Pre-feasibility Study into Measures to improve the Management of the Lower Orange River and to provide for future developments along the Border between Namibia and South Africa

INCEPTION REPORT : DRAFT

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INCEPTION REPORT

1 INTRODUCTION

1.1 INTRODUCTORY REMARKS

The Orange River basin is one of the largest river basins south of the Zambezi with a catchment area of approximately 1 million km^2. The Orange River originates in the Lesotho Highlands and flows in a westerly direction approximately 2 200 km to the west coast where the river discharges into the Atlantic Ocean (see **Figure 1.1**).

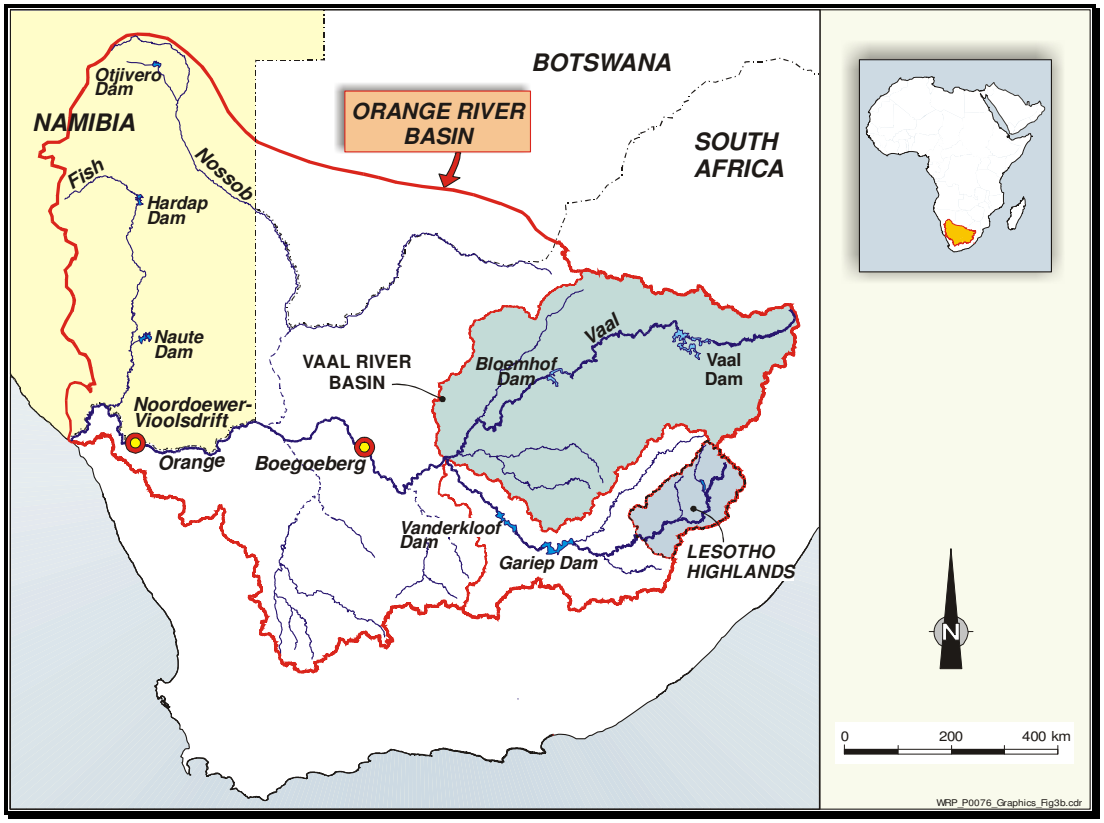

Figure 1.1: Orange River Basin.

It has been estimated that the natural runoff of the Orange River basin is in the order of 11 300 million m^3/a of which approximately 4 000 million m^3/a originates in the Lesotho Highlands and approximately 800 million m^3/a from the contributing catchment downstream of the Orange/Vaal confluence. The remaining 6 500 million m^3/a originates from the areas contributing to the Vaal, Caledon, Kraai and Middle Orange rivers (see **Figure 1.2**). Much of the runoff originating from the Orange River downstream of the Orange/Vaal confluence is highly erratic and cannot be relied

upon to support the various downstream demands unless further storage is provided.

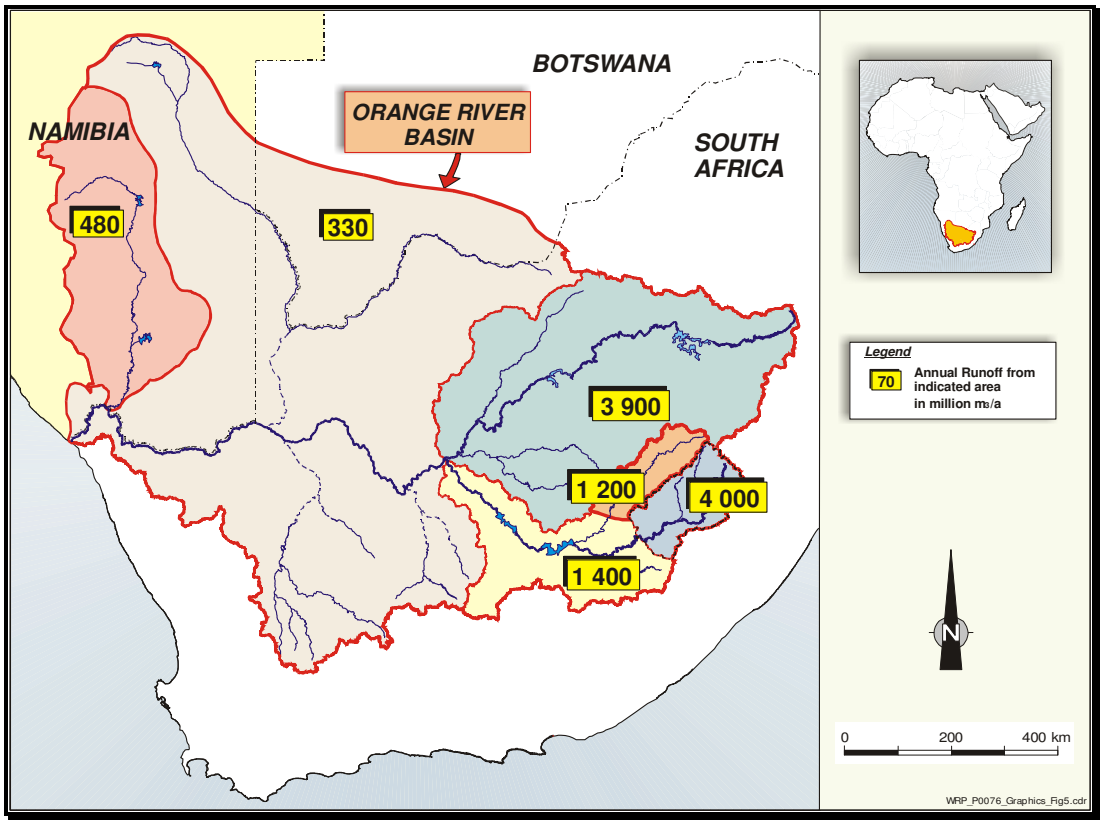

Figure 1.2: Approximate Water Balance for Natural Runoff in the Orange River Basin.

The portion of runoff originating from the Fish River in Namibia could theoretically be used to support some of the downstream demands, particularly the environmental demands at the river mouth. To date, however, the contributions from the Fish River have not been utilised due to the distance from the last upstream storage structure (Vanderkloof Dam) and the fact that the releases from the dam must be made two or three weeks in advance of the water reaching the river mouth. As such, the water required at the river mouth has normally been released prior to any contributions from the Fish River reaching the Orange River. This is only one of the many issues concerning the efficient utilisation of the Orange River resources that will be considered during the proposed study.

It should be noted that the figures indicated in **Figure 1.2** are approximate values which highlight the variable and uneven distribution of runoff from east to west in the Orange River basin. They refer to the natural runoff which would have occurred had there been no developments in the catchment. The actual runoff reaching the river mouth is considerably less than the natural values and has been estimated to be in the order of half the natural value. The explanation for the

difference is due mainly to the extensive water utilisation in the Vaal River basin most of which is for domestic and industrial purposes. Large volumes of water are also used to support the extensive irrigation and some mining demands occurring along the Orange River downstream of the Orange/Vaal confluence (see **Figure 1.3**) as well as some irrigation in the Eastern Cape supplied through the Orange/Fish Canal. In addition to the water demands mentioned above, evaporation losses from the Orange River and the associated riparian vegetation account for between 500 million m^3/a and 1 000 million m^3/a depending upon the flow of water (and consequently the surface area) in the river.

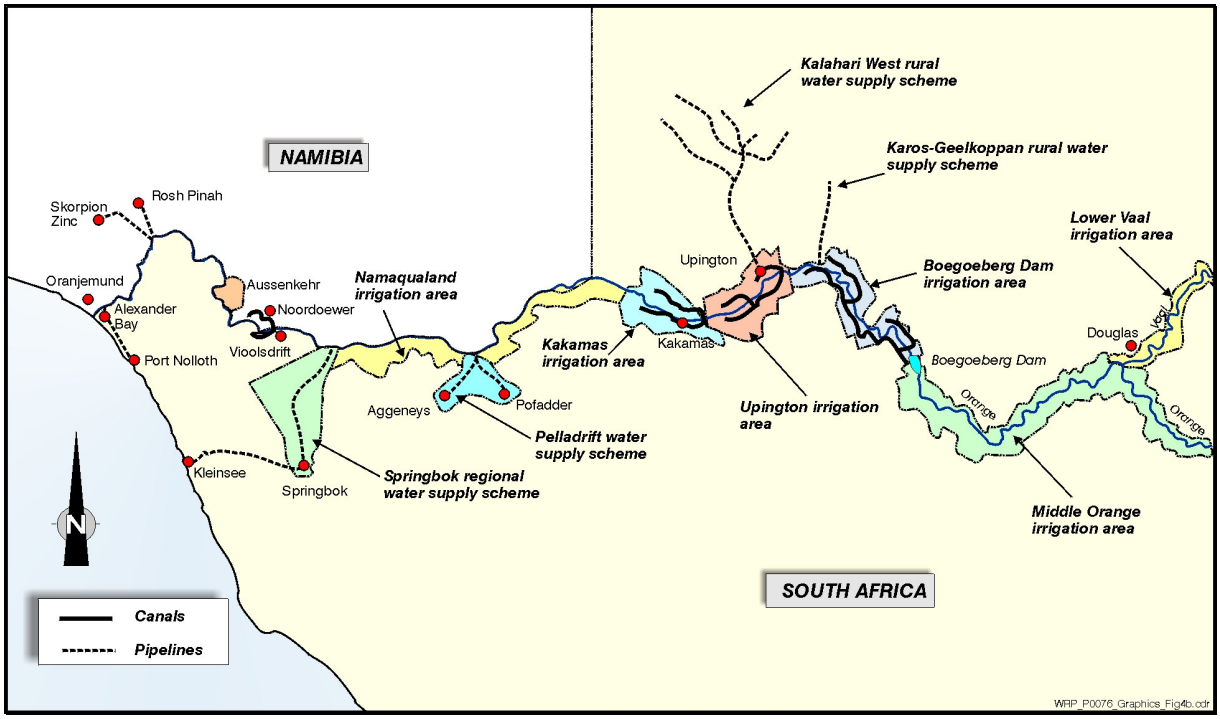

Figure 1.3: Major Water Demands along the Lower Orange River.

Several new potential developments have been identified both in Namibia and South Africa which may result in greater water demands from the Lower Orange River in future. In Namibia such developments include the Haib copper mine, Skorpion lead and zinc mine, the Kudu gas fired power station at Oranjemund and several irrigation projects for communal and commercial irrigation along the northern riverbank. Similar potential also exists on the South African side of the river with particular need to develop irrigation for previously disadvantaged farmers.

1.2 PROJECT OBJECTIVES

Since the lower 600 km of the Orange River forms the border between South Africa and Namibia, any measures to improve the management of the lower Orange River will benefit both countries. It is therefore important that any future projects in this regard be undertaken jointly by the two

countries with due consideration of the equitable and reasonable requirements of the other basin states.

In view of the existing and possible future developments which will influence the availability of water in the Orange River, this project has been commissioned and will be managed and financed jointly by South Africa and Namibia. The main purpose of this project is to investigate and make recommendations to improve the management of the Lower Orange River through reduced wastage and more efficient utilisation of the available resources. To this end, both supply management and water conservation measures will be investigated in a transparent and integrated manner from which the most practical and sustainable measures to achieve the project objectives will be formulated and proposed by the Project Team. In this regard the strategic objectives for the countries have been defined as follows:

- Regional economic development;
- Poverty alleviation;
- Job Creation;
- Protection of the environment;
- Water Resources Management aligned with Policies of the Governments;
- Assuring water supply to downstream users (of particular importance to the Namibian Government).

This Inception Report for the Pre-feasibility Study into Measures to improve the Management of the Lower Orange River and to provide for future developments along the border between Namibia and South Africa, is submitted by the Lower Orange River (LOR) Consultants, a consortium comprising Burmeister and Partners and Windhoek Consulting Engineers of Namibia, together with WRP (Pty) Ltd and Ninham Shand (Pty) Ltd of South Africa.

2 BACKGROUND TO THE PROJECT

2.1 GENERAL

Several important studies have been undertaken to investigate various aspects of the water resources of the Orange River by both South Africa and Namibia. While there has often been involvement of both parties on the different projects, the projects themselves have always been funded and directed by only one party. To date there have been no projects undertaken jointly by South Africa and Namibia.

In light of the major developments along the Orange River both inside South Africa and more recently in Lesotho, the water resources in the Orange River basin have been harnessed to a significant extent. The flow reaching the Lower Orange River is now controlled to a large degree by releases from Vanderkloof Dam which in turn is supported from Gariep Dam – the two largest storage reservoirs in South Africa. The new Katse Dam and soon to be commissioned Mohale Dam, will influence the flow of water into Gariep and Vanderkloof Dams which in turn will have an influence on water availability in the Lower Orange. In addition, Vaal, Bloemhof and several other smaller dams control the flow of water in the Vaal River upstream of its confluence with the Orange.

The controlled releases from the major storage reservoirs has improved the reliability of supply to water users along the Lower Orange River in South Africa and Namibia with the result that the river no longer experiences periods of zero flow. Various studies have been undertaken by the Sout\h African DWAF which indicate that the resources available in the Orange River Basin are sufficient to support all existing and anticipated future water demands. Information obtained from Namibia with regard to the Namibian demands for water from the Orange River were used in the South African studies. While the information and results from these studies is generally accepted by the Namibian Department of Water Affairs it has yet to be verified using their own personnel and specialist advisors.

Namibia is technically the most downstream riparian user of Orange River Water and all existing storage structures on the Orange River are located almost 1000 km upstream inside South Africa and now also Lesotho. This situation is understandably of concern to Namibia which has expressed a wish to secure an equitable and reasonable share of Orange River water on a more viable and permanent basis. To this end, Namibia has indicated that it would like to establish a new dam on the lower Orange River. Such a dam from the Namibian perspective would provide a storage facility that would become part of the Orange River system and would provide a secure

source of water for the long term water requirements along its southern border – estimated to be in the order of 207 million m^3/a. Any new dam would be a multipurpose facility to provide water for different users and to facilitate better and more efficient use of the Orange River water as a whole.

Namibia and South Africa previously investigated their anticipated water requirements from the lower 600 km reach of the Orange River which forms the common border between the two countries through two independent studies. The combined study described in this Inception Report will provide an integrated approach by both Namibia and South Africa towards the assessment, utilization, planning and management of water in this common reach of the Orange River. The combined study will take account of future water requirements in the Orange River basin, flow contributions from the Fish River in Namibia as well as the environmental water requirements of the river and its mouth.

Opportunities for water conservation and demand management will be investigated and evaluated as well as options for the potential development of a dam in the vicinity of Boegoeberg, wholly within South Africa, as well as a dam on the SA/Namibian border in the vicinity of Vioolsdrift/Noordoewer. A dam is normally seen as a supply orientated development option and is often criticised in this regard particularly by the environmental lobby. As mentioned previously, however, the main purpose of a dam on the Lower Orange River would be to re-regulate river releases from Vanderkloof Dam and intercept any additional releases which are not utilised by the upstream irrigators. In this manner a dam on the Lower Orange River can be considered as a water conservation measure as well as providing additional yield through the interception of floods and any isolated runoff occurring from the intermediate catchment.

The key technical aspects of the study are therefore as follows:

- Assessment and/or confirmation of present and future water requirements and reliability requirements.
- Demonstration of the opportunities for water conservation and demand management and potential benefits thereof.
- Review of the South African hydrological data base by Namibian consultants as well as the reassessment of the Fish River hydrology which will then be incorporated into an agreed hydrological data base.
- Selection of upstream development scenarios in the Orange River catchment (including the Vaal River System) for assessing the future water balance.

- Assessing the yields of a possible dam at Boegoeberg or Vioolsdrift, taking account of contributions from the Fish River.
- Assessment of the social and environmental impacts of all management options, including dams, and potential mitigation measures.
- Reliable assessment of dam development costs and yields.
- Determination of the Unit References Values of water from dams and the savings from water conservation measures as well as the possible allocation of costs and financial analyses.
- Consolidating the information on each management option, or combination of options, into management reports so that decision makers from Namibia and South Africa can make informed decisions.
- Ensuring that the public and particularly the stakeholders who would be directly affected are informed and that their opinions are recorded and taken into account.

2.2 STUDY PROCEDURE

In order to undertake the study, it has been split into a number of main tasks each of which is listed below and discussed in further detail in **Section 3**. It should be noted that the task numbering has been altered from that used in the project proposal. It was decided to group certain tasks and/or sub-tasks together so that the same task or sub task leader can assume responsibility for more than one related item where it is considered to be efficient and effective. In this manner the management of the tasks has been streamlined to a certain degree. No items in the original proposal have been eliminated and the changes made are summarised in **Table 2.1**.

Table 2.1: Task Description Changes Made to the Original Proposal

Original Proposal	Inception Report
Task 1: Inception Report	Remains **Task 1**
Task 2: Water Requirements	Becomes **Task 2.1** of the same name
Task 4: Water Conservation	Becomes **Task 2.2** of the same name
Task 3: Water Resources Yield Analysis	Remains **Task 3**
Task 5: Dam Development Options	Becomes **Task 4.1**. of the same name In addition, the previous **Task 5d** (Preliminary Designs) has been combined with **Task 5e** (Preliminary Cost Estimates) to form the new **Task 4.1d** (Preliminary Designs and Cost Estimates).
Task 6: Financial Analyses	Renamed to **Task 4.2** (Economic Analyses)
Task 10: Water Sharing, Cost Sharing and Dam Operation	Becomes **Task 4.3** of the same name
Task 7: Environmental Impacts	**Task 7**: and **Task 8b** have been combined to form the new **Task 5.1**(Environmental Impacts) which now also includes the Archaeological Issues.
Task 8: Social and Archaeological Issues	**Task 8a** (Social Issues) has been renumbered to **Task 5.2** of the same name.
Task 9: Public Consultation	Becomes **Task 5.3** of the same name
Task 11: Recommendations for Feasibility Study	Becomes **Task 6.1** of the same name
Task 12: Main Report	Becomes **Task 6.2** of the same name
Task 13: Project Management	Becomes **Task 7** of the same name
Task 14: Review of Reports	Has been adsorbed into the appropriate tasks and sub tasks since no budget was allocated to this item in the original proposal which may have led to some confusion.
Task 15: Additional Items	Additional items selected by the Client will be listed under **Task 8**. (Appendix A)

The revised task list and associated reports are provided in **Table 2.2**.

Table 2.2: Revised Task Descriptions (see Figure 2.1 for linkages)

Task 1 Inception Report		
Task 2 Water Requirements and Water Conservation		
Task 2.1: Water Requirements		
Task 2.1a	Irrigation Demands	Report 2
Task 2.1b	Urban/domestic and Industrial/mining Demands	Report 2
Task 2.1c	Social and Environmental Demands	Report 2
Task 2.1d	Assurance of Supply	Report 3
Task 2.2: Water Conservation		
Task 2.2a	Riverine and Operating Losses	Report 3
Task 2.2b	Irrigation Efficiency	Report 2
Task 2.2c	Urban/domestic and Industrial/mining	Report 2
Task 3 Water Resources and Yield Analyses		
Task 3.1	Hydrology	Report 3
Task 3.2	Water Quality	Report 3
Task 3.3	Sedimentation	Report 4
Task 3.4	Yield Analyses and System Modelling	Report 3
Task 3.5	Hydro Power	Report 4
Task 4 Dam Development Options		
Task 4.1: General		
Task 4.1a	Identification	Report 4
Task 4.1b	Pre-Screening	Report 4
Task 4.1c	Design and Cost Criteria	Report 4
Task 4.1d	Preliminary Designs and Cost Estimates	Report 4
Task 4.1e	Operating Rules	Report 3
Task 4.1f	Areas Inundated	Report 4
Task 4.1g	Border Demarcation	Report 4
Task 4.2: Economic Analysis		
Task 4.2a	Water Conservation	Report 6
Task 4.2b	Dam Development Options	Report 6
Task 4.3: Water Sharing, Cost and Dam Operations		Report 6
Task 5 Environmental and Social Issues		
Task 5.1	Environmental Impacts (including Archaeological)	Report 5
Task 5.2	Social Impacts	Report 5
Task 5.3	Public Consultation	Report 5
Task 6 Feasibility Study and Main Report		
Task 6.1: Feasibility Study:		
Task 6.1a	Recommendations	Report 7
Task 6.1b	Terms of Reference	Report 7
Task 6.1c	Funding Options	Report 6
Task 6.2: Main Report		Report 8
Task 7 Project Management		
Task 8 Additional Tasks		

It can be seen from **Table 2.2** that the number of main tasks has been reduced from the original 15 to 7. This greatly simplifies the management of the tasks since there will now be a maximum of 7 task leaders compared to the original 15. The overall management responsibility has also been changed to enable Mr F Becker from Namibia to manage Tasks 2,3, and 6 while Mr Vogel from South Africa will manage Tasks 1, 4 and 5 as shown in **Table 2.3**. In this manner it has been possible to improve the overall project management of the project and at the same time enable a more equitable split of work and responsibility between the two countries. Further details of the revised management structure are provided in **Section 4**. The linkages between the various tasks are indicated in **Figure 2.1**.

Table 2.3: Tasks Allocations to Deputy Project Managers

Task Description	Task Leader Responsible For Task	Deputy Project Manager Responsible for Task
Task 1: Inception Report	R Mckenzie	F Vogel
Task 2: Water Requirements and Conservation	C Muir	F Becker
Task 3: Water Resources and Hydrology	P van Rooyen	F Becker
Task 4: Dam Development Options, Economics and Water Sharing	F Vogel	F Vogel
Task 5: Environmental, Social and Public Involvement	M Luger	F Vogel
Task 6: Feasibility Study and Main Report	F Becker	F Becker
Task 7: Overall Project Management	A Tanner	
Task 8: Additional Tasks	To Be Confirmed	To Be Confirmed

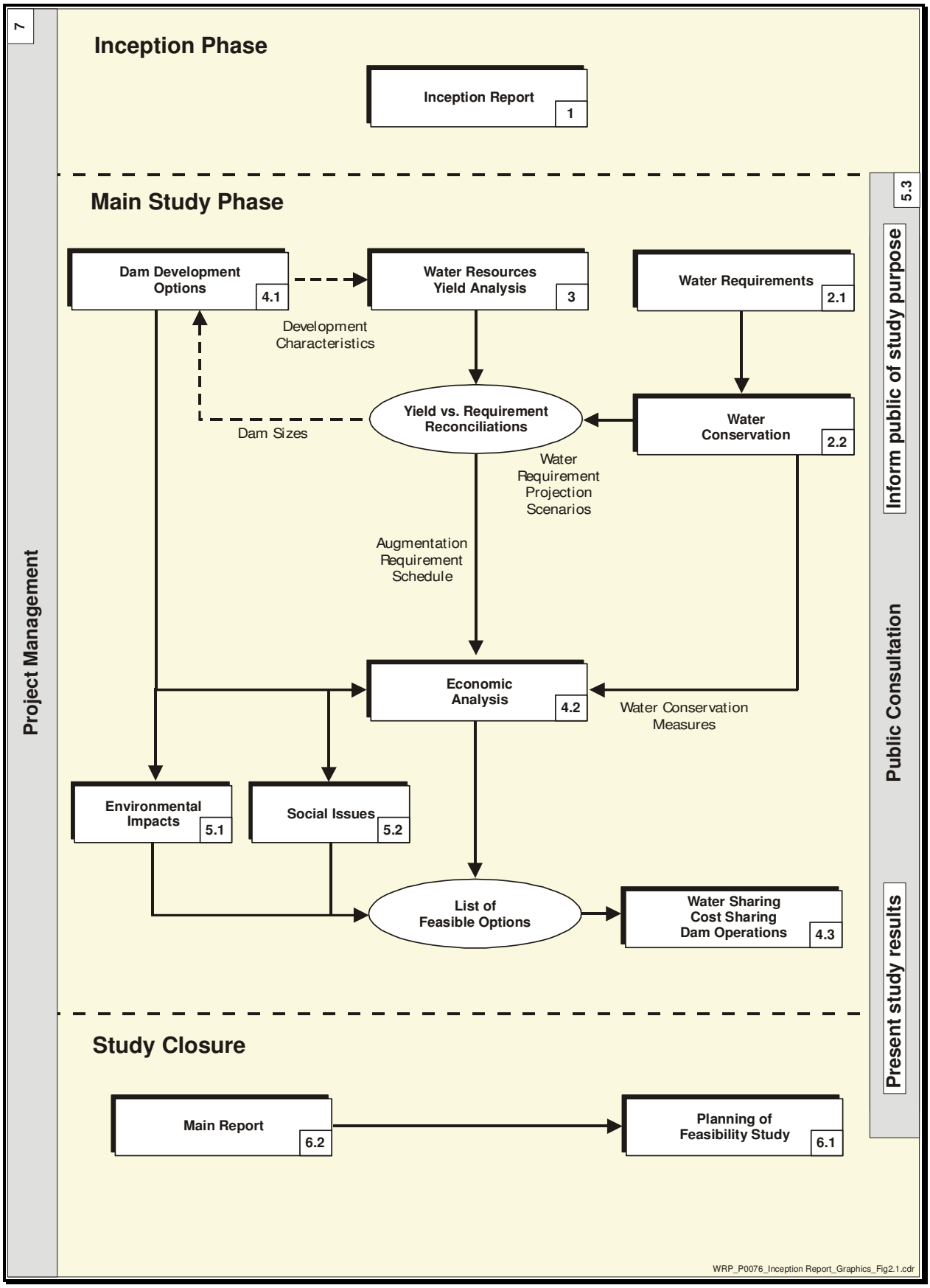

Figure 2.1 : Task Linkages

3 APPROACH AND METHODOLOGY

3.1 GENERAL OVERVIEW

The proposed study basically involves evaluating the water resources of the Orange River basin as well as the current and likely future demands and recommending future management actions. The evaluation will rely heavily on work undertaken previously by South Africa and Namibia which will be adjusted and/or updated where appropriate. The possibility of improving the utilisation of water through better system operation as well as water demand management practices will be investigated in parallel with the investigation of possible new development options. An economic analysis will be undertaken to establish the most appropriate management actions to ensure that the available water resources are being used efficiently. The study recommendations will be based on sound engineering, financial, social, and environmental considerations.

These apparently clear and straightforward objectives are complicated by numerous important issues with the result that the study has been split into a number of individual tasks (see **Section 2.2**), some of which include one or more sub-tasks. The various task descriptions provided in the Project Proposal have been renumbered where necessary to streamline the project methodology and to simplify the project management. The tasks and sub-tasks are documented in the remainder of **Section 3**.

3.2 TASK 1: INCEPTION REPORT

Methodology: The Inception Report is based on the project proposal which has been expanded and modified where required to provide a clear and concise description of how the project will be undertaken and what deliverables will be produced etc. In effect it is an expanded Project Proposal with detailed financial information and an updated project programme.

Deliverables: Inception Report

3.3 TASK 2: WATER REQUIREMENTS AND WATER CONSERVATION

3.3.1 Task 2.1: Water Requirements - General

It is important that the component of the study dealing with water requirements is carried out jointly with the study on water conservation and for this reason the two issues have been combined into one task. The proposals for water conservation and their probability of success will be included in the various scenarios produced for the long-term water demand forecasts.

The previously predicted demands will be compared to the real water consumptions where available and this information will be used to revise the previous projections of future demand if necessary. Demand projections will be made at 5-year intervals to 2025 for low, probable and high demand scenarios.

For the purpose of the study Task 2 has been split into the following sub-tasks:

- **Task 2.1: Water Requirements**
    - **Task 2.1a:** Irrigation Demands
    - **Task 2.1b:** Urban/domestic and Industrial/mining Demands
    - **Task 2.1c:** Social and Environmental Demands
    - **Task 2.1d:** Assurance of Supply
- **Task 2.2: Water Conservation**
    - **Task 2.2a:** Riverine and Operating Losses
    - **Task 2.2b:** Irrigation Efficiency
    - **Task 2.2c:** Urban/domestic and Industrial/mining

3.3.2 Task 2.1a: Irrigation Demands

Methodology: The Namibian Study on the Identification and Prioritization of Irrigation Development, the Orange River Replanning Study (ORRS) and the Northern Cape Situation Assessment will be reviewed and relevant information extracted. The 1 in 10 000 photo maps of the border along the Orange River based on the September 1992 aerial photography will also be used as well as satellite imagery previously purchased by the Department of Water Affairs and Forestry (DWAF) for the ORRS.

The information contained in the various reports on irrigated areas, quotas and application rates will be reviewed and compared with the following:

- information from the Department of Water Affairs' (DWA's) and DWAF's regional offices on Water User Associations (WUAs) (Irrigation Boards) including historical growth patterns.
- the SAPWAT and/or CROPWAT model results taking crop types, climatological factors etc., into account.
- selected sampling undertaken during the site visit and workshop discussions described below.

A site visit will be arranged to selected existing and identified potential irrigation developments for the purpose of:

- Assessing high water table drainage and salt leaching requirements.
- Verifying existing crop types and cropping patterns.
- Reviewing the suitability of soil types in areas for potential developments.
- Evaluating water demand management issues e.g. bulk distribution losses; inefficiencies in water use/application; the availability of technical support etc.

In addition two regional workshops will be held with irrigators to review

- The SAPWAT/CROPWAT results and quota information;
- Optimal crop selection;
- Potential future developments;
- Opportunities for water demand management.

Future water demands at 5 yearly intervals until 2025 will be based on:

- A study of historical growth trends.
- A review of regional economic data.
- A brief review of market trends.

Deliverables : Chapter in Report on Water Requirements and Conservation.

3.3.3 Task 2.1b: Urban/Domestic and Industrial/Mining Demands

Methodology: Urban/domestic usage will be based on information contained in previous reports on the Orange River, and the Northern Cape Provincial Water Resources Situation Assessments and water demand projections by DWAF and on available Water Services Development Plans and Integrated Development Plans.

Industrial/Mining demands will as far as possible be sourced directly from government departments and from the mines and industries themselves. A number of mines exist in the area and certain possible mining ventures have been identified. An evaluation will be made of the water consumption on the existing mines. The future expansion of the mines as well as plans to re-use water will be discussed with the mine management. If possible, estimates of the timing of the

development and ultimate closure of major industries and mines will be obtained.

Deliverables: The key deliverable from this task will be a Chapter in the Report on Water Demands and Conservation outlining all of the water requirement information to be used in the study.

3.3.4 Task 2.1c: Social/Environmental Demands

Methodology: Although the previous studies undertaken on the IFR and EFR of the Orange River Estuary exceeded the requirements for a planning estimate, it is proposed to compare these assessments with the Planning Estimate, the latter of which will be evaluated as part of the study. If it is found that the Reserve requirements based on the Planning Estimate agree well with the requirements obtained from the previous studies it will not be necessary to undertake any further detailed analyses as proposed under Task 8.3 of the Additional Tasks. The ecological component of the Reserve will exceed the Basic Human Needs Reserve Requirement. This will be addressed under the "Urban Water Demands" component of the study.

Deliverables: Comparison of IFR assessments and Basic Human Needs Requirements.

3.3.5 Task 2.1d: Assurance of Supply

Methodology: It is proposed that the assurance of supply requirements and reliability classification definitions for the different users be determined with input from water users in the study area. Assumptions in this regard were made as part of the ORRS, however, these need to be updated and revised particularly with respect to the Namibian water users. Specific questions will be prepared as part of the questionnaires to the users regarding their reliability requirements. The reply information will be assessed and proposed classification definitions will be compiled for each water use sector.

Deliverables: This information will be presented to the Study Management Committee (SMC) for consideration and approval and documented in the "Water Requirements" Report.

3.3.6 Task 2.2: Water Conservation - General

The increased recognition of water scarcity and the value of water have led to the acceptance of water conservation, which includes water demand management, as a national strategy and priority of both countries. Until recently, the general approach to water management in Southern Africa

was to develop new water projects and transfer schemes in order to stay ahead of the ever increasing requirements of the growing population and improved living standards. The new approach in both Namibia and South Africa is based on integrated resource management (IRM) where Water Conservation (WC) including Water Demand Management (WDM) play a major role.

If WDM is implemented in an integrated way as part of IRM, experience in the region, as well as international literature indicate major reductions in water demand as well as lower annual growth in future demand. WDM can:

- reduce water demand by 30% - 50% in the urban sector with no deterioration in life-style;
- reduce water demand by 30% - 50% in some irrigation areas with no lowering of production;
- significantly reduce capital requirements
- enhance the development and adoption of new technologies
- lead to financially and environmentally sustainable water systems
- expand the coverage of available development funds
- help meet the water needs of a growing population, and
- contribute to equity in pricing and access to water

Methodology: A systems approach (evaluating the whole catchment area from available reports and literature) will be followed with special emphasis on water consumption within the common border area. Within the study area it is known that there is room for improvement in irrigation use (biggest consumer), urban consumption and reuse of water within the mining industry. The approach will be to evaluate water use efficiency within the three main user groups.

Deliverables: Reasonable targets for water savings will be determined, the potential to achieve such savings will be assessed and the benefits will be calculated according to total least cost planning principles.

The water conservation task will be split into three sub-tasks for analysis purposes.

3.3.7 Task 2.2a: Riverine and Operating Losses

Methodology: There are two forms of riverine losses which have a significant influence on the water resources namely the evaporative river losses as well as the operational losses. The evaporative losses are relatively simple and straightforward to model and all work undertaken in

this regard was completed by members of the study team for the South African Water Research Commission (WRC). Three projects have been undertaken by members of the Study Team over a period of 5 years and several reports have been published. It is proposed to make use of the information documented in the WRC reports for estimating the evaporative losses from the Orange River and associated riparian vegetation. In this regard the evaporation losses can be estimated from the water surface area and the net A-pan evaporation. While this is a relatively simple and crude approach, the results obtained are considered to be realistic and well within the error margins required for the water resource assessment.

With regards to the operational losses, considerable investigation was undertaken as part of the ORRS. The operational losses take the form of excess releases from Vanderkloof Dam which are often made to prevent water shortages occurring towards the lower reaches of the Orange River and also due to the fact that accurate control of the outlet releases is difficult at low flows. For example, it is often not possible to release exactly 10 m^3/s and in practice it may be found that 11 m^3/s or even 12 m^3/s are released. In addition, any contributions to the Orange River from isolated storm events and in particular from the Fish River are not utilised since the water required for downstream demands (including the environmental demands) has already been released from Vanderkloof Dam and cannot be captured before it spills into the Orange River Estuary.

The operating losses were estimated in previous studies by using a simple spreadsheet in which the various over-releases were identified and quantified based on information supplied by the operational staff at Vanderkloof Dam. Through the use of this approach, it is possible to derive an estimate of the operational losses using a simple and empirical basis. While a more detailed analysis can be undertaken using hydraulic modelling, this was not included in the original project proposal since it represents a more costly and time consuming analysis which was not requested in the Terms of Reference. Details of the additional work and associated costs required to carry out the hydraulic modelling exercise are provided under **Task 8.2** of **Appendix A.**

If there is some form of storage towards the lower reaches of the Orange River, all excess releases can be captured and the contribution from the Fish River can then be utilised to support the estuary requirements as well as users along the last two hundred kilometres of the Orange River. In this regard, storage along the Lower Orange River can be viewed as a conservation measure and not necessarily as a water supply development option.

Deliverables: Estimates of the operational losses will be derived at a desk-top level making use of historical release data as well as the work undertaken during the ORRS .

3.3.8 Task 2.2b: Irrigation Efficiency

Methodology : DWAF's Water Conservation and Demand Management (WCDM) Strategy for the Agricultural Sector will serve as the guide for assessing opportunities for water conservation by irrigators. Members of the team will visit existing and potential irrigation areas in order to assess current usage and management procedures on a limited sample basis with a view to assessing the opportunities for WCDM. Irrigation is by far the biggest consumer in the lower Orange River and in this regard, technical, managerial, institutional and agronomic aspects will be investigated within the constraints of the budget. The following key items will be addressed:

- Irrigation practices and modes of application (drip, sprinkler etc);
- Crop types and alternative crops as well as optimal application depths (growing more food with less water)
- Derivation of crop water requirements;
- Drainage and leaching requirements;
- Irrigation scheduling;
- Measurement of irrigation water use;
- Pricing of irrigation water use, tariffs and institutional arrangements;
- Lining, operation and maintenance of canals.

Deliverables: The investigation will provide preliminary benchmarks for irrigation use and management with a view to establishing the potential savings that can be achieved through the implementation of WCDM.

3.3.9 Task 2.2c: Efficiency of Urban/Domestic and Industrial/Mining Users

Methodology : In view of the fact that the urban and industrial/mining demands represent such a small portion of the overall water use in the Orange River System, it is proposed to undertake an assessment of the water use efficiency in these sectors at a desk-top level of detail. In the original proposal it was suggested that a more detailed audit could be undertaken if it was considered

worthwhile by the Client. Following further discussions, it was agreed that the desktop level study would be sufficient for the purpose of this Pre-feasibility Study.

Current and future urban, domestic, industrial and mining water demands will be quantified using existing information contained in the South African and Namibian Reports. This will mainly focus on the sectors with large existing and possible future water requirements.

It is proposed that the standard South African leakage benchmarking forms will be used to provide a rough indication of the extent of wastage in the various urban centres and the scope for savings. The forms may be modified if necessary to incorporate any additional requirements for the Namibian users. The centres to be considered will include, Upington, Springbok, Mariental, Oranjemund etc. In addition to the basic urban water audits, it is proposed to send industrial audit forms to the large mines and to try and establish the level of wastage in the mines. Again, this will be a desktop review and will not involve site visits or detailed process investigation.

Deliverables: The benchmarking and auditing forms will be processed and a report produced.

3.3.10 Task 2.3: Vioolsdrift and Noordoewer: Joint Irrigation Scheme

At the request of the Client, an additional item was added to investigate the viability of the joint irrigation scheme at Vioolsdrift/Noordoewer. Full details of this additional item are provided under Task 8.8 in **Appendix A.** Since the Client has agreed to the inclusion of this task and the associated budget, it has been included under the main study as Task 2.3 and the budget for Task 2 has been increased by N$ 198 602 which includes N$ 14 000 for disbursements and

N$ 4 000 for communication but excludes VAT.

3.4 TASK 3: WATER RESOURCES AND YIELD ANALYSES

3.4.1 Task 3.1: Hydrology

Methodology: It is anticipated that very little additional hydrological analysis will be required as part of the new study. The hydrological data sets developed previously during the Orange River System Analysis (ORSA) and ORRS will be used as the basis on which an agreed hydrological database will be developed. Adjustments to certain data sets will be made where necessary if new and more reliable information is available which is not reflected in the current data sets.

The one catchment area which required further investigation was the Fish River catchment in Namibia. In the original South African studies, the hydrology in the Fish River catchment was developed at a very cursory level of detail. In view of the joint involvement of Namibia on this project, it was agreed that further work on the Fish River hydrology would be undertaken as an additional item, details of which are provided in **Appendix A.** The budget for the hydrology task (Task 3.1) was increased by N$ 63 000 to cover the additional work as specified in the task description. It should be noted that no further rainfall/runoff modelling is included in the study in line with the directives in **Section 7.3.1** of the TOR.

In addition, it is anticipated that time will be required by the Namibian component of the team to familiarise themselves with the hydrological data sets used previously on the ORRS and to ensure that they are comfortable that the various data sets are both realistic and reliable. This process will involve members from the original ORRS working closely with the Namibian counterparts to explain and set up a full hydrological data base of the system in Namibia as well as in South Africa.

Deliverables: The hydrology task will therefore involve the following:

- Review of previous hydrological data sets;
- Development of new hydrological data for the Fish River catchment;
- Replace hydrological data sets in the current Orange River data sets with the latest available data sets for Fish River catchment;
- Develop new parameter (PARAM.DAT) file for use in the system analysis task;
- Verification of stochastic flow sequences using GENTST Model
- Recommendations on river losses to be used in the system analysis task.

3.4.2 Task 3.2: Water Quality

Methodology: Recent flow and water quality data will be assembled and compared with historical data to check that no long term departures have arisen since the WRPM water quality model was calibrated and run as part of the ORRS. Salinity modelling is discussed in detail under **Task 3.4**.

Deliverables: Confirmation that the existing salinity model calibration is valid.

3.4.3 Task 3.3: Sedimentation

Methodology: The previous analysis of sediment yields undertaken during the ORRS will be reviewed taking account of all available information on sediment yields in South Africa and Namibia. Cognisance will be taken of the potential trap efficiencies associated with both the upstream development scenarios selected and the capacities of the reservoir options to be investigated.

Deliverable: The analysis and results will be included in the report on the dam development options.

3.4.4 Task 3.4: Yield Analyses and System Modelling

Methodology: It is proposed that the Water Resource Yield Analysis will be undertaken in four phases as described in the following paragraphs. Phases 2 and 3 will be based on the updated historical hydrological flow sequences.

- Phase 1: Model configuration
- Phase 2: Determine the need and timing of proposed dam development with and without the influences of water conservation.
- Phase 3: Determine the supply capability of proposed dam developments.
- Phase 4: Selective stochastic analyses and salinity modelling scenarios.

Phase 1 will entail configuration of the network model data files for the purpose of this study. The latest configurations of both the WRYM and WRPM will be updated where necessary and verification analysis will be carried out to ensure all components are functioning correctly. For the purposes of yield analysis it is proposed to analyse the Vaal River and Orange River Systems separately. In each case to be considered the Vaal River System will be analysed first and the appropriate outflow from the Vaal River will be included into the Orange River network through time series files. The WRPM configuration of the Vaal River System will be used for this purpose because it already includes all the required return flow and water quality blending components, which are not present in the existing WRYM configurations.

At this stage it is expected that the following aspects will need to be updated:

- Updated hydrology for the Fish River will be included in the Lower Orange River System configuration if available.
- The modeling structures required to simulate the In-stream Flow Requirements will be configured from the data defined in the Water Requirements Task.
- Appropriate assumptions will be made with respect to the consumptive and operating losses along the Vaal River downstream of Vaalharts Weir. The operating losses along this stretch of river are available for use downstream of the Douglas Weir and influence the need for transfer from the Orange River to support the irrigation demand supplied from the weir.
- Revised riverine, operating and evaporative losses from the Water Requirement task will be included in the model.

A hypothetical dam site on the Fish River will be included in the model to investigate if a dam would be feasible from a hydrological perspective. If it proves to be positive, further actions will be taken under Task 4.1.

During this first phase, the Namibian consultants will be exposed to the configuration of the models and operating rules of the system. It is proposed that some of the analysis be undertaken in Namibia. This will ensure that full understanding and acceptance of the adopted methodology and assumptions are achieved by both the Namibian and South African representatives responsible for managing the study.

Phase 2 will involve analysing the supply capability of the Lower Orange River based on the different upstream scenarios to be defined during the Inception Phase of the study. This will be undertaken assuming that no measures to improve the management are implemented in the study area. The yield results from this phase will be compared with the projected water requirements (from the Water Requirements Task) to determine the need and timing of proposed management measures.

It is envisaged that analyses will be undertaken for three future demand levels, say 2005, 2015 and 2025. For the purpose of budgeting it is assumed that two upstream development scenarios will be analysed, resulting in six options to be analysed in total. If it is found that the Vaal River System has excess supply capability over the medium term (2005 to 2015), the possibility of

releasing water from the upstream systems could be considered for the purpose of postponing the need for development in the Lower Orange River. It is proposed that historical analyses be undertaken for this phase using the WRYM.

Once the need for measures to improve management in the study area and the preliminary timings have been established (**Phase 2**) further system analysis will be undertaken, as part of **Phase 3**, to assess the supply capability of the system with the proposed measures in place. These yield results will be fed into the economic study where cost/benefit and URV calculations will be made for each measure in order to determine which are feasible.

Since the analysis in the above described phases will be based on historical analysis only, it is proposed that stochastic yield analyses be undertaken for the most promising option as part of **Phase 4** of this task.

Salinity modeling will also be undertaken as part of **Phase 4**, using the already calibrated WRPM. It is envisaged that this simulation will be carried out using historical analysis for three development levels, 2005, 2015 and 2025. The outcome of the salinity modeling exercise will give an indication of the changes that can be expected in the salinity levels of the Lower Orange River System for the different measures and scenarios.

Deliverables: Yield results for assessing the benefits of downstream development options and a chapter of the "Hydrology, Water Quality and System Analysis" Report.

3.4.5 Task 3.5: Hydropower Analyses

Methodology: The viability of hydropower will depend on the timing and magnitude of required irrigation and environmental releases from the dams. Two upstream development scenarios will be utilized together with the naturalized historical flow sequences to generate river inflow records using the WRYM. This information will be utilised to determine releases, storages and spills so as to assess the hydropower potential, with particular attention to low flow sequences.

These analyses will enable optional generating capacities to be selected. Capital costs including transmission costs and also operating costs will be determined. Running costs will include personnel, operation and maintenance costs, as well as provision for transmission losses. Income will be based on the sale of power to the local urban areas, mines and industries, and also to the

national grids. Thereafter a cost benefit analysis on a present value basis will be undertaken to compare income and costs. The vulnerability of local users to a plant shutdown, and the need to purchase power from the national grids, will also be assessed.

Deliverables: The description of the hydropower analysis will be included in the Dam Development Options report.

3.5 TASK 4: DAM DEVELOPMENT OPTIONS

3.5.1 Task 4.1: Dam Development Options - General

TOR "7.5.1 Identification of Possible Dam Sites" requires that dams in the vicinity of Vioolsdrift/Noordoewer or near Boegoeberg be considered, and also that previously identified options and any new options that may be identified be examined. Our proposed approach to the screening process is summarized below and described in more detail under the various tasks.

(a) All potential dam sites in the Fish and Oranger Rivers will be identified on the existing 1 in 50 000 maps. On the Orange River the 1 in 10 000 contour maps at Boegoeberg, and the 1 in 10 000 aerial photo maps west of 20° longitude as well as the aerial photos available elsewhere (see Identification of Possible Dam Sites" sub-task) will be utilised. In the case of the Fish River, aerial photos will be used.

(b) The Prescreening Task will aim to eliminate a number of these options utilising the existing mapping and aerial photos with a view to identifying the most favourable sites for the Preliminary Design Task.

(c) The Preliminary Design Task will entail more refined screening of the selected sites and will require the compilation of additional contour plans to a scale of 1 in 10 000 for the dam basins and 1 in 2 000 for the dam sites. This additional mapping will be utilized for more detailed site, dam type and height evaluation (See Preliminary Dam Design sub-task).

3.5.2 Task 4.1a: Identification of Dam Sites

Methodology: All options identified in the ORRS, in other studies, and any new options to the west of the Vaal confluence will be marked on the 1 in 50 000 topographical maps and on the available geological maps. Those situated between the 20° longitude and the mouth will also be marked on the existing 1 in 10 000 aerial photo maps that have been compiled from the 1 in 60 000 controlled black and white photography dated September 1992. Sites at Boegoeberg will be marked on the available 1 in 10 000 contour plans.

Deliverables: All potential sites on the Fish and Orange rivers will be marked on the 1 in 50 000 maps, on the geological maps, and also on the 1 in 10 000 photo maps where these are available as well as on aerial photos in other areas.

3.5.3 Task 4.1b: Pre-screening of development options

Prescreening factors to be considered in the study will include:

- Topography of site and basin;
- Potential social impacts;
- Potential environmental impacts;
- Contribution to the system yield;
- Proximity and location with respect to major demand centres and abstractions/distribution systems;
- Access roads;
- Considerations with regard to site establishment;
- Construction materials and borrow areas;
- Geological conditions;
- Seismic characteristics;
- Design floods and spillway arrangements;
- Likely sedimentation rates;
- The preferred type of dam;
- Flooding of existing or potential irrigation areas;
- Flooding of areas of archaeological importance;
- Possibility of hydro-power generation;
- River diversion during construction;
- Benefits for downstream users;
- Costs;
- Proximity to power lines;
- flooding of existing infrastructure and its relocation (including feasibility, costs and social impacts);
- Potential effects on water quality;

- International borders;
- Whether the proposed dam should be a small re-regulating dam or a large storage dam.

Methodology: All information on the options identified above will be reviewed. Capacity curves will be determined and areas of inundation for the range of dam sizes under consideration will be digitized and marked on the available contour plans if these are not already available.

Approximate dam cost versus height curves will be prepared based on very preliminary designs, taking account of topographical, geological, spillway and other engineering considerations. The sizes will be based on previous investigations and typical economic storage/MAR ratios. At Boegoeberg where both 1 in 50 000 and 1 in 10 000 contours are available, capacity curves and dam cost curves will be prepared for both sets of contours to gain a preliminary understanding of the likely reliability of estimates based only on the 1 in 50 000 contours.

Downstream of the 20° longitude on the Orange River the dams and basin contours digitized from the 1 in 50 000 mapping will be enlarged to a scale of 1 in 10 000 and superimposed on the 1 in 10 000 aerial photo maps to assist in identifying potential impacts. In other areas the extent of inundation will be approximately transferred from the 1 in 10 000 contour plans to the aerial photographs to facilitate the assessment of impacts. Prescreening will then take place against all the identified factors with a view to establishing a list of preferred options which should be given greater attention during a helicopter site visit.

In the case that the hydrological analysis in **Task 3.4** indicates that a dam on the Fish River may be feasible, further inputs will be required. These additional inputs, which have not been included in the budgets, will be necessary to bring the development options on the Fish River to a similar level as those already established on the Orange River.

It is envisaged that a helicopter trip will be arranged for selected team members (including dam, geological and environmental specialists) to view all the potential dam sites and reservoir basins to the west of the 20° longitude and to land at the most promising sites. Photographs and a video of key features will be taken. The helicopter trip may also extend to the confluence with the Vaal River or alternatively a fixed wing aircraft may be used and/or a ground visit.

Following the site visit the prescreening of options will be finalized, mainly taking account of engineering considerations but also the input provided by all specialists, the PWC and stakeholders. This process is likely to confirm the previous selection of sites and in this regard we have allowed for the further analysis of two development options under the Preliminary Dam Design Task.

Deliverables: The Prescreening Task must precede the Preliminary Dam Design Task. It is assumed that the prescreening process will result in two options which will be investigated in more detail. The selection process and information will be documented in the chapter on Dam Development Options.

3.5.4 Task 4.1c: Development of Design and Cost Criteria

Methodology: The design criteria utilised in the VAPS study will be reviewed and, if necessary, modified, and the cost criteria updated by utilising tender prices for Maguga and Mohale Dams and other recent DWAF projects, with appropriate allowance made for escalation. The respective levels of design detail for the prescreening designs based on 1 in 50 000 mapping and the more detailed preliminary designs based on 1 in 10 000 mapping will also be documented. This document will be produced prior to the prescreening of the dam development options.

***Deliverables*:** The information will be assembled as an Appendix to the report on Dam Development Options.

3.5.5 Task 4.1d: Preliminary Designs and Cost Estimates

Methodology: If the site in the vicinity of Vioolsdrift/Noordoewer is selected for preliminary design, then a DTM of the reach of river containing the potential dam sites and reservoir basins will be prepared from the 1 in 60 000 aerial photography of September 1992. This DTM would have vertical and horizontal accuracies of about 2 m. From this DTM, mapping to a scale of about 1 in 2 000, with 2 m contours, will be prepared for the potential dam sites, and to a scale of 1 in 10 000, with 5 m contours, for the basins. These contours will be superimposed on the 1 in 10 000 aerial photo maps (which have been rectified and geo-referenced) in order to produce contour ortho-photos. If the Boegoeberg site is selected the existing 1:10 000 mapping will be utilised. If sites in the Fish River basin are selected for preliminary design, there are likely to be significant additional costs in producing a DTM of the dam sites and basin. These costs have not been included in the Cost Proposal and would therefore represent an additional item if required.

The prescreening designs undertaken using the 1 in 50 000 mapping will be repeated using the 1 in 10 000 basin maps and 1 in 2 000 site maps where available. Capacity curves and cost curves will be compared (as already done at Boegoeberg during the prescreening process) in order to gain further confirmation that the utilization of the 1 in 50 000 mapping for prescreening did not favour or disadvantage any particular site.

Both sites will have been visited during the prescreening phase of this study. Additional visits to the two selected sites will be required for the assessment of:

- geological conditions;
- likely sources and availability of materials for concrete/embankment dams;
- spillway siting;
- outlet works siting;
- flood diversion arrangements;
- access.

If appropriate, alternative sites as well as alternative concrete/rollcrete and rockfill/earthfill embankment designs will be investigated, including for the latter, concrete faced rockfill, asphaltic concrete cores and clay cores. Alternative spillway designs will also be investigated with spillway capacities based on the SANCOLD Guidelines as well as a range of outlet works capacities. A range of dam heights will be investigated in order to compare the benefits of smaller and larger dams. These alternative dam types and heights will be priced under the costing sub-task which will enable the most economical dam type to be selected for a particular height of dam.

The cost estimates for the prescreening of dam options will be prepared to a lower level of detail and those for the preliminary designs to a higher level. All estimates will be based on the cost criteria determined in Dam Design and Cost Criteria Task above.

Deliverables The engineering assumptions assessments and quantities will be documented for a range of preliminary dam design capacities and outlet works sizes. This information will be utilized to prepare cost estimates and thereafter for financial analyses, and in the selection of the optimum scheme.

The cost estimates for the Prescreening and Preliminary Designs will be documented separately. In both cases cost/capacity curves will be prepared and utilised for the Unit Reference Value analysis.

3.5.6 Task 4.1e: Operating Rules

It has been identified that three aspects should be considered in the derivation of the operating rules of the system:

- **Releases and support between the existing and possible proposed dams**

It is proposed that system analysis be undertaken with the WRYM to evaluate different release rules between the reservoirs in the Orange River (Gariep, Vanderkloof and proposed dams). The objective will be to maximise the overall system yield and ensure the level of supply at the different abstraction points is equal. This will be achieved through firstly analysing various release rules using historical analyses and secondly confirming the best rule through stochastic analyses. Dam capacities and the associated outlet works will be sized to ensure that they are capable of releasing the required environmental flows.

- **Reliability of supply to users upstream and downstream of the dams**

Using the basic release rules (defined in the previous paragraph) as a point of departure, stochastic analysis will be undertake where the water requirements for a particular demand level (say 2005) are imposed on the WRYM system. The reliability of supply at the different abstraction points will be assessed and if it is found that the supplied assurances differ, appropriate adjustments will be made to the release rules. It is proposed that this be repeated for a further demand projection horizon of say 2015.

- **Drought restriction operating rules**

Since the drought allocation algorithm is only available in the WRPM, this mode will be used to derive the appropriate drought restriction operating rules. For this purpose it is assumed three sets of short-term yield reliability curves for different development scenarios will be developed. The reliability classification definitions derived from the Water Requirement Task will also be incorporated into the WRPM. Analysis will be undertaken using constant demands and the resulting supply to the different users along the Lower Orange River will be analysed. The supply results will be presented in such a way as to illustrate the equitability of the restrictions between users in South Africa compared to users in Namibia. These results will be presented to the Study

Management Committee (SMC) for approval. It is foreseen that the SMC may request certain adjustments and an allowance for three alternative rules has been made in the budget. These adjustments could include evaluating different reliability classification for users in Namibia and South Africa to achieve different levels of assurance of supply. The details will be discussed with the SMC.

An assessment of the practical implication of implementing the proposed rules will be undertaken and procedures will be compiled for the execution of the operating rules. The responsibilities and decision-making processes will be defined for a range of events and conditions. The rules and procedures will be described in the Main Report.

The reliability of supply results will also be assessed in terms of economic and social consideration and the restriction rules will be adjusted if necessary.

3.5.7 Task 4.1f: Areas of Inundation

Methodology: As discussed previously, it is proposed that for the prescreening of options, the areas inundated be based on existing 1 in 10 000 mapping at Boegoeberg and 1 in 50 000 mapping elsewhere. However, downstream of longitude 20° on the Orange River, the contours will be digitised off the 1 in 50 000 sheets and superimposed on the 1 in 10 000 aerial photo maps. On the Fish River the contours will be superimposed on the aerial photographs.

When the 1 in 10 000 contour mapping of the basins is prepared for the Preliminary Design Task this will also be superimposed on the 1 in 10 000 photo maps to facilitate the identification of land, housing and infrastructure that would be impacted by inundation.

The areas of inundation will be established from the topographical information on the dam site, the proposed height of the dam and the likely backwater effect during flood conditions. GIS maps will be provided for each dam development option considered in the study. The backwater analysis will be undertaken using a basic hydraulic model together with design floods for the 1 in 100 year return period. These will be delineated on the appropriate maps.

As mentioned under the Sedimentation Task sediment deposition at the headwaters of the reservoir would significantly increase backwater levels. This would require additional analyses for which no provision has been made in the budget.

Deliverables: The areas inundated by various heights of dams will be delineated and those to the west of longitude 20° will be superimposed on the 10 000 photo maps based on the 1992 aerial photography including backwater effects for the selected option as determined by simple analysis.

3.5.8 Task 4.1g: Border Demarcation

Methodology: Cognisance will be taken of the implications of locating a dam on the border in regard to access and operation. The legal implications of similar international cases will be investigated.

Deliverables: Comments on border demarcation.

3.6 TASK 4.2: ECONOMIC AND FINANCIAL ANALYSES

Methodology : The economic and financial analyses will be undertaken in two components namely:

- The analyses of water conservation options – Task 4.2a and
- The financial analyses of water supply options – Task 4.2b.

The broad aims of the economic and financial analyses will include:

- Summarising the capital and recurrent costs for the project alternatives at a level of accuracy as required in the TOR;
- Agreement on the parameters to be used for the economic and financial analyses, such as interest/discount rates and repayment/redemption periods.
- Development a basic spreadsheet model for calculating Unit Reference Values (URV) and carrying out of the benefit-cost analyses. Comparison of the URVs will provide one of the key factors that will be used to make the final recommendations concerning which management and/or dam development options should be considered for implementation and may be taken to the Feasibility Study. However, other non-economic factors will also be important and be considered in the evaluation process;
- Selection of best alternatives, based on the technical, operational, environmental and economic viability.
- Development of a financial model to make cash flow forecasts for the best development alternative over its entire life cycle;

- Performing sensitivity analyses to identify those parameters that can put the project economics at risk, and that require further investigation in the subsequent Feasibility Study.

Models will be developed in such a manner that different scenarios can be run to evaluate the effects that different cost sharing options, project phasing options, project funding options, project risk factors underlying economic/financial parameter assumptions and other relevant factors have on the outcome of the analyses.

The level of effort in this phase of the assignment will largely depend on the number of viable alternatives that are identified and quantified by the technical teams.

Economic analysis will be performed to support the evaluation and comparison of options to improve the management of the lower Orange River. The economic analysis will examine both water demand management as well as supply augmentation options. The costs of implementing water demand management measures will be compared to the savings and benefits achieved through a cost-benefit analysis. Where appropriate, URVs will be calculated for the water saved through demand management or other conservation measures. These will be compared to the URVs for development options such as those at Boegoeberg and Vioolsdrift/Noordoewer. The timing and phasing of possible new development options would be examined to assess the influence of different phasing of the options on the URVs.

Multicriteria decision analysis as previously successfully applied by the consultant to compare water supply augmentation and water demand management options is suggested as the most appropriate means of evaluating and comparing the diverse factors affecting the selection of schemes. This is discussed under Task 6.1, Recommendations.

Deliverables: The URV determinations for the water conservation and dam development options will be documented and discussed in the Economic and Financial Analysis Report. This report will also contain a summary of the information presented to and the conclusions of the multi criteria decision analysis workshop if it is held.

3.7 TASK 4.3: WATER SHARING, COST SHARING AND DAM OPERATION

Methodology: The Consultant shall provide proposals concerning the principles to be adopted with respect to the sharing of water between Namibia and South Africa, by considering:

- principles of equitable allocations such as "rights-based" criteria that are based on relative hydrography (including quantity, quality and reliability) and chronology of use;
- the "efficiency-based" criteria such as beneficial use and economics;
- needs-based criteria for water allocations such as irrigable land and/or population;
- other upstream dams and inter-basin transfer systems in the Orange River.

The Helsinki rules and the 1997 Convention of the United Nations and the revised SADC protocol on shared water resources will serve as important references in this regard. Case studies on similar situations elsewhere in the world, where more than one country has a stake in a major dam/river system, will be referenced.

Based on the proposed water sharing criteria, the Consultant will formulate different development and operational/control sharing models, hereinafter referred to as system sharing models. The Consultant will then adopt the previously developed economic analysis and financial forecasting models to create different scenarios of cost sharing in respect of each of the systems sharing models.

The Consultant will then use the outcome of these analyses to propose water sharing, cost sharing and a joint operational and control system to the Client that is considered as equitable and fair to both parties.

Deliverables: The principles in regard to the sharing of water, and capital and operating costs will be documented in the report entitled "Water Sharing Costs, Dam Operation and Financial and Institutional Mechanisms for Funding"

3.8 TASK 5: ENVIRONMENTAL AND SOCIAL ISSUES

3.8.1 Task 5.1: Environmental Impacts (Including Archaeological)

Methodology: The environmental impact assessment will rely on existing data and site visits. It will also include the findings of the social and archaeological assessments described in the next section. The environmental assessment will be at a scoping level and will clearly describe uncertainties and areas which would require further specialist investigation during a possible Feasibility Study. The Scoping Report will be informed by and integrate with the proposed Public Consultation and Social Processes.

The effect on the riverine ecosystem as a result of inundation and the barrier effect will be described. Other factors that will be assessed include, tourism, water quality, flora and fauna, sedimentation and recreational use both in the dam basin and downstream.

With regard to the archaeological issues, a reasonably comprehensive study of the Boegoeberg and Vioolsdrift/Noordoewer sites has already been completed for the ORRS. In order to add value for these sites it is suggested that the approach to the archaeological investigation should comply with the requirements of the SA National Heritage Resources Act and equivalent Namibian legislation. It is therefore proposed that a phase one assessment be undertaken and to involve the South African Heritage Resources Agency. We will request the Agency to comment on, but not apply for authorisation of the proposed development at this stage. It is proposed to review the literature and consult with local specialists. Thereafter, about 12 days will be spent in the field assessing the presence and range of sites and commenting on their importance. If a site on the Fish River is selected a similar investigation will be undertaken.

Deliverables: A comprehensive scoping level environmental assessment of two potential dams and a phase one cultural assessment with regards to the archaeological issues.

3.8.2 Task 5.2: Social Impacts

The social survey undertaken as part of the ORRS has successfully identified and addressed a number of social aspects. However, it is felt that the social implications of the proposed development options have not been qualitatively addressed. It is therefore proposed to engage the directly affected parties in a structured, sensitive and meaningful manner. This would complement the approach proposed in the public consultation component. Together with the data from the

ORRS, this should form a comprehensive quantitative and qualitative approach to social aspects.

The development of open channels of communication and trust between all parties is crucial to the success of this Pre-feasibility Study, as well as possible future phases. This will minimise the anxiety and fear that local communities may feel due to the uncertainty associated with the proposed development, and in particular the potential loss of livelihood, disruption to agricultural activity and changes to their socio-cultural milieu. The proposed approach will elicit the nature and magnitude of their concerns and expectations and contribute to the empowerment of the affected rural communities.

In order to develop the required trust, respect and communication measures with the affected communities, it is proposed that a site visit will be undertaken to each of the proposed two dam sites. As it is not appropriate at a pre-feasibility level to engage with the public, consultations will be held with key representatives in each settlement. The research tools will be questionnaires, observation and focus-group interviews.

Deliverables: A report on the attitudes of the potentially affected rural communities towards the proposed dams at Boegoeberg and Vioolsdrift/Noordoewer.

3.8.3 Task 5.3: Public Consultation

Methodology: The requirements for this component of the study are very clearly spelt out in the proposal call. The approach proposed is unlikely to allow the full range of stakeholders to become involved in the project. In terms of the rural communities, we have addressed this by proposing a relatively detailed social survey with extensive fieldwork. An alternative proposal to ensure adequate involvement by the authorities was suggested as additional **Task 8.6** which has since been accepted by the Client and now forms part of the main project proposal. The details of this additional work are described in **Appendix A** and the budget for Task 5 has been increased by R96 880 following the acceptance of the task.

The information meetings would comprise four open days involving public meetings as required by the TOR. These will be advertised to all identified stakeholders by means of personal letters, advertisements in the local and regional newspapers, posters at public buildings, consultation with local representatives and interest groups. All communication including the four newsletters required by the TOR will be conducted in English and Afrikaans. It is assumed that the previous stakeholder lists developed under the ORRS for DWAF will be available for this study.

Deliverables: A well documented public process with all issues and concerns highlighted. Detailed records of the through consultation process with the rural communities.

3.9 TASK 6: RECOMMENDATIONS FOR FEASIBILITY STUDY AND MAIN REPORT

3.9.1 Task 6.1: Recommendations for the Feasibility Study : General

The work towards a future feasibility study will be undertaken in three sub-tasks namely:

- Task 6.1a: Recommendations;
- Task 6.1b: Terms of Reference;
- Task 6.1c: Funding options.

Each of the above sub-tasks is discussed separately in the remainder of **Section 3.9**.

3.9.2 Task 6.1a: Recommendations

Methodology: It is suggested that the recommendation on the most appropriate options for Water Conservation and Demand Management (WCDM) and dam development could best be decided through a multi-criteria decision workshop involving representatives of the Permanent Water Commission (PWC), and key specialists (environmental, financial, social, dam and WCDM) to determine the most favourable overall development strategy. A proposal for this is described in more detail in **Appendix A, Task 8.1**. If this process is not followed the consultants will evaluate the environmental, social and financial implications of the WCDM and dam development options and make recommendation in regard to the most favourable options their phasing and operation.

Deliverables: Consolidated recommendations on options, phasing and operation.

3.9.3 Task 6.1b: TOR for Feasibility Study.

Methodology: The need and timing for the Feasibility Study will depend on the overall recommendations from the study. If positive, a draft TOR will be prepared.

Deliverables: TOR for a Feasibility Study and cost estimate for its preparation.

3.9.4 Task 6.1c: Funding Options

Methodology: The proposed procedures for the funding of the Feasibility Study are:

- to conduct a survey of those funding agencies/concerns which the Client considers to be appropriate and that may wish to participate in the financing of the project;
- to enquire from such funding agencies/concerns as to what their requirements are for participation and the potential amounts and terms of funding that may be available for the project;
- to define a number of alternative financing structures for the project and associated actions that will be required by both South Africa and Namibia in order to obtain funding.

Our economist/ financial specialist will, with the co-operation and agreement of the Client and without committing any party to any funding option at this stage, carry out the surveys referred to above. This will be undertaken by informing the agencies in writing about the purpose of the survey and the project scope, by issuing questionnaires and through interviews.

Deliverables: The options will be listed, together with the actions required by both South Africa and Namibia in order to obtain funding and a recommendation on how the costs of a Feasibility Study should be shared between Namibia and South Africa.

3.9.5 Task 6.2: Main Report

This task will involve abstracting the key information from each of the study reports and collating this into a single report which will be a stand-alone report summarising the whole study. This report will be of a high standard and involve re-structuring and re-writing much of the text to ensure that the information is presented in a clear and methodical manner. The Main Report will include an Executive Summary and be written in such a manner that it can be captured digitally for easy distribution through the Internet if required by the Client. All figures and spreadsheets will be developed in such a manner that they can easily be captured for use in a Portable Document Format (PDF) file.

3.10 TASK 7: PROJECT MANAGEMENT

This task is described in detail in **Section 4**.

3.11 TASK 8: ADDITIONAL TASKS

The possible additional tasks are discussed in **Section 7** and in **Appendix A**.

4 PROJECT MANAGEMENT AND STAFFING

4.1 PROJECT TEAM

4.1.1 General

In a study of this nature, it is essential that the project management team are experienced and familiar with the management of many Sub-consultants working on the same project. The Project Management will involve coordinating the various tasks and ensuring that the individuals or sub-consultants adhere to their budgets and time constraints. The Project Management Team will also be responsible for the regular progress reports and budget reports. Time needed to attend the various SMC meetings will be taken into account by each Task Leader and the associated man-hour costs will be included in the appropriate task budget and not the management budget.

It is considered appropriate that the Namibian and South African components of the team should have equally competent staff in all fields. In general the teams in each country would be responsible for the local investigations but fully informed about the investigations in the other country, at minimum in a review capacity, i.e. agreeing on the methodology and reviewing the work of others. It should be noted that there may be occasions for members of the South African component of the team to spend short periods working in Namibia and vice versa.

4.1.2 Study Management Committee (SMC)

The SMC is nominated by the PWC to perform the detailed management of the study on behalf of the PWC. The Project Leader will be the direct link between the SMC and the study team and will meet with the SMC on a bi-monthly basis to report on progress and budgets. He will also present interim technical reports and current findings to the SMC and will assist the SMC in presenting the Final Report to the Permanent Water Commission. From the Client, it is envisaged that the SMC will include Mr P Van Niekerk and Mr P Pyke from South Africa as well as Mr P Heyns, Mr D Biggs and Mr G Van Langenhove from Namibia.

4.1.3 Consultants Project Management Committee

The Consultants Project Management Committee (PMC) will comprise the Project Leader and two Deputy Project Leaders. It will meet at regular intervals, to suit project milestones and one or more Team Leaders may be required to attend the joint SMC/PMC meetings when necessary. In addition, senior representatives of each of the member firms of the association will meet at regular intervals to ensure the smooth running of the project.

4.1.4 Internal Project Coordination

In order to facilitate the lines of communication and coordination between the Namibian and South African consultants, for each key position in the project team two persons were originally nominated in the project proposal with one from each country. After further discussions between the project team and Client it was decided to select only one Task Leader for each task in order to reduce unnecessary management effort. In addition, a number of tasks have been grouped together in order to reduce the overall number of Task Leaders and in this manner to streamline the Project Management. The proposed Project Management structure is shown in **Figure 4.1**.

4.1.5 Project Leader

Andrew Tanner is proposed as the Project Leader on behalf of the Consultants. His previous experience on large water resources projects of this nature such as the Lesotho Highlands Water Project will ensure that he can provide the necessary leadership and direction for the project. He is located in close proximity to DWAF and Johannesburg International Airport which will facilitate co-ordination and Liaison between the project team and the Namibian and South African Clients.

4.1.6 Deputy Project Leaders

It was originally proposed to use a single Deputy Project Leader from South Africa to assist the overall Project Leader since it is often necessary for the two managers to work closely together and in the same office. After further discussions between the project team it was decided to split the management between South Africa and Namibia in order to ensure that the project is not heavily weighted towards either country and to provide a more equitable split of budget and responsibility. In this regard it is proposed to use Fanie Vogel to support to Andrew Tanner as the Deputy Project Manager for South Africa and to include Frikkie Becker as the second Deputy Project Manager for Namibia. To avoid possible confusion and duplication of effort, the overall management responsible for each task has been allocated to one or other of the Deputy Project Managers. The allocation of tasks is indicated in **Table 4.1** and shown in **Figure 4.1**.

4.1.7 Task Leaders

As discussed previously (see **Section 2.2**), the project has been split into 8 tasks of which 5 are technical tasks , one covers the Inception Report, one covers all suggested Additional Tasks and the last task covers Project Management. The Task Leaders are responsible for directing and coordinating the personnel working on the specific task. They must also ensure that the work is completed within budget and on schedule. It is their responsibility to provide adequate warning of any problems encountered which can either delay the project or result in budget over-runs.

The various Task Leaders are indicated on **Figure 4.1**. They and all support staff are listed per task on the detailed manpower schedule provided in **Appendix B**.

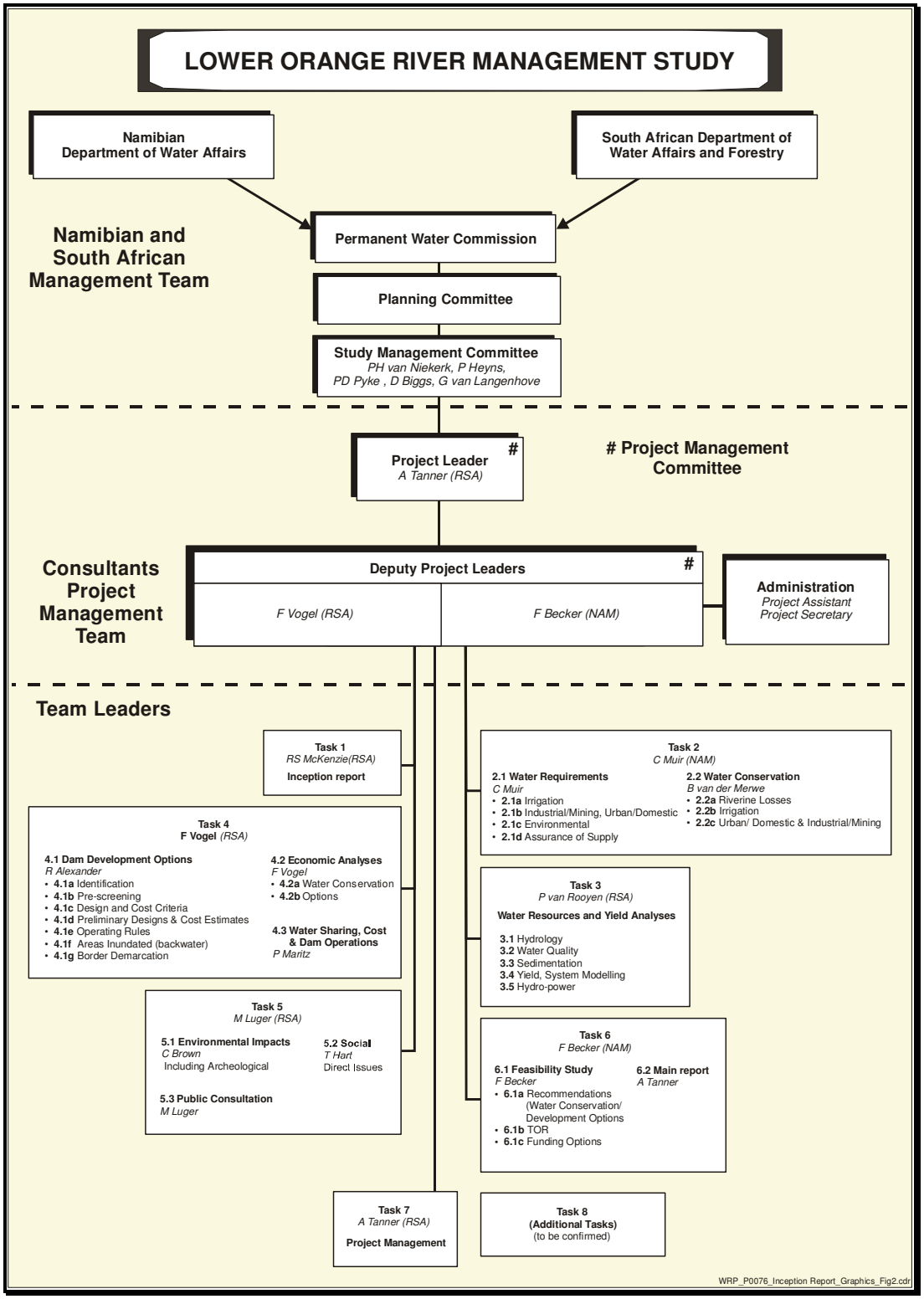

Figure 4.1: Management Structure

Table 4.1: Task Allocations to Deputy Project Managers

Task Description	Task Leader Responsible for Task	Deputy Project Manager Responsible for Task
Task 1: Inception Report	R McKenzie	F Vogel
Task 2: Water Requirements and Conservation	C Muir	F Becker
Task 3: Water Resources and Hydrology	P van Rooyen	F Becker
Task 4: Dam Development Options	R Alexander	F Vogel
Task 5: Environmental, Social and Public Involvement	M Luger	F Vogel
Task 6: TOR for Feasibility Study and Main Report	F Becker	F Becker
Task 7: Overall Project Management	A Tanner	
Task 8: Additional Tasks	To be Confirmed	To be Confirmed

4.2 MANPOWER SCHEDULE

Details of the manpower to be used on the project are summarised in **Table 4.2** and provided in detail in **Appendix B**. It should be noted that all man-hour inputs have been revisited and altered where appropriate to provide a more efficient team and to provide a more equitable distribution of work between South Africa and Namibia. Certain changes were made following discussions with the Client and the revised manpower schedule is now considered to be both realistic and equitable.

It should be noted that the overall project cost was not altered significantly during the adjustments to the man-hours and personnel involvement.

Table 4.2: Summary of Man-hour Inputs

Name	Hours	Rate (N$/R per hr)	Company	Position
Alexander	200	400	B&P	Task Leader : Dam Development
Becker	642	400	B&P	Deputy Project Leader (Nam)
Beukes	118	250	WCE	Support: Dams
Brown1, C	263	350	NS	Task Leader: Environmental
Brown2, CJ	406	400	WCE	Task Leader (Nam) : Environmental
Burger	52	500	B&P	Key Support : Water Requirements, WCDM
Burmeister	84	550	B&P	Project Leader (Nam), Reviewer
Chivell	276	250	WCE	Support: GIS
Craig	106	400	WRP	Task Leader (SA):Water Requirements
Crerar	683	450	WCE	Task Leader(Nam) Water Resources and System Analysis
Crosby	141	350	WRP	Specialist: Irrigation Requirements
De Sousa	75	250	WRP	Key Support : GIS
De Villiers	215	250	NS	Key Support: Public Consultation
De Wet	274	400	B&P	Specialist: Water Requirements, Financial
De Witt	8	550	NS	Specialist: Hydropower
Dippenaar	40	250	NS	Key Support: Public Consultation
Du Plessis	374	475	WRP	Key Support: Irrigation
Eberhard	92	450	NS	Task Leader: Financial
Erasmus	43	450	B&P	Specialist:Legal
Frindt	324	400	B&P	Key Support Dam: Development Options
George	56	450	WCE	Specialist: Geology
Gorgens	38	550	NS	Reviewer: System Modelling, Water Quality, Hydrology

Name	Hours	Rate (N$/R per hr)	Company	Position
Halkett	140	180	NS	Specialist: Archaeology
Hart	132	550	NS	Task Leader: Social and Public Consultation
Hattingh	60	400	WRP	Key Support: Dams
Hidema	43	400	WRP	Specialist: Legal
Hoabeb	20	350	B&P	Specialist: Social
Huizinga	16	375	NS	Specialist: EFR
Kamish	24	192	NS	Support: Water Quality
Kania Vlok	10	200	WCE	Support Project Management
Khosa	16	500	NS	Key Support: Funding
Kinahan	73	250	B&P	Specialist: Archaeology
Kleynhans	96	250	NS	Key Support: WCDM, Dams
Kock	72	300	WRP	Key Support: WCDM and Hydrology
Kruger	20	250	B&P	Task Leader (Nam): Public Consultation
Lamprecht	145	300	WRP	Specialist: Irrigation/Agricultural production
Leyland	20	450	NS	Specialist: Hydropower
Louw	87	300	WRP	Specialist: Agricultural Economics
Luger	278	411	NS	Task Leader: Environmental
Mackellar	40	550	NS	Task Leader: Dams
Mare	100	450	WRP	Specialist: Hydrology and System Analysis
Maritz	79	550	WCE	Task Leader: Water Sharing/Reviewer
Masia	48	300	NS	Support: Environmental
McKenzie	360	550	WRP	Task Leader: Water Resources, WCDM and Main Report
Meyer	32	300	WRP	Key Support: Project Management
Mngumi	30	400	WRP	Key Support: WCDM and System Analysis
Moahloli	30	250	WRP	Support: Agricultural Economics
Morris	26	200	NS	Specialist: Archeologist
Mosimane	232	250	WCE	Task Leader (Nam): Social
Muir	259	500	WCE	Task Leader(NAM): Inception and Water Requirements
Nabo	120	250	NS	Key Support: Public Consultation
Namaseb	8	400	B&P	Key Support: Financial
Namassist - Vlok	265	200	B&P	Assistant to Frikkie Becker
Neethling	100	200	WRP	Support: Project Management
Nel	8	391	NS	Key Support: Water Requirements
Oosthuizen	131	350	B&P	Task Leader (Nam): Financial
Oppelt	20	250	NS	Key Support: Public Consultation
Pearson	20	380	NS	Specialist: Hydropower
Renke	138	250	WRP	Support : GIS/Graphics
Rooseboom	76	500	WRP	Specialist: Sedimentation
Rossouw	4	477	NS	Specialist:Water Quality
Rutherford	5	550	WRP	Specialist Advisor, Irrigation
Schafer	24	450	WRP	Team Leader (SA): WCDM
Shand	58	550	NS	Reviewer: Dams, Feasibility
Solomons	258	127.5	NS	Support: Social
Swart Susan	346	450	WRP	Specialist: Hydrology and System Analysis
Tanner	402	550	NS	Project Leader/Team Leader: Feasibility, (SA)
Timm	100	472.5	NS	Deputy Project Leader
Tromp	132	250	WCE	Support: Water Requirements
Van Den Heever	165	200	NS	Support Project Management
Van Der Merwe	284	400	WCE	Task Leader: WCDM
Van Rooyen	350	500	WRP	Task Leader: System Analysis, Water Quality
Van Wyk	297	458	NS	Key Support: Dams
Vogel	438	472.5	NS	Deputy Project Leader
	10746			

Note (1):
- B&P Burmeister & Partners
- NS Ninham Shand
- WCE Windhoek Consulting Engineers
- WRP WRP (Pty) Ltd

Further details of the split of work between the various Consultants and per country for each task are summarised in **Appendix B**. From the summarised information it can be seen that the work to be undertaken by the Consultants has been redistributed from the 31% and 69% as indicated in the original proposal to approximately 42% and 58% for Namibia and South Africa respectively.

In order to further reduce the management activities of the overall Project Manager, it was agreed to allocate all Sub-consultants to one of the four main Consultants. This will greatly facilitate and streamline the invoicing procedures as well as improve budget control.

5 STUDY PROGRAMME

A bar chart showing the detailed programme of activities, milestone events reporting events and critical path activities is provided in **Figure 5.1**.

The various reports referred to in the task descriptions are listed below in **Table 5.1**, together with proposed review dates and dates of submission.

Table 5.1: List of Study Reports

Report Number	Title	First Draft	Final Report
1	Inception Report	March 2002	April 2002
2	Water Requirements and Conservation	Oct 2002	Dec 2002
3	Hydrology, WQ and Systems Analysis	Jan 2003	Mar 2003
4	Dam Development Options and Hydropower	Mar 2003	Apr 2003
5	Environmental, Social and Public Consultation	Apr 2003	May 2003
6	Financial Analyses, Water Sharing and Funding Mechanisms	Apr 2003	May 2003
7	Feasibility (TOR if required)	May 2003	Jun 2003
8	Main Report	May 2003	Jul 2003

6 BUDGET

6.1 INTRODUCTION

The costs presented in this document are based on the work program and estimated man-hour schedule provided in the Technical Proposal. The costs are applicable to the study period, which has been programmed to run from November 2001 to April 2002.

6.2 PROFESSIONAL FEES

Estimates of the total professional fees for each team member are provided in **Table B.1** of **Appendix B** while **Table B.2** provides a schedule of the man-hours for each team member as allocated to the various tasks.

A breakdown of the proposed professional costs for the 13 tasks in the original proposal are provided in **Table 6.1** and the figures can be compared to the revised task budgets which are summarised in **Table 6.2**. Full details of the budget breakdowns for each task are provided in **Table B.4** of **Appendix B**.

Table 6.1 : Summary of the Original Professional Costs per Task (excl. VAT).

Task	COST (R/N$)
Task 1: Inception Report;	231 876
Task 2: Water Requirements;	335 242
Task 3: Water Resources and Yield Analyses;	594 466
Task 4: Water Conservation;	277 300
Task 5: Dam Development Options;	707 557
Task 6: Financial Analyses;	103 920
Task 7: Environmental Impacts;	223 264
Task 8: Social and Archaeological Issues;	160 240
Task 9: Public Participation;	196 352
Task 10: Water Sharing, Cost Sharing and Dam Operation;	103 796
Task 11: Feasibility Study;	62 832
Task 12: Main Report	168 572
Task 13: Project Management	611 129
Total (VAT excl.)	**3 776 546**

It should be noted that the breakdown of costs between companies and/or countries is not shown in either **Table 6.1** or **Table 6.2** and that such details are provided in **Appendix B**. The various inputs were decided jointly by the Namibian and South African Consultants and it was agreed during the proposal stage of the project that the distribution of work would be altered during the Inception Phase in accordance with the requirements of the Client.

Table 6.2 : Summary of the Revised Professional Costs per Task (excl. VAT).

Task	COST (R/N$)
Task 1: Inception Report;	241 666
Task 2.1: Water Requirements	331 522
Task 2.2: Water Conservation	283 400
Task 2.3: Vioolsdrift/Noordoewer Irrigation Assessment (new task)	180 590
Task 3: Water Resources and Yield Analyses (including additional N$ 62 000)	656 441
Task 4.1: Dam Development Options – General	703 904
Task 4.2: Economic Analysis	103 920
Task 4.3: Water Sharing, Cost and Dam Operations	103 796
Task 5.1: Environmental Inputs including Archaeological Issues	280 216
Task 5.2: Social Issues	117 513
Task 5.3: Public Consultation (including additional R96 880)	299 737
Task 6.1: Feasibility Study	59 530
Task 6.2: Main Report	193 800
Task 7: Project Management	630 386
Task 8: Additional Tasks (excluding 3 approved tasks) : Contingency	
Total (VAT excl.)	**4 186 419**

It should be noted that the above table includes the professional fees with respect to the three additional tasks approved by the Client. The additional professional fees for the three approved additional tasks are as follows:

• Task 2.3	Vioolsdrift/Noordoewer Irrigation Assessment	N$ 180 602
• Task 3	Fish River Hydrology	N$ 62 000
• Task 5.3	Additional Public Involvement	N$ 96 880
	Total Additional Professional Fees	N$ 339 482

The decision regarding certain of the proposed additional tasks was deferred and the associated budget for these tasks has not been included in the above tables. Details of the various additional tasks and the associated budgets are summarised in **Table 7.1**. The total cost for all of the Additional Tasks is R 1 112 982 exclusive of VAT and the cost details are summarised in **Table 7.1**.

6.3 DISBURSEMENT COSTS

The proposed disbursement costs for the Study are the original R/N$ 430 000 plus R14 000 for the additional task totaling R/N$444 000 (excl. VAT) and **Table 6.3** provides a breakdown of these. It should be noted that an allowance of R60 000 has been included under Task 1 (Inception Report) for a possible field trip. After further consideration it has been decided that the field trip will only be considered later in the study once the project team have had the opportunity to investigate the study area and key issues in more detail. A field trip will then be discussed with the Client and only undertaken on the basis that it can be justified on technical grounds to ensure that it is both cost effective and useful to the project. The budget of R60 000 will therefore reside under Task 1 until such time that the decision to proceed with the field trip is taken. Additional details of the disbursements are provided in **Appendix D**.

Table 6.3 : Estimated Disbursement Costs per Task (excl. VAT).

Task	COST (R/N$)
Task 1: Inception Report - (including R60 000 for field trip)	70 000
Task 2.1: Water Requirements	40 000
Task 2.2: Water Conservation	20 000
Task 2.3: Vioolsdrift/Noordoewer irrigation assessment	14 000
Task 3: Water Resources and Yield Analyses	10 000
Task 4.1: Dam Development Options – (including R60 000 for field trip)	80 000
Task 4.2: Economic Analyses	10 000
Task 4.3: Water Sharing, Cost Sharing and Dam Operation	10 000
Task 5.1: Environmental Impacts including Archaeological Issues	30 000
Task 5.2: Social Issues	10 000
Task 5.3: Public Participation	40 000
Task 6.1: Feasibility Study	10 000
Task 6.2: Main Report (include costs of printing reports)	70 000
Task 7: Project Management	30 000
Total (VAT excl.)	**444 000**

6.4 RECOVERABLE COSTS AND INFRASTRUCTURE COSTS

Recoverable costs will be charged to the Client without mark-up and economy air travel will be used in all cases. Costs for copies and printing etc will be agreed with the client and the standard rates normally approved by the Client will be used. The Client's standard rates for car travel will be used and any other similar items will be agreed with the client during the Inception Phase of the project.

The estimated monthly infrastructure costs expected to accrue for all the contributing organizations total R/N$ 5 000 per month, which totals R/N$ 75 000 over the proposed 15 month study period. These costs will cover all computer time, emails, faxes and telephone calls. It is considered more practical to charge a lump sum per month rather than try to count all faxes, emails etc, the accounting of which can often add considerably to the administration of the project. An additional N$ 19 000 was added to the disbursement costs for the three additional tasks added to the project. N$ 14 000 was included for subsistence and travel for the Vioolsdrift/Noordoewer irrigation assessment in 6.3 above and N$ 5 000 for communications and computers; N$ 1 000 for the Fish Hydrology task (Task 3.1) and N$ 4 000 for the Vioolsdrift/Noordoewer irrigation assessment (Task 2.3).

It should also be noted that the project programme suggests an 18 month project and not 15 months as suggested in the TOR. The Study Team believes that the bulk of the technical work will be completed during the 15 month period and for this reason the infrastructure costs mentioned only refer to the 15 month period and not 18 months. The additional three months will be taken up with finalising and reviewing the study reports which is often delayed due to the process of receiving comments and feedback from the Client and other interested parties.

6.5 SUMMARY OF COSTS

A summary of the proposed Project Costs is provided in **Table 6.4** .

Table 6.4 : Summary of the proposed Project costs.

ITEM	COST (R/N$)
Professional fees (VAT excl.)	4 186 419
Disbursement costs (VAT excl.)	444 000
Infrastructure costs (VAT excl.)	80 000
Project Total (excluding VAT)	**4 710 419**

Additional tasks (excl VAT)		
Three tasks included above	358 482	
Other tasks not included	754 500	754 500
Total budget if all additional tasks are approved	1 112 982	5 464 919

The above project cost includes the N$/R 358 482 for the additional three tasks but excludes the N$/R 754 500 for the remaining possible additional tasks (all excluding VAT). If the remaining additional tasks are approved, the total budget will increase to N$/R 5 464 919 excluding VAT.

7 ADDITIONAL TASKS

As part of the project proposal, various additional tasks were identified which the project team believed could be valuable additions to the project. Each task has been motivated to the Client and a decision regarding their inclusion on the project was taken. Following the discussions with the Client it was decided to exclude three tasks, (unnumbered over in table 7.1) include three tasks i.e. 8.6, 8.7 and 8.8 and to defer the decision on the remaining six tasks. Details on each task accepted or deferred are provided in Appendix A while a summary of the costs and decisions is provided in **Table 7.1** together with relevant details.

Table 7.1: Summary of Additional Tasks

Task Number	Task Description	Task Budget (N$/R exc VAT)	Decision regarding Inclusion of Task in Project
8.1	Multi-Criteria Decision Analysis	184 000	Agreed to defer decision on this task but to include budget under contingencies to be used only with Client's approval. Full motivation and budget provided in Inception Report. See **Appendix A**.
8.2	Hydraulic Modelling of Orange River	237 000	Agreed to defer decision on this task but to include budget under contingencies to be used only with Client's approval. Full motivation and budget provided in Inception Report. See **Appendix A**.
8.3	Compatibility of Environmental Flows	190 000	Agreed to defer decision on this task but to include budget under contingencies to be used only with Client's approval. Full motivation and budget provided in Inception Report. See **Appendix A**.
	Detailed Industrial/Mining Water Audits		Excluded from Project
8.4	Eutrophication Assessment	53 500	Full motivation and budget provided in Inception Report. See **Appendix A**.
8.5	Backwater Analysis and Sedimentation	90 000	Full motivation and budget provided in Inception Report. See **Appendix A**.
	Additional Hydropower Analyses		Excluded from project.
8.6	**Alternative Public Consultation Process**	**96 880**	**Agreed to include this task in project. Full motivation and budget provided in Inception Report. See Appendix A. Included in main project budget under Task 5.3.**
	Agricultural Economic Analysis		Excluded from project.
8.7	**Hydrological Analysis of Fish River in Namibia**	**63 000**	**Included in the project. Full motivation and budget provided in Inception Report. See Appendix A. Include in main project budget under Task 3.1.**
8.8	**Vioolsdrift/Noordoewer irrigation assessment**	**198 590**	**Included in the project at Client's request. Full motivation and budget provided in Inception Report. See Appendix A. Included in main project budget under Task 2.3**
Total Costs R/N$		**1 112 982**	

APPENDIX A

Details of Additional Tasks

Task Number:		**8.1 (Task 15.1 in Original Proposal)**
Title:		**Multi-Criteria Decision Analysis Workshops**
Original Proposal:		In the TOR no specific methodology was requested for evaluating diverse management options. In the proposal a single criteria decision making process, based on economics, with the effect of other criteria such as social and environmental impact of alternatives being considered in a relatively subjective manner was envisaged.
Motivation:		Multi-Criteria Decision Analysis (MCDA), as previously successfully applied by the consultant to compare water supply augmentation and water demand management options, is suggested as the most appropriate means of evaluating and comparing the diverse factors affecting the selection of management options. It is proposed that this technique be applied to evaluate development options for which preliminary designs and costing have been completed (Task 4.1d) against water conservation, demand management and other management options.
Methodology:		The MCDA technique would be used in a workshop environment attended by representatives of the Study Management Committee (SMC) and selected representatives of the consultant in order to agree on and weight the various factors impacting on the selection of options. This would lead to well-informed decisions, which are supported by the representatives of Namibia and South Africa as well as by the representatives of the various discipline groups. Some of the factors to be considered in the selection process would include: • Engineering considerations • Yield • Potential effects on water quality • Financial considerations • Unit Reference Values • Environmental impacts • Social issues • Archaeological issues • Flooding of infrastructure and its relocation • Compensation considerations • International considerations • Management of releases The MCDA workshops would assess the selected dam options including different dam sizes, timing and phasing and these would be compared with water conservation ,demand management and other management options. It is envisaged that the following tasks would be undertaken for the MCDA workshop: (a) <u>Arranging workshop</u> • Agree on the list of participants and contact all participants to arrange a suitable date. • Arrange a venue, facilities etc. (b) <u>Preparation and distribution of information</u> • Assemble information prepared for the other study tasks and distribute to workshop delegates. • Prepare a comprehensive report describing the main factors

<table>
<tr><td></td><td></td><td>associated with each development and management option.

(c) <u>Facilitatation and attendance of workshop</u>
• The workshops would be facilitated by a member of the study team and attended by the selected representatives.

(d) <u>Workshop summary</u>
• A summary of the workshop proceedings would be prepared.

Deliverables: Summary of proceedings of the Multi-Criteria Decision Analysis Workshop documenting the process, the criteria, the weightings and the sensitivity of the selections to the various criteria.</td></tr>
<tr><td>Personnel:</td><td></td><td>The workshop preparation will be co-ordinated by the deputy study leaders, with the team leaders providing the background documentation.

The workshop will be facilitated by Mr Mike Luger while the VISA software would be operated by Alison Joubert of the University of Cape Town, Department of Mathematics and Statistics, who will prepare the report on the proceedings.</td></tr>
<tr><td>Budget:</td><td></td><td>• The budget for the workshop is estimated to be R184 000 excluding VAT.
• The components of the budget can be summarised as follows:

<table>
<tr><th></th><th>Workshop</th></tr>
<tr><td>(a) Arrange workshop</td><td>R 14 000</td></tr>
<tr><td>(b) Preparation of information</td><td>R 49 000</td></tr>
<tr><td>(c) Facilitation and attendance</td><td>R 83 000</td></tr>
<tr><td>(d) Workshop summary report</td><td>R 16 000</td></tr>
<tr><td>(e) Disbursements</td><td>R 22 000</td></tr>
<tr><td>Total (excluding VAT)</td><td>R184 000</td></tr>
</table>
</td></tr>
<tr><td>Programme:</td><td></td><td>The workshop will be held once the short-listed development and management options have been investigated. It will be the main activity in the selection of one or more management options.</td></tr>
</table>

Task Number:		**8.2 (Task 15.2 in Original Proposal)**
Title:		**Hydraulic Modelling of the Orange River**
Original Proposal		In the TOR for the project, it was requested that "***some investigation into the existing operational losses from the system***", should be undertaken. In this regard it was proposed to use the same approach as used in the Orange River Replanning Study in which the operational losses were estimated using a simple spreadsheet together with information from the operators at the dams. In the project proposal it was stated that *"**Estimates of the operational losses will be derived at a desk-top level making use of historical release data as well as work undertaken during the ORRS study***".
Motivation:		Considerable time and effort have been spent over the past 6 years developing a hydraulic model for certain reaches of the Orange River. This model can be used to analyse the attenuation of releases from Vanderkloof Dam as the water travels approximately 1 400 km to the river mouth. While the model is relatively coarse and based to a large degree on cross-sections derived from aerial photographs, it has been shown to provide realistic and reliable estimates of the releases as they move downstream. Such a model can assist in various ways including the analysis of riverine losses, different release patterns from Vanderkloof Dam and also the attenuation of specific flood events. Approximately R2 million has already been spent on two separate studies developing the model over a period of 5 years. It has been used to analyse the river losses from the Orange River in an attempt to derive better estimates of the necessary releases from Vanderkloof Dam. In this manner it can be used to minimise spillage from the estuary and still meet the various environmental requirements along the river and at the Orange River Mouth. Since one of the primary objectives of the study is to investigate water use efficiency and propose measures to improve the efficiency it is recommended that the development and use of a hydrodynamic model be considered. Such a model would greatly assist in analysing the operating rules and how the operating losses can be reduced through the use of different release patterns and operating rules. Such a model can also provide useful information for the environmental assessments and even assist with estimating areas of inundation due to new reservoirs and flood events.
Methodology:		Much data are already available from the previous work and it would take approximately one man-month to collect and collate the necessary information from the two WRC studies and combine them into a single data set. Having established the model, it can be used to analyse different release patterns from Vanderkloof Dam as well as to calculate the areas of inundation at each of the possible new dam sites.

		Both South Africa and Namibia will then have access to a hydraulic model of the Orange River for a relatively low investment cost. The task involves collecting the available information from the previous studies and combining the data sets into a single model for the Orange River from Vanderkloof Dam to the River Mouth. One or two calibration runs will be undertaken to ensure that the model is operating properly and that it can be used and modified where necessary by both South Africa and Namibia. This proposal therefore utilises the expertise of the original model developers to set up and run a hydraulic model for the Orange River from Vanderkloof Dam to the River Mouth. **It does not include the real-time modelling capability which is still in the experimental phase and would require a major study in its own right**. The proposed budget does, however, allow for the inclusion of the Fish River in Namibia. It is assumed that the cross-sectional data will also be derived from aerial photographs as was the case for most of the main Orange River and that suitable photographs will be made available to the project team by DWA (Namibia). Approximately 100 hours of Mr Craig's time has been allocated to this component and therefore the proposed budget can be reduced by N$/R35 000 if the Fish River component is not considered necessary.
Personnel		The work would be undertaken mainly by A Craig with support from Dr Whitlow (ISIS Developer), R Mckenzie and D Mngume. Mr Craig was the key researcher on the initial WRC project and is the most appropriate person available to set up and run the model of the Orange River while Dr Whitlow can provide quick and efficient specialist support which will greatly facilitate the work. As the main model developer, Dr Whitlow add great value to the team for a relatively modest cost and has agreed to accept local rates on the project. His travel costs will be for his own account.
Budget		A total budget of R236 500 (excluding VAT) is anticipated for this task and involves the following personnel and hours: A R Craig: 420 hours at R350/hr R Mckenzie: 40 hours at R550/hr D Mngume: 40 hours at R350/hr C Whitlow: 50 hours at R550/hr Subsistence and Travel: R20 000 Communications and Computers: R6 000 No allowance has been made for the software license since both the WRC in South Africa and the Namibian Department of Water Affairs have access to the ISIS Model.
Programme		It is anticipated that the model would be set up and tested during the first 6-months of the project and that it would then be used to assist with various scenario analyses during the subsequent 12 months of the project. The task is not a critical path item and would basically form a support role on the project.

Task Number:		**8.3 (Task 15.3 in Project Proposal)**
Title:		**Compatibility of Environmental Flows**
Original Proposal		In the TOR for the project it was indicated that the "Planning Reserve" should be derived and used in the water resources analysis. This method of defining the Reserve has been developed over the past few years and was therefore not available when the Instream Flow Requirements and Estuarine Freshwater Requirements were determined previously in the Orange River Replanning Study. These early estimations of the environmental flows of the lower Orange River were based on prototypes of the "building block" methodology, entailed significant fieldwork, integration of findings at workshops, and culminated in twelve single monthly flow values. It is understood that the "Planning Reserve" is the desktop analysis developed by Prof. D Hughes. It is further understood that the method is based on curves, or relationships, that were developed using the natural (or virgin) WR90 hydrology (or an improved hydrology developed in studies subsequent to WR90) as the main driver to determine the Reserve. The method does not take cognisance of current development levels. The output from this method is monthly distribution curves for "maintenance" and "drought" flows. Although the TOR mentions the previously determined Instream Flow Requirements and Estuarine Freshwater Requirements, these requirements would not have been taken into account in the "Planning Reserve" method. The application of the "Planning Reserve" would result in a new and totally independent estimate of the environmental flows, which could differ markedly from those previously determined.
Motivation:		The estimations for Instream Flow Requirements and Estuarine Freshwater Requirements undertaken in earlier studies did not address the management class for a river but rather set a management objective. This management objective was to determine the lowest flow scenario that could just maintain the riverine ecosystem. In this sense it meant that the early studies determined what would probably today equate to a drought conditions of the "Planning Reserve". As such, the "Planning Reserve" estimate could be much larger than previously estimated. From a water resources analysis perspective, the "Planning Reserve" method incorporates a more refined simulation methodology that uses full monthly distribution curves as the definition of the flow requirements in the river. A single flow value (in each month of the year) was defined for the flow requirements in the earlier studies. To this end, it is proposed that the Environmental Flow Requirements of the two methods be compared and that their compatibility be assessed as an additional task of this study. The proposed breakdown of work for this task comprises the activities listed in **Table 1.1**. A more detailed description of the activities is provided in the following Sections.

ACTIVITY	DESCRIPTION
1	Review and compare the results from the two approaches;
2	Try to explain the differences;
3	Compile a background information document;
4	Workshop the findings; and
5	Refine the report and final recommendations.

Methodology:

Review and compare the results from the two approaches.

The first activity to be undertaken within this task will be to review and compare the results arising from the two approaches of determining the Reserve. It is understood that others will undertake the actual determination of the "Planning Reserve" as a separate task. The challenge will be to determine a management class for this highly regulated river, the current flow conditions of which bear little resemblance to the natural conditions. As mentioned in the introductory remarks, the main focus will be to compare the difference between the drought flow conditions as determined in the "Planning Reserve" with the "minimum required environmental flow" as determined in the earlier studies.

Part of this first activity will be to liase with the Client to obtain input and determine their objectives regarding the intended approach of this task. This will ensure that that the end-product of the task is acceptable to the Client.

Try to explain the differences.

It is quite likely that there will be differences arising from the two approaches. Fortunately, the understanding of the ecology of the system at the time of the determination of the initial environmental flow requirements was obtained in much the same way as the current "Building Block Methodology". An important aspect in explaining the differences will be to understand and summarise the two different methodologies.

Compile a Background Information document.

It is proposed that a concise report be compiled based on the outcomes of Activities 1 and 2. This document will be used as a background information document for the participants in the workshop (Activity 4). The objective of this document will be:

- Critically review the different methodologies and relate their outputs to the "real life" situation. Adequate attention will have to be given to the fact that there is no practical way of restoring the original ecological characteristics of the Orange River, given the importance of the uses that the river is put to. The river is most probably modified to such an extent by the developments and infrastructure that the ecosystem structure, functions and processes have been irreversibly changed;
- Provide an indication of the ecological management class with motivation, so that we may attempt to reach some form of consensus;

		▪ Detail information on the ecological elements and important functional groups of biota as well as the physical elements about the river that are important in the management of the river; ▪ List operational constraints from both the physical and water use point of view; ▪ The social importance of the river has not been addressed and it is proposed that some indication of this be provided. This will be done by requesting feedback from participants to the workshop beforehand; **Workshop the findings.** Following the compilation of the background information document, it is proposed that a workshop be convened with a broader audience including a number of other specialists (e.g. fish, estuary and social) and relevant knowledgeable staff from the Client body (e.g. RDM office). The purpose of the workshop will be to review the findings in the report and ensure that that various specialists and the Client are satisfied with these. **Prepare a Final Report.** A short summary report will be compiled at the completion of the assignment, which will be a synopsis of the findings of the various activities. The final report will be based on the background information document and will incorporate the findings of the workshop. It will also make recommendations for further work if necessary. The format of the report will be that of an executive summary which will contain only relevant data and information for executive management decisions. The main supporting information will be contained in the various annexures to the task report. **Additional Remarks**. It should be noted that it is likely that achievement of the reference conditions (what the river used to be like before the impoundments) for the Orange would be inappropriate. An additional objective of this workshop could be to reset the reference conditions to more accurately reflect the current ecological conditions that exist now (e.g. the system is now perennial as opposed to virgin seasonal). Furthermore, it may also be worthwhile to compile a River Flow Management Plan with the aim of improving the ecological conditions in the Orange River. These two activities are not included as part of this proposal, however, could be achieved quite cost effectively given that a team of specialist is to be mobilized to undertake a review of the Reserve estimates.
Personnel		The work would be undertaken by W Schäfer (Task Leader), D Mguni, M Chutter, and P van Rooyen. Specific specialists will be consulted during the assignment and will be invited to participate in the workshop.
Budget		A total budget of R190 000 (excluding VAT) is anticipated for this task and involves the following personnel and hours: W Schäfer: 88 hours at R450/hr

		D Mnguni: 132 hours at R350/hr M Chutter: 56 hours at R350/hr P van Rooyen: 8 hours at R500/hr Support staff: 48 hours at R120/hr Subsistence and Travel: R15 000 Communications and printing: R5 000 Workshop and ecological specialists: R 30 000
Programme		Since the flow requirements for the Ecological Reserve need to be quantified early during the study period it is proposed that this task be undertaken during the first five months of the study with the report produced by August 2002.

Task Number:		**8.4 (Task 15.5 in Original Proposal)**
Title:		**Eutrophication Assessment**
Original Proposal:		The TOR did not request any assessment of eutrophication or water quality issues in assessing the management options and none was proposed.
Motivation:		The potential for eutrophication becoming more or less of a problem with the implementation of each management option should be considered as a factor in the selection process. It should also be assessed to provide a fuller understanding of the future status of quality of the resources of the Orange River and possible management actions which will be required.
Methodology:		The assessment of the eutrophication potential of the lower Orange River and potential sites for development will be undertaken at a reconnaissance level. It will entail assembling all the relevant data and information on nutrients, algal growth and water clarity that is available in the lower Orange River. The work done by the Institute for Water Quality Studies and DWAF's Northern Cape Regional Office on algal blooms will be reviewed. The investigation will examine the broad scale causes of nutrient enrichment (point and non-point sources), the extent and magnitude of algal blooms (consequences of nutrient enrichment) and the factors that control algal blooms in the lower Orange River. The eutrophication potential of proposed developments will be examined using management oriented reservoir eutrophication models and extensive use will be made of the yield analyses to assess the impact of flow and loads on retention time and algal growth in the proposed reservoirs/weirs. Deliverables: Report on potential eutrophication and algal growth in the proposed reservoirs and identification of management actions to minimise the risk.
Personnel:		The work will be lead by Mr J N Rossouw, an experienced water quality scientist who was in the original team. He will be assisted by Mr W Kamish.
Budget:		JN Rossouw 80 hrs @ R477 R38 160 W Kamish 80 hrs @ R192 R15 360 Total R53 520
Programme:		The initial data collection will commence during the screening of development options. The eutrophication potential of the shortlisted developments will be assessed prior to the evaluation of development and management options and provide input to the proposed MCDA workshop, if it is included in the project.

Task Number:		**8.5 (Task 15.6 in Original Proposal)**
Title:		**Backwater Analysis and Sedimentation**
Original Proposal:		Normal flood backwater analyses were included in the proposed investigation of alternative reservoirs to determine the areas to be inundated. No specific mention was made of the investigation of sediment deposition patterns and their affect on the backwater analysis in the TOR or proposal. Sediment yield assessment was part of the proposal and the sediment trapped by proposed reservoirs would be allowed for in evaluating the long term active storage.
Motivation:		There are a number of existing and planned reservoirs in Southern Africa where the adverse effects of sediment deposition patterns on the reservoir operation affected infrastructure on the headwaters of the reservoir, and backwater levels are of concern.
Methodology:		This task would be closely integrated with the "Areas to be inundated" sub-task as the deposition of sediment above and below the headwaters of the reservoir is likely to result in significant increases in the backwater levels compared to the levels if this is not taken into account. This additional analysis would be particularly important should the Boegoeberg Dam be constructed and the headwaters extend to the vicinity of Prieska. A possible further extension of the investigation would be to assess whether in the case of a smaller re-regulating dam there would be benefit in providing large sluice gates to release sediment to the river downstream and thus also preserve storage. **Deliverables:** Reports on: • Sediment build up and backwater effects • Feasibility of sluicing sediment.
Personnel:		The specialist studies would be undertaken by Professors G Basson and A Rooseboom of Stellenbosch University. They would be co-ordinated by the Task Leader – Development Options.
Budget:		The study tasks would be as follows: (a) Modelling of sediment build-up upstream of dam to predict backwater effects using an interactive model: G R Basson 150 hrs @ R400 R60 000 Assistant 125 hrs @ R80 R10 000 (b) Investigation of feasibility of using sluice gates for the sluicing of sediments and co-ordination of sediment studies: A Rooseboom 40 hrs @ R500 R 20 000 Total (excluding VAT) R 90 000
Programme:		The work would be undertaken as part of Task 4.1, dam development options task, once the shortlisted options had been agreed. It would form part of the Pre-Feasibility level investigations.

Task Number:		**8.6 (Task 15.9 in the Original Proposal)**
Title:		**Public Consultation**
Original Proposal:		The TOR describes an appropriate level of consultation with interested and affected parties, primarily at community level, in the vicinity of proposed development options. However, we did not believe that the approach outlined adequately addressed the needs of the rural communities and in this regard Task 5.2 was expanded as explained to address this perceived shortcoming. No additional work is suggested in this regard. The TOR and hence the proposal limited the public participation to stakeholders in the vicinity of the physical development options. However, the development of management options for the Orange River will affect a wide range of stakeholders throughout the catchment and consultation with these stakeholders was not included in the TOR or proposal.
Motivation:		The study touches on a diverse array of issues at a local, national and international scale. Different approaches are required to ensure the participation of the various interested and affected parties. The purpose of this additional task is to include key stakeholders and especially authorities in a more comprehensive manner. Our experience has shown that failure to involve these parties in the appropriate manner from the outset frequently results in a lack of buy-in to the study and its results. Not only will this undermine the rigor and acceptability of the pre-feasibility study, but may also affect the potential feasibility and even construction phases of any proposed scheme in the future. Investing in this more comprehensive key stakeholder and authority consultation process is also consistent with the guidelines recommended by the World Commission on Dams and DWAF's Generic Public Participation Guidelines. If this additional task is accepted, the key stakeholder component will be an extension and integral part of Task 5.3 Public Consultation, that will link well with the process of consultation with the authorities.
Methodology:		The task can conveniently be divided into two components, the first dealing with key stakeholders and the other with the authorities. The key stakeholders would be identified from previous studies, from the authorities and via chain referral. In addition to personal invitations to the public information meetings, we would contact them telephonically and try to ensure that they either attend the public meetings, or participate in the process by means of correspondence. It is important that all relevant authorities are involved at the earliest possible stage in the study. It is envisaged that the authority consultation would involve all tiers of government from both countries dealing with the environment, commercial and emerging agriculture, heritage and cultural issues, the district and local councils, UNESCO, and the Ramsar Commission. As described in the TOR, liaison with Lesotho and Botswana would be via the PWC's. The main purpose of this consultation would be to inform the authorities of the study, to obtain their views of the possible water resource developments and associated developments, and to obtain clarity with respect to any legal or procedural requirements for this study as well as the need for more detailed studies in the future. It is also an important

		objective to obtain the support of the authorities to this process. It is not possible at this stage to foresee all the issues that may be raised by the stakeholders and authorities but a detailed rollout plan will be agreed with the client once the initial feedback is obtained. Generally public meetings do not constitute a suitable forum for engaging with the authorities. It may be possible that some of this consultation would be by correspondence, with limited additional telephonic liaison. However, should this not be adequate, an initial authority meeting will be required. Both the key stakeholders and authorities would be kept informed of the study progress by the newsletters described in Task 5.3 All public participation activities will be coordinated and all actions will be managed as a total logical process.
Personnel:		The work would be undertaken by A De Villiers, T Nabo, and C J Brown and overseen by MK Luger.
Budget:		A total budget of R 96 880 (excluding VAT) is anticipated for this task and involves the following personnel and hours: A De Villiers: 120 hours at R250/hr = R30 000 T Nabo: 40 hours at R250/hr = R10 000 CJ Brown: 60 hours at R400/hr = R24 000 MK Luger: 80 hours at R411/hr = R 32 880 It is anticipated that the disbursements would be covered under Tasks 5.2 and 5.3. Disbursements could amount to about R20 000. Depending on the eventual nature of the consultations and in particular the need for further meetings and workshops, this may need to adjusted on a needs basis.
Programme:		The above key stakeholder and authority meetings would constitute the earliest steps in the public participation process, and would require some adjustment to the programme by some by some four weeks.

Task Number:		**8.7 (New task requested by Client)**
Title:		**Re-assessment of Fish River Hydrology**
Original Proposal		In the TOR for the project it was indicated that the existing hydrology data should be used in the project and that no major hydrological analyses were envisaged. In this regard, the project proposal indicated that the project team would use the available information. With reference to the Fish River, it was proposed that the flow record for the Fish River produced by DWA (Namibia) would be included in the main data set used in the Orange River Replanning Study. No additional hydrological analyses were envisaged.
Motivation:		During the hydrological assessment and modelling exercise carried out as part of the Orange River Replanning Study use was made of relatively unverified Fish River runoff data. No rainfall/runoff modelling was carried out in order to fill gaps, verify estimates or extend the record to be concurrent with that of the Orange River. The Namibian Department of Water Affairs (Hydrology Division) was aware of this and made a brief examination of the data being used. While there were clearly problems with the data set, these were not considered to be unacceptable when used as part of a general study on the whole Orange River basin. However, relative to a closer examination of the Lower Orange River Basin, the impact of the Fish River becomes more significant and an improved data set is required. While a detailed rainfall/runoff assessment would be desirable, there is insufficient time to carry out this work without causing major delays to the study. Some review and limited modelling is, however, required since no work has been carried out since a study commenced in 1995 by DWA was aborted due to the transfer of staff to the newly-created NamWater.
Methodology:		The work would be carried out in the following steps: • Review data (runoff at Seeheim and other key stations and rainfall data) and any preliminary findings from the incomplete 1995 study. • Collection and analysis of rainfall data from selected key rainfall stations. Data are available at DWA and Namibia meteorological Services (NMS) • Simplified rainfall/runoff modelling to improve, patch and extend Fish River runoff record at confluence with Orange and also as inflow record for any potential Lower Fish River dam site. • Analysis of lower Fish River runoff under different scenarios (present state and future/maximum dam and abstraction development. • Short written report commenting on results and sensitivity analysis as well as recommendations on further work.
Personnel		The work would be undertaken by S Crerar, N Tromp and E Chivell under the direction of S Crerar.

Budget		A total budget of N$63 000 is anticipated for this task and involves the following personnel and hours: S Crerar: 60 hours at N$450/hr N Tromp: 40 hours at N$250/hr E Chivell: 100 hours at N$250/hr Subsistence and Travel: N$0 Communications and Computers: N$1 000
Programme		This is a high priority task and work should commence as soon as possible. The task is a critical path item and would require one month to complete.

Task Number:		**8.8 (New Task requested by Client)**
Title:		**Vioolsdrift and Noordoewer Joint Irrigation Scheme - Viability Of Further Investments**
Motivation:		The Vioolsdrift/Noordoewer Joint Irrigation Authority (JIA) and the farming community are experiencing financial difficulties that are apparent from: • their low level of reserves; • the low income of the Irrigation Board; • the farmers struggling with high levels of debt; • the perceived higher incidence of vacant farms and bankruptcies than neighbouring areas. • the inability of the JIA to maintain some sections of the infrastructure without external finance, • and the negative impact the poor condition of some parts of the infrastructure has on the performance of the scheme. Apart from the above there are also some physical factors that impose risk on the farming community such as the flood risk and shortcomings in the water conveyance system. Higher water demands due to different cropping patterns and areas under irrigation, as well as "bottlenecks" in the existing water conveyance system, plus broken and damaged sections of the conveyance, have resulted in the shortfall of irrigation water in some sections of the irrigation scheme during certain periods of the year. In order to reduce this shortfall additional river pumps were recently installed along the river. There is concern about the proper management of the system including these pumps, and urgent maintenance work is required on the infrastructure of the scheme. Due to the request for financial assistance from the Irrigation Authority to the PWC, the PWC wish to determine, at a strategic level, the financial viability of the irrigation scheme including any further investment, and the socio economic benefits of the scheme for the area. Further, more detailed studies may need to follow. The objective of this work is thus to provide a financial and socio economic situation assessment at a strategic level, of the irrigation development and the farming community and make recommendations for changes including institutional, managerial and agricultural changes which may be necessary to improve the financial and socio economic situation of the scheme and the agricultural community.
Methodology:		This task will be integrated with **Task 2** (Water Requirements and Water Conservation) of the LORMS study, but will require a more strategically focused investigation of this scheme than is required for the whole project. The particular elements of these tasks and extensions required for this proposed additional task are given below. 1. Irrigation Demands 1.1 General Approach The Namibian Study on the Identification and Prioritization of Irrigation Development, the ORRS and the Northern Cape Situation Assessment will be reviewed and relevant information extracted. The 1 in 10 000 photo maps of the border along the Orange River based on the September 1992 aerial photography will also be used as well as satellite imagery previously purchased by DWAF for the ORRS.

Methodology cont.

The information contained in the various reports, particularly those studying the JIS, on irrigated areas, quotas and application rates will be reviewed and compared with the following to establish the effectiveness of the agricultural practices in the scheme.

- information from DWA's and DWAF's regional offices on Water User Associations (Irrigation Boards) including historical growth patterns.
- Results utilising the SAPWAT and/or CROPWAT models taking crop types, climatological factors etc., into account.
- selected sampling undertaken during the site visit and workshop discussions described below.

1.2 Specific activities

A site visit will be arranged to the Vioolsdrift and Noordoewer Irrigation scheme for the purpose of:

- Broad Assessment of high water table drainage and salt leaching requirements.
- Verifying existing crop types and cropping patterns.
- Broad review of the suitability of soil types in areas for potential developments that can be linked to the scheme's existing infrastructure.
- Evaluating water demand management issues e.g. bulk distribution losses; inefficiencies in water use/application, the availability of technical support etc.

2 Irrigation Efficiency

2.1 General Approach

DWAF's Water Conservation and Demand Management (WCDM) Strategy for the Agricultural Sector will serve as the guide for assessing opportunities for water conservation by irrigators. Members of the team will visit the scheme in order to assess current usage and management procedures with a view to assessing the opportunities for WCDM. The following activities will be undertaken at a level of investigation applicable to the strategic assessment of the viability of the JIA

- Irrigation practices and modes of application (drip, sprinkler etc);
- Crop types and alternative crops as well as optimal application rates (growing more food with less water)
- Derivation of crop water requirements;
- Drainage and leaching requirements;
- Irrigation scheduling;
- Measurement of irrigation water use;
- Pricing of irrigation water use and tariffs
- Lining and maintenance of canals.

2.2 Specific Activities

During the site visit discussions will be held with the Joint Irrigation Authority regarding technical and financial problems experienced:.

The institutional arrangements and the institutional and management capacity of the JIA will be evaluated:

methodology contd.

The extent of capital works required for repairs and extension of the water conveyance system will be determined according to information obtained from existing relevant reports on the water distribution network. This will include the report by A S Engels, Ryan Peters & Leonardo Manus of November 2001 (Report on technical inspection of Noordoewer / Vioolsdrift irrigation scheme and the report by Africon, "Rehabilitation of the Noordoewer/-Vioolsdrift Irrigation Scheme – Report on the Capacity of the System and Upgrading Proposals", October 1998.

Possible limiting production factors such as the capacity of the conveyance to provide peak as well as annual water requirements will be evaluated for the existing and future needs on both the South African and Namibian sides. (These will follow from the work required for sub-Tasks 2.1a and 2.2b, as well as through discussions with the JIA.)

The extent and utilization of irrigable areas that lie below the present and possible future flood lines will also be established through these discussions as well as through discussions with the farmers.

The irrigation and efficiency and on farm management practices of this scheme will be evaluated and compared with neighbouring areas.

In this manner an estimate will be made of;

a) The cost to perform urgent repair and maintenance work,

b) The cost to upgrade the system in order to supply the present and future needs, and

c) The future operational costs and tariffs for financial viability.

d) The income expenditure and cash flow of the JIA from.

e) The institutional and managerial effectiveness of the JIA .

f) Debt repayments for various loan/subsidy alternatives.

2.3 Socio-economics

In addition to the above tasks the following will be undertaken at a strategic level:

The socio-economic situation (population, income, agri-business, farm workers, unemployment, etc) in the Vioolsdrift/Noordoewer community will be evaluated.

The Institutional arrangements and different tax/support bases between SA and Namibia will be determined

Input regarding opportunities for horticulture development will be obtained and evaluated with options of different cropping patterns

The study will undertake an economic assessment of costs and benefits of the various development scenarios at a strategic level of detail. These development scenarios range from closure of the scheme to limited re-organisation and restructuring. The assessment of costs and benefits will include the social impacts of the different scenarios. Alternatively the social and economic aspects will be outlined qualitatively.

Personnel:		The work for this task requires high level and strategic inputs. The work will mainly be undertaken as an extension of the work of the team members of Task 2. It has a balanced involvement of Namibian and South African team members. The main individuals involved will be Dr D Louw, P de Wet, F Oosthuizen and F du Plessis that will deal with the agricultural economic investigation. B van der Merwe will provide inputs to irrigation efficiency. The team under guidance of T Hart will provide the input relating to the social aspects, whilst the strategic focus and perspective will be ensured by the task leader, project manager and deputy project managers. The services of J Rutherford of LVA will be utilized to ensure proper bench marking and congruence with previous work – (His cost will be recovered as a disbursement).
Programme:		**The work will be undertaken as an extension of and parallel with Task 2, Water Requirements and Water Conservation, of the LORMS study, and will take about 12 weeks to complete to allow it to tie in with the related tasks in the main project.**
Budget:		The cost of this additional task is R198 602.00 excluding VAT.

APPENDIX B

Costs and Man-hour Details

- B1: Man-hours per Task
- B2: Costs per Task
- B3: Man-hour and Cost Breakdown per Task
- B4: Costs per month
- B5: Cash-flow Projection
- B6: Comparison of Initial and Current Hours

Table B1: Details of Hours Per Task

Name	Task1	Task2.1	Task2.2	Task 2.3	Task3	Task4.1	Task4.2	Task4.3	Task5.1	Task5.2	Task5.3	Task6.1	Task6.2	Task7	Total
Alexander	0	0	0	0	0	200	0	0	0	0	0	0	0	0	**200**
Becker	0	0	0	24	0	0	0	0	0	0	162	26	0	430	**642**
Beukes	0	0	0	0	0	118	0	0	0	0	0	0	0	0	**118**
Brown1, C	0	12	0	0	0	0	0	0	186	65	0	0	0	0	**263**
Brown2, CJ	0	40	0	0	0	104	0	0	148	54	60	0	0	0	**406**
Burger	0	32	20	0	0	0	0	0	0	0	0	0	0	0	**52**
Burmeister	50	0	0	0	0	0	0	8	0	0	0	16	0	10	**84**
Chivell	0	0	0	0	100	176	0	0	0	0	0	0	0	0	**276**
Craig	0	86	20	0	0	0	0	0	0	0	0	0	0	0	**106**
Crerar	0	0	0	0	633	50	0	0	0	0	0	0	0	0	**683**
Crosby	0	92	34	15	0	0	0	0	0	0	0	0	0	0	**141**
De Sousa	0	0	0	0	0	15	0	0	0	0	0	0	60	0	**75**
De Villiers	0	0	0	15	0	0	0	0	0	0	200	0	0	0	**215**
De Wet	0	68	120	86	0	0	0	0	0	0	0	0	0	0	**274**
De Witt	0	0	0	0	8	0	0	0	0	0	0	0	0	0	**8**
Dippenaar	0	0	0	0	0	0	0	0	0	0	40	0	0	0	**40**
Du Plessis	0	174	104	96	0	0	0	0	0	0	0	0	0	0	**374**
Eberhard	0	0	0	0	0	0	77	15	0	0	0	0	0	0	**92**
Erasmus	0	0	0	0	0	0	0	43	0	0	0	0	0	0	**43**
Frindt	0	0	0	0	0	324	0	0	0	0	0	0	0	0	**324**
George	0	0	0	0	0	56	0	0	0	0	0	0	0	0	**56**
Gorgens	0	0	0	0	38	0	0	0	0	0	0	0	0	0	**38**
Halkett	0	0	0	0	0	0	0	0	140	0	0	0	0	0	**140**
Hart	0	0	0	4	0	0	0	0	0	38	90	0	0	0	**132**
Hattingh	0	0	0	15	0	45	0	0	0	0	0	0	0	0	**60**
Hidema	0	0	0	0	0	0	0	43	0	0	0	0	0	0	**43**
Hoabeb	0	0	0	0	0	0	0	0	0	20	0	0	0	0	**20**
Huizinga	0	16	0	0	0	0	0	0	0	0	0	0	0	0	**16**
Kamish	0	0	0	0	24	0	0	0	0	0	0	0	0	0	**24**
Kania Vlok	0	0	0	10	0	0	0	0	0	0	0	0	0	0	**10**
Khosa	0	0	0	0	0	0	0	0	0	0	0	16	0	0	**16**
Kinahan	0	0	0	0	0	0	0	0	73	0	0	0	0	0	**73**
Kleynhans	0	0	0	0	0	0	96	0	0	0	0	0	0	0	**96**
Kock	0	0	72	0	0	0	0	0	0	0	0	0	0	0	**72**
Kruger	0	0	0	0	0	0	0	0	0	0	20	0	0	0	**20**
Lamprecht	0	106	24	15	0	0	0	0	0	0	0	0	0	0	**145**
Leyland	0	0	0	0	20	0	0	0	0	0	0	0	0	0	**20**
Louw	0	28	59	0	0	0	0	0	0	0	0	0	0	0	**87**
Luger	16	4	0	0	0	76	0	0	90	0	92	0	0	0	**278**
Mackellar	0	0	0	0	0	40	0	0	0	0	0	0	0	0	**40**
Mare	0	0	0	0	0	100	0	0	0	0	0	0	0	0	**100**
Maritz	0	4	0	0	0	16	0	43	0	0	0	16	0	0	**79**
Masia	0	0	0	0	0	0	0	0	48	0	0	0	0	0	**48**
McKenzie	110	0	8	0	64	12	0	16	0	0	0	0	60	90	**360**
Meyer	32	0	0	0	0	0	0	0	0	0	0	0	0	0	**32**
Mngumi	0	0	0	0	30	0	0	0	0	0	0	0	0	0	**30**
Moahloli	0	30	0	0	0	0	0	0	0	0	0	0	0	0	**30**
Morris	0	0	0	0	0	0	0	0	26	0	0	0	0	0	**26**
Mosimane	0	0	0	0	0	0	0	0	122	111	0	0	0	0	**232**
Muir	50	30	0	40	0	0	8	11	20	0	0	0	60	40	**259**
Nabo	0	0	0	0	0	0	0	0	0	0	120	0	0	0	**120**
Namaseb	0	0	0	0	0	0	8	0	0	0	0	0	0	0	**8**
Namassist - Vlok	0	0	0	0	0	0	0	0	0	0	0	0	0	265	**265**
Neethling	0	0	0	0	0	0	0	0	0	0	0	0	0	100	**100**
Nel	0	8	0	0	0	0	0	0	0	0	0	0	0	0	**8**
Oosthuizen	0	0	0	24	0	0	96	11	0	0	0	0	0	0	**131**
Oppelt	0	0	0	0	0	0	0	0	0	0	20	0	0	0	**20**
Pearson	0	0	0	0	20	0	0	0	0	0	0	0	0	0	**20**
Renke	48	0	0	0	30	0	0	0	0	0	0	0	60	0	**138**
Rooseboom	0	0	0	0	76	0	0	0	0	0	0	0	0	0	**76**
Rossouw	0	0	0	0	4	0	0	0	0	0	0	0	0	0	**4**
Rutherford	0	0	0	5	0	0	0	0	0	0	0	0	0	0	**5**
Schafer	0	0	24	0	0	0	0	0	0	0	0	0	0	0	**24**
Shand	50	0	0	0	0	0	8	0	0	0	0	0	0	0	**58**
Solomons	0	0	0	0	0	0	0	0	122	136	0	0	0	0	**258**
Swart Susan	0	0	0	0	246	100	0	0	0	0	0	0	0	0	**346**
Tanner	44	0	0	16	0	0	0	27	0	0	0	26	60	230	**402**
Timm	22	0	0	0	0	0	0	0	0	0	18	0	20	40	**100**
Tromp	0	92	0	0	40	0	0	0	0	0	0	0	0	0	**132**
Van Den Heever	0	0	0	0	0	0	0	0	0	0	0	0	0	165	**165**
Van Der Merwe	0	8	236	40	0	0	0	0	0	0	0	0	0	0	**284**
Van Rooyen	56	34	0	0	170	30	0	0	0	0	0	0	60	0	**350**
Van Wyk	0	0	0	0	0	297	0	0	0	0	0	0	0	0	**297**
Vogel	22	0	0	24	0	0	0	0	0	0	32	20	60	280	**438**
															10747

Table B2: Details of Costs per Task

Name	Task1	Task2.1	Task2.2	Task2.3	Task3	Task4.1	Task4.2	Task4.3	Task5.1	Task5.2	Task5.3	Task6.1	Task6.2	Task7	Total
Alexander	0	0	0	0	0	79840	0	0	0	0	0	0	0	0	**79840**
Becker	0	0	0	9600	0	0	0	0	0	0	64800	10400	0	172000	**256800**
Beukes	0	0	0	0	0	29500	0	0	0	0	0	0	0	0	**29500**
Brown1, C	0	4200	0	0	0	0	0	0	65100	22750	0	0	0	0	**92050**
Brown2, CJ	0	16000	0	0	0	41600	0	0	59120	21760	24000	0	0	0	**162480**
Burger	0	16000	10000	0	0	0	0	0	0	0	0	0	0	0	**26000**
Burmeister	27500	0	0	0	0	0	0	4422	0	0	0	8800	0	5500	**46222**
Chivell	0	0	0	0	25000	44000	0	0	0	0	0	0	0	0	**69000**
Craig	0	34400	8000	0	0	0	0	0	0	0	0	0	0	0	**42400**
Crerar	0	0	0	0	284625	22500	0	0	0	0	0	0	0	0	**307125**
Crosby	0	32200	11900	5250	0	0	0	0	0	0	0	0	0	0	**49350**
De Sousa	0	0	0	0	0	3750	0	0	0	0	0	0	15000	0	**18750**
De Villiers	0	0	0	3750	0	0	0	0	0	0	50000	0	0	0	**53750**
De Wet	0	27200	48000	34400	0	0	0	0	0	0	0	0	0	0	**109600**
De Witt	0	0	0	0	4400	0	0	0	0	0	0	0	0	0	**4400**
Dippenaar	0	0	0	0	0	0	0	0	0	0	10000	0	0	0	**10000**
Du Plessis	0	82650	49400	45600	0	0	0	0	0	0	0	0	0	0	**177650**
Eberhard	0	0	0	0	0	0	34720	6646	0	0	0	0	0	0	**41365**
Erasmus	0	0	0	0	0	0	0	19296	0	0	0	0	0	0	**19296**
Frindt	0	0	0	0	0	129760	0	0	0	0	0	0	0	0	**129760**
George	0	0	0	0	0	25200	0	0	0	0	0	0	0	0	**25200**
Gorgens	0	0	0	0	20900	0	0	0	0	0	0	0	0	0	**20900**
Halkett	0	0	0	0	0	0	0	0	25245	0	0	0	0	0	**25245**
Hart	0	0	0	2200	0	0	0	0	0	21038	49500	0	0	0	**72738**
Hattingh	0	0	0	6000	0	18000	0	0	0	0	0	0	0	0	**24000**
Hidema	0	0	0	0	0	0	0	17152	0	0	0	0	0	0	**17152**
Hoabeb	0	0	0	0	0	0	0	0	0	7000	0	0	0	0	**7000**
Huizinga	0	6000	0	0	0	0	0	0	0	0	0	0	0	0	**6000**
Kamish	0	0	0	0	4608	0	0	0	0	0	0	0	0	0	**4608**
Kania Vlok	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	**2000**
Khosa	0	0	0	0	0	0	0	0	0	0	0	8000	0	0	**8000**
Kinahan	0	0	0	0	0	0	0	0	18275	0	0	0	0	0	**18275**
Kleynhans	0	0	0	0	0	0	24000	0	0	0	0	0	0	0	**24000**
Kock	0	0	21600	0	0	0	0	0	0	0	0	0	0	0	**21600**
Kruger	0	0	0	0	0	0	0	0	0	0	5000	0	0	0	**5000**
Lamprecht	0	31800	7200	4500	0	0	0	0	0	0	0	0	0	0	**43500**
Leyland	0	0	0	0	9000	0	0	0	0	0	0	0	0	0	**9000**
Louw	0	8400	17700	0	0	0	0	0	0	0	0	0	0	0	**26100**
Luger	6576	1644	0	0	0	31236	0	0	37072	0	37812	0	0	0	**114340**
Mackellar	0	0	0	0	0	22000	0	0	0	0	0	0	0	0	**22000**
Mare	0	0	0	0	0	45000	0	0	0	0	0	0	0	0	**45000**
Maritz	0	2200	0	0	0	8800	0	23584	0	0	0	8800	0	0	**43384**
Masia	0	0	0	0	0	0	0	0	14400	0	0	0	0	0	**14400**
McKenzie	60500	0	4400	0	35200	6600	0	8844	0	0	0	0	33000	49500	**198044**
Meyer	9600	0	0	0	0	0	0	0	0	0	0	0	0	0	**9600**
Mngumi	0	0	0	0	12000	0	0	0	0	0	0	0	0	0	**12000**
Moahloli	0	7500	0	0	0	0	0	0	0	0	0	0	0	0	**7500**
Morris	0	0	0	0	0	0	0	0	5100	0	0	0	0	0	**5100**
Mosimane	0	0	0	0	0	0	0	0	30400	27625	0	0	0	0	**58025**
Muir	25000	15000	0	20000	0	0	4000	5360	10000	0	0	0	30000	20000	**129360**
Nabo	0	0	0	0	0	0	0	0	0	0	30000	0	0	0	**30000**
Namaseb	0	0	0	0	0	0	3200	0	0	0	0	0	0	0	**3200**
Namassis - Vlok	0	0	0	0	0	0	0	0	0	0	0	0	0	53000	**53000**
Neethling	0	0	0	0	0	0	0	0	0	0	0	0	0	20000	**20000**
Nel	0	3128	0	0	0	0	0	0	0	0	0	0	0	0	**3128**
Oosthuizen	0	0	0	8400	0	0	33600	3752	0	0	0	0	0	0	**45752**
Oppelt	0	0	0	0	0	0	0	0	0	0	5000	0	0	0	**5000**
Pearson	0	0	0	0	7600	0	0	0	0	0	0	0	0	0	**7600**
Renke	12000	0	0	0	7500	0	0	0	0	0	0	0	15000	0	**34500**
Rooseboom	0	0	0	0	38000	0	0	0	0	0	0	0	0	0	**38000**
Rossouw	0	0	0	0	1908	0	0	0	0	0	0	0	0	0	**1908**
Rutherford	0	0	0	2750	0	0	0	0	0	0	0	0	0	0	**2750**
Schafer	0	0	10800	0	0	0	0	0	0	0	0	0	0	0	**10800**
Shand	27500	0	0	0	0	0	4400	0	0	0	0	0	0	0	**31900**
Solomons	0	0	0	0	0	0	0	0	15504	17340	0	0	0	0	**32844**
Swart Susan	0	0	0	0	110700	45000	0	0	0	0	0	0	0	0	**155700**
Tanner	24200	0	0	8800	0	0	0	14740	0	0	0	14080	33000	126280	**221100**
Timm	10395	0	0	0	0	0	0	0	0	0	8505	0	9450	18900	**47250**
Tromp	0	23000	0	0	10000	0	0	0	0	0	0	0	0	0	**33000**
Van Den Heever	0	0	0	0	0	0	0	0	0	0	0	0	0	33000	**33000**
Van Der Merwe	0	3200	94400	16000	0	0	0	0	0	0	0	0	0	0	**113600**
Van Rooyen	28000	17000	0	0	85000	15000	0	0	0	0	0	0	30000	0	**175000**
Van Wyk	0	0	0	0	0	136118	0	0	0	0	0	0	0	0	**136118**
Vogel	10395	0	0	11340	0	0	0	0	0	0	15120	9450	28350	132206	**206861**
	241666	**331522**	**283400**	**180590**	**656441**	**703904**	**103920**	**280216**	**280216**	**117513**	**299737**	**59530**	**193800**	**630386**	**4186419**

Table B3a: Hours per Company

Task	WRP	WCE	NS	B&P	SA TOT	NA TOT	Total	Task as % of Total
Task 1 : Inception Report	246	50	154	50	400	100	500	5
Task 2.1 : Water Requirements	550	174	40	100	590	274	864	8
Task 2.2 : Water Conservation	345	236	0	140	345	376	721	7
Task 2.3 Vioolsdrift/Noordoewer Irrigation	146	90	59	134	205	224	429	4
Task 3 : Water Resources Yield and Evaluation	616	773	114	0	730	773	1503	14
Task 4.1 : Dam Development Options	302	520	413	524	715	1044	1759	16
Task 4.2 : Economic Analysis (Cost benefit/URV)	0	8	181	104	181	112	293	3
Task 4.3 : Water Sharing, Cost & Dam Operations	59	54	42	62	101	115	216	2
Task 5.1 : Environmental Inputs (Including Archeological)	0	289	612	73	612	363	974	9
Task 5.2 : Social Issues	0	165	239	20	239	185	424	4
Task 5.3 : Public Consultation	0	60	612	182	612	242	854	8
Task 6.1 : Feasibility Study	0	16	62	42	62	58	120	1
Task 6.2 : Main Report	240	60	140	0	380	60	440	4
Task 7 : Project Management	190	40	714	705	904	745	1649	15
Task 8: Additional Tasks	0	0	0	0	0	0	0	0
Total	2694	2534	3382	2136	6076	4670	10746	100
% of Total	25	24	31	20	57	43		
Combined % of Total	49		51		57	43		

Table B3b: Cost per Company

Task	WRP	WCE	NS	B&P	SA TOT	NA TOT	Total	Task as % of Total
Task 1 : Inception Report	110100	25000	79066	27500	189166	52500	241666	6
Task 2.1 : Water Requirements	213950	59400	14972	43200	228922	102600	331522	8
Task 2.2 : Water Conservation	131000	94400	0	58000	131000	152400	283400	7
Task 2.3 Vioolsdrift/Noordoewer Irrigation	64100	38000	26090	52400	90190	90400	180590	4
Task 3 : Water Resources Yield and Evaluation	288400	319625	48416	0	336816	319625	656441	16
Task 4.1 : Dam Development Options	133350	171600	189354	209600	322704	381200	703904	17
Task 4.2 : Economic Analysis (Cost benefit/URV)	0	4000	63120	36800	63120	40800	103920	2
Task 4.3 : Water Sharing, Cost & Dam Operations	25996	28944	21386	27470	47382	56414	103796	2
Task 5.1 : Environmental Inputs (Including Archeological)	0	99520	162421	18275	162421	117795	280216	7
Task 5.2 : Social Issues	0	49385	61128	7000	61128	56385	117513	3
Task 5.3 : Public Consultation	0	24000	205937	69800	205937	93800	299737	7
Task 6.1 : Feasibility Study	0	8800	31530	19200	31530	28000	59530	1
Task 6.2 : Main Report	93000	30000	70800	0	163800	30000	193800	5
Task 7 : Project Management	69500	20000	310386	230500	379886	250500	630386	15
Task 8: Additional Tasks	0	0	0	0	0	0	0	0
Total	1129396	972674	1284604	799745	2414000	1772419	4186419	100
% of Total	27	23	31	19	58	42		
Combined % of Total	50		50		58	42		

Table B.4 Costs per Month

Task	Jan/2002 Month 1	Feb/2002 Month 2	Mar/2002 Month 3	Apr/2002 Month 4	May/2002 Month 5	Jun/2002 Month 6	Jul/2002 Month 7	Aug/2002 Month 8	Sep/2002 Month 9	Oct/2002 Month 10
Task 1 : Inception Report	76600	96638	68428	0	0	0	0	0	0	0
Task 2.1 : Water Requirements	0	0	26100	33100	111550	27100	92172	41500	0	0
Task 2.2 : Water Conservation	0	0	0	0	0	0	54000	133900	40800	54700
Task 2.3 Vioolsdrift/Noordoewer Irrigation	0	0	0	0	0	0	0	0	0	0
Task 3 : Water Resources Yield and Evaluation	0	0	67950	23200	46400	140325	75800	0	58300	31000
Task 4.1 : Dam Development Options	0	0	0	0	25740	71264	17196	62592	52856	120064
Task 4.2 : Economic Analysis (Cost benefit/URV)	0	0	0	0	0	0	0	0	0	26000
Task 4.3 : Water Sharing, Cost & Dam Operations	0	0	0	0	0	0	0	0	0	0
Task 5.1 : Environmental Inputs + Archaeological	0	0	0	0	0	0	0	0	0	0
Task 5.2 : Social Issues	0	0	0	0	0	0	0	0	0	0
Task 5.3 : Public Consultation	0	0	0	19932	0	0	77500	0	0	8220
Task 6.1 : Feasibility Study	0	0	0	0	0	0	0	0	0	0
Task 6.2 : Main Report	0	0	0	0	0	0	0	0	0	0
Task 7 : Project Management	0	0	71500	156950	237846	0	0	0	0	0
Task 8: Additional Tasks	0	0	0	0	0	0	0	0	0	0
Total	76600	96638	233978	233182	421536	238689	316668	237992	151956	239984
% of Total	2%	2%	6%	6%	10%	6%	8%	6%	4%	6%
Cumulative Total	76600	173238	407216	640398	1061934	1300622	1617290	1855282	2007238	2247222
Cumulative % of Total	2%	4%	10%	15%	25%	31%	39%	44%	48%	54%

Table B.4 (cont) Costs per Month

Task	Nov/2002 Month 11	Dec/2002 Month 12	Jan/2003 Month 13	Feb/2003 Month 14	Mar/2003 Month 15	Apr/2003 Month 16	May/2003 Month 17	Jun/2003 Month 18	TOTAL
Task 1 : Inception Report	0	0	0	0	0	0	0	0	241666
Task 2.1 : Water Requirements	0	0	0	0	0	0	0	0	331522
Task 2.2 : Water Conservation	0	0	0	0	0	0	0	0	283400
Task 2.3 Vioolsdrift/Noordoewer Irrigation	46170	56670	35800	41950	0	0	0	0	180590
Task 3 : Water Resources Yield and Evaluation	95500	40716	56250	0	21000	0	0	0	656441
Task 4.1 : Dam Development Options	0	14000	146056	70956	123180	0	0	0	703904
Task 4.2 : Economic Analysis (Cost benefit/URV)	24600	0	0	0	53320	0	0	0	103920
Task 4.3 : Water Sharing, Cost & Dam Operations	0	0	79810	23986	0	0	0	0	103796
Task 5.1 : Environmental Inputs + Archaeological	0	158888	121328	0	0	0	0	0	280216
Task 5.2 : Social Issues	0	58213	59300	0	0	0	0	0	117513
Task 5.3 : Public Consultation	49645	5000	13500	46500	21720	57720	0	0	299737
Task 6.1 : Feasibility Study	0	0	0	0	0	33930	25600	0	59530
Task 6.2 : Main Report	0	0	0	0	0	94350	30000	69450	193800
Task 7 : Project Management	164090	0	0	0	0	0	0	0	630386
Task 8: Additional Tasks	0	0	0	0	0	0	0	0	0
Total	380005	333487	512043	183392	219220	186000	55600	69450	4186419
% of Total	9%	8%	12%	4%	5%	4%	1%	2%	100%
Cumulative Total	2627227	2960714	3472757	3656149	3875369	4061369	4116969	4186419	
Cumulative % of Total	63%	71%	83%	87%	93%	97%	98%	100%	

B5: Cumulative Cash Flow: Fees

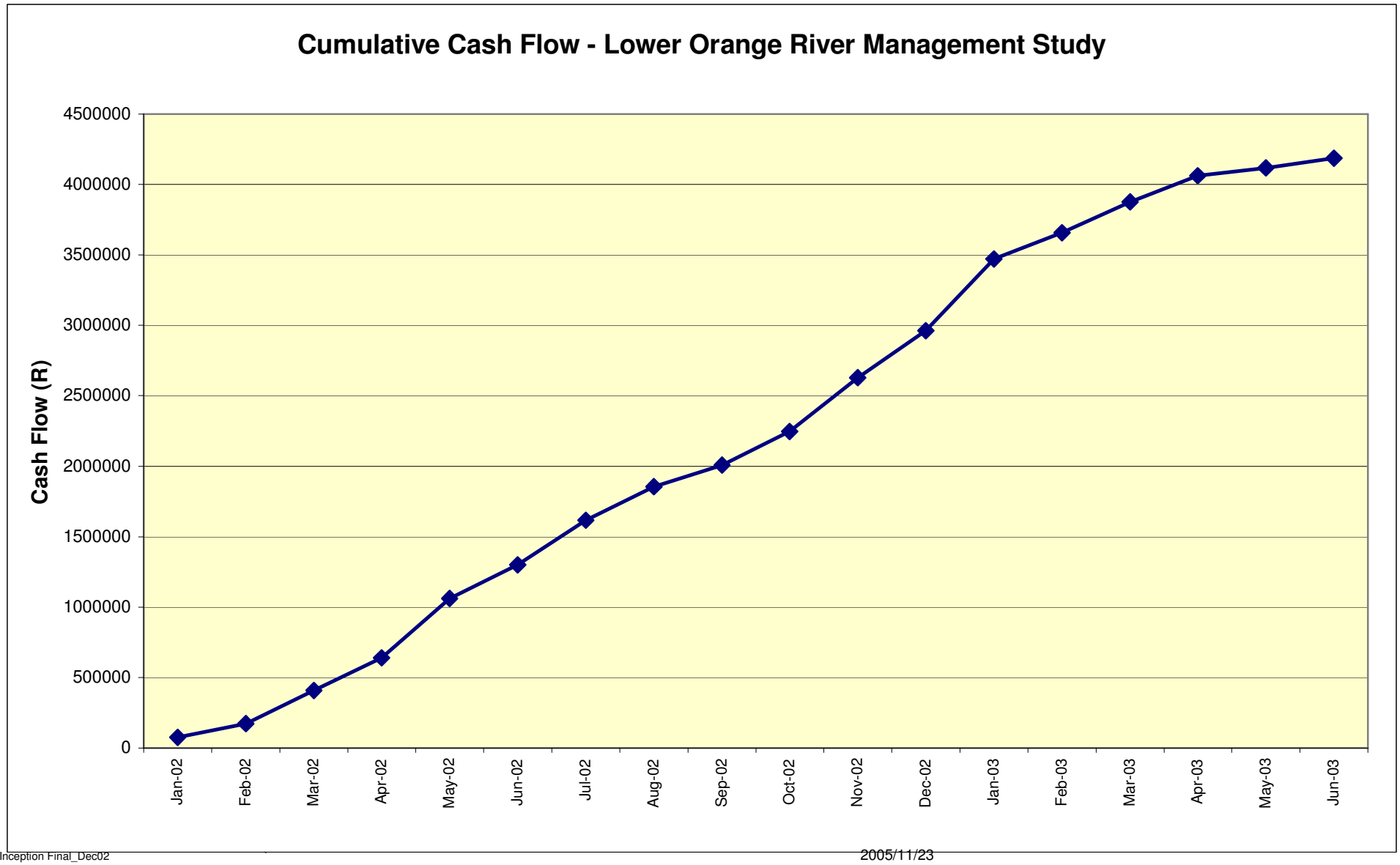

Table B6 Comparison of Original Hours and Current Hours (before additional tasks)

Name	Rate	Company	Study Position	Hours Proposal	Hours Inception	Difference
Alexander	400	B&P	Task Leader : Dam Development	148	200	52
Becker	400	B&P	Deputy Project Leader (Nam)	152	618	466
Beukes	250	WCE	Support: Dams	72	118	46
Brown, C	350	NS	Task Leader: Environmental	349	263	-86
Brown, CJ	400	WCE	Task Leader (Nam) : Environmental	285	346	61
Bruwer	350	NS	Key Support: Water Requirements	76	0	-76
Burger	500	B&P	Key Support : Water Requirements, WCDM	52	52	0
Burmeister	550	B&P	Project Leader (Nam), Reviewer	140	84	-56
Chivell	250	WCE	Support: GIS	103	176	73
Craig	400	WRP	Task Leader (SA):Water Requirements	202	106	-96
Crerar	450	WCE	Task Leader(Nam) Water Resources	452	623	171
Crosby	350	WRP	Specialist: Irrigation Requirements	116	126	10
De Jager	350	WRP	Key Support: System Analysis	45	0	-45
De Sousa	250	WRP	Key Support : GIS	59	75	16
De Villiers	250	NS	Key Support: Public Consultation	80	80	0
De Wet	400	B&P	Specialist: Water Requirements, Financial	114	188	74
De Witt	550	NS	Specialist: Hydropower	8	8	0
Dippenaar	250	NS	Key Support: Public Consultation	40	40	0
Du Plessis	475	WRP	Key Support: Irrigation	274	278	4
Du Toit	300	WRP	Support : GIS/Graphics	207	0	-207
Eberhard	450	NS	Task Leader: Financial	66	92	26
Erasmus	450	B&P	Specialist:Legal	0	43	43
Fair	400	WRP	Specialist: Hydraulic Modelling	40	0	-40
Frindt	400	B&P	Key Support Dam: Development Options	247	324	77
Furumele	400	WRP	Reviewer: System Analysis	39	0	-39
George	450	WCE	Specialist: Geology	62	56	-6
Gorgens	550	NS	Reviewer: System Modelling, Water Quality,	38	38	0
Halkett	200	NS	Specialist: Archaeology	140	140	0
Hart	550	NS	Task Leader: Social and Public Consultation	128	128	0
Hattingh	400	WRP	Key Support: Dams	24	45	21
Hidema	400	WRP	Specialist: Legal	43	43	0
Hoabeb	350	B&P	Specialist: Social	20	20	0
Huizinga	375	NS	Specialist: EFR	16	16	0
Kamish	192	NS	Support: Water Quality	24	24	0
Khosa	500	NS	Key Support: Funding	16	16	0
Kinahan	250	B&P	Specialist: Archaeology	73	73	0
Kleynhans	250	NS	Key Support: WCDM, Dams	184	96	-88
Kock	300	WRP	Key Support: WCDM and Hydrology	208	72	-136
Kruger	250	B&P	Task Leader (Nam): Public Consultation	20	20	0
Lamprecht	300	WRP	Specialist: Irrigation/Agricultural production	130	130	0
Larsen	320	NS	Key Support: Water Requirements	12	0	-12
Leyland	450	NS	Specialist: Hydropower	20	20	0
Louw	300	WRP	Specialist: Agricultural Economics	100	87	-13
Luger	411	NS	Task Leader: Environmental	189	198	9
Mackellar	550	NS	Task Leader: Dams	60	40	-20
Mare	450	WRP	Specialist: Hydrology and System Analysis	0	100	100
Maritz	550	WCE	Task Leader: Water Sharing/Reviewer	77	79	2
Masia	300	NS	Support: Environmental	48	48	0
McKenzie	550	WRP	Task Leader: Inception Report	430	360	-70
Melvill	500	NS	Key Support: Dams	89	0	-89
Meyer	300	WRP	Key Support: Project Management	339	32	-307
Miller	450	NS	Specialist:Legal	43	0	-43
Mngumi	400	WRP	Key Support: WCDM and System Analysis	30	30	0
Moahloli	250	WRP	Support: Agricultural Economics	30	30	0
Morris	200	NS	Specislist:Archeologist	26	26	-1
Mosimane	250	WCE	Task Leader (Nam): Social	232	232	0
Muir	500	WCE	Task Leader(NAM): Water Requirements	221	219	-2
Nabo	250	NS	Key Support: Public Consultation	80	80	0
Namaseb	400	B&P	Key Support: Financial	8	8	0
Namassist - Vlok	200	B&P	Assistant to Frikkie Becker	0	265	265
Neethling	200	WRP	Support: Project Management	531	100	-431
Nel	391	NS	Key Support: Water Requirements	8	8	0
Oosthuizen	350	B&P	Task Leader (Nam): Financial	107	107	0

Table B6 Comparison of Original Hours and Current Hours (before additional tasks)

Name	Rate	Company	Study Position	Hours Proposal	Hours Inception	Difference
Oppelt	250	NS	Key Support: Public Consultation	20	20	0
Pearson	380	NS	Specialist: Hydropower	20	20	0
Potgieter	400	WRP	Key Support: WCDM	17	0	-17
Renke	250	WRP	Support : GIS/Graphics	137	138	1
Rooseboom	500	WRP	Specialist: Sedimentation	76	76	0
Rossouw	477	NS	Specialist:Water Quality	4	4	0
Schafer	450	WRP	Team Leader (SA): WCDM	24	24	0
Shand	550	NS	Reviewer: Dams, Feasibility	94	58	-36
Solomons	127.5	NS	Support: Social	258	258	0
Swart Susan	450	WRP	Specialist: Hydrology and System Analysis	403	346	-57
Swartz	157.5	NS	Support: GIS	160	0	-160
Tanner	550	NS	Project Leader/Team Leader: Feasibility, (SA):	358	386	28
Timm	472.5	NS	Deputy Project Leader	350	100	-250
Tromp	250	WCE	Support: Water Requirements	92	92	0
Van Den Heever	200	NS	Support Project Management	0	165	165
Van Der Merwe	400	WCE	Task Leader: WCDM	200	244	44
Van Rooyen	500	WRP	Task Leader: System Analysis, Water Quality	298	350	52
Van Wyk	458	NS	Key Support: Dams	234	297	63
Vogel	472.5	NS	Deputy Project Leader	0	414	414
Total				**9922**	**9817**	**-105**

APPENDIX C

Breakdown of Disbursements

LOWER ORANGE RIVER MANAGEMENT STUDY: INCEPTION REPORT

Disbursements Budget: Breakdown

			Task I	Task 2.1	Task 2.2	Task 3	Task 4.1	Task 4.2	Task 4.3	Task 5.1	Task 5.2	Task 5.3	Task 6.1	Task 6.2	Task 7	
			Inception Report	Water Requirements	Water Conservation	Water Resources and Yield	Dam Development Options -	Economic Analyses	Water Sharing, Cost Sharing	Environmental Impacts Including	Social Issues	Public Participation	Feasibility Study	Main Report	Project Management	Total
		Item	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	
1		Air travel														
		Return trips														
		Sub total	6800	17400	6800	6800	6700	3300	6800	3600	3300	7200	6800	R 20,600.00	R 20,400.00	R 116,500.00
2		Air Charter														
		Sub total	28500	0	0	0	30000	0	0	0	0	0	0	R 0.00	R 0.00	R 58,500.00
3		Road travel														
		Sub total	23409.5	16575	8545	949.5	9530	2185	1795	17540	5070	14260	1755	R 8,415.00	R 2,685.00	R 112,714.00
4		Accommodation														
		Sub total	10600	4200	2000	1600	7800	1200	1200	6400	1800	0	800	R 6,400.00	R 1,800.00	R 45,800.00
5		Printing etc														
		Subtotal	1420	2160	3510.8	830	1010	780	540	1380	840	7600	0	R 30,500.00	R 1,370.00	R 51,940.80
6		Special services**														
		Sub total	0	0	0	0	25500	2075	500	1200	0	11150	0	R 5,000.00	R 4,250.00	R 49,675.00
		Grand Total	R 70,729.50	R 40,335.00	R 20,855.80	R 10,179.50	R 80,540.00	R 9,540.00	R 10,835.00	R 30,120.00	R 11,010.00	R 40,210.00	R 9,355.00	R 70,915.00	R 30,505.00	R 435,129.80
		Allocation	R 70,000.00	R 40,000.00	R 20,000.00	R 10,000.00	R 80,000.00	R 10,000.00	R 10,000.00	R 30,000.00	R 10,000.00	R 40,000.00	R 10,000.00	R 70,000.00	R 30,000.00	R 430,000.00
		Difference	-R 729.50	-R 335.00	-R 855.80	-R 179.50	-R 540.00	R 460.00	-R 835.00	-R 120.00	-R 1,010.00	-R 210.00	R 645.00	-R 915.00	-R 505.00	-R 5,129.80
		Special services**														
		Postage														
		mapping														
		etc														