water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme

(WP 10317)

INCEPTION REPORT

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Authors:	***JD Rossouw, HS Pieterse***
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Consultants: *AECOM SA (Pty) Ltd* in association with AGES, KARIWA, Scherman Colloty & Associates and Urban-Econ.*

Approved for ***Consultants:***

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DEPARTMENT OF WATER AFFAIRS (DWA)

Directorate: Options Analysis

Approved for DWA:

M Mugumo	***LS Mabuda***
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* *BKS (Pty) Ltd was acquired by AECOM Technology Corporation on 1 November 2012*

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Appendices

1 INTRODUCTION

This **Inception Report** is the first deliverable for the *Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme*. The Inception Phase provides an opportunity to finalise the Scope of Work for the assignment, to confirm the composition of the Project Team, the manpower schedule, work programme, expenditure budget and estimated cash flow.

1.1 APPOINTMENT OF CONSULTANT

The Tender for this study was submitted on 26 January 2010, in response to the Department of Water Affairs' (DWA's) request for a proposal in accordance with the Terms of Reference and DWA tender guidelines.

The Contract was approved with effect from 1 September 2010 and the Department of Water Affairs appointed **BKS** in association with four sub-consultants (**Africa Geo-Environmental Services, KARIWA Project Engineers & Associates, Scherman Colloty & Associates and Urban-Econ**) to undertake the **Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme**.

On 1 November 2012, BKS (Pty) Ltd was acquired by **AECOM Technology Corporation**. The new entity is a fully-fledged going concern with the same company registration number as that for BKS. As a result of the change in name and ownership of the company during the study period, all the final study reports will be published under the AECOM name.

1.2 BACKGROUND TO THE PROJECT

To better understand the project's context and to effectively assist the DWA in accomplishing the objectives of this study, a sound understanding of the project's origins and previous studies was essential. BKS has reviewed the reports on previous investigations that were made available by the DWA and is thus able to avoid duplicating work already undertaken. This section provides a summary of previous studies and looks at how this feasibility study will compare with and expand on previous data.

1.2.1 Previous studies

In the 1970's consultants O'Connell Manthé and Partners and Hill Kaplan Scott recommended that a regional water supply scheme based on a dam on the Xura River and a main bulk supply reservoir close to Lusikisiki (located within the then defined "administration area" of Zalu Dam) would provide potable water supply for the entire region between Lusikisiki and the coast, extending from the Mzimvubu River in the south west to the Msikaba River in the north east. Some areas up to 15 km inland of Lusikisiki would also be supplied. A **White Paper** describing the scheme was tabled by the Transkei Government in 1979. It was envisaged that the scheme would be constructed in phases - details of the proposed phasing of the scheme are provided in *Lusikisiki Regional Water Supply: Preliminary Report, Hill Kaplan Scott's 1986*.

After the reincorporation of the Transkei Homeland into the Republic of South Africa (RSA) in 1994, the DWA took over responsibility for further development of the scheme. The Directorate: National Water Resource Planning commissioned the *Eastern Pondoland Basin Study* (EPBS) in 1999 to further investigate the water supply situation in the area, with a specific focus on further development in the area originally earmarked for the Lusikisiki Regional Water Supply Scheme (LRWSS). This detailed investigation was undertaken for surface and groundwater sources, which re-affirmed that the Zalu Dam was the preferred source of surface water and recommended further investigation of groundwater sources to augment water supply to the entire area or to sub-areas.

In 2007, SRK Consulting undertook the *Lusikisiki Groundwater Feasibility Study* to investigate groundwater potential and compare the new data with data produced by earlier studies. This study reported that there is a relatively strong possibility of finding high yielding boreholes, and that a combination of surface water (Zalu Dam) and groundwater would be the most feasible solution for the LRWSS.

1.2.2 Additional required study: Environmental impact assessment

The Terms of Reference (TOR) stipulated that a full environmental impact assessment (EIA) would be commissioned by the DWA under a separate contract after the appointment of the Professional Services Provider (PSP) for the feasibility study. This separate study will also include the Scoping of the Msikaba Estuary, as required by the Reserve Team.

Co-ordination of activities and information sharing in the two assignments is crucial to the success of both studies. The team's management will therefore work closely with both the DWA and the PSP for the EIA to ensure that work progresses optimally as it affects the work schedules. Also refer to **Section 2.11**.

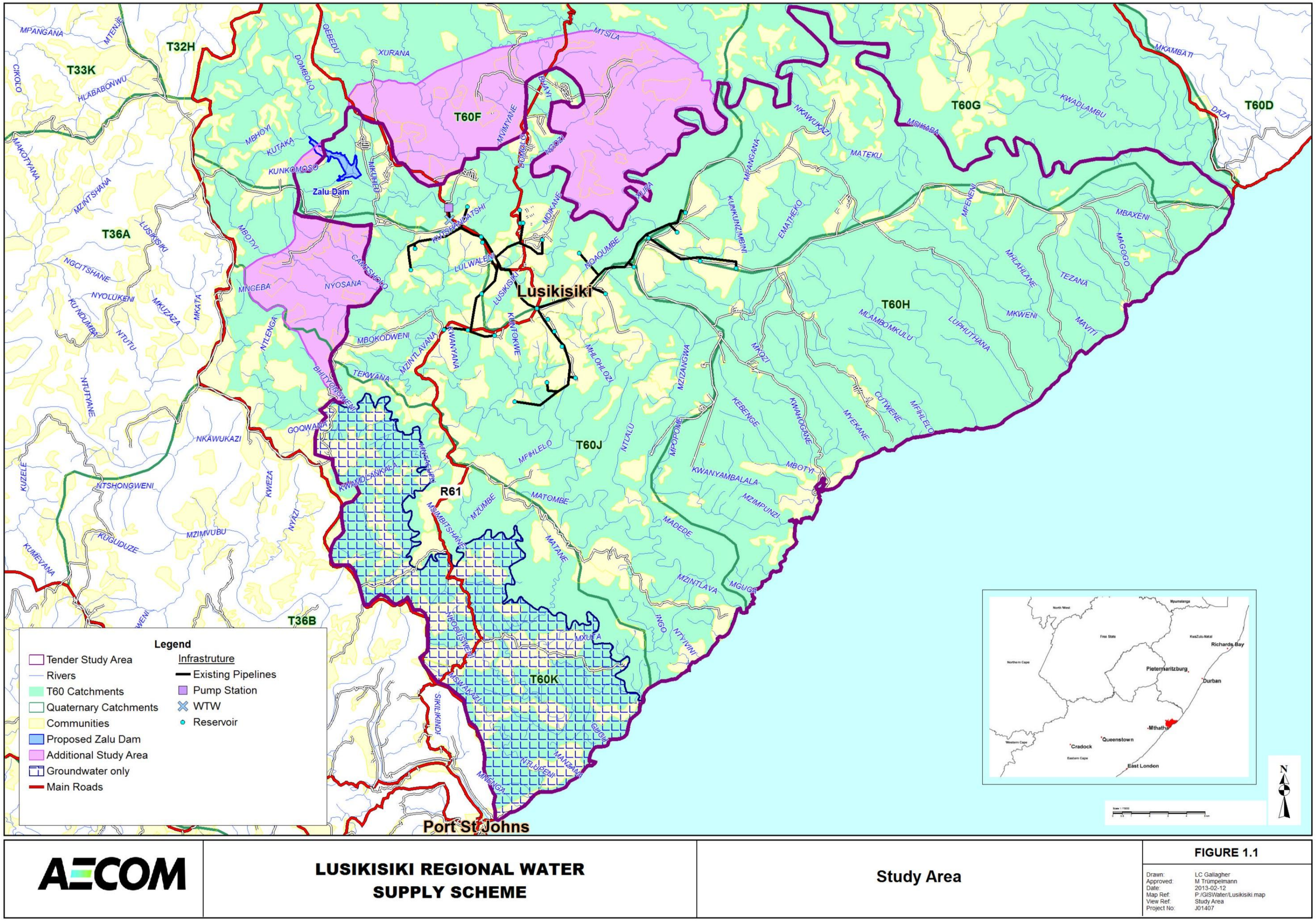


Figure 1.1: Study area

1.3 Study Area

The study area, as defined in the ToR, comprises the entire region between Lusikisiki (up to about 15 km inland) and the coast, extending from the Mzimvubu River in the south west to the Msikaba River in the north east. This area includes the Zalu Dam site in the Xura River, as well as the catchment area of Zalu Dam, and the selected conveyance routes between the dam and the extended supply area. It also includes the boreholes selected for augmentation and the routes of the pipelines to augment the water supply to the users.

During the Inception Phase the study area was extended in the vicinity of the Zalu Dam and to the north of Lusikisiki, as agreed with the DWA and as indicated on **Figure 1.1**. In the south-western part of the study area the main focus will be on water supply from groundwater, due to the distance from the surface water source, Zalu Dam, as well as unfavourable topography.

1.4 Objective, Scope and Organisation of the Study

1.4.1 Objective of the feasibility study

The objective of this study is to complete a comprehensive engineering investigation at the feasibility level for the proposed Lusikisiki Regional Water Supply Scheme, including the possible Zalu Dam in the Xura River, and to define the most attractive composition and size of the water supply components, taking augmentation from groundwater resources into account. AECOM appreciates that significant work has already been done through previous studies (see **Section 1.2.1**) and this feasibility study will focus on adding maximum value to achieve the objectives.

Part of the study is the inclusion of the Reserve for the activity, which is a legal requirement to be undertaken before licensing and dam construction can commence. The Reserve study is often undertaken after the feasibility study and EIA, with this Lusikisiki Feasibility Study providing the unique opportunity to complete the Reserve Module during the planning stages.

1.4.2 Scope of the feasibility study

This feasibility study will provide for the assessment of all aspects that impact on the viability of utilising a combination of surface water (via the Zalu Dam on the Xura River) and groundwater (via boreholes) for the expansion of the existing water supply scheme to provide all water users in the study area with an appropriate level and assurance of water supply. The study is therefore required to:

- Identify all of the technical issues likely to affect implementation, and to define and evaluate all of the actions required to address these issues;
- Provide an estimate of cost with sufficient accuracy and reliability to ensure that management decisions can be made with confidence;
- Investigate irrigation viability; and
- Provide sufficient information to enable design and implementation to proceed without further investigation.

1.4.3 Organisation of the study

The required activities for this project have been grouped into 14 modules, which were slightly restructured from the original BKS Tender and reported on and accepted accordingly at the first Project Management Committee (PMC) Meeting with the DWA on **7 September 2010**. This restructuring has not changed the scope of work, the budget or the timeframes, and has not eliminated / altered any of the tasks that were listed in the original Terms of Reference and included in the Tender for this project. After discussions with DWA Directorate: RDM, the Msikaba Estuary has been included in **Module 4** at a scoping assessment level only (see **Section 2.4**). Inclusion of the estuary was recommended in the Tender.

The new study structure, as discussed with and approved by the DWA at the first PMC meeting (**7 September 2010**), is shown in **Table 1.1** below.

Table 1.1: Study structure

Restructured modules	Modules from ToR	Module leader	Company	Deliverable
1. PROJECT MANAGEMENT 1.1 Study initiation and inception 1.2 Project management and administration	Project management (incl. study initiation and inception)	JD Rossouw	AECOM	**Inception Report**
2. WATER RESOURCES	***Module 2***: Yield analysis	JD Rossouw	AECOM	**Water Resources Report**
2.1 Hydrology	***Module 1***: Hydrology	E van Niekerk	AECOM	♦ Hydrology chapter in Water Resources Report
2.2 Yield analysis	2.1 Water resources	JD Rossouw		♦ Yield Analysis chapter in Water Resources Report
2.3 Reservoir sedimentation	2.3 Reservoir sedimentation	Dr A le Grange	AECOM	♦ Sedimentation chapter in Water Resources Report
3. GROUNDWATER AUGMENTATION	***Module 5***: Groundwater augmentation	JA Myburgh	AGES	**Assessment of Augmentation from Groundwater Report**

Restructured modules	Modules from ToR	Module leader	Company	Deliverable
4. RESERVE - ECOLOGICAL WATER REQUIREMENTS	2.2 Ecological water requirements	Dr P Scherman	SC&A	**Intermediate Reserve Determination Report** ♦ Reserve Template
5. WATER REQUIREMENTS	***Module 3***: Water requirements	HS Pieterse	AECOM	
5.1 Domestic water requirements	3.1 Domestic water requirements	T Feigenbaum	Urban-Econ	**Domestic Water Requirements Report**
5.2 Agriculture / Irrigation potential	3.2 Irrigation potential	G Bloem	Kariwa	**Irrigation Potential Assessment Report**
6. WATER SERVICE INFRASTRUCTURE		Dr GH de Villiers	AECOM	**Water Distribution Infrastructure Report**
6.1 Distribution infrastructure	3.3 Distribution infrastructure	JPC van Heerden	AECOM	♦ Chapter in Water Distribution Infrastructure Report
6.2 Water quality	***Module 4*** Water quality	Dr GH de Villiers	AECOM	♦ Chapter in Water Distribution Infrastructure Report
7. PROPOSED ZALU DAM		W van Wyk	AECOM	
7.1 Site investigations	***Module 6*** Site investigations	M van Schalkwyk	AECOM	**Materials and Geotechnical Investigations Report**
7.2 Dam technical details	***Module 7*** Dam technical details	W van Wyk	AECOM	**Dam Feasibility Design Report, including design criteria, dam type selection, dam sizing and costing**
8. COST ESTIMATE AND COMPARISON	***Module 8*** Cost estimate and comparison	HS Pieterse	AECOM	♦ Project cost chapters included in Feasibility Design and Main Study Reports
9. REGIONAL ECONOMICS	***Module 10*** Regional economics	BJ van der Merwe	Urban-Econ	**Regional Economics Report**
10. ENVIRONMENTAL SCREENING	***Module 9*** Environmental screening	N Liversage	AECOM	**Environmental Screening Report** ♦ Scope of works for EIA
11. PUBLIC PARTICIPATION	***Module 13*** Public participation	HS Pieterse	AECOM	♦ Included in Environmental Screening Report
12. LEGAL, INSTITUTIONAL & FINANCIAL ARRANGEMENTS	***Module 12*** Legal, institutional and financial arrangements	RA Pullen	AECOM	♦ Legal, institutional & financing arrangements chapter in Main Study Report

Restructured modules	Modules from ToR	Module leader	Company	Deliverable
13. RECORD OF IMPLEMENTATION DECISIONS	***Module 11*** Record of implementation decisions	HS Pieterse	AECOM	**Record of Implementation Decisions Report**
14. MAIN REPORT AND REVIEWS	***Module 14*** Task reviews, recommendations and Main Report	JD Rossouw	AECOM	**Main Study Report**

The project is programmed over 36 months to allow for project start-up, the Inception Phase, the Intermediate Reserve Determination over two full wet and dry seasons (24 months) and the close-out of the project. The programme for the study is shown in **Figure 1.2**.

1.5 Governance of the Study

Integration management is crucial to the successful completion of this project and requires sound project management and a strong working relationship within the project team and between the project team and the DWA. AECOM has thus assigned Module Leaders to tend to and oversee each of the key modules of the feasibility study (see **Table** 1.1). The individual Module Leaders will report to the Study Leader.

Effective liaison between the DWA Project Manager and the Study Leader and his team is ensured through the establishment of a Project Management Committee (PMC). The PMC will be responsible for governing and driving the study, and will include the DWA Project Manager, the Study Leader (supported by Module Leaders and support staff) and representatives of other DWA directorates nominated to participate at certain stages of the project. A representative of the OR Tambo District Municipality has also been invited to the PMC meetings to ensure that the local considerations and situation of interested and affected parties are accounted for at the appropriate level. Further details of the PMC meetings are discussed in **Section 2.1.2**.

Although a detail public participation process will be conducted in the concurrent Environmental Impact Assessment, consultation with key stakeholders is crucial for preparation, and later possible ownership and associated responsibilities of a regional water supply scheme. Therefore, a Stakeholder Committee (SC) will be established and all key stakeholders will be invited to participate. Details of the SC are discussed in **Section 2.11**.

ID	Outline Number	Task Name	Duration	Start	Finish
1	1	START OF CONTRACT	0 days	Wed 10/09/01	Wed 10/09/01
2	2	**MODULE 1: PROJECT MANAGEMENT (JD ROSSOUW)**	**710 days**	**Wed 10/09/01**	**Mon 13/08/26**
3	2.1	**1.1 Study Initiation & Inception**	**185 days**	**Wed 10/09/01**	**Mon 11/06/20**
19	2.2	**1.2 Project Management & Administration**	**710 days**	**Wed 10/09/01**	**Mon 13/08/26**
22	3	**MODULE 2: WATER RESOURCES**	**538 days**	**Thu 10/12/09**	**Thu 13/03/28**
23	3.1	**2.1: Hydrology (E van Niekerk)**	**65 days**	**Thu 10/12/09**	**Wed 11/04/06**
29	3.2	**2.2: Yield analysis (JD Rossouw)**	**473 days**	**Mon 11/02/21**	**Wed 13/02/13**
38	3.3	**2.2: Reservoir sedimentation (A la Grange)**	**40 days**	**Fri 11/07/29**	**Fri 11/09/23**
40	3.4	**Water Resource Assessment Report**	4 wks	Thu 13/02/14	Wed 13/03/13
41	3.5	Approval of Water Resource Assessment Report by PMC	2 wks	Thu 13/03/14	Thu 13/03/28
42	4	**MODULE 3: GROUNDWATER AUGMENTATION (J MYBURGH)**	**366 days**	**Thu 10/12/09**	**Thu 12/07/05**
49	5	**MODULE 4: RESERVE - EWRs (P SCHERMAN)**	**822 days**	**Wed 10/09/15**	**Thu 14/03/06**
60	6	**MODULE 5: WATER REQUIREMENTS (HS PIETERSE)**	**170 days**	**Wed 10/09/15**	**Fri 11/06/10**
61	6.1	**5.1 Domestic water requirements (T Feigenbaum)**	**80 days**	**Thu 10/12/09**	**Thu 11/04/28**
69	6.2	**5.2 Agriculture/Irrigation Potential (G Bloem)**	**130 days**	**Wed 10/09/15**	**Wed 11/04/13**
75	6.3	**5.3 Afforestation (E van Niekerk)**	**10 days**	**Thu 10/12/09**	**Fri 11/01/14**
77	6.4	Water Requirements Report	4 wks	Fri 11/04/29	Fri 11/05/27
78	6.5	Approval of Water Requirements Report by PMC	2 wks	Mon 11/05/30	Fri 11/06/10
79	7	**MODULE 6: WATER SERVICES INFRASTRUCTURE (J Enslin)**	**358 days**	**Mon 11/07/11**	**Tue 13/01/15**
80	7.1	**6.1 Distribution Infrastructure (P van Heerden)**	**307 days**	**Wed 11/09/21**	**Tue 13/01/15**
86	7.2	**6.2: Water Quality (G de Villiers)**	**85 days**	**Mon 11/07/11**	**Mon 11/11/07**
90	8	**MODULE 7: PROPOSED ZALU DAM (D Badenhorst)**	**568 days**	**Mon 11/09/19**	**Wed 14/02/12**
91	8.1	**7.1: Site Investigations (M van Schalkwyk)**	**192 days**	**Wed 12/05/02**	**Mon 13/02/18**
98	8.2	**7.2: Dam Technical Details (D Badenhorst)**	**568 days**	**Mon 11/09/19**	**Wed 14/02/12**
106	9	**MODULE 8: COST ESTIMATE & COMPARISON (HS PIETERSE)**	**225 days**	**Tue 13/03/05**	**Wed 14/02/12**
112	10	**MODULE 9: REGIONAL ECONOMICS (B VD MERWE)**	**80 days**	**Tue 13/03/19**	**Mon 13/07/15**
120	11	**MODULE 10: ENVIRONMENTAL SCREENING (N LIVERSAGE)**	**222 days**	**Mon 11/07/11**	**Thu 12/06/14**
125	12	**MODULE 11: PUBLIC PARTICIPATION (HS Pieterse)**	**556 days**	**Thu 11/05/19**	**Fri 13/09/06**
137	13	**MODULE 12: LEGAL, INSTITUTIONAL & FINANCIAL ARRANGEMENTS (RA PULLEN)**	**611 days?**	**Mon 11/01/17**	**Mon 13/07/29**
148	14	**MODULE 13: RECORD OF IMPLEMENTATION OF DECISIONS (RID) (HS PIETERSE)**	**64.5 days**	**Thu 13/10/24**	**Wed 14/02/12**
151	15	**MODULE 14: MAIN REPORT & REVIEWS (JD ROSSOUW)**	**79.25 days**	**Thu 13/11/07**	**Wed 14/03/19**
155	16	END OF CONTRACT / HANDOVER	0 days	Wed 14/03/19	Wed 14/03/19

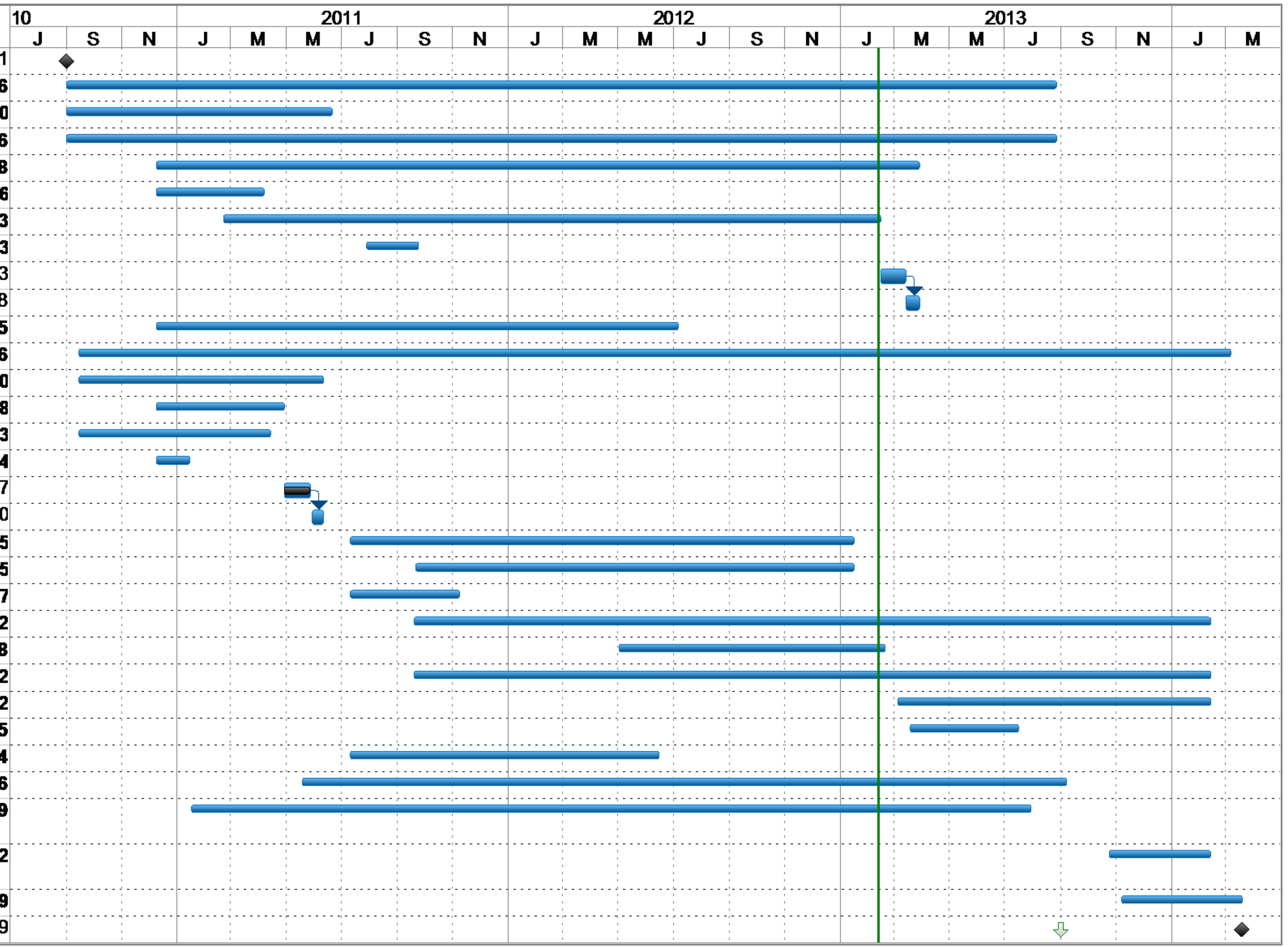


Figure 1.2: Summarised study programme (Nov 2012)

2 STUDY MODULES

2.1 MODULE 1: PROJECT MANAGEMENT (LEADER: JOHAN ROSSOUW)

2.1.1 Study initiation and inception

The *objective* of this task was to mobilise the Study Team through the Module Leaders, set up project management and governance structures and initiate activities necessary for compiling this Inception Report.

The Feasibility Study assignment was initiated by the Study Leader on receipt of confirmation that the AECOM-led team had been selected to execute the project. Initial contact was made with the DWA Project Manager through the first PMC meeting on 7 September 2010. Subsequently, Module Leaders were alerted and a project team meeting was convened on 30 September 2010 to facilitate a full understanding of the assignment, align activities as a first step towards integration and confirm important milestones on the work programme. A meeting was also held with the DWA RDM on 4 November 2010 (Ms Jacqueline Jay attended) to clarify the scope for the Reserve Module because it is a legal requirement that the Reserve must be signed off prior to implementation. The outcomes of this meeting are discussed in **Section 2.4**.

During the Inception Phase the study team finalised the Scope of Work for the assignment, confirmed the composition of the Project Team, the manpower schedule, work programme, revised budget and cash flow.

The first key task was to review work done in previous studies with the aim of informing all of the modules in this assignment. The Study Team focussed on the following studies:

- *Lusikisiki Regional Water Supply Scheme* (various reports), done by Hill Kaplan Scott (1979-1985);
- *Eastern Pondoland Basin Study* (UWP, 2001), including the Engineering Geological Reconnaissance Report (GN Davis, 1999 and 2001); and
- *Lusikisiki Groundwater Feasibility Study Phase 2* (SRK, May 2009).

The review of the reports enabled the team members to appraise the information available and familiarise themselves with the findings from the previous studies so that they could reconsider or refine the proposals made in the original tender and compile this Inception Report. Provision was made for a significant amount of start-up technical work as important reviews and preparatory work were required.

The proposed work plan for each task was examined in appropriate detail on the basis of the information available from previous study documents and other sources provided by the DWA.

The methodology proposed for each task has been refined and re-ordered. Areas of risk were identified and mitigating measures were suggested. Where necessary, key information was updated and more detailed work was initiated, as required. Findings and recommendations are regularly discussed with the DWA Project Manager to avoid uncertainties.

The outcome of this review is documented in this Inception Report under the specific module sections, and is approved as the final terms of reference defining study methodology, project team, work programme and revised budget.

2.1.2 Project management and administration

Specific organisational arrangements were made during the Inception Phase of the assignment to ensure that the execution of all activities are supervised and managed in an effective way and in accordance with the needs of DWA.

The objective of the Project Management Module is to ensure that there is:

- close and effective liaison between the DWA Project Manager and the Team Leader, and, therefore, also with all Module Leaders and their teams,
- regular and timely progress reporting against the agreed-upon programme,
- effective management of project costs and expenses against budget, DWA cash flow provisions and progress,
- a robust structure for preparing and making presentations to the DWA management team,
- communication with stakeholders to elicit their support for the assignment through providing information, facilitating fieldwork and developing their confidence in the findings and recommendations,
- effective support for and integration with the independent and parallel Environmental Impact Assessment (EIA) and the public participation process, and
- adherence to and compliance with the work programme and milestones.

As discussed in **Section 1.5**, effective liaison between the DWA Project Manager and the Study Leader will be ensured through the Project Management Committee (PMC), which should meet on a bi-monthly basis. Based on the level and intensity of activities during the second part of the study, it is proposed that PMC meetings should be reduced to every third or fourth month during this period. However, this will depend on activities completed and is subject to mutual agreement between the DWA Project Manager and the Study Leader. It is thus envisaged that about 16 PMC meetings will be required, but the approved budget for meetings will be ring-fenced and will only be reallocated if approved by the DWA. The PMC commenced with a kick-off / first PMC Meeting on *7 September 2010*, followed by a meeting on *9 November 2010*, both in Pretoria. All future PMC meetings have been scheduled to take place closer to the study area.

Attendance of PMC meetings in the study area will be carefully planned to control cost implications. Key stakeholders interested in or affected by the management of the study will be provided with documentation of PMC meetings.

Due to the possible sensitive nature of contractual and financial issues, it was decided at the first PMC meeting that these matters be discussed in a separate meeting, referred to as Study Management Meeting (SMM). These meetings will mostly take place on the same day as the PMC meetings.

The PSP Study Team will be responsible for all logistical arrangements for PMC, SMM and stakeholder meetings and will provide full secretarial and documentation support. The Project Management and Administration component of the assignment will be responsible for providing the following deliverables:

- Progress Reports on a bi-monthly basis;
- Monthly invoicing, supported by progress reports, financial control, and Historically Disadvantaged Individuals (HDI) participation records;
- Presentations to the DWA Management Team;
- Public participation meetings (including the six meetings provided for integration with the to-be-appointed EIA PSP); and
- Agendas, Minutes and other documentation for PMC meetings.

2.2 MODULE 2: WATER RESOURCES (LEADER: JOHAN ROSSOUW)

2.2.1 Hydrology (Leader: Estelle van Niekerk)

The *objective* of this task is to evaluate and improve the reliability of the hydrology for quaternary catchments T60E, T60F and T60G. This will serve as input to the water resources module for assessment of dam yields, irrigation module, groundwater module and the Reserve module.

Rainfall: Rainfall data inside, and in close proximity of the T60E, T60F and T60G will be identified, evaluated for outliers and unreliable values, and patched using the ClassR/PatchR methodology in the Rain-IMS. Catchment rainfall records for every quaternary catchment will be created for the period October 1920 to September 2007 to serve as input to the WRSM2000-model, WRYM, groundwater and irrigation modules.

Flow data: The WR2005 setup for the WR2000 model will be refined to a higher level of detail and updated with new land-use information. The most up-to-date WR2000 model data, which includes the new enhanced methodologies for facets such as groundwater, afforestation and irrigation, will be used for the analyses. The existing configuration will also be adjusted to create nodes at points of interest and refined to calibrate flow at gauge T6H004 and simulate flow data at all points of interest within T60E, T60F and T60G. The flow data will be simulated per quaternary catchment and smaller, where required, to be available to the Reserve team (SPATSIM) and the system modellers (WRYM model).

The following studies will be used as references:

- *Eastern Pondoland Basin Study*, 2001 (October 1920 to September 1997);
- the SRK, 2009 simulated data based on a combination of WR90 and the Pondoland Study (October 1920 to September 2005); and
- the recently completed WR2005 project (October 1920 to September 2005).

Personal communication with the DWA Directorate: Hydrological Services and the DWA Regional Office in Cradock indicated that the flow data at the new flow gauge T6H004 in the Xura River are reliable since December 1997. There are thus approximately 10 years of observed flow data that can be used to improve the current hydrology. This gauge was not used in the generation and calibration of any of the previous studies due to its short record. An upstream gauging point in the Xura River, T6H005, has measured the abstraction from the Xura River to Lusikisiki since 2000, which is also regarded as good. Both of these stations will be used in updating and calibrating the hydrology.

The daily observed flow data record will be used for the EWR study to develop a better understanding of the base flow and peaks and to determine the ecological water requirements (EWR).

The ***major tasks*** involved in the hydrological investigation will thus be:

- Evaluation of the value of the observed flow record for calibration at T6H004 in the Xura River;
- Selection, evaluation, patching and processing of point rainfall records in the RAIN-IMS;
- Creation of catchment rainfall records for every quaternary catchment;
- Liaison and information sharing with the groundwater and irrigation modules, i.e. supplying rainfall data and receiving data on current irrigation, farm dams, stock watering, alien invasive plants and afforestation;
- Updating and extending the flow data with the latest WRSM2005 model using the best available land-use and observed flow data, as well as possible new parameters derived from the calibration at gauge T6H004. This will include an evaluation of the value of the observed flow record at T6H004 in the Xura River;

- Preparation of the Water Resources Yield Model (WRYM) hydrological data input files;
- Preparation of flow data files for the Ecological Reserve Determination; and
- Separation of the groundwater contribution to flows for surface water-groundwater interaction, including liaison with the groundwater consultant;

Deliverables will be the **Hydrology chapter** of the **Water Resources Report**, which will provide details on the data used, methodology followed to generate flow records, assumptions made, any uncertainties and any problems encountered. A time series of monthly flow records and land-use records for the various water users will be produced as input to the WRYM, which will also be used in the Reserve determination process.

2.2.2 Yield analysis (Leader: Johan Rossouw)

The WRYM-IMS has been configured to model the updated flow and water requirements on a quaternary basis (or smaller, where required) to allow for the proposed Zalu Dam, using the latest approved DWA methodologies for present-day water use and future scenarios.

The water available for each user will be determined for various scenarios using the following approach:

- Validation and verification of the hydrology using a suite of programs (ANNUAL, CROSSYR, and GENSTST);
- Configuration of T60E, T60F and T60G sub-catchments (and smaller, where required) in the WRYM-IMS;
- Estimation of sediment yield up to 2030;
- Model testing;
- Historical firm yield analyses;
- Long-term stochastic yield analyses for different sizes of Zalu Dam for the following scenarios:
  - base (present) scenario;
  - proposed Zalu Dam with various dam sizes;
  - impact of sedimentation;
  - with and without EWRs; and
  - with and without possible future land-use development.

The ***deliverable*** of this task is a chapter in the **Water Resources Report**, which will describe the water availability of the existing and potential water resources. It will also report on the water requirements and impact on the yield for various scenarios. The results of the sedimentation task (see below) will also be included in the Water Resources Report.

2.2.3 Reservoir sedimentation (Leader: Dr Aldu le Grange)

The most likely sediment yield of the catchment area of the proposed Zalu Dam will be estimated with due consideration to the availability of sediment within the catchment as well as other factors which influence sediment yield. The 2007 estimate of reservoir sedimentation will be reviewed to arrive at a reliable estimate of the yield of the proposed dam in the long term, taking into account the loss of effective storage with time. Reservoir sedimentation is dependent on catchment sediment yield, which is calculated according to catchment location and size, as well as sediment yield potential within the catchment. Land use in the Xura River catchment is diverse and includes highly deteriorated areas, including cattle farms, as well as some subsistence farming areas in the Eastern Cape drainage region.

At Tender Stage, it was proposed to base the proposed review on the 1992 Sediment Yield Map of Southern Africa. This map is based on dividing southern Africa into nine sediment yield regions and subsequent calibration against recorded yield values. In addition, an attempt is made to provide statistical bands of confidence around the mean, giving statistical meaning to the estimate, taking catchment size into consideration. According to this map the Xura River catchment falls within sediment yield **Region 9** with recorded sediment yield values that vary from 4 to 881 t/km^2/a. Subsequently, a new Water Research Commission study (*Sediment Yield Prediction for South Africa – 2010 Prediction*) has been completed. This study includes amended sediment yield regions and updated catchment sediment yield values.

It is proposed that both the 1992 and 2010 sediment yield methodologies be used for study purposes. The results will be compared with recorded sedimentation of nearby existing reservoirs based on a recent similar study undertaken in the adjacent Mzimvubu River catchment. Such a methodology will be appropriate for the feasibility-level study.

The sedimentation results will be included in the **Water Resources Report**.

2.3 Module 3: Groundwater Augmentation (Leader: Jan Myburgh)

A phased approach for the geohydrological component of the Feasibility Study is proposed through the tasks indicated below.

2.3.1 Inception report

- Review of information and reports, with special emphasis on the *Lusikisiki Groundwater Feasibility Study* that was conducted and reported by SRK in 2006 and 2009, as well as groundwater aspects of the *Eastern Pondoland Basin Study*, which was reported on in 2001 by UWP Engineers.;

- Review of information that is readily available from other regional groundwater studies, including the recent and partially completed *Groundwater Resource Information Project* (GRIP), which is being managed by AGES under the instruction and guidance of the Department of Water Affairs (DWA);
- Meetings and workshops with appropriate people on the project team to quantify the domestic water demands and existing infrastructure in relation to the groundwater potential as well as to define the institutional and social development (ISD) structure for the study;
- Development of the hydrogeological Scope of Work and identification of additional tasks for execution under the study; and
- Interaction with the DWA for clarification of the total hydrogeological scope of work for proper definition thereof in the inception report.

2.3.2 Hydrogeological desktop study

After agreement on the scope of work included in this Inception Report, the hydrogeological team will be able to proceed with the desktop phase of the feasibility-level study. The desktop study will be carried out in the following phases:

- The continued review of existing information and reports as identified in the inception stage and the incorporation of the Eastern Cape GRIP project data for the compilation of borehole and groundwater use statistics.
- The known groundwater resources (aquifers), as defined in the SRK studies, will then be indicated on a GIS system with the updated borehole distribution data. The aquifers will be ranked based on potential to supply domestic water.
- The availability of groundwater and surface water will be combined to determine areas where water is in short supply and where conjunctive use would be possible with special reference to the Zalu Dam. This will require a collaborative and integrated approach in which the Task Leaders will be responsible for the water demand determination, the water resource assessment and the bulk distribution infrastructure.
- The GIS system will be used to rank areas in terms of shortage of domestic water supply and to focus the further development work required. An initial indication has already been given in the previous studies where potential is low and high; this will be critically reviewed to provide an improved assessment.
- Evaluation of groundwater quality and mapping of low quality groundwater areas will be provided for and interpretation thereof will be included in the assessment of groundwater available for domestic water supply.
- Where possible, proposals for groundwater quality improvement will be developed and will include a definition of groundwater treatment solutions and blending scenarios.

- Preliminary analytical groundwater flow balances will be executed on the quaternary and local catchments to determine the first order of groundwater availability as an assurance check for the initial feasibility-level recommendations.
- Cost curves for groundwater augmentation to surface water supply will be compiled and will include capital and operational cost modelling within the amended budget framework's time-cost allocation

This first-level estimation of groundwater available (quantity, quality and locality) will serve as input to the tasks attending to the demands for water from the proposed dam and the bulk distribution infrastructure.

2.3.3 Detailed groundwater flow balances and numerical modelling

During this task a more detailed assessment will be done on the availability of groundwater to determine the sustainability of supply for a higher level of confidence appropriate with a feasibility-level study. The groundwater flow balances and numerical modelling in selected areas will be assessed to determine the sustainable yield of the resource for groundwater reserve definition purposes. DWA has agreed that data gaps will be addressed through focussed hydrocensus work in parts of the project area where limited or no information is available regarding existing groundwater use, through the Term Tender appointment that DWA has with the groundwater specialist PSP (AGES), therefore no additional funding will be required from this contract.

This improved information will be provided to the other task leaders for the continued improved assessment of water source development, distribution and augmentation. A working group will be formed between the groundwater, hydrology, Reserve and irrigation modules to define scenarios and overlaps / interactions with other modules. The following actions will be undertaken to achieve the stated objectives:

- Obtain and evaluate existing groundwater data. This includes an evaluation of borehole locations, borehole depth, water levels, hydrogeological units and water quality.
- Evaluate rainfall and groundwater recharge with spatial and temporal variations. The rainfall will be analysed in terms of statistical significance of droughts and the potential effects they can have on the sustainability of the groundwater resource.
- Collate and evaluate spatial land-use data, geology, surface water features and environmental components. The integration of surface water features such as dams, rivers and wetlands will be done.
- Develop a regional conceptual groundwater flow model to determine interactions between surface water and groundwater with other environmental components. Detailed conceptual models will be developed for selected local aquifers of interest.
- Develop a Groundwater Yield Model for the Reserve (GYMR on quaternary catchment scale for all the quaternary catchments.

- The analytical models will yield flow volumes that are in line with the groundwater component of the reserve.
- Numerical models will be developed for selected aquifers of interest.
- Comparison of groundwater results of the GYMR approach with the numerical model and other methods such as the Groundwater Resources Assessment Phase 2 (GRAII) outputs.
- Compilation of the groundwater modelling component of the final technical Groundwater Report.

2.3.4 Groundwater – community interdependency survey

An assessment of community dependencies and attitudes towards groundwater as a domestic water source, considering the development of the Zalu Dam and possible groundwater augmentation, will be essential. It is thus proposed that this component of the study will include:

- An assessment of community dependencies and attitudes towards groundwater
- An assessment of regional groundwater use and infrastructure statistics;
- Attitude analyses – groundwater versus surface water;
- Groundwater awareness creation workshops in target areas to cultivate community understanding and acceptance concerning issues related to groundwater; and
- Survey inputs will be given for the final Groundwater Report.

2.3.5 Optimisation of groundwater abstraction network

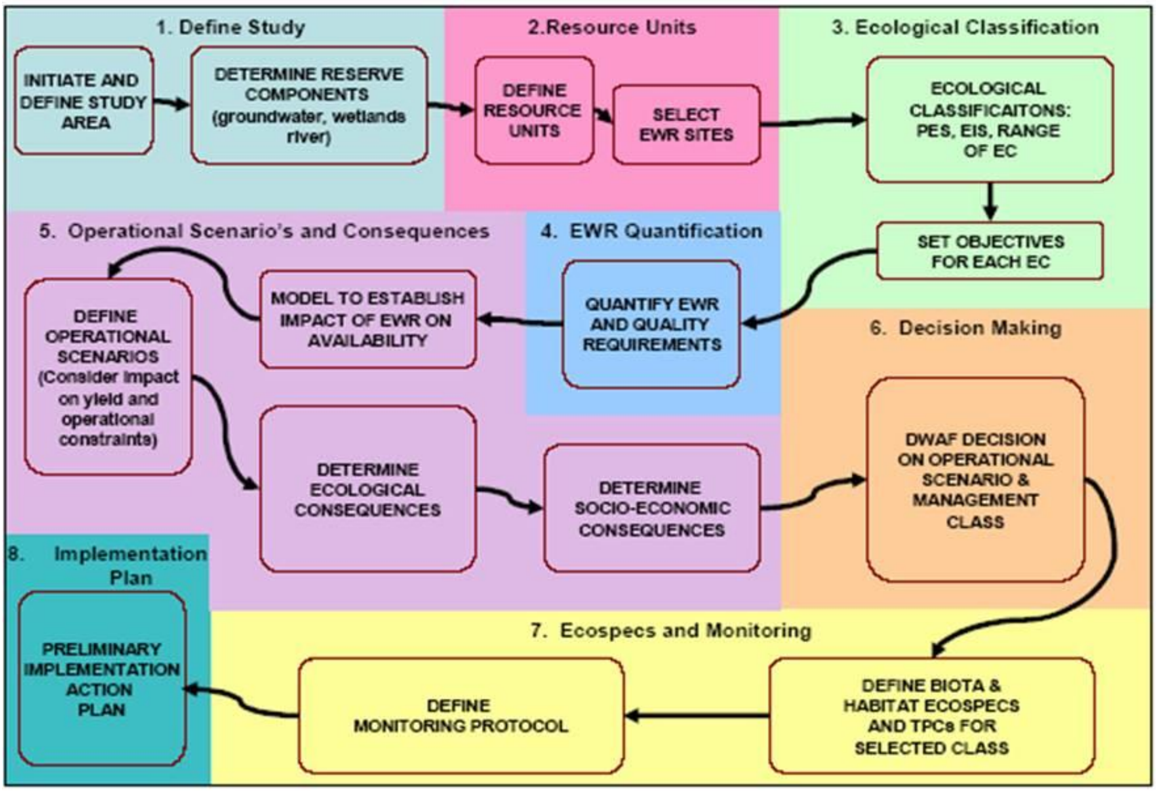
Based on discussions during the Inception Phase and project launch meeting, as well as taking note of the inputs defined as part of the desktop study phase of the hydrogeological study, a limited time input is defined for the optimisation of the groundwater abstraction network, based on the outcomes of the desktop, groundwater modelling and community study phases.

Inputs for the final **Groundwater Report** will be given with updated information within the framework as defined for the desktop phase:

- The availability of groundwater and surface water will be combined to determine areas where water is in short supply and where conjunctive use would be possible with special reference to the Zalu Dam. This will require a collaborative and integrated approach with the Task Leaders responsible for the water demand determination, the water resource assessment and the bulk distribution infrastructure.

2.4 MODULE 4: RESERVE – ECOLOGICAL WATER REQUIREMENTS (LEADER: PATSY SCHERMAN)

Module 4 encompasses a task on the determination of Ecological Water Requirements (EWR, or the Ecological Reserve) for the system under investigation. Although the Water Resources Classification System (WRCS) has recently been gazetted, the proposal assumed that the Reserve will not be determined following the WRCS approach for the Lusikisiki RWSS as this is currently in a testing phase on the Olifants and Vaal rivers, but will follow the 8-step methodology currently in place for Reserve determination shown below. The approach and sub-tasks of the module have been discussed and verified with the Chief Directorate: Resource Directed Measures (CD: RDM), i.e. the DWA directorate responsible for undertaking or supervising Reserve determinations. Meetings were held with CD: RDM during November 2010, and a letter outlining the approach and registering the project was submitted to Mr Atwaru and Ms Weston of CD: RDM by the task leader. ***This Scope of Work does not include the Msikaba Estuary. However, the scoping level assessment of the Msikaba Estuary will be included in the separate, but related, EIA study***.



The Terms of Reference (ToR) called for a Comprehensive Reserve assessment. Note that the level of determination at which the study should be conducted is normally dependent on a number of factors (e.g. water constraints in the catchment and the necessity for compulsory licensing), and when assigned, determines the way forward for the task.

The proposed approach has been determined in consultation with the DWA and is outlined in this report. Due to the constraints of the ToR, the study will focus on the ***river*** component at a detailed level of assessment. The study is therefore classified as an **Intermediate → Comprehensive Reserve Determination** for the river, based on the Reserve methodology to be used for the study**.** Note that a desktop assessment was done using Google Earth to see whether river-associated wetlands are found in the study area, but no apparent linkages between rivers and wetlands were seen.

The implication of meeting various Ecological Reserve Categories on the yield of the system will be assessed as part of the EWR task, with the modelling undertaken through the yield analysis task. Modelling will include a number of estuary-specific operational scenarios. The socio-economic implications of selected Reserve categories and river scenarios will be handled by Urban-Econ, following the requirements of the Reserve team. The Basic Human Needs Reserve (BHNR) will be calculated according to the methodology of Huggins (2008), which focuses on identifying run-of-river requirements for domestic water supply within a selected buffer zone of the river. Urban-Econ will be collecting latest population data, which will be provided to the Reserve team. BHNR calculations will be included in the Reserve template by the team leader. Tasks to be conducted by Urban-Econ are shown in Task 6.

The summarized aims, objectives and proposed outcomes of the study are listed below.

- Delineate the study area and select the EWR sites for detailed assessment.
- Determine the Reference Condition (RC) and Present Ecological State (PES) for the EWR sites of the river system. A desktop assessment will also be undertaken for the Msikaba Estuary.
- Recommend the Ecological Category (EC) for each relevant EWR site.
- Identify other ECs and provide implications / consequences of meeting these categories.
- Determine Ecological Water Requirement Scenarios (EWRS) for each of these ECs using the Flow-Stressor Response (FSR) approach.
- Determine the impact of EWRs on the allocatable yield.
- Determine the ecological consequences of each of these additional scenarios to be determined during the study.
- Liaison with the Urban-Econ team so that the socio-economic consequences of these scenarios can be assessed at a scoping level.
- Present the results of the study to DWA including recommendations for the management of the Msikaba Estuary at a desktop level.
- Provide the ecological specifications associated with the river EC, once DWA has reached a decision on the management objectives and future Ecological Category for the river sites. This information can be used to develop a river monitoring programme. ***Note that this step can only be conducted once DWA's decision-making process has been completed.***

- Prepare the Reserve template (river only) for CD: RDM for authorization by the Director-General of the DWA. The letter to the region will also be drafted by the team leader.

2.4.1 Study Area and EWR Site Selection

a) Background

The previous Reserve study for this area was done for the Xura (a tributary of the Msikaba River) and Mzintlava rivers as part of UWP's Eastern Pondoland Basin Study, and was done at a Rapid II level for quantity only. Both the upper and gorge sections of the rivers were assessed during the low confidence study. Note that a low confidence Planning Estimate was conducted for the Msikaba Estuary in 1999.

b) Scope of work

As the focus of this study is on water supply from Zalu Dam, the focus of the Reserve study will also be on the section of the Xura River below Zalu Dam. The Reserve template signed off for this catchment (June 2007) is cumulative at the outlet of quaternary catchment T60F (Msikaba River), so it is recommended that a site also be placed in the Msikaba River below the confluence with the Xura River. Final site selection can only be determined once the study area has been delineated and sites have been ground-truthed for the availability of suitable instream habitat. Other parameters influencing site selection are the availability of hydrological information, access, proximity to the estuary and license applications in the area. In this way, the specialist information gathered during the Lusikisiki study is maximised for DWA's purposes. Two sites will be selected and surveyed. Note that hydraulic surveys will be conducted during the dry and wet seasons, with two rounds of biological data selection.

The delineation of the study area into Management Resource Units will be required before sites can be selected. Delineation and site selection will be undertaken as the first steps of the Reserve process.

2.4.2 Activities and Tasks

The activities to be undertaken as part of the Reserve study are listed below as specific tasks.

a) Task 1: Technical and Financial Management

- Management of the technical team, including project initiation and appointments;
- Preparation of the Inception Report;

- The attendance of management team meetings. Two meetings have already been held with CD: RDM, Urban-Econ and AECOM regarding the inclusion of the Msikaba Estuary and socio-economic Scope of Work, the total amount of meetings to be attended has been escalated to **six**, with the disbursement budget expanded accordingly.
- Input to a Background Information Document for public awareness purposes, if required. As the groundwater and socio-economic teams will also be collecting data in the catchment, liaison with Jan Myburgh (Groundwater task leader), Hermien Pieterse (Stakeholder involvement team leader) and Ben van der Merwe (Economics team leader) has already been initiated.

b) *Task 2: Delineation of the study area into Management Resource Units*

- Geomorphological zoning;
- Eco-Regions;
- Water quality sub-units;
- Land-use;
- EWR site selection, including site visit and first data collection survey; and
- Production of a Delineation Report.

c) *Task 3: River Eco-Classification*

- Management of river tasks;
- Site visit (data collection, including wet and dry season hydraulic surveys and photo-point monitoring);
- An assessment of socio-cultural importance;
- Analysis of data; and
- Eco-Status workshop (results will be detailed in the Intermediate Reserve Determination Report (see **Task 5**).

d) *Task 4: Determining river scenarios - EWR scenarios*

- Preparation of EWR hydrology;
- Preparation of SPATSIM model to use FSR method at the selected sites;
- Hydraulic calculations; and
- Preparation of stress indices (with SPATSIM) and EWR scenario determination: EWR workshop to provide the flows as demands for the range of Ecological Categories to be modelled using the yield model. All hydrological and yield modelling tasks to be undertaken by AECOM specialists.

e) *Task 5: Determining river ecological consequences*

- Yield modelling and running operational scenarios through the yield model, including a number of estuary-specific scenarios (provisionally three);

- Operational scenario workshop: workshop to determine the ecological consequences of selected scenarios (note that three riverine scenarios will be assessed i.e. in addition to present day and natural); and
- Preparation of an Intermediate Reserve Determination (IRDM) report detailing all riverine scenario results (including socio-economic consequences when available).

f) *Task 6: Determining consequences of riverine flow scenarios on socio-economic status of the study area*

- This task will include the provision of EWR results to Urban-Econ, who will run a scoping level socio-economic assessment, which will include changes in Goods and Services based on the three selected scenarios.
- Due to the rural economics base of the area, it was decided in collaboration with AECOM, DWA and Urban-Econ that the economics study be conducted at a scoping level only, with the Goods + Services component focussing on a buffer zone on each side of the river. Persons living within 200-400m on either side of the river will be interviewed as a representative sample of persons using the river (van der Merwe, Urban-Econ, personal communication, February 2011). DWA's Water Impact Model (WIM) developed during an Inkomati study[1], or similar alternative model in use by Urban-Econ, will be used to evaluate changes in yield under various scenarios, including EWRs.
- This task will be conducted by Urban-Econ, the PSP undertaking the economic module for the larger study.
- Summarized information needed from Urban-Econ for the Reserve study is therefore as follows:
  - *Baseline profile:* A social and economic profile of the affected communities in the area, drawn from existing data sources and groundtruthing surveys
  - *Valuation - instream water:* The ecological goods, services and attributes that are influenced by instream flow will be identified, i.e. a profile of the Goods + Services that the river provides to communities living alongside the river.
  - *Valuation – out of stream water use:* The current uses of water will be valued in terms of their contribution to national income (GDP, Value Added), and their contribution to local livelihoods and poverty reduction. A baseline condition of each sector in the catchment's dependence on out of stream water use will be produced.
  - *Estimate economic impacts of flow scenarios, including and excluding EWRs:* Conduct an economic value of water between competing water uses at a reconnaissance level of assessment for three scenarios.

[1] Reference: Conningarth Economists (2009), Report prepared for the Komati / Ngwenya Private Sector Forum, Mpumalanga. *The macro-economic impacts of the Water Allocation Reform process in the Nkomazi region and Middle Crocodile and the cost benefit analysis of the water augmentation option.*

- *Estimate social impacts of flow scenarios, including and excluding EWRs:* The social implications of the different EWR scenarios can only be assessed once the scenarios have been developed. Each scenario will have a set of accompanying social implications.
- *BHNR information:* The number of people utilizing run-of-river for water supply within the buffer zone of the river on a quaternary catchment level (for the BHNR calculations), following the Huggins (2008) method.
- *Summarized information:* Provide the above information to the Reserve team according to the required deadlines in a summarized form. More detailed information required by the Reserve team, e.g. the baseline socio-economic profile, will be sourced from the Economics Report for the study. Information regarding scenarios and ecological consequences will be given to the economics team according to the programme.

DWA MANAGEMENT MEETING: PRESENTATION OF RESULTS TO DWA
DWA to sign-off Reserve Template

g) Task 8: Monitoring and Eco-Specs: River

- Preparation of data: Development of river EcoSpecs per component and design of a monitoring programme to assess compliance with EWRs and the selected Ecological Category (as decided by DWA during the DWA Management Meeting); and
- Compilation of the monitoring programme, which will be appended to the Intermediate Reserve Determination Report.

h) Task 9: Project termination

- Preparation of the Reserve Report and presentation of results to the DWA;
- Preparation of riverine Reserve templates for signing by the Director-General of DWA, and letter to the region; and
- Presentation of final results at two stakeholder workshops, and provide input to a newsletter for public awareness purposes, as required. Budget provides for the attendance of two stakeholder workshops in the Lusikisiki area.

2.5 MODULE 5: WATER REQUIREMENTS (LEADER: HERMIEN PIETERSE)

2.5.1 Domestic water requirements (Leader: Ben van der Merwe)

The objective of this task is to review results of previous studies of the population living in the study area and, ***together with a local investigation***, provide reliable and up to date estimates of the current and future population. This information is necessary to finally determine the water requirements and therefore, a thorough review of data sources, field verifications and final assessments are required.

a) *Orientation*

The first step will be used for orientation purposes and the following aspects will be addressed:

- identification, sourcing and reviewing of all background information;
- delineation of study area(s);
- identification of important linkages with other team members, relevant outputs required and the establishment of methods to meet the requirements; and
- formulation of a programme and action plan.

This phase will include a short site visit to familiarise the task team with the area.

b) *Demographic review*

The purpose of this task is to review and analyse all the existing studies and the base data utilised, and to compare it with the latest available data. This data will include the Stats SA Community Survey 2007, DWA settlement data (Steven Marais, DWA) and future population estimates and distribution (Directorate: Water Resource Planning Systems) as well as in-house population data. The review and analysis will mainly relate to:

- Comparative study areas;
- Smallest geographic level of population figures (villages, sub-places, etc);
- Size of existing population (2009);
- Historic growth rates;
- Expected future growth rates;
- Future population estimates; and
- Anticipated changes in the socio-economic structure and circumstances.

An initial review of the existing studies showed that the *Eastern Pondoland Basin Study* (2001) was based on 1996 population figures, which have since been shown to be relatively inaccurate. The growth rates were also based on historical trends and future estimates, which have changed considerably due to HIV and AIDS and outmigration from the rural Eastern Cape. The later study by SRK used the 2001 Census as a base, but was not reviewed for this specific area in light of the latest available data. The growth rate of 2.65% used by the later study for this area, and stated as a conservative growth rate, was regarded as highly exaggerated in light of the latest figures released by StatsSA. Based on StatsSA's mid-year estimates, the national population growth has declined from 1,45% in 2001/02 to 0,82 in 2007/08, and the Eastern Cape's contribution to the national total has declined from 14,4% in 2001 to 13,5% in 2008, which indicates less growth than the national figure.

c) *Primary data collection*

In light of the above-mentioned population discrepancies and previous experience with similar studies, it is vital that site visits are undertaken to a selection of villages to help verify population figures, growth rates and changing socio-economic circumstances. The visits will also include selected sample household verification surveys and interviews with knowledgeable people in the area, including tribal authorities and interviews with the municipalities and relevant Provincial Departments, such as Housing.

During the above primary data collection phase, data will also be obtained by the fieldwork team to feed into, amongst others, the following modules:

- Regional Economics
- Reserve: Ecological Water Requirements

This phase may also join resources with other Module Leaders to improve the efficiency of the primary data gathering process, i.e. the Groundwater Augmentation and Agriculture/Irrigation potential Modules.

d) *Base demographic profile*

Based on all the above information above, a baseline demographic profile will be compiled. Information will be provided on, among other things:

- population size and age;
- household size and composition;
- income and expenditure;
- education;
- employment; and
- urbanisation trends.

e) *Demographic projections*

Population projections will be made based on the latest demographic knowledge and information obtained from the interviews. This will be augmented with the latest research and data available on future growth expectations, including the impact of HIV and AIDS, fertility rates, mortality rates and migration and urbanisation. Urban-Econ has an in-house population model that can be used to project the population; professional fees have thus not been allocated to developing a model.

f) Domestic water demands

Water demand scenarios applicable to the rural area of Lusikisiki and surrounds will be adopted after the DWA's approval is obtained and are expected to be based on:

- rural villages – basic level of service: 25 ℓ/c/d
- rural villages – stand connections: 60 ℓ/c/d
- rural villages with provision for schools, clinics and hospitals: 90 ℓ/c/d
- dense rural towns with some economic development and water-borne sewerage: 150 to 250 ℓ/c/d

The domestic water demands for the present population and for future planning horizons will be developed and included in the **Water Requirements Report**.

2.5.2 Agriculture / Irrigation potential (Leader: Geurt Bloem)

a) Project mobilisation

The Agricultural specialist team representative, Mr G Bloem from Kariwa, attended the project mobilisation meeting at AECOM offices at the end of September 2010, after which, Kariwa mobilised the soil scientist, Prof Eben Verster and agricultural-economist, Mr Junior Ferreira for the planned scoping process.

b) Preparation work for scoping process

In preparation for the scoping site visit by the team members, the following actions were done:

- Setup of a GIS model and development of a set of 1:10 000 ortho-photo maps on GIS. The agricultural team members were supplied with a PDF copy of each of these maps.
- Kariwa collated specific climatic data consisting of average monthly rainfall, mean monthly minimum and maximum temperatures, relative humidity, radiation and other climatic data sets for the study area. Kariwa then populated the CROPWAT (software) with the data sets in preparation for use in modelling crop-water requirements for the identified possible cropping patterns.
- Mr Eddie Mashau (Public Participation Module Leader) from AECOM named specific officials in Lusikisiki to contact during the scoping site visit. Prof Verster contacted the district officials based in Lusikisiki and set up an information exchange meeting to inform the officials of the actions planned during the site visit on 18 October 2010.
- The agricultural team obtained contact details of officials in the Eastern Cape Department of Agriculture.

- The agricultural economist developed an agriculture-based questionnaire that will be distributed to the various stakeholders in the study area in an effort to obtain more data on agricultural economics presently practiced in the study area.

c) *Scoping soils investigation*

As per initial project mobilisation instruction, only the area downstream of the planned dam wall position was investigated and this area was further limited to a height of no more than 60 m above normal river bed. Another norm was used in support of the initial geo-graphical limits and this consisted of limiting soil investigation to those areas that have slopes not steeper than 8% as suitability for irrigation is normally limited to slopes not steeper than this. This limit was to be lifted where lucrative and highly intensive permanent cropping patterns were found or possibly planned.

The scoping soil site visit was conducted from 17 to 22 October 2010. The collated soil land-form boundaries were transferred to the printed maps throughout the process of traversing of the area. Sample hand-auger drill holes were frequently made and sub-soil conditions were assessed and noted. The collated data was assessed and a soil-land form table was developed and transferred to GIS data set.

d) *Initial soil landform results*

An area of approximately 8 500 hectares was traversed and investigated. The findings were tabulated (the tables are included in **Table 2.1**). No intensive cropping practice or lucrative crop production were seen during the soil scoping investigation or identified to be in a planning process. The slope limit of 8% was thus used through-out the scoping process to limit the scoping process.

The initial results from the scoping process are provided below and will be enhanced with a detailed discussion report in a later stage of the project.

Table 2.1: Description of map units and landform found during scoping soil investigation

Map Unit	Landform and Dominant Slope Class	Dominant Soil and Associated Features	Soil Form	
			Dominant	Other
LA1	Level to gently sloping crest, mid- and foot slope, foot slope of limited extent in places, 1-5% slope.	Very shallow to shallow (20-60cm) somewhat poorly drained, dark greyish to greyish, weekly structured, loam to silt loam overlaying hard and non-hard weathered shale.	Cartef 1100 Glenrosa 1121,1221	Longlands 1000 Wasbank 1000 Klapmuts 1120 Shortlands 1110 Katspruit 1000
LB1	Level to gently sloping crest and mid slope, 1-5% slope	Deep to very deep (10-100cm) well drained, dark red, fine sub-angular blocky structured, clay associated with dolerite occurrences	Shortlands 1110	

Map	Landform and	Dominant Soil and Associated	Soil Form	
LC1	Gently sloping mid slope, 2-5% slope	Mainly deep (>100cm), moderately well drained, red, weakly structured, loam to clay loam overlaying unspecified material with signs of wetness.	Tukulu 1210	Hutton 1100
LD1	Mainly level to gently sloping river terrace (valley bottom) and lower foot slope, 0-3% slope	Mainly deep (>100cm), somewhat poorly to moderately well drained, dark coloured, weakly to strong fine blocky structured, loam to silt clay overlaying unspecified material with signs of wetness, in places with layers of rounded stones in profile.	Tukulu 1110, 2110 Bonheim 1110	Westleigh 1000 Katspruit 1000 Dundee 1210
LE1	Level to gently sloping river terrace, river banks with incised streambeds, bank and gully erosion evident, <3% slope	Association of deep, dark grey, weakly structured, clay loam to clay with subsoil wetness, development from alluvium	Katspruit 1000 Dundee 1210	Tukulu 1110
LF1	Moderately sloping to very steep crest, scarp, mid- and foot slope, >6 – 45% slope	Association of very shallow, dark grey, loam to silt clay soils, in places with rock outcrops	Glenrosa 1121 Cartef 1100 Mispah 1100	Shortlands 1110

The mapping unit areas are listed in **Table 2.2**. A preliminary soil map is supplied with this Inception Report and the map clearly shows the extent for each of the landforms. Other data sets still need to be manipulated and added, but this will be done during the detailed report stage.

Table 2.2: Map unit suitability classification and expected area coverage

Map unit	Generalised physical irrigation suitability class	Dominant limitations	Size (ha)
LA1	5 (not suitable)	Restricted soil depth; temporary soil wetness	1 692
LB1	1 (highly suitable)	Mainly higher laying land	5
LC1	2 (moderately suitable)	Temporary soil wetness in deep subsoil	26
LD1	3 (marginally suitable)	Temporary soil wetness; flooding	244
LE1	5 (not suitable)	Temporary soil wetness; flooding; riparian land	± 532
LF1	5 (not suitable)	Steepness of land; restricted soil depth	> 6 000
		Total	**± 8 500**

e) Discussion of results

The above table shows that there are no large areas of high potential soils found in the study area directly below the planned dam wall position. A small area of 5.4 ha that was found, LB1 landform, is in reality placed well above the dam control limit.

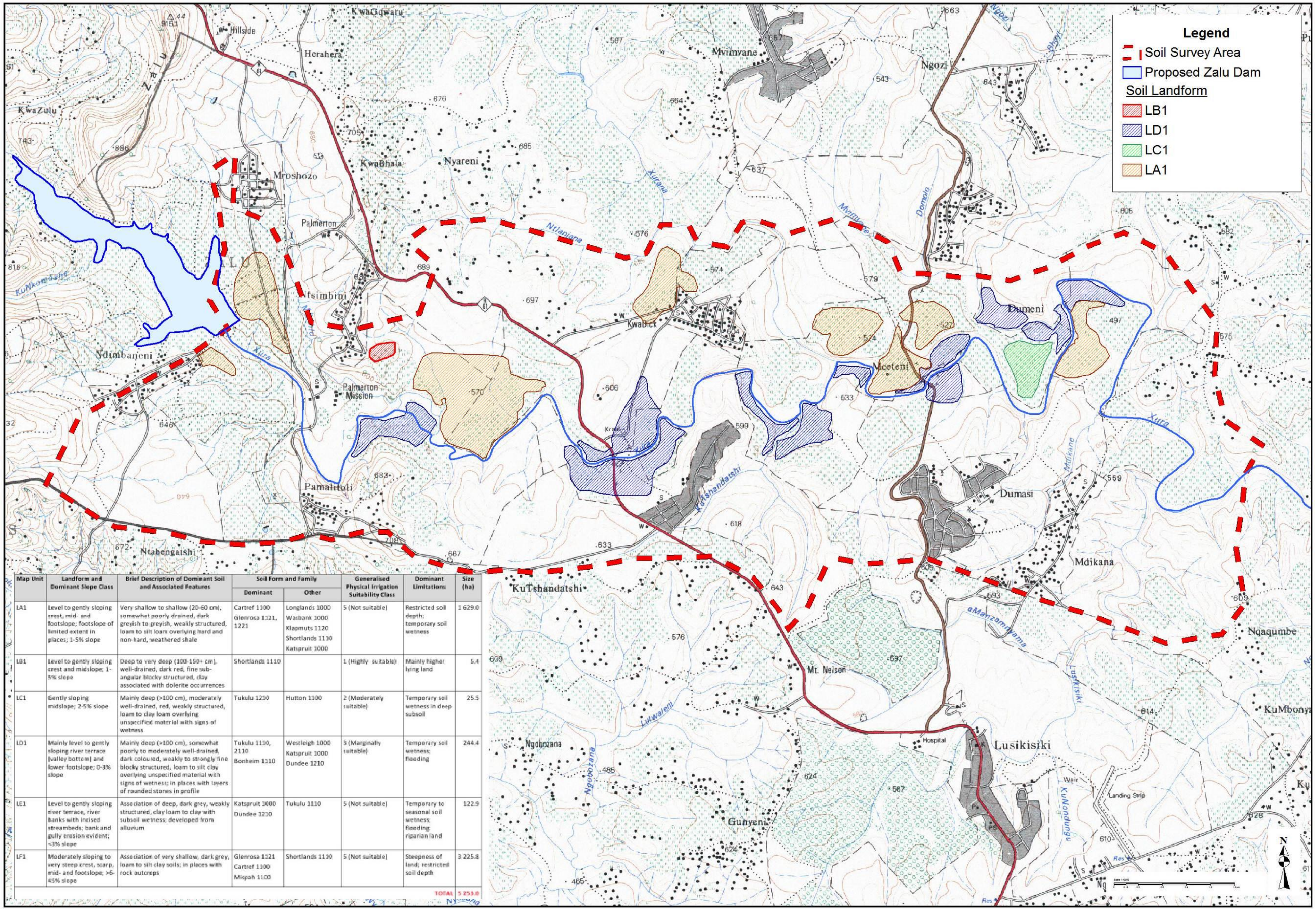
Landforms LC1 and LD1 are moderately to marginally suitable for irrigation and cover a combined area of about 270 ha. The main limitations for these soil areas are subsoil wetness, which indicate possible problems with flooding and possible expensive sub-soil drainage will be required. Initial discussions with the soil scientist indicated that, with careful selection, farmers of these soils could select soil areas where irrigation can be successful. It is the expert team's opinion that, for planning purposes, the expected available irrigable areas will be 40 to possibly 50% of the areas of marginal to moderately suitable soils, which is thus probably only 135 ha.

At an interim discussion with the project leader(s), it was proposed that no further detailed soils investigation will be required. The agricultural team will base its water-use requirements on an area equivalent to the 270 ha but this will be further reduced after a careful study of the soil scientist's notes of which area of the 270 ha area could be effectively irrigated without major sub-surface drainage cost implications to the stakeholder.

f) *Other concurrent work*

The agriculture economist has started data collection and has contacted the various officials for further information. The questionnaires he has prepared will be distributed to individual officials and some of the questions will be taken up in the questionnaires that the social consultants will prepare and hand out early this year. The economist conducted his specialist investigation in the study area from 22 November to 2 December 2010.

Kariwa has prepared a typical irrigation scheme cost evaluation in preparation for the cost-benefit analysis information that the economist will soon require. Kariwa will start a detailed cropping pattern water use, once the economist has collected and reviewed the detailed data from the questionnaires and discussions with officials.



Map Unit	Landform and Dominant Slope Class	Brief Description of Dominant Soil and Associated Features	Soil Form and Family		Generalised Physical Irrigation Suitability Class	Dominant Limitations	Size (ha)
			Dominant	Other			
LA1	Level to gently sloping crest, mid- and footslope; footslope of limited extent in places; 1-5% slope	Very shallow to shallow (20-60 cm), somewhat poorly drained, dark greyish to greyish, weakly structured, loam to silt loam overlying hard and non-hard, weathered shale	Cartref 1100 Glenrosa 1121, 1221	Longlands 1000 Wasbank 1000 Klapmuts 1120 Shortlands 1110 Katspruit 1000	5 (Not suitable)	Restricted soil depth; temporary soil wetness	1 629.0
LB1	Level to gently sloping crest and midslope; 1-5% slope	Deep to very deep (100-150+ cm), well-drained, dark red, fine sub-angular blocky structured, clay associated with dolerite occurrences	Shortlands 1110		1 (Highly suitable)	Mainly higher lying land	5.4
LC1	Gently sloping midslope; 2-5% slope	Mainly deep (>100 cm), moderately well-drained, red, weakly structured, loam to clay loam overlying unspecified material with signs of wetness	Tukulu 1210	Hutton 1100	2 (Moderately suitable)	Temporary soil wetness in deep subsoil	25.5
LD1	Mainly level to gently sloping river terrace (valley bottom) and lower footslope; 0-3% slope	Mainly deep (>100 cm), somewhat poorly to moderately well-drained, dark coloured, weakly to strongly fine blocky structured, loam to silt clay overlying unspecified material with signs of wetness; in places with layers of rounded stones in profile	Tukulu 1110, 2110 Bonheim 1110	Westleigh 1000 Katspruit 1000 Dundee 1210	3 (Marginally suitable)	Temporary soil wetness; flooding	244.4
LE1	Level to gently sloping river terrace, river banks with incised streambeds; bank and gully erosion evident; <3% slope	Association of deep, dark grey, weakly structured, clay loam to clay with subsoil wetness; developed from alluvium	Katspruit 1000 Dundee 1210	Tukulu 1110	5 (Not suitable)	Temporary to seasonal soil wetness; flooding; riparian land	122.9
LF1	Moderately sloping to very steep crest, scarp, mid- and footslope; >6-45% slope	Association of very shallow, dark grey, loam to silt clay soils; in places with rock outcrops	Glenrosa 1121 Cartref 1100 Mispah 1100	Shortlands 1110	5 (Not suitable)	Steepness of land; restricted soil depth	3 225.8
						TOTAL	5 253.0

Figure 2.1: Detail reconnaissance soil-landform map

g) The way forward

AECOM believes that the current budget for the agricultural scoping study and contribution towards expected water use and cost-benefit analysis should be adequate for what was initially planned. There is no need for further in-depth soils investigation as was expected in the Technical Proposal that AECOM submitted and the DWA accepted.

Further immediate actions as per the original proposal are to:

- Identify crops currently produced within the study area;
- Obtain production figures, which include costs of production and prices obtained for produce;
- Do gross margin analyses of major crops;
- Determine major constraints regarding crop production and propose realistic yields, should constraints be removed; and
- Identify markets where farmers sell their produce (size and position of the markets).

This information will help the specialist agricultural professional team assess the feasibility of irrigation and cost-benefit ratio over and above rain-fed production.

The tasks that will form part of the irrigation feasibility study are:

- Soil report on findings of the scoping exercise, which will include a basic soil sample assessment to determine soil fertility and estimate water constraints;
- Production of the final soil map that demarcates soil changes and indicates expected areas per soil type;
- Assess results from water analyses to assess quality influences for irrigation;
- Assess possible cropping patterns based on soils, climate and off-set market locality;
- Calculate crop water requirements and potential water use volumes;
- Assess crop production costs and income potential;
- Assess the cost of irrigation (capital, operating and maintenance costs);
- Assess and advise on the cost of irrigation water;
- Determine detailed gross margins and other costs involved;
- Revise the cropping programme and make suggestions regarding alternative crops;
- Propose sustainable plot sizes by applying the information listed above;
- Determine before- and after-income scenarios for projects;
- Assess regional economics based on current economics and the impact that viable irrigation could have on GDP and GGP; and
- Assess employment potential for viable irrigation.

The viability of irrigation developments will be assessed on the incremental cost of constructing a larger Zalu Dam and the provision of conveyance structures to support such development. A cost-benefit analysis will be undertaken to provide information regarding viability. Benefits over and above rain-fed development will be used in the analysis.

2.6 Module 6: Water Services Infrastructure (Leader: Gideon de Villiers)

2.6.1 Distribution infrastructure (Leader: Pat van Heerden)

Phase I of the Lusikisiki water supply scheme was commissioned in 1989 and supplies the town of Lusikisiki (then 11 000 people) and 23 villages (then 41 000 people). The *Investigating the potential to supplement the Lusikisiki Water Supply Scheme: Lusikisiki Groundwater feasibility Study Phase 2* report (SRK, 2009) states that the existing distribution infrastructure is in a poor condition and cannot provide adequate water due to insufficient system capacity. The level of supply is also stated as being below the RDP standard. No other information is provided on the status of existing infrastructure and the ToR does not specifically require that the condition of existing infrastructure be evaluated but the capacity is required.

However, during the Inception Phase it was deduced from the available information that the existing infrastructure will, be potentially important for the operation of the augmented scheme. Certain parts and/or portions of the existing infrastructure will however need to be replaced. Other parts and/or portions will require refurbishment and duplication for increased capacity of the system. An assessment of the existing infrastructure is therefore recommended as part of this feasibility study, and is motivated for the following reasons:

- The option to convey water from the proposed Zalu Dam via the existing weir proves to be the most economical option, with a URV of R4.14 per m^3, according to the SRK Report of 2009 (*DWA Report Number P WMA 12/000/00/1507*). The existing weir will therefore probably be an important component in the operation of the augmented scheme.
- The capacity of the existing scheme, which was completed in 1989, is just over 1 million m^3/a (2 760 m^3/d), and the existing pump station was also designed for this capacity. According to the afore-mentioned SRK Report of 2009 the 2030 requirements are 17 452 m^3/d, 9 644 m^3/d and 7 890 m^3/d for the high, low and constant water demands respectively. These figures translate into 6.32, 3.49 and 2.85 times the capacity of the current scheme. The super-structures of pump stations are designed for a lifespan of 40 to 50 years, and the existing pumping station is about 22 years old. The existing structure could therefore be modified and be used for the operation of the augmented scheme. The positioning of new pumps,

with the required larger capacities, could also be assessed in order to utilise the existing structure optimally.

- It is accepted that the existing pumps served their purpose over the past 22 years, but it is recommended that their refurbishment and subsequent uses as standby pumps in future also be assessed.
- The existing water treatment works was also designed for 2 760 m^3/d and it could probably serve as one "train" of the upgraded water treatment works. The lifespan of the civil engineering structures at the works are 40 to 50 years, and it is only 22 years old to date.
- Potable water is conveyed from the water treatment works to the distribution reservoirs via a 300mm diameter pipeline. The original design capacity of 2 760 m^3/d translates into a flow rate of 32 ℓ/s, which yields a flow velocity of 0.45 m/s in the pipe. Higher flow velocities are however acceptable in the pipeline and therefore the existing 300 mm pipe could convey more than 32 ℓ/s. The existing pipeline is, however, 22 years old and therefore many portions of the pipe are probably beyond repair. The increase in the pipe's roughness over the years will also have a significant impact on its capacity.
- The capacity of the existing distribution reservoirs will most probably be insufficient for the augmented scheme, and additional reservoirs will be required. The existing reservoirs are however only 22 years old, and have therefore not yet reached their design life of 40 to 50 years, for this reason the existing reservoirs can still be used in the operation of the augmented scheme.

After the recommended assessment of the existing supply infrastructure, especially the pipes, it is also recommended that the existing system be modelled with EPANET, or with a similar model, from the water treatment works up to the distribution reservoirs. This modelling is required to assess the capacity of the existing system, also taking its age into account. This will inform the design of the additional required bulk water supply infrastructure. The assessment and modelling of existing infrastructure will only be done if approved by the Client.

As a separate task under **Module 5**, the water requirements will be evaluated and confirmed. The confirmed water requirements will be used to size the planned water distribution infrastructure. Multiple scenarios will be reviewed to accommodate inputs from other study modules; for example, water supply from a large Zalu Dam versus water supply from a reduced-yield Zalu Dam combined with borehole supply. Other combinations, including utilisation from the existing weir abstraction system, will also be reviewed.

Previous studies have made recommendations regarding bulk infrastructure requirements. These will be evaluated in terms of the following criteria:

- Full coverage of the supply scheme area;

- Practicality of routes and supply zones;
- Positioning of reservoirs; and
- Supply sources.

A cost estimate will be done to cover all aspects of the bulk distribution system for the different scenarios identified (practical solutions). The design of the bulk distribution infrastructure up to the service reservoirs and field edge will be done to detailed feasibility level (preliminary design), from where it can be taken forward to the detailed design phase without the need for further investigations. The feasibility-level design of the bulk distribution infrastructure will cover the following for a 30-year design horizon:

- Additional pumping requirements at the existing weir;
- Rising main capacities and pipe sizes;
- Additional water treatment works (WTW) capacities;
- Appropriate water treatment technologies;
- Bulk supply reservoirs;
- Sizes and lengths of distribution mains from the bulk supply reservoirs to the terminal reservoirs (field edge); and
- Linkages to the bulk supply system from potential groundwater schemes.

The reticulation will be priced based on the area of the supply zone and the housing/population density of the area. No modelling of reticulation systems will be done at this feasibility study level. The results will be presented in the **Water Distribution Infrastructure Report**.

2.6.2 Water quality (Leader: Dr Gideon de Villiers)

Surface water quality tests for the proposed Zalu Dam were performed on six grab samples that were taken from the Xura River upstream of the proposed dam wall. These tests were performed as part of the 2009 study by SRK. The afore-mentioned samples were taken on one particular date (*13 October 2006*) during a period when significant rainfall occurred in the river's catchment, and therefore these test results may not be representative of the long-term water quality situation. The results from these tests however indicate that the quality of intake water from the proposed Zalu Dam is generally good, with the exception of Total Iron and Total Coliform.

The Department of Water Affairs also takes surface water samples at gauging weir T6H004, on the Xura River, for regular testing. This weir is located down-stream of the proposed Zalu Dam, and raw water is abstracted at the weir for the existing water treatment works (WTW). The Department of Water Affairs took the first samples for testing during August 1995.

Twelve boreholes, to be used as production boreholes, were previously recommended for conjunctive use with surface water. The water in two of these boreholes has unacceptably high Iron concentrations, and the water in four of these boreholes was found to have marginal Iron concentrations. Both the surface water, upstream of the proposed Zalu dam, and water in three of the recommended production boreholes have unacceptably high bacterial content.

All the available water quality data will be reviewed, including the data from the Department of Water Affairs, to recommend:

- Whether any additional constituents should be tested;
- The frequency of testing, especially to address seasonal variations, and
- The duration of water quality testing and monitoring.

Surface and ground water sampling as well as testing will probably need to be undertaken over the entire study period and, if possible, be extended into the detailed design phase. This will however only be confirmed after the available water quality data has been reviewed. Water quality constituents that do not vary significantly during sampling can be tested less frequently, thus allowing the sampling and testing to focus on the problem areas.

If the review of the available water quality data concludes that additional sampling and testing are required then additional surface water grab samples will be taken at identified points, upstream of the proposed Zalu Dam. Additional samples will also be taken from the twelve recommended production boreholes. The sampling and testing will be done over a period of time to:

- Assess the intake water quality from the proposed dam;
- Assess the water from the recommended production boreholes, and
- Increase the amount of data available and to identify any seasonal fluctuations and trends during seasonal variations in flow.

Although the surface water samples will be taken of the river water, the surface water quality will change when this water is impounded in the proposed Zalu Dam, especially after the first filling when significant amounts of vegetation will still be present in the dam basin. The low flow velocities through the dam will also promote conditions for algae growth and the deposition of sediment, which will also contribute towards the already high Iron content in the water.

For the purposes of this feasibility study only conceptual water quality changes in the proposed Zalu Dam will be considered. Surface water data from the river will therefore be reviewed to estimate the expected water quality in the proposed Zalu Dam. *Detailed*

Water Quality Modelling for the Proposed Zalu dam could also be undertaken by AECOM, but this is, however, beyond the scope of this feasibility study.

Unless strict catchment management plans are adhered to, the quality of water in the catchment will deteriorate over time, and therefore trend analysis will also be performed to determine the expected water quality at the end of the 30-year design horison.

The two main water quality parameters of concern are the iron and bacterial concentrations in both the surface and ground water sources. The bacterial contamination will be reduced through treatment (clarification and filtration) and disinfection. At iron concentrations over 1 mg/ℓ, sensitive population groups may start to experience certain health complications related to iron in the water; and most groups will experience chronic health effects at iron concentrations exceeding 5 mg/ℓ. Iron can however be removed from water through oxidation, coagulation and settling in the treatment process. Increased available water quality data will however confirm the Iron concentrations in the surface and ground water, which will also inform and refine the treatment process design.

Treatment of both the surface and ground water can best be achieved at a central water treatment works (WTW). Treatment systems for borehole supplies are however also available, but these systems require technical operation and maintenance, which may not be present at a decentralised point.

From previous reports (SRK, 2009) the treatment capacity at the existing WTW is stated to be in the order of 32 ℓ/s (2.76 Mℓ/d), to be confirmed during the study. The water treatment capacity of the scheme must be increased from 2.76 Mℓ/d to 4.32 Mℓ/d, and therefore the following aspects will also be taken into account:

- The existing WTW's processes and plant layout;
- Optimal abstraction positions for surface and ground water relative to the WTW and the supply point/s (command reservoir/s);
- Available land for the extension and/or upgrading of the existing WTW;
- Available land for a new WTW, if required;
- Modular future expansion of the extended/upgraded/new WTW in terms of increased demand and deteriorating water quality over the 30-year design horison;
- Appropriate water treatment technologies for this rural town and villages; and
- Operational and maintenance aspects of the WTW.

The upgrading of the scheme will involve the selection of water treatment processes that must take the expected future trends and the resulting deteriorating water quality into account, over the 30-year design horison. A phased approach will therefore be investigated in terms of future treatment requirements that will not be required during the initial phases, but considered for a future upgrade, or retrofit, of the WTW in future.

The existing 2.76 Mℓ/d WTW (SRK, 2009) comprises the following treatment processes:

- Chemical dosing;
- Flocculation;
- Sedimentation;
- Slow sand filtration;
- Rapid sand filtration, and
- Chlorination.

A Status Quo Investigation will also be conducted for the existing WTW in order to:

- Assess and evaluate the existing WTW's capacity in terms of its processes and hydraulics;
- Assess the condition of the existing WTW's concrete structures;
- Assess the condition of the existing WTW's mechanical and electrical equipment;
- Make recommendations on whether the existing WTW should be upgraded and/or extended in order for it to be integrated into the upgraded scheme, and
- Make recommendations whether the existing WTW should rather be de-commissioned altogether and replaced by a new WTW.

The position of the intake works, for optimum quality of raw water and reduced suspended solids, as well as allowance for off-takes at various water levels in the dam, will be reviewed in the dam site selection and design modules.

The following activities will be performed during the Status Quo investigation:

- ***Site visit***: Assess the condition of the existing WTW's concrete structures and the mechanical/electrical equipment.
- ***Data collection***: Collection of as-built data of the existing WTW from the Lusikisiki Local Municipality, if available.
- ***WTW Capacity establishment***: A preliminary process design will be conducted in order to establish the required capacity of the required WTW for the upgraded scheme, taking the intake water quality and potable water requirements into account.

The results and findings of the water quality assessment, as well as the preliminary process design for the upgraded/extended/new WTW, will be included in the **Water Distribution Infrastructure Report**.

2.7 Module 7: Proposed Zalu Dam (Leader: Willem van Wyk)

2.7.1 Site investigations (Leader: Prof Monte van Schalkwyk)

a) General

Geotechnical investigations were conducted by Hill Kaplan Scott (1979), but the full report on these investigations could unfortunately not be located. Geotechnical information currently available includes:

- Hill Kaplan Scott (1979): Preliminary geological and soils investigation. This preliminary investigation did not include core drilling or detailed materials investigations.
- Council for Geoscience (1999): First engineering geological reconnaissance report, which covers five alternative dam sites and contains a summary of the information in the Hill Kaplan Scott (1979) Design Report.
- SRK Consulting (2009): *Lusikisiki Groundwater Feasibility Study Phase II*.
- Hill Kaplan Scott (1979): Design Report Volume II: Accompanying Drawings. This document includes:
  - a geological map showing borehole positions on a scale of 1:1 000;
  - borehole and geological long sections; and
  - a map showing borrow areas, trial hole positions and geology at a scale of 1:5000.

The borehole and trial pit logs and laboratory test results are presumably contained in the Hill Kaplan Scott document that could not be found, and this seriously hampers the verification of (i) the proposed excavation depths for different types of dams, particularly on the right flank, and (ii) the suitability and quantities of construction materials.

Except for noting an existing quarry roughly 12 km from Lusikisiki, and a potential quarry site on a dolerite sill about 3,5 km north of the dam site, previous investigations did not cater for concrete aggregates, rockfill, rip-rap or filter sands.

As part of this Inception phase, AECOM visited the site on 27 October 2010 to verify topographical and geological conditions at the dam site and to identify potential areas for borrow pits and quarries in the dam basin or close to the dam site. On 3 November 2010, AECOM also visited the DWA offices at the Mthatha Dam, where a copy of the Design Report Volume II by Hill Kaplan Scott was found.

b) Dam site

The previously investigated dam site has a gently sloping (1:7) left flank and a steep (1:2.5) right flank (see **Plates 1 – 3**). The river bed level is at 585 masl and both flanks flatten markedly above 630 masl. At the proposed crest level of 620 masl, the crest length is about 300 m.

The following description of geological conditions is based on the summary report by the Council for Geoscience (2001) and on the boreholes and geological long sections on Drawing 6671/G/2 of the Hill Kaplan Scott Design Report Volume II. This information needs to be confirmed and amplified by the records (logs or cores) of previous core drilling and also by seismic surveys to provide information between boreholes. The main limitations of the Hill Kaplan Scott report are the vague descriptions of the degree of weathering of the rocks, the lack of data on core recovery and Rock Quality Designation (RQD and insufficient water test results.

The river section is about 80 m wide and is covered by up to 5 m of alluvium comprising clayey silt at the top and pebbles or boulders at the bottom. These deposits are underlain by "generally unweathered" dolerite that extends for at least 35 m in depth. The previous boreholes were spaced between 10 m and 20 m apart on the left side of the river channel, but since three of the five holes were drilled at very small angles from the horizontal (reportedly at 30°, but the protruding casings appear to be much flatter), their effective spacing at bedrock level is about 30 m. Provided that additional seismic refraction surveys are conducted here, the information from these boreholes is considered sufficient for conceptual design purposes.

On the left flank, the dolerite sill that underlies the river section extends to a level of about 608 masl (23 m above river bed level) and is overlain by sub-horizontally bedded siltstones. The dolerite is covered by up to 5 m of colluvial soils and is "essentially unweathered" except for a 2-6 m thick "weathered" zone at the top. The siltstone on the upper left flank is covered by up to 2 m of colluvial soils, and the rock is described as soft to medium hard and "weathered" to an unspecified degree to depths of between 10 m and 14 m. Borehole spacing is, on average, about 50 m. Provided that additional seismic refraction surveys are conducted, the information from these boreholes is considered sufficient for conceptual design purposes.

Plate 1. View of right flank. Red line indicates approximate upper dolerite contact. Blue line indicates previously drilled centre line. Orange rectangle indicates position of possible downstream quarry.

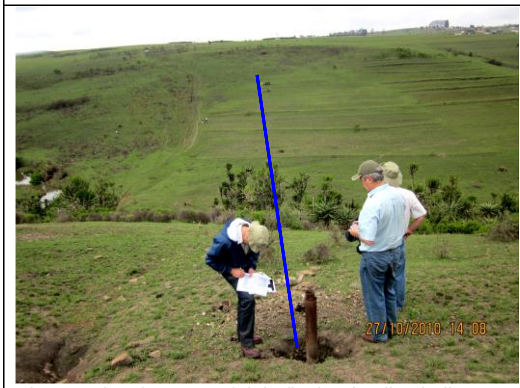


Plate 2. View from top of right flank. Blue line indicates previously drilled centre line.

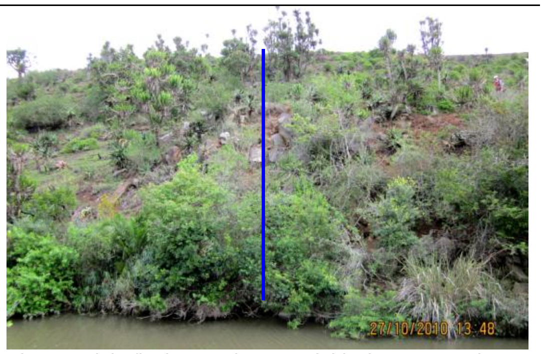


Plate 3. Right flank. Note loose rock blocks on spur along centre line.

On the right flank, the dolerite sill that underlies the river section extends to a level of about 614 masl (29 m above river bed level) and is described as "unweathered" with a soil cover of between 1 m and 5 m. The centre line is located on a small spur formed by moderately weathered and closely jointed rock with many loose blocks occurring on surface (see **Plate 3**). Only one borehole that was inclined at 30^{o} had been drilled within the distance of 70 m between the river channel and the top of the dolerite sill, and the two boreholes drilled in the siltstone higher up show the depth of weathering to be 3 m and 14 m, respectively. Therefore, the available geological information along the right flank is sparse and inconclusive, and even if borehole logs with specific information on core recovery and degree of weathering are found, it will be necessary to drill at least four additional boreholes along the centre line. In order to investigate conditions for the present proposal to obtain rockfill material and aggregate from an approach channel on the upstream side of the centre line and from a stilling basin on the downstream side of the centre line, ***additional boreholes are required*** on this flank.

c) Quarries and borrow areas

No previous investigations for sources of concrete aggregate, rip-rap and rockfill have been conducted, and previous reports mention that the chances of locating a suitable quarry within the confines of the proposed dam basin appear rather remote. A dolerite outcrop roughly 3,5 km north of the dam was identified as a potential quarry site.

The quantities of rock required for concrete-faced rockfill (CFR) (410 000 m^3), alternatively earth core rockfill (ECR) (270 000 m^3) or concrete aggregate (150 000 m^3) imply that about 600 000 m^3 of rock must be proved.

During the site visit in October 2010, AECOM noted that a quarry had been developed in the dolerite 3,5 km north of the site, and that considerable reserves appear to be available (see **Plate 4**). Although the quarry had been developed in a way that minimised the environmental impact, there is no certainty that a permit for further quarrying could be obtained.

Plate 4. View looking upstream from right flank. Possible dolerite quarry is located between red lines.

Plate 5. Alluvium upstream of centre line. Note sandy nature and gravel beds.

Solid outcrops of the dolerite sill downstream of the centre line on the right flank (see **Plate 1**) indicate the possibility of establishing a quarry for aggregate, rip-rap and rockfill that might also form the stilling basin for a side channel spillway. The condition of the rock at depth will have to be investigated by means of core drilling and, if suitable, a mining permit will have to be obtained.

The steep slope on the left river bank about 200-500 m upstream of the centre line is underlain by a dolerite sill capped by siltstone (see **Plate 5**). A quarry in this area might yield suitable siltstone and dolerite for a rockfill embankment and dolerite for concrete aggregate. This quarry site can be located below FSL of the dam, but the condition of the rock and available volume of rock will have to be investigated by means of seismic surveys and cored boreholes.

No suitable sources of sand for fine aggregate or filters were identified in the vicinity of the dam site. At this stage, it may be assumed that sand will have to be obtained by crushing dolerite.

d) Need for seismic surveys, further drilling and test pitting and other geotechnical investigations

Drawing No 6671/G/3 from the Is 'near horizontal' not a better term?report shows the locations of nine potential borrow areas. A summary of the results is given in **Table 2.3**.

The test pit logs and laboratory test results were not available at the time of writing, and the summary of results presented in **Table 2.3** is therefore not conclusive. According to the report by the Council for Geoscience, the laboratory results indicate that (i) soils derived from dolerite have poor workability (very high PI), (ii) information on soils derived from siltstone is inconclusive and (iii) alluvial soils are possibly suitable as impervious material but are dispersive and the layer thickness is limited (see **Plate 6**).

Plate 6 Google image of the abandoned quarry

For an embankment dam, about 180 000 m^3 of impervious core material and 800 000 m^3 of soil or rockfill material must be proved.

If it is necessary (for environmental reasons) to establish the borrow areas below FSL, only the alluvium in BA1 and BA2 might be suitable for core material. However, the alluvium observed during the Study Team's site visit appears to be very sandy with substantial gravel layers, and in BA1 only one test pit had been dug. Therefore, even if the logs and test results of previous investigations are found, it is recommended that additional investigations for core material be conducted.

Considerable volumes of soil for shoulder material appear to be available in borrow areas BA9, BA10 and BA11 that are located below FSL on the right side of the river. This will have to be confirmed and additional quantities must be found to prove the required quantity of about 800 000 m^3. If a rockfill dam is to be constructed, a rock quarry must be investigated (refer to paragraph (c) above).

Table 2.3: Results of borrow pit investigations

Borrow area no.	Location	Volume (m^3)	Potential use	Origin	Comment
BA1	0,5 km upstream below FSL	163 200	Shoulder/ core	alluvium	Thin layer, dispersive
BA2	1,2 km upstream below FSL	180 000	Shoulder/ core	alluvium	Thin layer, dispersive
BA3	0,5 km downstream	283 000	Core	dolerite	High PI
BA4	1 km downstream	216 000	Core	dolerite	High PI
BA5	1,7 km downstream	540 000	core	dolerite	High PI
BA6	0,3 km downstream	unknown	core	dolerite	High PI
BA9	0,8 km upstream below FSL	162 000	shoulder	Siltstone/ shale	Results inconclusive
BA10	0,7 km upstream below FSL	216 000	shoulder	siltstone/ shale	Results inconclusive
BA11	0,7 km upstream below FSL	202 000	shoulder	siltstone/ shale	Results inconclusive

i) Seismic refraction surveys

No seismic surveys were conducted during the previous investigations, and the gaps between boreholes along the dam centre line are too large to enable reliable interpretation of founding depths. It is **recommended** that three parallel seismic lines be done to confirm that the proposed centre line is geologically the most favourable, and to interpret founding conditions between previous boreholes. The seismic survey will also ensure that more boreholes are drilled at the most appropriate locations. The length of seismic traversing required is about 1 000 m.

Before drilling is undertaken to investigate the proposed quarry site upstream of the dam on the left side of the river, a number of seismic lines should be surveyed to establish the feasibility of a quarry (overburden thickness and siltstone/dolerite contact) and to ensure that boreholes are located at appropriate locations. The length of seismic traversing required is about 400 m.

ii) Core drilling

The available information from core drilling along the left flank and the river section is considered sufficient for ***conceptual*** design purposes. However, the ***drilling of four additional cored holes*** on the right flank along the centre line is recommended to investigate foundation conditions. In addition, ***four holes along the approach channel*** and ***four holes in the stilling basin*** are required to investigate the suitability of material for rockfill and concrete aggregate.

Core drilling (eight holes) will also be required to investigate the quantity and quality of material in the proposed quarry on the left side of the river.

In total, 20 boreholes with a total length of about 500 m are required.

iii) Geotechnical mapping

Adequate geological maps of the dam site and the borrow areas are contained in the report by Hill Kaplan Scott (1979) and no further mapping is required.

iv) Test pitting, soil sampling and laboratory testing

The previous soil surveys did not provide conclusive information on the availability of embankment materials, particularly for impervious core material. It is recommended that a ***TLB be hired for three days to dig test pits within the dam basin*** and if permissible from an environmental point of view, in the flat-lying areas above FSL. The test pits will be geotechnically logged and representative samples will be taken for additional laboratory testing. Laboratory tests will include Grading, Atterberg Limits, Standard Proctor Compaction, Permeability and Dispersivity testing.

Samples of rock will also be subjected to standard tests for concrete aggregate and rockfill.

v) Seismic risk analysis

A site-specific probabilistic and deterministic seismic risk analysis will be undertaken by Dr A Kijko of the Aon Benfield Natural Hazards Centre, Africa at the University of Pretoria.

2.7.2 Dam technical details (Leader: Willem van Wyk)

a) General

The available information described in the SRK (2009) and UWP Engineers (2001) reports will be used as a starting point for the feasibility study. The dam site was visited on 27 October 2010 to ascertain the site conditions, especially with regard to available construction materials, the planning of additional geotechnical investigations (see **Section 2.7.1**) and to determine the need for additional topographical surveys.

A topographical survey with 1 m contours was carried out by the Department of Water Affairs (date unknown) covering the dam site to approximately 1 km downstream and the whole dam reservoir. This survey is considered adequate for the conceptual design of the dam, determination of tailwater levels and for the verification of stage-storage volume and surface area relationships. The survey does not extend far enough for access route selection, but the required contour extensions will be generated from the NASA 90m DTM Grids.

The planning and conceptual design of the dam will be carried out in the sequence described below. The information from the geotechnical investigation (**Section 2.7.1**) is a prerequisite for the planning and conceptual design.

b) Dam sizes

The required dam size will be determined in collaboration with the Task Leaders of the other Modules and guided by the following information:

- Results from the firm yield analysis (**Module 2**) compared with water requirements to define the full supply level
- Reservoir sedimentation to assist in defining the lowest draw-down level and associated dead storage volume (**Module 2**)

The size of the dam depends on whether water is to be supplied for domestic purposes only or also for irrigation. The first dam size will be based on water supply for domestic purposes only and the second dam size will be larger to also cater for water supply for irrigation purposes. Allowance will be made for the Reserve requirements and the optimum use of groundwater.

As the yield analyses may not be finalised at the time of the preliminary dam design task due to the time taken for comprehensive reserve determination, the assessment of the reserve as per the previous studies will be used, to be refined, subsequently, with the results from the Reserve Study. A third dam size (between the first and second dam sizes) will also be designed conceptually for interpolation purposes.

c) Dam types

The following dam types will be evaluated for all three of the dam sizes mentioned above:

- Concrete (RCC) gravity dam with a spillway across river channel
- Earthfill dam with a spillway on the side
- Rockfill dam with a spillway on the side
- Composite concrete and earthfill dam with a spillway across the river channel.

The different dam types will be designed conceptually for comparison and evaluation purposes, based on founding conditions, topographical constraints and available natural and commercial construction materials.

d) *Flood hydrology and flood peak attenuation*

The safety evaluation flood (SEF) dictates the required non-overspill crest (NOC) level and a revision of the recommended design flood (RDF) will thus have no beneficial value for the feasibility study and, specifically, for the cost comparison of different sizes and types of dams. The different dam sizes will be categorised and the appropriate SEF will be determined for each size based on the regional maximum flood (RMF) for the applicable region or region numerically one step higher, as applicable.

Flood hydrographs will be derived for the SEF and RDF, and flood peak attenuation analyses will be carried out for the different dam sizes and spillway types using the level-pool routing method.

e) *Spillway design*

The sizing of the different spillways required for the different dam types will be based on the attenuated SEF peaks. In the case of an RCC dam or composite dam, energy is partially dissipated along the steps on the downstream face of the RCC and the stilling basin will be sized and designed to dissipate the residual energy. It is envisaged that such a spillway will be constructed over the full width of the river channel.

In the case of an earthfill or rockfill dam, the spillway will be designed on the side. These may be of the bywash type with a plunge pool or conventional type with either side channel (trough) spillway, a concrete chute and an appropriate energy dissipating structure at the downstream end.

f) *Stability analyses*

Stability analyses will be carried out for different loading combinations covering usual loading (water at FSL), unusual loading (RDF conditions) and extreme loading (SEF conditions and water at FSL with earthquake loading).

g) *River diversion*

The damage that can be caused during construction when the river diversion design flood is exceeded is far higher in the case of an earthfill or rockfill dam than in a concrete (RCC) dam. It is thus proposed that the 10-year flood be used for sizing the river diversion in the case of a concrete dam and that the 20-year flood be used for an earthfill or rockfill dam.

It is expected that the main stage of river diversion will be accomplished by means of an opening (conduit) through the RCC dam wall and by means of culverts (tunnel) in the case of earthfill or rockfill dams. Upstream and downstream cofferdams will be required. Attention will also be given to the possibility of using the outlet works for the final river diversion stage.

h) Outlet works

The outlet works will comprise an intake structure or tower upstream, outlet pipes through the dam wall and a valve house for controlling the releases. In the case of a Concrete Gravity dam, the intake structure will be positioned against the wall and connected structurally to the mass RCC. In the case of an earthfill or rockfill dam, the intake tower will be positioned towards the heel of the embankment. The intake structure or tower will house trashracks, fine screens, multi-level intakes with bellmouths and butterfly level selector valves. Twin outlets will be provided with the multi-level intakes staggered to provide abstraction levels that are spaced at about 5 m.

Access to the intake structure (RCC dam) will be from the crest and at the bottom directly from the downstream valve house through the RCC dam wall. Similar access will be required for an earthfill or rockfill dam, with access from the dam crest along a bridge and at the bottom through a tunnel from the downstream valve house.

The outlet pipes will be cast in conventional concrete where they pass through the dam wall in the case of a Concrete Gravity dam. As mentioned above, a tunnel will be required in the case of an earthfill or rockfill dam. The downstream outlet valve house will be provided with sleeve valves of different sizes to control small releases.

The sizing of the outlet pipes will be based on the maximum required releases not exceeding a flow velocity of 7 m/s in the outlet pipes, allowing for maximum environmental releases (which may be required for short periods) through both outlet pipes.

i) Infrastructure

The required infrastructure will be similar for all dam types and will comprise access roads, a downstream river crossing, an office for the chief operator, power supply (including standby diesel generator), ablution facilities and drinking water supply. These will be designed conceptually, as required for the cost estimates.

j) Flow gauging station

Control over the releases to meet the reserve requires monitoring of the inflow into the dam and the releases. A flow gauging station is thus to be provided upstream of the dam reservoir. The releases or river flow are presently measured at the downstream abstraction point to the water treatment works. In addition, the necessity, for example, of ultrasonic flow meters on the outlet pipes will be investigated.

k) Construction programme

A construction programme will be compiled for the preferred size and type of dam including the distribution infrastructure.

l) Preliminary design report

A **Preliminary Design Report** will be compiled dealing with all the above-mentioned aspects, including cost estimates and recommendations with regard to the size and type of dam (see **Module 8**).

2.8 MODULE 8: COST ESTIMATE AND COMPARISON (LEADER: HERMIEN PIETERSE)

The project cost for the construction of the Zalu Dam and the supply infrastructure will be prepared for the different supply alternatives as identified in the preceding modules. The comparison of these costs will be used to determine the optimum use of groundwater in combination with the Zalu Dam to provide the most cost-effective solution for the augmentation of the water supply scheme.

Construction cost estimates for the Zalu Dam will be based on an approved level of accuracy for quantities and recent applicable rates will be determined for:

- Three alternative dam layouts with varying dam types associated with different dam storages, including all infrastructure associated with the dam indicated in **Module 6**. The first layout will be based on water supply for domestic users and the second layout on providing water for both domestic and irrigation.
- Groundwater augmentation options including water distribution and treatment works.

Comparison analyses of the three dam layouts with different dam types will be carried out on a cost and "information received from the geotechnical investigation" basis and will indicate the most cost effective and preferred dam. It may be proved that a different layout and dam type is identified for the larger second layout to be evaluated. Furthermore, sensitivity analyses will also be carried out determining the likely effect on the best option.

The viability of irrigation developments will be assessed on the incremental cost of constructing a larger Zalu Dam third layout and the provision of conveyance structures to support such development. A cost-benefit analysis will be undertaken to provide information regarding viability. Benefits over and above rain-fed development will be used in the analysis. During the execution of the above-mentioned analyses affordability and, therefore, least cost will be the focus.

Cost estimates from **Modules 3**, **6** and **7** will be used to calculate unit reference values and to calculate applicable water tariffs for each of the augmentation alternatives based on the total project cost covering the dam, groundwater augmentation as well as the distribution infrastructure, including operating and maintenance costs of these facilities.

2.9 MODULE 9: REGIONAL ECONOMICS (LEADER: BEN VAN DER MERWE)

The purpose of this Module is to provide a strategic economic assessment of the potential impacts of the project, including major development initiatives and spinoff development, on the regional and national economies.

2.9.1 Orientation and delineation of study area

This task will entail consultation with the DWA regarding the particular requirements of the assignment to ensure all relevant aspects are addressed, collection of background data and the delineation of the study area for purposes of economic impact analysis.

2.9.2 Baseline economic profile and assessment

To determine the potential economic impact of the proposed dam, a baseline profile needs to be compiled of the study area by utilising all the relevant information available. Regional population and sectoral economic growth profiles of each of the affected municipal areas will be developed. The profiles refer to the nature and extent of economic activities per economic sector and extent of growth of each of the sectors in the economy. Economic data obtained by the demographics fieldwork team will be used for verification purposes.

2.9.3 Development scenarios

In terms of quantifying the potential future economic growth and distribution, the historical data and trends will be combined with the potential of the area taking new developments and possible economic and population spinoffs into account. All new potential developments considered in the water demands will be included.

The spinoffs related to the above developments will also be considered, which will include population growth with related social and infrastructural services and growth of industries, businesses and services to serve the major developments. The scenarios will be developed based on the interpretation of the information and utilised in Step 4 to model the total impacts on the economy.

2.9.4 Economic modelling

The scenarios developed above will be utilised as the input data for an economic impact model for the region which will be developed on the basis of the input-output modelling technique.

An input-output modelling technique has various analytical applications that can be used to determine the direct, indirect and induced impacts of the proposed transformation process on the total national economy. The approach considers the interdependence of different sectors in the local economy as well as economic flows of goods and services to and from the economy.

A computerised model framework based on Urban-Econ's in-house Input-Output Model will be set up and calibrated in accordance with the principles underlying the following user requirements specifications:

- Spatial allocation options;
- Scenario simulation;
- Economic growth and multiplier analysis; and
- Sensitivity analysis.

The above results can now be used as input in the Input-Output Model to assess the various indirect and induced economic spin-offs that the project will have on the study area, per specified scenario. The approach provides, inter alia:

- Local multipliers to assess the impact of an exogenous change in the economy on, for example: employment, gross geographical product (GGP) and household income;
- The extent of sectoral linkages (interdependence) and the local economy's dependence on the larger region of which it is part; and
- The effect of development changes.

The impact assessment will be undertaken for the various phases and elements of the project development, namely:

- construction and development (short term and potentially temporary impacts);
- operational phase (sustainable impacts);
- potential irrigation impacts if viable; and
- impacts of reserve goods and services.

The envisaged outputs will be utilised to determine the potential future impacts of the dam on different activities.

Distinction will be made between the various components of the project, whether of a short- or long-term, direct or related nature.

Typically, the effects of the input/output analysis of the project are identified as follows:

- The direct effects: this takes into account direct purchases made within the economy by the project, the number of people employed;
- The indirect effects (backward linkages): this takes into account the fact that the supplying industries will also have to purchase more inputs, employ more labour and pay more wages, and that there will be a chain reaction or multiplier effect; and
- The induced effects (forward linkages): this takes into account the fact that the increased household income leads to an increase in household expenditure and to increases in regional production. Furthermore, the project will pay large amounts of revenue to the different tiers of government, which in turn will increase overall government expenditure in the economy.

2.9.5 Impact analysis

This step provides a qualitative and quantitative assessment of the perceived positive and negative economic impacts of the proposed project including the results of the input-output analysis. The following results are typically provided:

- The impact of the increase expected in terms of GGP;
- The increased tax base;
- The impact of employment on the various sectors in the study area; and
- The new business sales that will result per sector in the economy.

This Task will thus provide objective comparative interpretation of the economic impact and value of the augmentation option, which can guide the determination of the water needs and requirements in the region. The results of the analyses will be interpreted and expressed as an indication of the size of the potential regional economic impacts and significance of the proposed water augmentation option in the region, in the **Regional Economics Report**. Conclusions and recommendations will be formulated relating to the economic significance of the water augmentation options and solution, taking cognisance of the expected growth and development of the regional economy.

2.10 MODULE 10: ENVIRONMENTAL SCREENING (LEADER: NICOLA LIVERSAGE)

An environmental scoping has been done in a previous study. A thorough review of previous work, updating where necessary and assessment of additional factors is proposed in this assignment.

The proposed location of the Zalu Dam and the area immediately upstream and downstream of the proposed dam will be screened for the following, *inter alia*, factors:

- Biophysical
  - Terrestrial ecology (including fauna and flora)

    - Riverine ecology
    - Water quality
    - Hydrology and water availability
- Social
    - Population dynamics and expected growth
    - Land Use (Agricultural potential)
    - Displacement of people
    - Heritage and tourism
    - Health and safety (including HIV/Aids)
    - Access routes (accessibility to site)
    - Visual (deterrent on ecological scenic environment)
    - Infrastructural development (water, electricity, etc.)
- Economic
    - Loss of local income due to project
    - Generation of employment by project
    - Sustainability analysis (including water supply to agricultural projects in the area)
    - Environmental costs (including green building design)
- Enviro-legal compliance

Readily available information will be used in a desktop review. Once a preliminary assessment is made, biophysical, social and economic aspects will be verified on site, where other studies have not already done so. Thereafter, an analysis can be done of the key environmental factors to inform the Environmental Screening Module of this study and the EIA study that will be undertaken by an independent environmental assessment practitioner.

The screening assessment will be undertaken using a rating approach which has been used successfully by the project team in a number of other previous screening and due diligence investigations. The rating system to be used will be as follows:

- Positive impact (rated at 5 points) – sufficient information exists to consider a positive impact;
- Favourable (rated at 4 points) – sufficient information exists to make a considered rating that the overall environmental impact would not be significant;
- Uncertain (rated at 3 points) – there is uncertainty on the nature and extent of the impact primarily due to a lack of information on site specific conditions;
- Less Favourable (rated at 2 points) – sufficient information exists to determine that the site will be negatively impacted; and
- Fatal flaw (rated at 1 point) – where there could be an impact which cannot be mitigated.

The rating for each of the aspects considered will then be totalled and the overall impact described, to be documented in the **Environmental Screening Report**. An interpretation will then be made on the significance of the rating and the implications for future consideration during the independent Scoping and EIA.

Due to the lengthy process required to undertake the Reserve determination, the Environmental Screening Module will not be able to wait for the results of this study. However, as information becomes available it will be included in the screening report. The outstanding information can then be used at the Scoping and EIA phase, which is to be carried out through a separate appointment by independent environmental impact assessment practitioners.

A key component will be the effective interchange of information to avoid duplication and therefore the establishment of a coordinating mechanism. This has been addressed through the placement of the environmental screening midway through the overall study once most of the baseline information has been collected and analysed. Furthermore, mechanisms have been arranged through the project manager to filter the necessary information from the various components through the environmental team for integration as soon as it is made available.

As part of the Environmental Screening report, a scope of work for the EIA study will be prepared outlining the key environmental issues that were identified as part of the assessment, gaps in information that will require further investigation during the scoping and EIA phase as well as significant impacts requiring mitigation measures.

It is not the responsibility of the Study Team to acquire any licenses or permissions regarding environmental matters for any stage of the project including feasibility, construction, and operation.

2.11 MODULE 11: PUBLIC PARTICIPATION (LEADER: HERMIEN PIETERSE)

The ToR called for limited public participation as follows:

- Establishment of a stakeholder committee;
- Two stakeholder meetings per year in support of the Environmental Screening process and in preparation for the initiation of the independent EIA; and
- Attendance of six (6) EIA meetings by the Study Leader in the study area to provide technical information in support of the public participation process.

The public participation task allows for adequate consultation with the District and Local Municipalities during the course of the study. Consultation is crucial for the preparation of the Municipality and Water Services Authority (WSA) for the possible ownership and concomitant responsibilities of a regional water supply scheme. It is imperative that the

Municipality and WSA buy into their commitments including implementation, operation and maintenance responsibilities. Although, the DWA has requested only two public participation meetings per year, participation of key stakeholders will be realised with PMC meetings.

To date contact has been made with the following stakeholders:

- Port St John's and Ingquza Hill Local Municipalities representatives (liaising with them where and when necessary);
- Local ward councillor for Ingquza Hill and Ward Committee members (facilitating the contact persons representing the tribal authorities);
- Provincial Department of Cooperative Governance and Traditional Affairs (currently in communication to obtain information about existing rural development associations); and
- DWA Regional Office (assisted in the confirmation of the existence and locality of some identified stakeholders).

The following stakeholder entities have been identified for inclusion in the Stakeholder Committee (SC), to be finalised at the third PMC meeting.

- National Departments:
  - Department of Water Affairs;
  - Department of Environmental Affairs;
  - Department of Agriculture, Forestry & Fisheries
  - Department of Cooperative Governance and Traditional Affairs;
- Provincial Departments:
  - Provincial Government (Premier's Office);
  - Provincial Department of Agriculture and Rural Development;
  - Provincial Department of Economic Development and Environmental Affairs;
  - Provincial Department of Health; and
  - Provincial Department of Social Development;
- OR Tambo District Municipality;
- Local Municipalities:
  - Port St Johns; and
  - Ingquza Hill;
- Tribal Authorities;
- Business Chamber of Commerce (Umthatha);
- AsgiSA - Eastern Cape;
- Eastern Cape Development Corporation.
- National African Farmers Union (Eastern Cape Office);
- Agri Eastern Cape;
- Rural Development Association;
- Agricultural Co-operatives;

- Eskom;
- Silaka Nature Reserve and Mkhabathi Nature Reserve;
- Land Claims Commissioner (Provincial Office);
- Water Boards
- Water User Association (OR Tambo);
- Civic Organizations;
- Magwa Tea Estate;

In view of the intention to proceed with a concurrent assignment leading to environmental authorization, ***very careful coordination and planning of activities requiring stakeholder involvement is imperative***. This is necessary to avoid "stakeholder fatigue" and to ensure clarity of communications with the necessary openness and transparency.

2.12 Module 12: Legal, Institutional and Financial Arrangements (Leader: Bob Pullen)

2.12.1 Legal aspects

The main legislations relevant to a feasibility study for water resource development comprise the following statutes and subsidiary regulations:

- National Water Act (NWA), Act 36 of 1998;
- Water Services Act (WSA), Act 108 of 1997;
- National Environmental Management Act (NEMA), Act 107 of 1998, and regulations published in terms of this Act;
- Public Finance Management Act (PFMA), Act 29 of 1999;
- Local Government Municipal Finance Management Act (MFMA), Act 56 of 2003;
- Local Government Municipal Systems Act, Act 32 of 2000; and
- Mineral and Petroleum Resources Development Act, Act 28 of 2002.

Module 4 of this Study is designed to determine the Reserve in the Xura River in compliance with **Section 17** of the **NWA**. This is a necessary precursor for the DWA to be able to issue licences for storage and new abstractions and allocations from the river. Once development proposals are formulated, consideration will be given to the preparation of Water Use License Applications for construction of a dam and for associated works that may affect the banks of the river or the flow of the stream. The recommended institutional arrangements for the implementation phase will inform these steps.

The current understanding of the development possibilities indicates that the envisaged major storage dam will probably meet the criteria for National Water Resource Infrastructure as determined by the NWA and this will define the options for funding the development costs and ownership of the works. The Feasibility Study will lead to formulation of a consultation and environmental impact assessment notice to be published by the Minister in terms of **Sec 110** of the **Act** concerning the intention of the State to develop the project.

The basic principles underlying the **NEMA** such as sustainability of development proposals, consultation with stakeholders, and avoidance, minimization or mitigation of negative impacts on all aspects of the environment, are applicable to this project. As a consequence, the work programme includes attention to these matters and liaison with the professional team that will be appointed to undertake an EIA. **Module 11** (Public Participation) makes provision for consultation with stakeholder entities that have a direct interest in this project.

The specific tasks to be undertaken by the team are:

- Study the above listed legislation and compile a check-list of legal requirements;
- Schedule the legal requirements between those that need to be initiated during the feasibility stage and those that will be required thereafter, both before implementation and after implementation (such as dam safety inspections);
- Make application for the relevant water use licences; and
- Make recommendations on the required contractual relationships and prepare a framework for such contractual negotiations.

2.12.2 Institutional arrangements

The project is driven by the need to augment water supply for domestic use, with the opportunity to develop irrigation also being an objective. Water services provision must comply with the Water Services Act and with municipal legislation. It is understood that there are no proposals for establishing a Catchment Management Agency in the short-term in the project area. This means that all water management functions will remain the responsibility of existing relevant entities until such catchment management agency has been created.

The OR Tambo District Municipality is the designated Water Services Authority (WSA) in the project area. In terms of the Water Services Act, the WSA can fulfil the function of the Water Services Provider (WSP) in which case it must account separately for the provider function. Alternatively a Local Municipality, a Water Board or a private sector entity can contract with the WSA to provide this function. Various forms of this contractual arrangement will be considered, bearing in mind the benefits and disbenefits of possible water services provider options, and propose a practical and affordable contractual arrangement that will ensure the sustainable management of the proposed infrastructure and water services.

Contractual arrangements will be based on an assessment of the existing institutional arrangements regarding water services, the financial status of existing entities, and their resources (manpower, plant, equipment and systems) for fulfilling these functions in future. Direct liaison with representatives of these entities will be necessary.

The possible use of water for irrigation (being considered in **Module 5**) will be complemented by formulation of a suitable institutional arrangement for this component. Water User Associations (previously known as Irrigation Boards) are usually established to manage water abstractions by farmers and the collection of payments for this water. Since the irrigators who may benefit from an allocation of water from new water works will probably be emerging farmers, their preferred crop pattern, their ability and willingness to pay for water, their preferences as determined in consultations, and the size of the area to be placed under irrigation, will be important factors when proposing a suitable institutional arrangement.

The specific tasks to be undertaken by the team are:

- Assess existing institutions that can play a meaningful role in funding, implementing and operating the works;
- Prepare alternative proposals for institutional arrangements for the following components:
    - Implementation and funding of works (dam and bulk and retail infrastructure);
    - Operation of the water works by WSA or WSP;
    - Operation of existing but interrelated works if any;
    - Customer relations including billing and credit control if separate from operations.
- Consult on options; and
- Propose best institutional arrangement and prepare framework agreements (heads of agreements) and delegated functions for negotiation.

2.12.3 Financial arrangements

The ability and willingness of the users to pay for water is the primary driver of the decision on how most appropriately to fund the capital works and the on-going operations and maintenance of the proposed scheme. This aspect has direct consequences for the institutional arrangements.

The absence of a substantial, economically active user group indicates that the possibility of at least partially funding the capital component of the project through loan financing is remote. Since the user base is predominantly rural and spread out geographically, the project probably has to be funded from the Fiscus and on-budget. The Institutional Model must be appropriate for funding this project and for funding the ongoing operation and maintenance.

The sources of funding for operations and maintenance of such a scheme are generally a combination of recoverable user charges and equitable share allocations to local government. The predominantly rural user base is indicative that heavy reliance will probably have to be placed on grant funding.

Proposals will be developed for an appropriate mix of funding for capital works and the ongoing operation and maintenance of the scheme. These proposals will be compatible with the proposed institutional arrangements.

The specific tasks to be undertaken by the team are:

- Prepare broad based capital investment and operations cost budget based on inputs from engineering and costing team;
- Assess affordability criteria of user base with support of macro-economic team;
- Assess current financial status of existing water services authorities and water services providers through review of financial statements (already completed for the water boards);
- Propose arrangements for funding of capital works (percentage national grant, percentage MIG contribution and percentage loan funding if any); and
- Propose arrangements for funding of on-going operation and maintenance (user charges and revenue income, percentage equitable share contribution, percentage agricultural subsidy, means of dealing with any remaining shortfall if any).
- Compile framework funding agreements (heads of agreements) for negotiations.

2.13 Module 13: Record of Implementation Decisions (Leader: Hermien Pieterse)

A Memorandum of Agreement between the Chief Directorates Integrated Water Resources Planning (IWRP) and National Water Resource Infrastructure (NWRI) dated March 2005, clarifies "*the division and/or sharing of roles, responsibilities and accountability of the Chief Directorates through the various project phases from planning to the commissioning of a project*" and described the Record of Implementation Decisions (RID) as a ***formal handover document***, which summarises all decisions as approved.

The objective of the RID is to record all the key decisions made during the feasibility study to support the implementation process for the design and construction phases for the water supply project proposed. The key results from the feasibility study's modules will provide input to the **RID**. The findings from the "Reserve Determination" and the "Legal, Institutional and Financing Arrangements" are particularly important to the finalisation of the RID.

This report should be signed off by both the IWRP and NWRI chief directorates.

2.14 Module 14: Main Report and Reviews (Leader: Johan Rossouw)

The ToR requested "Module reviews" of the "Deliverables" to be submitted. These are summarised in the table below and have been re-arranged to provide for "Reviews" (right hand column) to be seen as sub-reports of the Module Reports (deliverables).

Table 2.4: Deliverables and Task Reviews

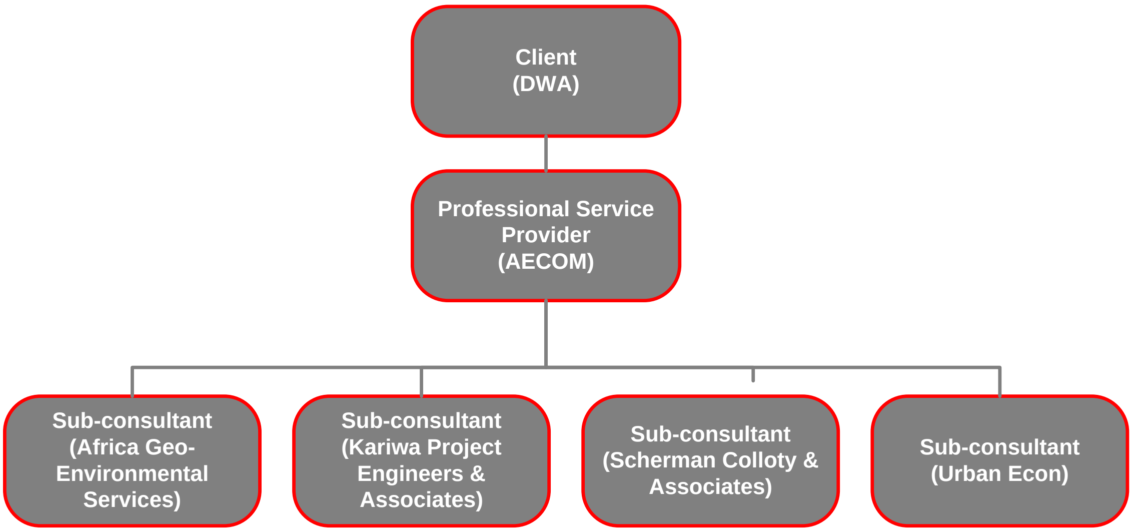
Module	Module reports / deliverables	Module reviewers
1. PROJECT MANAGEMENT		
1.1 Study initiation and inception	***Inception Report***	DWA: OA
1.2 Project management & administration	♦ All contractual arrangements ♦ Minutes of PMC meetings ♦ Invoices ♦ Progress reports	♦ DWA/ PSP QMS ♦ PMC ♦ DWA ♦ DWA
2. WATER RESOURCES	***Water Resources Assessment Report***	
2.1 Hydrology	*Hydrology chapter*	JD Rossouw
2.2 Yield analysis	*Yield analysis chapter*	JD Rossouw
2.3 Reservoir sedimentation	*Sedimentation chapter*	*No review*
3. GROUNDWATER AUGMENTATION	***Assessment of augmentation from groundwater Report***	JJP Vivier
4. RESERVE - ECOLOGICAL WATER REQUIREMENTS	***Intermediate Reserve Determination Report***	DWA RDM
5. WATER REQUIREMENTS		
5.1 Domestic water requirements	***Water requirements Report***	HS Pieterse
5.2 Agriculture / Irrigation potential	***Irrigation Potential Assessment Report***	RA Pullen
6. WATER SERVICE INFRASTRUCTURE	***Water distribution infrastructure Report***	
6.1 Distribution infrastructure	*Distribution infrastructure chapter in Water distribution Report*	Dr G de Villiers
6.2 Water quality	*Water quality chapter in Water distribution Report*	Dr G de Villiers
7. PROPOSED ZALU DAM		
7.1 Site investigations	***Material and geotechnical investigations Report***	DB Badenhorst
7.2 Dam technical details	***Dam Design Report***, that includes the preliminary dam layout and design criteria, dam design of different dam types and dam type selection	DB Badenhorst
8. COST ESTIMATE AND COMPARISON	*Project cost chapter in Main Report, Dam design Report, Water distribution Report*	DB Badenhorst
9. REGIONAL ECONOMICS	***Regional Economics Report***	RA Pullen
10. ENVIRONMENTAL SCREENING	***Environmental Screening Report***	P Teurlings
11. PUBLIC PARTICIPATION	*Public participation chapter in Environmental Screening Report*	P Teurlings
12. LEGAL, INSTITUTIONAL & FINANCIAL ARRANGEMENTS	*Legal, institutional and financing arrangements chapter in Main Report, and results taken up in RID*	A Vermeulen

Module	Module reports / deliverables	Module reviewers
13. RECORD OF IMPLEMENTATION OF DECISIONS	***Record of implementation decisions (RID)***	JD Rossouw
14. MAIN REPORT AND REVIEWS	***Main Study Report***	RA Pullen

3 STUDY TEAM

3.1 TEAM COMPOSITION

AECOM (Pty) Ltd is the lead consultant for this project, and will receive specialist inputs and support from the following sub-consultants: Africa Geo-Environmental Services (Pty) Ltd, KARIWA Project Engineers & Associates (Pty) Ltd, Scherman Colloty & Associates (SC&A) and Urban-Econ. Detailed company profiles for each of these companies were provided in the Tender submitted by AECOM on 26 January 2010.



The study team members have the required knowledge and experience for the execution of the project.

3.2 STUDY MANAGEMENT

Mr Johan Rossouw from AECOM was originally identified as a Module Leader for water resources modelling in the Tender. He has subsequently been approved by DWA to serve as the **Study Leader** for the duration of the project, taking over from Dr MS Basson (see Section **Error! Reference source not found.** for clarification).

Ms Hermien Pieterse from AECOM is **Deputy Study Leader**. She will assist with the co-ordination on the various activities, and is also responsible for the day-to-day management of the study.

The **Study Management Team** (Johan Rossouw and Hermien Pieterse) will be responsible for liaison with the DWA, the general supervision of the Study and providing direction on all tasks. Their collective previous experience in water resources planning and management studies as well as specific intimate knowledge of the study area will ensure that they provide the necessary direction to the Study Team in undertaking the Study and liaising efficiently with the DWA.

3.3 Module Leaders

The Module Leaders, listed in **Table 3.1**, will manage the various tasks. They are responsible for directing and co-ordinating the personnel working on each task, as well as ensuring technical precision and applicability. They will ensure that each task is completed within budget and on time, and to acceptable standards. Their responsibility is also to provide timeous and adequate warning of any problems encountered that could either delay the study or result in budget overruns.

Table 3.1: Module Leaders

Module	Module leader	Company
1. Project Management 1.1 Study initiation and inception 1.2 Project management and administration	JD Rossouw	AECOM
2. Water Resources	JD Rossouw	AECOM
2.1 Hydrology	E van Niekerk	AECOM
2.2 Yield analysis	JD Rossouw	AECOM
2.3 Reservoir sedimentation	Dr A le Grange	AECOM
3. Groundwater Augmentation	JA Myburgh	AGES
4. Reserve - Ecological Water Requirements	P Scherman	SC&A
5. Water Requirements	HS Pieterse	AECOM
5.1 Domestic water requirements	BJ van der Merwe	Urban-Econ
5.2 Agriculture /Irrigation potential	G Bloem	Kariwa
6. Water Service Infrastructure	GH de Villiers	AECOM
6.1 Distribution infrastructure	JPC van Heerden	AECOM
6.2 Water quality	GH de Villiers	AECOM
7. Proposed Zalu Dam	W van Wyk	AECOM
7.1 Site investigations	M van Schalkwyk	AECOM
7.2 Dam technical details	W van Wyk	AECOM
8. Cost Estimate and Comparison	HS Pieterse	AECOM
9. Regional Economics	BJ van der Merwe	Urban-Econ
10. Environmental Screening	N Liversage	AECOM
11. Public Participation	HS Pieterse (initially by EM Mashau)	AECOM
12. Legal, Institutional and Financial Arrangements	RA Pullen	AECOM
13. Record of Implementation of Decisions	HS Pieterse	AECOM
14. Main Report and Reviews	JD Rossouw	AECOM

3.4 STUDY TEAM

[Contractual information not included]

3.5 HDI COMPONENT

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

4 COST ESTIMATE

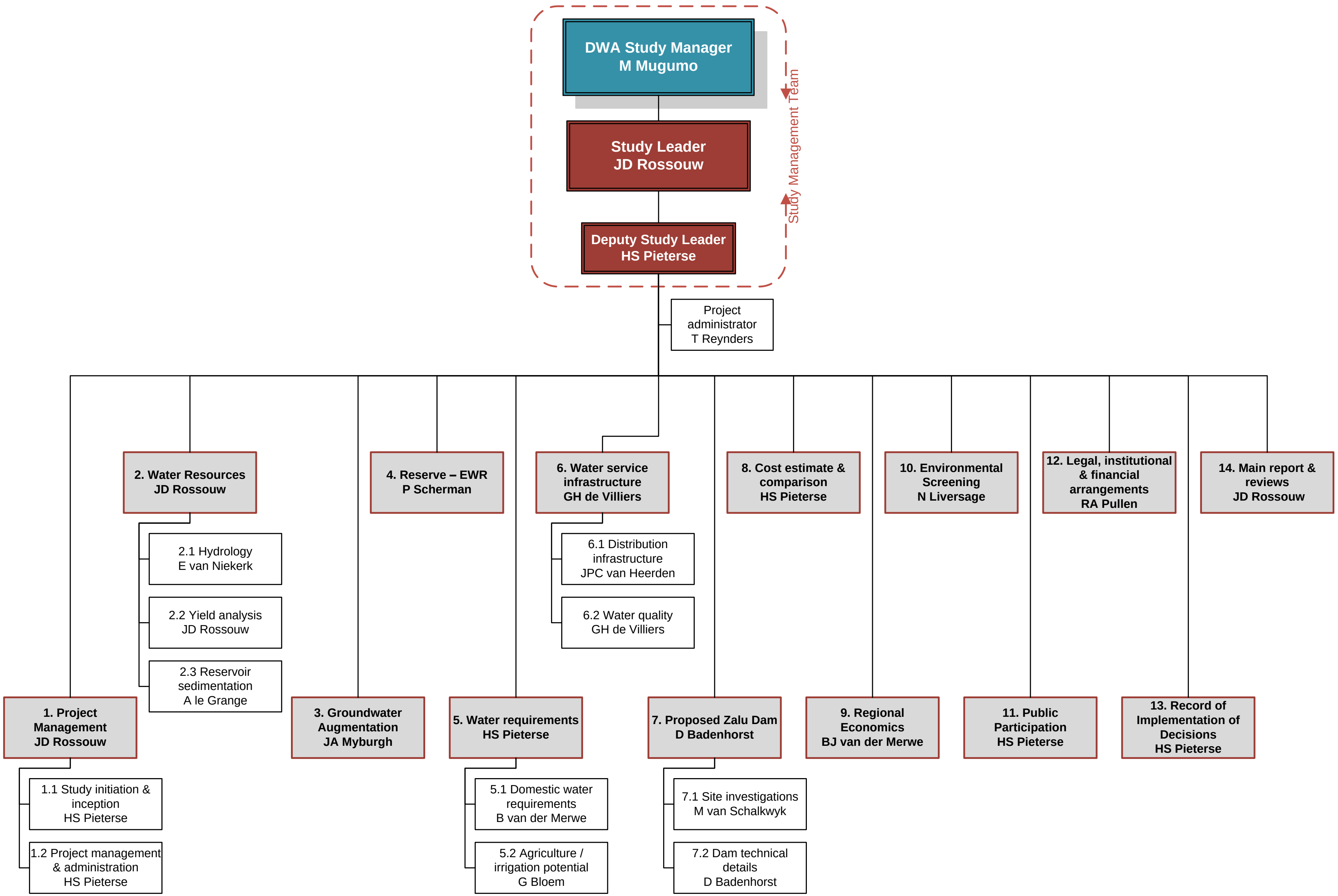
[Contractual information not included]

Appendix A

Study Programme

Appendix B

Organisational and Task Breakdown Structure


DWA Study Manager
M Mugumo
Study Leader
JD Rossouw
Deputy Study Leader
HS Pieterse
Study Management Team
Project administrator
T Reynders
1. Project Management
JD Rossouw
1.1 Study initiation & inception
HS Pieterse
1.2 Project management & administration
HS Pieterse
2. Water Resources
JD Rossouw
2.1 Hydrology
E van Niekerk
2.2 Yield analysis
JD Rossouw
2.3 Reservoir sedimentation
A le Grange
3. Groundwater Augmentation
JA Myburgh
4. Reserve – EWR
P Scherman
5. Water requirements
HS Pieterse
5.1 Domestic water requirements
B van der Merwe
5.2 Agriculture / irrigation potential
G Bloem
6. Water service infrastructure
GH de Villiers
6.1 Distribution infrastructure
JPC van Heerden
6.2 Water quality
GH de Villiers
7. Proposed Zalu Dam
D Badenhorst
7.1 Site investigations
M van Schalkwyk
7.2 Dam technical details
D Badenhorst
8. Cost estimate & comparison
HS Pieterse
9. Regional Economics
BJ van der Merwe
10. Environmental Screening
N Liversage
11. Public Participation
HS Pieterse
12. Legal, institutional & financial arrangements
RA Pullen
13. Record of Implementation of Decisions
HS Pieterse
14. Main report & reviews
JD Rossouw

Appendix C

Human Resources Schedule

[Contractual information not included]

Appendix D

Variation Order 1

[Contractual information not included]