water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

DWA REPORT NO: P WMA 12/T60/00/4811

Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme (WP 10317)

RECORD OF IMPLEMENTATION DECISIONS

FEBRUARY 2014

W18_2014_J01407

Project name:	***Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme***
Report Title:	***Record of Implementation Decisions***
Author:	***Directorate: Options Analysis***
PSP project reference no.:	***J01407***
DWA Report no.:	***P WMA 12/T60/00/4811***
Status of report:	***Final***
Final issue:	***February 2014***

DEPARTMENT OF WATER AFFAIRS (DWA)

*Approved for **Chief Directorate: Integrated Water Resources Planning by:***

M Mugumo	*LS Mabuda*
Chief Engineer: Options Analysis (South)	*Chief Director: Integrated Water Resource Planning*

*Received for **Chief Directorate: Infrastructure Development***

J Kroon	*M Williams*
Senior Specialist Engineer: Infrastructure Development	*Chief Director: Infrastructure Development*

DWA to decide on which signature page to include

Project name:	***Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme***
Report Title:	***Record of Implementation Decisions***
Author:	***Directorate: Options Analysis***
PSP project reference no.:	***J01407***
DWA Report no.:	***P WMA 12/T60/00/4811***
Status of report:	***Final***
Final issue:	***February 2014***

DEPARTMENT OF WATER AFFAIRS (DWA)

*Approved for **Chief Directorate: Integrated Water Resources Planning by:***

M Mugumo *Chief Engineer: Options Analysis (South)*	*LS Mabuda* *Chief Director: Integrated Water Resource Planning*

*Received for **Chief Directorate: Infrastructure Development***

J Kroon *Senior Specialist Engineer: Infrastructure Development*	*M Williams* *Chief Director: Infrastructure Development*

*Received for **Chief Directorate: Infrastructure Development***

L Mokoena
Chief Director: Regional Bulk Infrastructure

DWA to decide on which signature page to include

Table of Contents

Page

1 INTRODUCTION 1-1
1.1 Background 1-1
1.2 Purpose of the Scheme 1-3
1.3 Scope of the Record of Implementation Decisions 1-3
1.4 Water Requirements 1-4
1.4.1 Domestic water requirements 1-5
1.4.2 Irrigation 1-6

2 ZALU DAM AND APPURTENANT WORKS 2-1
2.1 Location 2-1
2.2 Water Resources 2-1
2.2.1 Dam yield and system modelling 2-1
2.2.2 Ecological reserve 2-2
2.2.3 Flood hydrology 2-3
2.2.4 Sedimentation 2-3
2.3 Water Supply from Zalu Dam 2-4
2.3.1 Domestic water requirements 2-4
2.3.2 Irrigation 2-4
2.4 Dam Site Characteristics 2-4
2.5 Description of Zalu Dam Infrastructure 2-4
2.5.1 Foundation 2-5
2.5.2 Embankment 2-5
2.5.3 Spillway 2-6
2.5.4 Outlet works 2-6
2.5.5 River diversion during construction 2-7
2.5.6 Hydropower potential 2-8
2.6 Costs 2-8
2.7 Construction Materials and Geotechnical Investigations 2-9
2.8 Flow Gauging Requirements Upstream and Downstream of the Dam 2-9
2.9 Zalu Dam Implementation Programme 2-10
2.10 Recommendations Arising from the Feasibility Design 2-10

3 GROUNDWATER DEVELOPMENT 3-1
3.1 Groundwater Resources 3-1
3.2 Locality 3-1
3.3 Water Supply Areas from Boreholes 3-3

3.4 Description of Borehole Infrastructure 3-4
3.5 Groundwater Development Costs 3-4
3.6 Borehole Implementation Programme 3-4
3.7 Recommendations Arising from the Preliminary Design 3-5

4 BULK WATER INFRASTRUCTURE 4-1
4.1 Location 4-1
4.2 Recommended Development Options 4-1
4.3 Infrastructure Description 4-3
4.4 Design Philosophy 4-5
4.5 Implementation Programme 4-5

5 GENERAL CRITERIA 5-1
5.1 Design Guidelines 5-1
5.2 Current Best Practices and Efficiency 5-2
5.3 Electricity Supply 5-2
5.4 Security Measures 5-2
5.5 Land Matters 5-2
5.6 Advance Works 5-2
5.6.1 Preparation to construct 5-2
5.6.2 Construction activities 5-3
5.6.3 Construction housing 5-3
5.7 Quality Assurance and Control 5-3
5.8 Operation and Maintenance 5-3
5.8.1 Operating and control philosophy 5-3
5.8.2 Maintenance philosophy 5-4

6 COMPLIANCE WITH APPLICABLE LEGISLATION, REGULATIONS AND POLICIES 6-1
6.1 National Water Act 6-1
6.1.1 Government Waterworks 6-1
6.1.2 Government Gazette Notice of Intent to Implement LRWSS 6-1
6.1.3 Dam Safety Regulations 6-1
6.1.4 Water Use Licence 6-1
6.2 Environmental Authorisation 6-2
6.2.1 Environmental Impact Assessment 6-2
6.2.2 Environmental Management Plans for the Department of Mineral Resources 6-2
6.3 Statutory Requirements 6-2

7 INSTITUTIONAL AND FINANCIAL ARRANGEMENTS 7-1
7.1 Project Cost 7-1
7.2 Funding Arrangements 7-1

7.3 Institutional Arrangements 7-1

8 LIST OF FEASIBILITY STUDY REPORTS....................8-1

List of Figures

Page

Figure 1.1 Location of Zalu Dam 1-2
Figure 1.2: Detailed reconnaissance soil-landform map of the study area 1-7
Figure 2.1: Storage volume and surface area curves for the proposed Zalu Dam 2-4
Figure 3.1: Positions of the proposed production boreholes 3-2
Figure 4.1: Possible area of supply 4-2

List of Tables

Page

Table 1.1: Domestic water requirements projections for the LRWSS Supply Area 1-6
Table 1.2: Physical suitability classes for irrigation development 1-6
Table 2.1: Yield results with the abstraction point at T6H004 2-2
Table 2.2: Locality and characteristics of EWR sites 2-2
Table 2.3: Summary of the final EWR results as a percentage of the natural MAR 2-3
Table 2.4: Cost estimate for the Zalu Dam (2012) 2-8
Table 3.1: Estimated yields from the envisaged production boreholes....................3-1
Table 4.1: Summary of required bulk supply infrastructure 4-4
Table 4.2: Estimated capital costs for the recommended bulk supply option (2012 prices) 4-4
Table 5.1: DWA specifications for the design of water infrastructure 5-1
Table 7.1: Estimated capital cost of the project for the two dam sizes....................7-1

Appendices

APPENDIX A **PROPOSED IMPLEMENTATION PROGRAMME**

APPENDIX B **ENVIRONMENTAL AUTHORIZATION**

APPENDIX C **MINISTER'S APPROVAL**

List of units

a	annum
ha	hectare
hrs	hours
km	kilometre
km^2	square kilometre
ℓ	litre
ℓ/c/d	litre per capita per day
m	metre
m/s	metre per second
m^3/s	cubic metre per second
masl	metres above sea level
million m^3	million cubic metres
million m^3/a	million cubic metres per annum
Mℓ/day	megalitre per day
mm	millimetre
kW	kilowatt
Ø	diameter in millimetres
s	second

List of abbreviations

D:NWRP	Directorate: National Water Resource Planning
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EWR	Ecological Water Requirements
FSL	Full Supply Level
H	Horizontal
HFY	Historic Firm Yield
IHI	Index of Habitat Integrity
LM	Local Municipality
LRWSS	Lusikisiki Regional Water Supply Scheme
MAR	Mean Annual Runoff
MOL	Minimum Operating Level
NOC	Non-overspill Crest
NWA	National Water Act No 36 of 1998
O&M	Operation and Maintenance
OD	Outside Diameter
PES	Present Ecological State
PSC	Project Steering Committee
RDF	Recommended Design Flood
REC	Recommended Ecological state
RMF	Regional Maximum Flood
RSA	Republic of South Africa
SANS	South African Bureau of Standards
SEF	Safety Evaluation Flood
V	Vertical
WSA	Water Services Authorities
WTW	Water Treatment Works

1 INTRODUCTION

The Lusikisiki area has been experiencing water shortages and low water security for several years. The need for a regional water supply scheme based on a dam on the Xura River was identified in the late 1970s and the Lusikisiki Regional Water Supply Scheme (LRWSS) was proposed to meet this need. A **White Paper** describing the scheme was tabled by the Transkei Government in 1979.

The need for this scheme (Zalu Dam as the preferred source of surface water, with groundwater to augment the LRWSS and/or to supply sub-areas) was confirmed by the *Eastern Pondoland Basin Study* (EPBS) in 1999 and the *Lusikisiki Groundwater Feasibility Study* in 2007. The detailed planning and sizing were conducted as part of the *Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme* (LRWSS).

1.1 BACKGROUND

The supply area for the LRWSS stretches from the Mzimvubu River in the south-west to the Msikaba River in the north-east and up to 15 km inland of Lusikisiki.

The Zalu Dam site (31° 18' 55.4" S, 29° 28' 37.3"E) is located on the Xura River approximately 10 km north-west of the town of Lusikisiki. This falls under the Ingquza Hill Local Municipality, within the OR Tambo District Municipality in the Eastern Cape Province. The location of the dam site within the Province is shown in **Figure 1.1**.

The LRWSS study area falls within the catchment of the Msikaba River. The mean annual precipitation (MAP) over the Msikaba River catchment decreases from 1 500 mm at the coast to 800 mm inland at the headwaters of the Msikaba River. The natural MAR of the Msikaba River is 221 million m^3. The catchment area for the Zalu Dam site is approximately 71.3 km^2. The major tributaries of the Msikaba River are the Xura, Kwadlambu and Mateku Rivers.

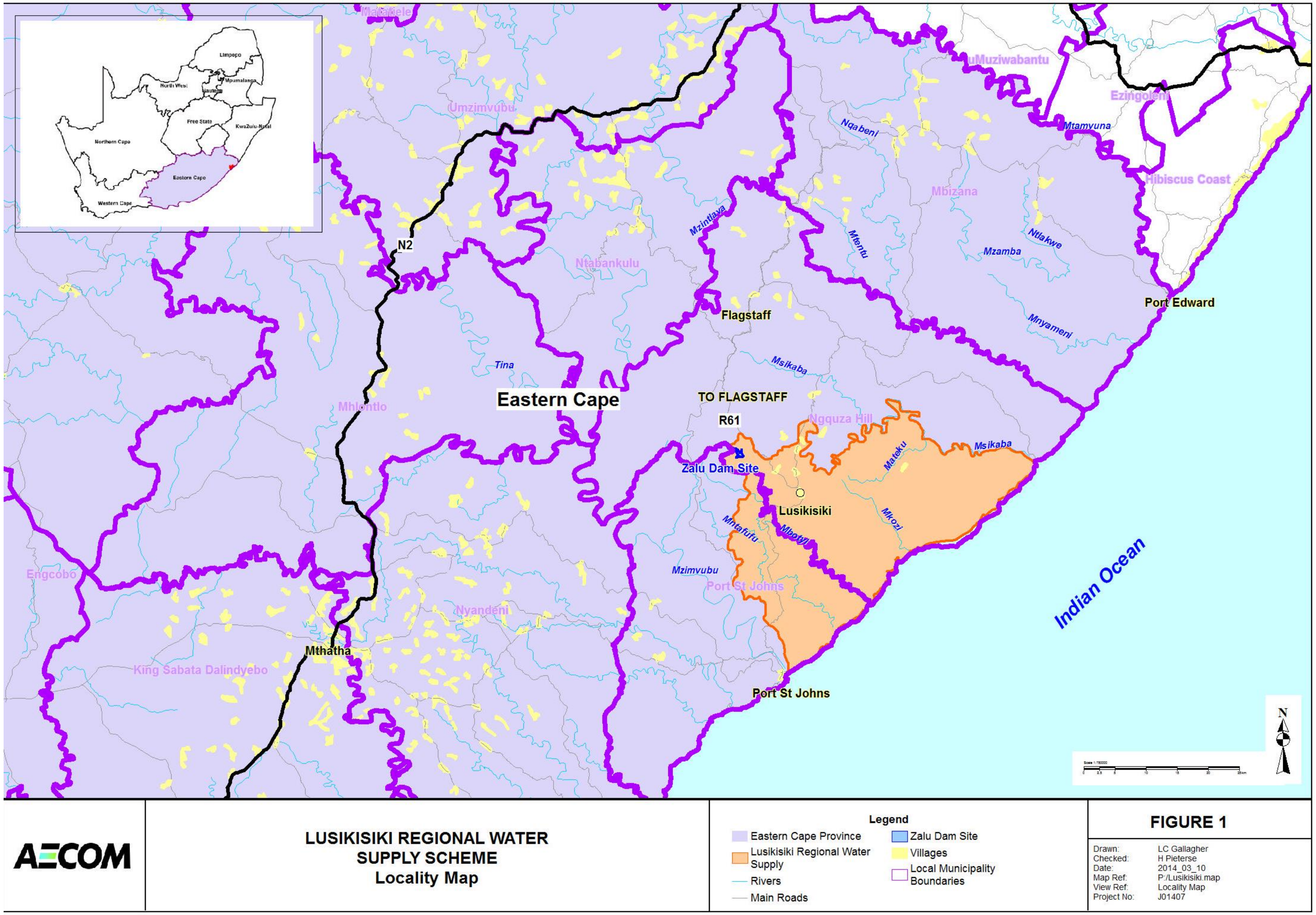


Figure 1.1 Location of Zalu Dam

1.2 PURPOSE OF THE SCHEME

The LRWSS is an initiative by the Department of Water Affairs (DWA) in support of the social and economic development strategy for the Eastern Cape Province. The purpose of the project is:

- to meet the projected growing water requirements over a 40-year planning horizon at an acceptable assurance of supply;
- to prevent further degradation of the riverine ecosystem by implementing the Reserve determined in compliance with the National Water Act No 36 of 1998; and
- to make water available for the establishment of farming (possibly subsistence) in the irrigated agriculture sector.

The LRWSS consists of the following infrastructure components:

- A new major storage dam on the Xura River, at the site known as Zalu;
- Development of groundwater resources;
- Raw water supply infrastructure to the existing water treatment works; and
- Development of a water treatment works and bulk water distribution infrastructure.

The Minister of Water and Environmental Affairs has approved the implementation of the LRWSS as a regional water scheme to be owned by OR Tambo District Municipality and operated by Amatola Water. A comprehensive Environmental Impact Assessment with associated public participation and consultation was undertaken which culminated in an Environmental Authorization issued by the Department of Environmental Affairs (DEA) on {Date} (refer to the Record of Decision).

1.3 SCOPE OF THE RECORD OF IMPLEMENTATION DECISIONS

A Memorandum of Agreement between the Chief Directorates (CD) Integrated Water Resources Planning (IWRP) and Infrastructure Development (ID) 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*".

The Memorandum states that once the detailed planning of a Project has been concluded, and the scheme configuration and other related requirements for implementation have been approved by the Minister, the project shall be formally handed over from the CD:IWRP to the CD:ID for implementation. This formal handing-over of the Project is concluded through an official document, the Record of

Implementation Decisions (RID), and is signed off by responsible officials from both the CD:IWRP and the CD:ID. The RID summarises all decisions as approved, describes the scope of the Project, the specific configuration of the scheme to be implemented, the required implementation timelines, the financing arrangements, the finalisation of required institutional arrangements and the required environmental mitigation measures as described in the Environmental Impact Report (EIR) as well as any further requirements that may be prescribed by the Environmental Authorisation from the Department of Environmental Affairs (DEA). Any work performed outside the scope of the RID will be considered unauthorized work unless official approval for such work has been obtained from the CD:IWRP prior to such work being performed.

The Chief Directorate: Infrastructure Development (CD: ID) shall coordinate the implementation of the different components of the project to be implemented by themselves and the other role players as directed by the Minister. The governance structure for project implementation shall include the following as a minimum:

- Project Coordination Committee chaired by CD: ID and attended among others by NWRI, IWRP, RBIG, Water Services, Hydrological Services, Eastern Cape Regional Office, OR Tambo District Municipality, Inquza Hill Local Municipality and Amatola Water (if directed by the Minister to operate the scheme).
- Project Steering Committee, at a higher level than the Project Coordination Committee, might be required as well. It would then be necessary to streamline the composition of the Project Coordination Committee.

This document is the formal Record of Implementation Decisions for the implementation of the **Lusikisiki Regional Water Supply Scheme (LRWSS)** and therefore concludes the handover process.

The RID provides the outcome of the ***detailed planning and feasibility designs and cost estimates as guidelines for the construction of Zalu Dam and the development of groundwater and bulk distribution infrastructure***. This document should, however, be read in conjunction with the Main Report on the *Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme* which, in turn, is based on the detailed specialist reports from the Technical Modules and the Environmental Impact Report (EIR).

1.4 WATER REQUIREMENTS

A detailed assessment of the demographics of the study area was required to estimate the projected long-term water requirements to size the proposed Zalu Dam and bulk distribution infrastructure as well as to indicate the number of required boreholes. The following water use categories were distinguished:

- domestic (urban and rural); and
- agriculture (mainly irrigation).

1.4.1 Domestic water requirements

Projections of future water requirements were made for the domestic water requirements, each based primarily on population growth, known and projected economic developments and expected changes in socio-economic standards of living.

Domestic water requirements in the study area for the period 2010 to 2040 were estimated using the four population growth scenarios with the most likely scenario being adopted for planning purposes. The following service levels were used:

- **Category 1:** Rural villages with basic level of service: 25 ℓ/c/d (population < 500 people)[1];
- **Category 2:** Rural villages with stand connections: 60 ℓ/c/d (500 > population < 1 500 people);
- **Category 3:** Rural villages with provision for schools, clinics and hospitals: 90 ℓ/c/d (1 500 > population < 5 000); and
- **Category 4:** Dense rural towns with some economic development and water-borne sewerage: 150 to 250 ℓ/c/d (population > 5 000).
- The average per capita water consumption in the Study Area for 2013 is estimated at **114 ℓ/c/d** with 59% of the population using 90 ℓ/c/d and 26% using 200 ℓ/c/d. Only 15% of the population in the Study Area use 60 ℓ/c/d or less at present. See ***Domestic Water Requirements Report***, P WMA 12/T60/00/4111. The existing water supply system is supplied from a run-of-river abstraction in the Xura River near flow gauging station T6H004. This water source is not secure since there is no upstream storage and shortages occur during periods of low flow.

A summary of the water requirement projections is shown in **Table 1.1**.

Table 1.1: Domestic water requirements projections for the LRWSS Supply Area

	Water requirements (Mℓ/d and *[million m³/a]*) for designated year				
Scenario	**2010**	**2015**	**2020**	**2025**	**2040**
Low	8.9 *[3.3]*	9.3 *[3.4]*	9.5 *[3.5]*	9.6 *[3.5]*	9.7 *[3.6]*

[1] *The water supply for a basic level of service of 25 ℓ/c/d was set in the 1994 White paper on Water Supply and*

Medium	8.9 *[3.3]*	9.4 *[3.4]*	10 *[3.6]*	10.5 *[3.8]*	12.4 d *[4.5]*
High	8.9 *[3.3]*	9.7 *[3.5]*	10.7 *[3.9]*	12 *[4.3]*	17 *[6.2]*
Most Probable	**8.9** ***[3.3]***	**9.6** ***[3.5]***	**10.3** ***[3.8]***	**11.2** ***[4.1]***	**14.7** ***[5.4]***

The most probable water requirements scenario was chosen as the most likely future growth scenario. The ***domestic water requirements*** for the LRWSS Supply Area is estimated to be approximately 14.7 Mℓ/d (5.4 million m³/a) by 2040.

1.4.2 Irrigation

A rapid assessment of the irrigation potential downstream of the Zalu Dam site in the Xura River was conducted. The irrigation potential assessment considered factors such as soil characteristics, agricultural-economic factors, and engineering considerations.

The available land was divided into physical suitability classes for irrigation development, in a **land suitability** process (for details refer to the *Irrigation Potential Assessment Report*, P WMA 12/T60/00/4211). The final soil survey results for sustainable irrigation development, which were based on the integration of land evaluation and land suitability, are summarised in **Table 1.2** and **Figure 1.2**.

Table 1.2: Physical suitability classes for irrigation development

Map Unit	Physical Irrigation Suitability Class	Gross Area (ha)	Recommendations For Irrigation Development
LB1	1 (Highly suitable)	5.4	Due to very limited extent and height above river level – probably not viable.
LC1	2 (Moderately suitable)	25.5	Limited extent – probably not viable. However, if any development is considered, a detailed soil survey needs to be undertaken.
LD1	3 (Marginally suitable)	244.4	Not recommended for formal development. Limited areas could be used for garden purposes with technical and managerial support.
LA1	5 (Not suitable)	1 629.0	Not recommended.
LE1		122.9	
LF1		3 225.8	

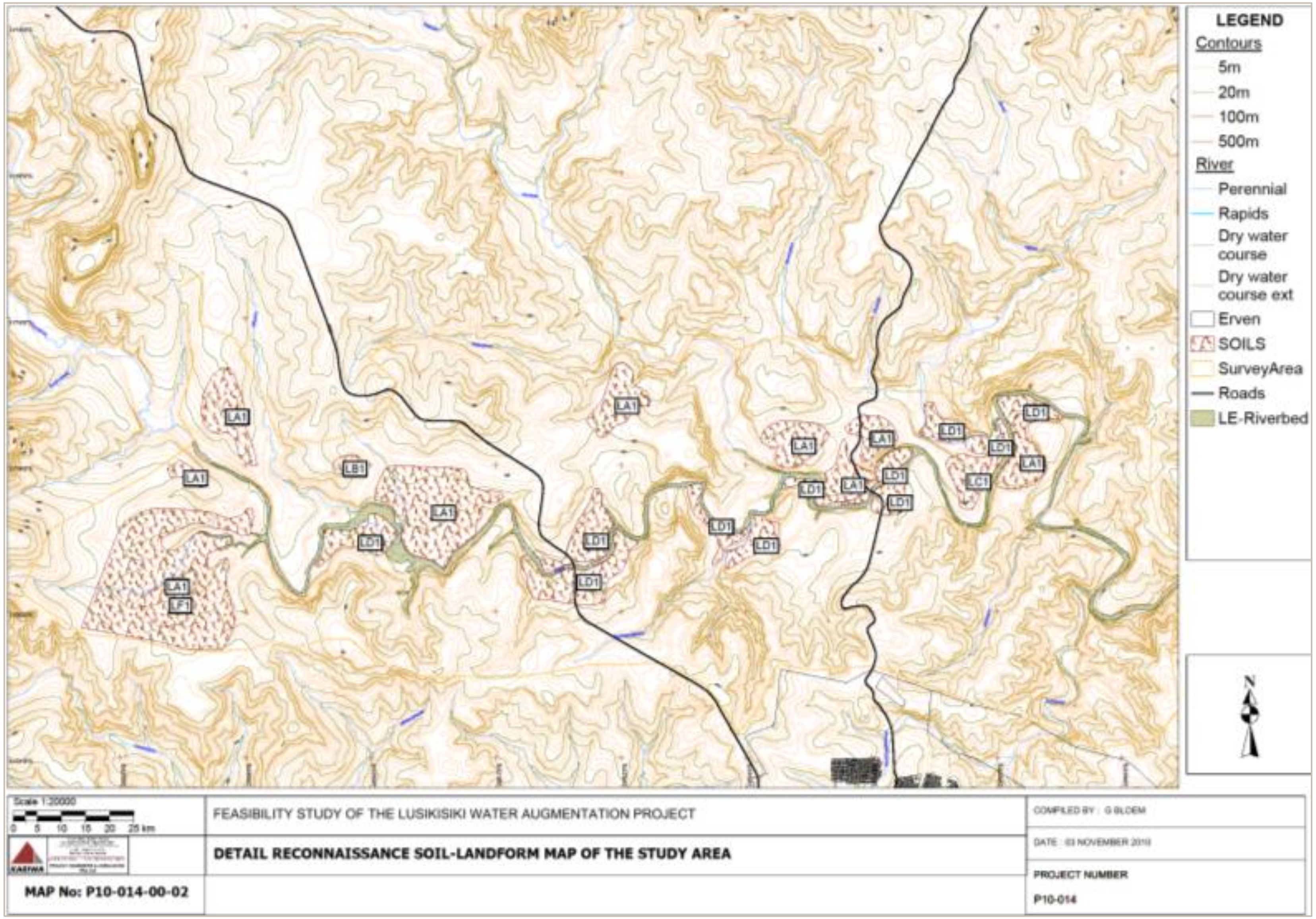


Figure 1.2: Detailed reconnaissance soil-landform map of the study area

Only 5.4 ha labelled as LB1, i.e. 0.1% of the land surveyed, is **highly suitable land (Class 1)** for irrigation. This small area and elevated position in the landscape (60-70 m above the river level) probably renders this piece of land not economically viable for irrigation development. Similarly, the land identified as being **moderately suitable (Class 2)** for irrigation and shown as map unit LC1 has a gross area of only 25.5 ha (0.6% of the land surveyed). This land is 15-30 m above the river level. A detailed soil survey is required to confirm the suitability of LC1 for irrigation development. The marginally **suitable land** in **Class 3** labelled as LD1 (5% of the land surveyed) is not recommended for formal irrigation development but limited areas could be utilised for garden plots.

Development of new irrigation schemes in economically deprived rural areas is viewed as a key strategic objective by the National Government in order to stimulate socio-economic development. Consequently, provision is made for allocating water from the yield of the planned Zalu Dam for irrigation, based on the areas of land in LB1, LC1 and LD1 that can be used effectively. *However, the use of these marginal soils for irrigation development should only be undertaken after a detailed soil investigation*.

The irrigation water requirements for a variety of crops (beans, beetroot, pumpkin, tomato, spinach, carrot, mango and citrus) were calculated using the computer programme SAPWAT 3. The estimated annual irrigation water requirement at field edge amounts to 1.32 million m^3 per annum for the 275.3 ha of land that could possibly be developed. This corresponds to an annual allocation of 4 878 m^3/ha/annum.

If the new irrigation area is supplied from the proposed Zalu Dam, the allocation of ***water for irrigation*** will be 1.45 million m^3/a to accommodate a 10% provision for transmission losses. It is recommended that the irrigation development be subjected to the following conditions:

- a detailed soil survey is required to confirm suitability of LC1 for irrigation development; and
- the Class 3 (marginally suitable land) is not recommended for formal irrigation development; however, limited areas could be utilised for garden applications.

2 ZALU DAM AND APPURTENANT WORKS

Current DWA guidelines and best practices (see **Section 5**) must be applied for the Scope of Work as described hereafter. The implementation of the project must be undertaken in the most effective and efficient manner and in accordance with all applicable legislation, guidelines, protocols and current practices.

2.1 LOCATION

The proposed **dam** to be constructed on the Xura River **at Zalu**, is situated about 0.5 km northeast of the Ndimbaneni village. ***No decision has yet been made regarding the name of the dam, although it is currently referred to as Zalu Dam***.

The coordinates of the point where the centre line of the proposed dam intersects the river are:

31° 18' 55.4" S and 29° 28' 37.3"E

2.2 WATER RESOURCES

2.2.1 Dam yield and system modelling

Firm yields, based on the historic inflow sequences, were determined for a range of storage capacities. The largest net storage capacity was taken as 17.3 million m^3, corresponding to 1.5 times the mean annual runoff (MAR), and the smallest storage capacity was 2.8 million m^3, corresponding to a 0.4 MAR dam. Yields were determined for 0.6 MAR and 1.5 MAR dams with abstraction at weir T6H004 for the scenarios where no releases were made for the Ecological Water Requirements (EWR) and where the full EWR is provided for in the domestic water releases. In addition, probabilistic yield analyses were performed. The results are shown in **Table 2.1**.

Table 2.1: Yield results with the abstraction point at T6H004

Contour masl	Gross Capacity		Net Cap million m^3	HFY (no EWR)[1] million m^3/a	HFY with low flow EWR (AB)[1] million m^3/a	Stochastic Yield with low flow AB EWR			
	million m^3	As proportion of MAR				Return Period (year)			
						1:20	1:50	1:100	1:200
622.6	**19.8**	**1.5**	**17.3**	**9.8**	**9.8**	**12.1**	**10.9**	**10.3**	**9.8**
614.9	10.6	0.8	8.0	7.4	7.4	9.4	8.4	7.9	7.5
612.0	**7.6**	**0.6**	**5.1**	**6.0**	**6.0**	**7.9**	**7.2**	**6.8**	**6.5**
610.3	6.6	0.5	4.1	5.2	5.2	7.2	6.6	6.2	5.9
607.5	5.1	0.4	2.86	4.1	4.1	5.6	5.3	5.1	4.9

[1]EWR has no impact for scenario with abstraction at the weir

HFY = historic firm yield

It is estimated that the natural MAR at the Zalu Dam site is 13.2 x 10^6 m^3. The 0.6 MAR Zalu Dam, developed to a FSL of 612 masl, will have a **historic firm yield (HFY) of 6 x 10^6 m^3/a**, with full provision for release of the Ecological Reserve[2] for EWR site 1 as part of the domestic supply, (refer to the *Intermediate Reserve Determination Report*). The proposed 1.5 MAR Zalu Dam, developed to a Full Supply Level (FSL) of 622.6 masl, will have a **historic firm yield of 9.84 x 10^6 m^3/a**, with full provision for release of the Ecological Reserve.

2.2.2 Ecological reserve

The potential large impact development of the Zalu Dam in the Xura River, a tributary of the Msikaba River, necessitated an Intermediate Reserve study to determine the Ecological Water Requirements (EWR) for the Msikaba River and its Xura tributary.

The locality of the EWR sites are provided in **Table 2.2**. EWR 1 is located downstream of the Zalu dam site in the Xura River, whilst EWR 2 is in the Msikaba River downstream of its confluence with the Xura River.

Table 2.2: Locality and characteristics of EWR sites

EWR site	River	Co-ordinates		Quaternary catchment	Catchment area (km²)	Altitude (masl)	Natural MAR (million m³/a)
		Latitude	Longitude				
EWR 1	Xura	31°19.620'S,	29°29.212'E	T60F	77.4	586	14.16
EWR 2	Msikaba	31°15.105'S	29°44.931'E	T60G	712.5	208	128.9

The Instream Index of Habitat Integrity (IHI) at EWR 1 was found to be in a Category A/B. The Instream IHI at EWR 2 was found to be a Category B. A summary of the final EWR results as a percentage of the natural MAR together with the required volumes for

[2] *Refer to the Intermediate Reserve Determination and Water Resources report for detail on the Reserve.*

the Present Ecological State (PES) and Recommended Ecological Category (REC) are provided in **Table 2.3**.

Table 2.3: Summary of the final EWR results as a percentage of the natural MAR

EWR site	Ecological Class	Maintenance low flows		Drought low flows		High flows		Long term mean	
		(%nMAR)	million m^3	(%nMAR)	million m^3	(%nMAR)	million m^3	(% nMAR)	million m^3
EWR 1	PES and REC: A/B	22.49	3.186	5.70	0.807	20.21	2.863	36.79	5.212
EWR 2	PES and REC: B	18.37	23.684	9.96	12.837	12.98	16.687	30.08	38.792

* *PES = Present Ecological State, REC = Recommended Ecological Category, nMAR = natural MAR*

It is recommended that Operating Rules for the Zalu Dam be developed for the releases of the Reserve according to the Reserve template.

2.2.3 Flood hydrology

a) *Spillway Design Floods*

The Zalu Dam will be a large dam (over 30 m high) with a high hazard potential (due to extensive downstream developments) and will be classified as a **Category III** dam in terms of the Dam Safety Regulations.

The following flood peaks were selected to size the spillway:

- Recommended Design Flood (RDF) (1:200 year): 625 m^3/s
- Safety Evaluation Flood (SEF) ($RMF_{+\Delta}$): 1 405 m^3/s

b) *River Diversion Design Flood*

The flood flow rate adopted for the conceptual design of the river diversion during construction was based on the 1:10 year flood of 182 m^3/s.

2.2.4 Sedimentation

Based on the Reservoir Sedimentation study, undertaken as part of the *Water Resources study*, a catchment sediment yield of 975 $t/km^2/a$ has been estimated for the Zalu Dam. The volume of sediment that will be accumulated in the dam basin after 50 years is estimated to be 2.52 million m^3.

2.3 WATER SUPPLY FROM ZALU DAM

2.3.1 Domestic water requirements

The ***domestic water requirements*** for the LRWSS Supply Area are estimated to be approximately 14.7 Mℓ/d (5.4 million m³/a) by 2040.

2.3.2 Irrigation

If the irrigation potential supplied from Zalu Dam is developed, the ***irrigation water requirements*** will amount to 1.45 million m³/a (including a 10% provision for losses).

2.4 DAM SITE CHARACTERISTICS

The stage-storage volumes and surface area relationships from the available contour map are shown in **Figure 2.1**.

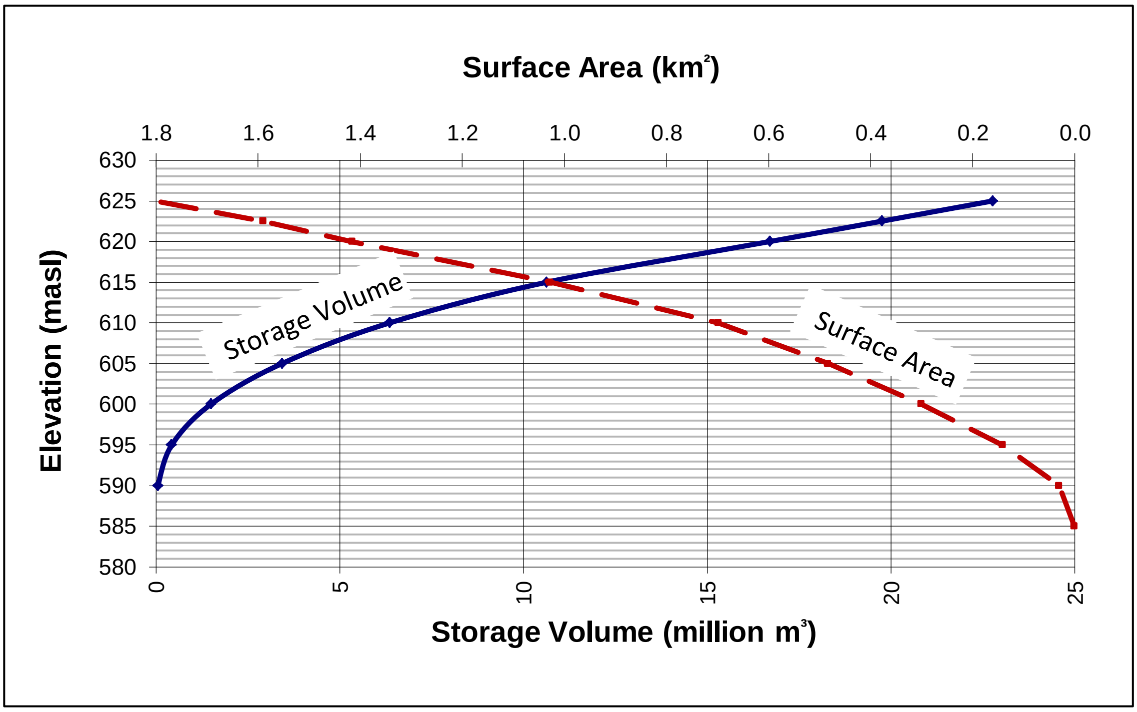


Figure 2.1: Storage volume and surface area curves for the proposed Zalu Dam

The predicted sediment load is 2.52 million m³ over 50 years.

2.5 DESCRIPTION OF ZALU DAM INFRASTRUCTURE

Refer to the *Zalu Dam Feasibility Design Report* for design information, including layouts of the main embankment, spillway and outlet works.

For the future LRWSS water requirements a dam size of 0.6 MAR and the Full Supply Level (FSL) of 612.0 masl a dam at the Zalu site will be required.

However, it was estimated that the yield potential of the Xura River at the Zalu site is considerably more than that required for meeting domestic water needs up to 2040 and for providing for new irrigation development. It may be practical to create storage at the Zalu Dam site at least equal to 1.5 MAR which will deliver a yield of approximately 10.3 million m^3/a. This is far more than is required in the foreseeable future but, depending on the engineering design approach and affordability, it may be justifiable to develop the larger capacity in order to make maximum use of the storage capability at the site. The final dam size need to be confirmed before final design.

The feasibility design focused on the 0.6 MAR dam with a full supply level of 612 masl and conceptual design for a 1.5 MAR dam with a full supply level of 622.6 masl. *The differences, where applicable, between the two dam sizes are described under each section.*

2.5.1 Foundation

The foundation level on dolerite rock for the spillway approach and ogee gravity spillway structure on the right bank is 611 masl. Material below 611 masl consists of durable coarse dolerite and is suitable for the construction of a rockfill dam.

Founding for the Rockfill dam will mainly be on slightly weathered to moderately weathered dolerite. On the left and right banks the foundation rock consists of shales.

2.5.2 Embankment

The Earth Core Rockfill dam was found to be the most feasible dam type. The materials will be obtained from the quarries identified inside the dam basin as well as the excavation for the side channel spillway.

The materials and geotechnical investigation identified two types of rockfill. The soft rockfill consisting of moderately weathered shale (3D material) is layered on top of the coarse rockfill consisting of slightly weathered to unweathered dolerite (3C material). The soft rockfill will be used in the inner zone between the downstream shell and central core of the dam. Coarse rockfill will be used in the upstream shell and parts of the downstream shell.

Seepage through the foundation of a filled dam will be controlled with a cement grout curtain drilled along the core trench. The small amount of seepage passing through the core will be intercepted by the filters directly downstream of the core.

Transition zones will be installed downstream of the central clay core.

The embankment crest width is 6 m and guardrails will be positioned to ensure a 5 m wide road.

The slope stability analysis showed that the minimum upstream and downstream slopes meeting the safety criteria are 1V:1.6H and 1V:1.7H respectively.

a) 0.6 MAR dam

The non-overspill crest (NOC) level for the 0.6 MAR dam (FSL = 612 masl) was determined as 620 masl.

b) 1.5 MAR dam

The non-overspill crest (NOC) level for the 1.5 MAR dam (FSL = 622.6 masl) was determined as 629 masl.

2.5.3 Spillway

The spillway consists of an excavated approach channel, a concrete gravity ogee structure with an overflow length of 25 m and a return channel excavated in dolerite to discharge flood water downstream of the dam embankment toe. The approach and return channel side slopes must be excavated to a slope of 1V:1H in dolerites and 1V:1.5H in shales.

A hydraulic model study would need to be conducted during the detailed design stage to confirm the size and dimensions of the spillway structure.

a) 0.6 MAR dam

The ogee crest level is at 612 masl with a freeboard of 7.91 m accommodating the attenuated SEF.

b) 1.5 MAR dam

The ogee level is at 622.6 masl with a freeboard of 6.4 m accommodating the attenuated SEF.

2.5.4 Outlet works

The outlet works consists of an intake tower, a conduit through the embankment and the outlet valve house. It is positioned with the intake and outlet near the river, which will also assist with the river diversion.

The pipe work in the intake structure consists of a twin or dual system comprising multi-level intakes at different levels with butterfly valves in the intake structure, for selecting the level at which water is to be drawn off, and sleeve valves in the outlet valve house at the downstream end of the conduit for controlling the releases. The pipe diameter is 900 mm and a minimum of 2.0 m^3/s can be released through one outlet pipe when the dam is at the minimum operating level of 595 masl. The dual system intake tower consisting of dry and wet chambers is required for maintenance.

The intakes are protected with precast concrete trash racks and fine screens to prevent blockage by floating debris. An emergency gate is required for closure for maintenance purposes at the bell mouth entrances.

Access to the outlet works is available from the embankment via the access bridge and from the downstream end along the conduit for inspection purposes.

The bottom intake level is based on the estimated sediment level after 50 years at 593 masl with the minimum operating level (MOL) at 595 masl.

a) 0.6 MAR dam

Without any inflow from upstream, the dam can be drawn down from the FSL (612 masl) to the MOL in 26.8 days (less than the maximum permissible 120 days) through one 900 mm diameter outlet pipe, and to half the depth between the FSL and the MOL in 13.3 days (less than the maximum permissible 60 days).

b) 1.5 MAR dam

Without any inflow from upsteam, the dam can be drawn down from the FSL (622.6 masl) to the MOL in 50 days (less than the maximum permissible 120 days) through one 900 mm diameter outlet pipe, and to half the depth between the FSL and the MOL in 32.7 days (less than the maximum permissible 60 days).

2.5.5 River diversion during construction

The following stages of river diversion are applicable:

- Stage 1: No cofferdam is required for the period when the bottom outlet conduit is constructed. The level of the streamflow for a 1:10 year flood occurrence is lower than the level where the outlet conduit will be constructed.
- Stage 2: Diversion through the outlet conduit which will be made possible with an upstream coffer dam.
- Stage 3: Plugging of the opening to the conduit with concrete, during which impoundment can commence.

2.5.6 Hydropower potential

This study did not undertake a detailed investigation of hydropower development. It was however decided to conduct a high level assessment of hydropower development potential as all water and instream flow supplies will be released from the dam.

a) 0.6 MAR dam

The baseload hydropower potential is estimated to be 19 kW based on the 2040 release of the domestic water requirement.

b) 1.5 MAR dam

The baseload hydropower potential is estimated to be 29.5 kW based on the 2040 release of the domestic water requirement.

2.6 COSTS

Refer to *Zalu Dam Feasibility Design Report* for a detailed cost estimate for each construction activity. The cost estimates for the two dam sizes are summarised in **Table 2.4**.

Table 2.4: Cost estimate for the Zalu Dam (2012)

Activity	0.6 MAR dam (FSL = 612 masl) Amount (R)	1.5 MAR dam (FSL = 622.6 masl) Amount (R)
Section		
Main Embankment	78 404 670	118 366 320
Spillway	58 201 200	111 236 500
Outlet works	65 596 500	70 797 200
Subtotal A	**202 202 370**	**300 400 020**
Landscaping (5% of Sub-Total A)	10 110 119	15 020 001
Miscellaneous (15% of Sub-Total A)	30 330 356	45 060 003
Subtotal B	**242 642 844**	**360 480 024**
Preliminary & General (40 % of sub-total B)	97 057 138	114 192 010
Preliminary works	4 500 000	4 500 000
Accommodation	8 640 000	8 640 000
Subtotal C	**352 839 982**	**517 812 034**
Contingencies (20% of subtotal C)	70 567 996	103 562 407
Subtotal D	**423 407 978**	**621 374 440**
Design and supervision (15% of subtotal D)	63 511 197	93 206 166
Subtotal E	**486 919 175**	**714 580 606**
VAT (14% of subtotal E)	68 168 684	100 041 285
Total Dam Cost	**555 087 859**	**814 621 891**

2.7 CONSTRUCTION MATERIALS AND GEOTECHNICAL INVESTIGATIONS

The following information was obtained during the materials and geotechnical investigation.

- Residual dolerite clay for the central core of the Rockfill dam was identified in the borrow area downstream of the dam centre line.
- Unweathered dolerite (3C material), covered with moderately weathered shales (3D material), for the Rockfill was identified on the right bank, 2 km upstream of the centre line of the dam. This source is located below the full supply level of the dam. Rockfill material was also identified at the location of the spillway and the excavation required for the construction of the spillway can be used for the embankment. The dolerite quarry can produce crusher sand and aggregates for the concrete structures of the spillway and intake tower as well as gravel for the transition layers.
- No natural sand was identified on site and must thus be imported from a commercial source.

2.8 FLOW GAUGING REQUIREMENTS UPSTREAM AND DOWNSTREAM OF THE DAM

The dam reservoir level will be monitored; balance calculations will assist in determining the inflow into the dam. No new flow gauging station is required upstream of the dam. Although the current flow gauging station T6H004 is in the Xura River downstream of the proposed Zalu Dam (water is abstracted at T6H004 and piped to the Lusikisiki Water Treatment Works (WTW) where it is measured at T6H005), DWA identified the following hydrological requirements at Zalu Dam:

- Water level recording at the dam (data logger and gauge plate),
- An evaporation station, and
- A gauging weir downstream of the dam.

The gauging weir must be located adequately downstream of the return point of the side channel spillway to ensure established flow patterns. It must also be upstream of the first tributary, in order to avoid gauge measurements mixing dam releases and streamflow from the tributary. The gauging weir must be sized to measure the first 400 mm over the dam spillway and the river releases. The need for real-time instrumentation must be finalised during the detailed design stage and all instrumentation must cater for the requirements of Eastern Cape Hydrological Services.

2.9 ZALU DAM IMPLEMENTATION PROGRAMME

The preliminary implementation programmes for the two dam size options are provided in **Appendix A**. The philosophy followed was:

- Finance to be secured before commencement of the project.
- No large access roads are required prior to construction.
- A local quarry must be developed and required plant must be erected.
- The construction of the intake tower is on the critical path.
- Construction placement rates described in the *Zalu Dam Feasibility Design Report* are applicable.
- River diversion is to be carried out in three stages.

Any construction work undertaken in the river channel shall, as far as possible, be scheduled to take place during the dry season in order to avoid possible flooding and associated damage of the works during the wet season. The appointed contractor must allow sufficient time to restore the construction site to original conditions upon completion of the works.

2.10 RECOMMENDATIONS ARISING FROM THE FEASIBILITY DESIGN

It is recommended that the following be undertaken for the two dam size options during the detailed design phase:

- Further geotechnical investigation to determine if the return channel requires a concrete lining.
- Confirmation of the minimum operating level (MOL) of the dam. The Environmental Impact Assessment (EIA) will be completed before the detailed design commences and the required minimum water level in the dam will thus be known,
- Optimisation of the spillway width and height.
- A physical hydraulic model study of the side channel spillway.
- Development of hydropower should be reconsidered in detail in relation to the power requirements of the scheme.
- Consider strategic factors, including the size of the supply area and future level of service, in selecting the right dam size.
    - Future raising of the dam if the 0.6 MAR dam (FSL = 612 masl) is selected.
    - Optimisation of the conceptual design of the 1.5 MAR dam (FSL = 622.6 masl).

3 GROUNDWATER DEVELOPMENT

3.1 GROUNDWATER RESOURCES

A total of 17 potential production boreholes were identified in the study area, and the estimated total yield from these boreholes is 0.95 million m^3/a. This additional supply from the boreholes will extend the supply area of the LRWSS. The yields from the proposed production boreholes are summarized in **Table 3.1**.

Table 3.1: Estimated yields from the envisaged production boreholes

Borehole Number	Annual Yield (million m^3/a)
EC/T60/051	0.09
EC/T60/052	0.03
EC/T60/053	0.03
EC/T60/054	0.24
EC/T60/055	0.02
EC/T60/061	0.07
EC/T60/064	0.02
EC/T60/072	0.05
EC/T60/078	0.03
CS-1	0.03
CS-2	0.04
CS-3	0.06
CS-4	0.06
CS-5	0.04
CS-6	0.06
CS-7	0.05
CS-8	0.03
Total Yield from Boreholes	**0.95**

3.2 LOCALITY

The localities of these potential production boreholes are shown in **Figure 3.1**. For more detail on boreholes refer to the *Assessment of Augmentation from Groundwater Report.*

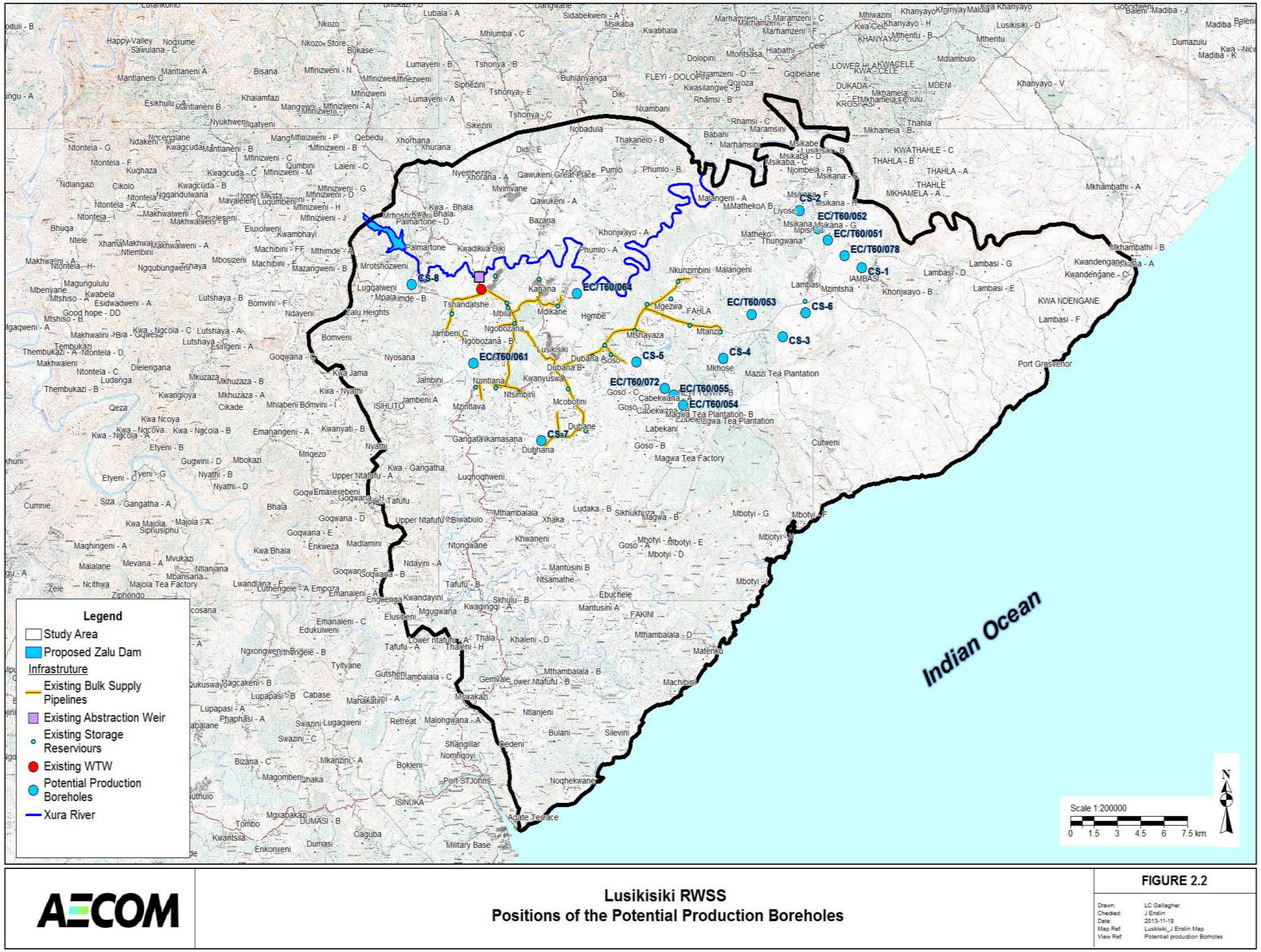


Figure 3.1: Positions of the proposed production boreholes

3.3 WATER SUPPLY AREAS FROM BOREHOLES

Boreholes EC/T60/053, CS-3 and CS-6 will suffice for 100% of the water requirements until 2040 for the villages of Lambasi and Mzimtsha. There will still be a 22% surplus of the water supplied from Boreholes EC/T60/053, CS-3 and CS-6 that will be available to the rest of the bulk supply system, and the supply from Borehole CS-1 will also contribute further to the aforementioned 22% surplus.

Boreholes CS-2, EC/T60/052 and EC/T60/051 will suffice for 100% of the water requirements until 2040 for the villages of Msikana-F, Msikana-H and Mpisi-C. There will also be a 37% surplus of the water supplied from Boreholes CS-2, EC/T60/052 and EC/T60/051 that will be available to the rest of the bulk supply system. The supply from Borehole EC/T60/T60/078 will be directly supplied to the system. The surplus water from all the aforementioned boreholes that will be discharged into the rest of the bulk supply system will supply a proposed reservoir at Tungwana. The water, from groundwater sources, that will reach Tungwana will suffice for 100% of the water requirements for the villages of Tungwana and Matheko until 2040. The remainder of this water, from the groundwater sources, will be able to supply 37% of the demand at Malangeni Village until 2040.

Boreholes EC/T60/054, EC/T60/055 and EC/T60/072 will suffice for 100% of the water requirements until 2040 for the villages of Cabekwana, Goso-D and Goso-C. There will still be a 64% surplus of the water supplied from Boreholes EC/T60/054, EC/T60/055 and EC/T60/072 that will be available for supply to Goso Village. The surplus from Boreholes EC/T60/054, EC/T60/055 and EC/T60/072, together with the supply from Borehole CS-5 will be able to supply 85% of the demand at Goso Village until 2040.

Borehole CS-7 will suffice for 100% of the water requirements until 2040 for Dubhana Village and the remaining 73% of the supply from Borehole CS-7 will be able to supply 28% of the water requirements at Dubane Village until 2040.

Borehole EC/T60/61 will be able to supply 18% of the water requirements until 2040 for the villages of Jambeni, Jambeni-A, Ishilito, Nyathi, Upper Ntafufu-A and Upper Tafufu.

Borehole EC/T60/64 will be able to supply 3% of the water requirements until 2040 for the Mdikane Village.

Borehole CS-8 will be able to supply 11% of the water requirements until 2040 for the villages of Mpala, Lugqalweni, Zulu Heights and Bomveni.

3.4 DESCRIPTION OF BOREHOLE INFRASTRUCTURE

The infrastructure for each borehole will consist of, but is not necessarily limited to, the following:

- Borehole casing;
- Borehole pump;
- Cover slab;
- Valves;
- Piping to storage reservoirs;
- Power supply, or other means of energy (e.g. solar pumps);
- Small on-site treatment works at those boreholes where some treatment is required in terms of Iron, Chloride, Bacteria and Coliforms; and
- Telemetry, in order to start and stop pumps as and when required.

3.5 GROUNDWATER DEVELOPMENT COSTS

The estimated total development cost for the identified 17 potential production boreholes is R 9 147 600 (excluding VAT) at 2012 prices (average development cost of R 538 094 per borehole).

3.6 BOREHOLE IMPLEMENTATION PROGRAMME

The activities of the borehole implementation programme are listed below. The detail programme is shown in **Appendix A**:

- Application for, and obtaining of, Section 21(a) and 21(b) Water Use Licences from the DWA;
- Detailed design and specifications of the borehole infrastructure and appurtenant works for each of the boreholes;
- Tendering;
- Equipping of the boreholes;
- Final pump tests in order to confirm the yields;
- Final water quality tests to assess the required treatment;
- Sourcing of appropriate water treatment package plants;
- Connecting of boreholes to the bulk supply system;
- Installation and testing of the telemetry;
- Training of operators;
- Security and protection of the borehole infrastructure; and
- Final testing and commissioning.

3.7 RECOMMENDATIONS ARISING FROM THE PRELIMINARY DESIGN

The development of groundwater will contribute 0.95 million m^3/a to the scheme's bulk supply; therefore conjunctive use of water supplied from the boreholes with water supplied from the proposed Zalu Dam is recommended.

4 BULK WATER INFRASTRUCTURE

4.1 LOCATION

The proposed bulk water supply infrastructure will supply the demand up to 2040 for the existing supply area, extended to take up the full yield of the proposed Zalu Dam. The additional supply from groundwater sources will enable further extension of the supply area beyond the command of the Zalu Dam and will provide enhanced security of supply. The possible extent of supply is shown in **Figure 4.1**.

4.2 RECOMMENDED DEVELOPMENT OPTIONS

The following is recommended regarding the development of the preferred bulk distribution infrastructure option:

- Decommissioning of the existing bulk supply system AC pipes.
- Construction of a new bulk supply pipe network along the same routes of the existing pipelines and beyond (for detail see *Water Distribution Infrastructure Report*).
- Conjunctive use of surface and groundwater from Zalu Dam and the 17 identified potential production boreholes.
- Refurbishment of the existing WTW and the construction of a new WTW for the treatment of water supplied from Zalu Dam (for detail see *Water Distribution Infrastructure Report*).
- On-site treatment of the borehole water at those boreholes, where treatment is required.
- Construction of a new raw water pumping station and utilization of the existing structure, if possible.
- Construction of a new clear water pumping station and utilization of the existing structure, if possible.
- Construction of new storage reservoirs and the refurbishment of the existing reservoirs, where and if possible.

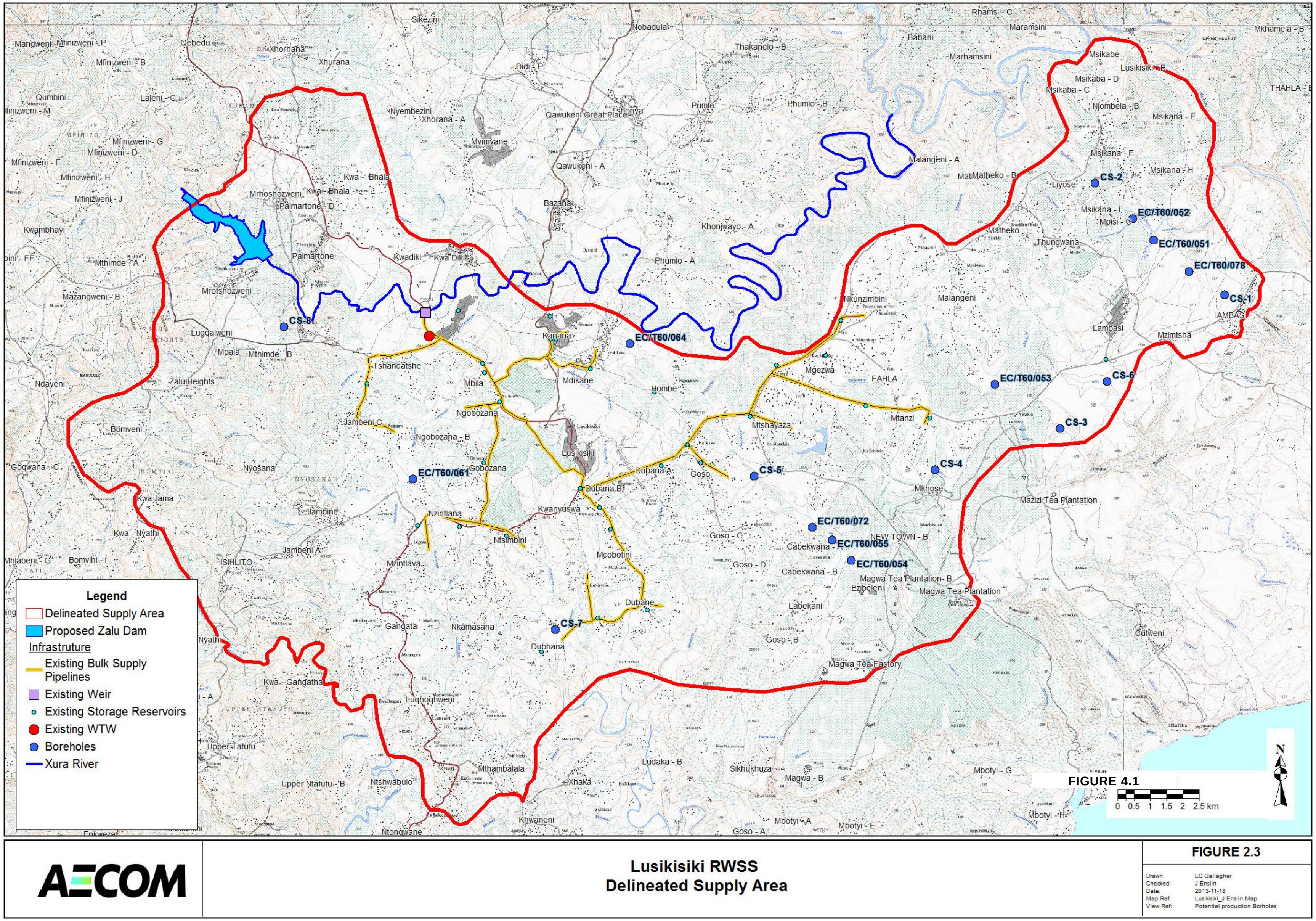


Figure 4.1: Possible area of supply

Two scenarios were analysed for the Water Distribution Infrastructure for the supply area as shown in **Figure 4.1**:

- **Scenario 1:** A domestic supply of 5.4 million m^3/a from Zalu Dam and 0.95 million m^3/a from the groundwater if the envisaged irrigation is implemented to provide water to the LRWSS until 2040; and
- **Scenario 2:** A domestic supply of 7.2 million m^3/a from Zalu Dam and 0.95 million m^3/a from the groundwater if the envisaged irrigation is <u>not</u> implemented to provide water to the LRWSS until 2060.

The recommended development option in terms of the water treatment works is a phased approach in terms of the current treatment requirements for the initial phases, and in terms of the future treatment requirements for the design horizon/s of 2040 and/or 2060, taking possible future deterioration of surface water quality into account as well.

The size of the dam and the implementation of the irrigation should be confirmed before the final design of the bulk distribution infrastructure commences.

4.3 INFRASTRUCTURE DESCRIPTION

The required infrastructure for the recommended option for the LRWSS consists of:

- New uPVC bulk supply pipelines varying between 63 and 315 mm outside diameter (OD);
- New steel bulk supply pipelines varying between 400 and 450 mm OD;
- New supply reservoirs;
- Pumping stations;
- Refurbished existing water treatment works (WTW);
- A new WTW; and
- Seventeen equipped boreholes (refer to **Section 3**).

A summary of the required infrastructure for the two scenarios is given in **Table 4.1**.

Table 4.1: Summary of required bulk supply infrastructure

Infrastructure Description	Scenario 1: 5.4 million m³/a from Zalu Dam	Scenario 2: 7.2 million m³/a from Zalu Dam
uPVC Bulk Supply Pipelines ranging from 63 to 315 mm OD	178.27 km length of uPVC Pipes	174.87 km length of uPVC Pipes
Steel Bulk Supply Pipelines ranging from 400 to 450 mm OD	4.14 km length of Steel Pipes	7.54 km length of uPVC Pipes
New concrete bulk supply reservoirs	78 521 m³ total storage volume	106 575 m³ total storage volume
Pumping stations	Total power requirement of 599 kW	Total power requirement of 783 kW
Refurbished existing WTW	2.76 Mℓ/day	2.76 Mℓ/day
New WTW	12.03 Mℓ/day	16.97 Mℓ/day
Boreholes	17 equipped boreholes	17 equipped boreholes

A summary of the capital cost, at 2012 prices, for the required infrastructure for the recommended option is given in **Table 4.2** for the aforementioned two scenarios:

Table 4.2: Estimated capital costs for the recommended bulk supply option (2012 prices)

Bulk Supply Infrastructure Component	Estimated Capital Costs	
	Scenario 1 - 5.4 million m³/a from Zalu Dam	Scenario 2 - 7.2 million m³/a from Zalu Dam
Bulk Supply Pipelines	R 160 556 187	R 167 055 697
Bulk Supply and Village Reservoirs	R 162 930 455	R 221 143 737
Pumping Stations	R 25 326 259	R 33 071 590
Borehole Development	R 9 147 600	R 9 147 600
Water Treatment Works	R 55 249 200	R 75 602 000
Sub Total	**R 413 209 700**	**R 511 706 223**
Preliminary and General (20% of Sub Total)	R 82 641 940	R 102 341 245
Total (excl. VAT)	**R 495 851 641**	**R 614 047 468**
VAT (14% of Total)	R 69 419 230	R 85 966 646
Total (incl. VAT)	**R 565 270 870**	**R 692 236 213**

* *Water Treatment Works: refurbishing of the existing 2.76 Mℓ/day WTW and construction of new 12 Mℓ/day WTW adjacent to exiting works.*

4.4 Design Philosophy

The design of the bulk supply infrastructure is based upon an average requirement of 114 ℓ/cap/day, which is based upon the design of the existing scheme. In summary, the key design philosophy entails the following:

- Preliminary design and costing of a bulk supply system for a supply of 5.4 million m^3/a from Zalu Dam until 2040;
- The preliminary design and costing of a bulk supply system for a supply of 7.2 million m^3/a from Zalu Dam until 2060 for the same area. The same supply area to demonstrate the impact if the irrigation requirements were not taken up. Although it is possible to supply a larger area, the topography make proof to be challenging, and several booster pumpstations may be required;
- Pipelines to follow the same routes of the existing bulk supply pipelines and for extended pipelines to be adjacent to existing roads and paths; and
- Storage capacity of the reservoirs to be twice the daily demand, in order to ensure a supply for 48 hours between filling operations.

4.5 Implementation Programme

The implementation for the bulk supply infrastructure programme is shown in **Appendix A**; some of the activities are listed below.

- Application for, and obtaining of, the applicable Water Use Licences from the DWA for the purposes of the LRWSS;
- Detailed design and specifications of the bulk supply pipelines and appurtenant works;
- Detailed design and specifications of the refurbishment of the existing WTW;
- Detailed design and specifications of the proposed new WTW;
- Detailed design and specifications of the proposed pumping stations;
- Detailed design and specifications of the proposed new bulk supply and village reservoirs;
- Tendering phase;
- Construction phase;
- Installation and testing of the telemetry;
- Training of operators;
- Security and protection of the newly constructed infrastructure (during construction); and
- Final testing and commissioning of all the components of the bulk supply system.

5 General Criteria

The LRWSS is a Government Waterworks in terms of the National Water Act, 1998 (Act 36 of 1998), Chapter 11. Implementation of the LRWSS must adhere to the general criteria described in Chapter 11 of the Act.

5.1 Design Guidelines

The existing DWA guidelines should be used together with recognized standards, codes and acts such as those of the South African Bureau of Standards (SANS codes), the DWA, and the Occupational Health and Safety Act whilst applying professional expertise and sound engineering judgement. A list of specifications available from DWA is shown in the table below.

Table 5.1: DWA specifications for the design of water infrastructure

Number	Description
DWS 0510	Drilling and grouting
DWS 0750	Water retaining concrete
DWS 1110	Construction of pipelines
DWS 1130	Design, manufacture and supply of steel pipes
DWS 1131	Lining and coating of steel pipes and specials
DWS 1140	Design, manufacture and supply of asbestos-cement pressure pipes and joints
DWS 1150	Glass reinforced plastic (GRP) pipes and joints for use for water supply
DWS1160	Design, manufacture, supply, and installation of Polyvinyl Chloride (PVC) Pressure Pipes and fittings
DWS 1710	Bricklaying
DWS 1720	Plasterer, tiler, and floorer
DWS 1730	Glazing and painting
DWS 1740	Plumbing
DWS 1810	Specialist services
DWS 1910	Supply, delivery, installation and commissioning of mechanical and electrical equipment for a bio-filter plant
DWS 2010	Boundary fencing
DWS 2410	Landscaping
DWS 2510	Valves (set of specifications)
DWS 9900	Corrosion protection (set of specifications)
DWS GTE	General Technical Specifications (Electrical)

5.2 Current Best Practices and Efficiency

Current Best Practices and Efficiency and where applicable, international standards, shall be applied to the design, construction, supervision and operation of the works.

5.3 Electricity Supply

Provision of a secure supply of power should be given priority against the background of possible shortages from Eskom. Timeous and detailed liaison with Eskom on this matter is necessary to ensure that sufficient permanent power supply will be available.

5.4 Security Measures

The project shall be implemented in compliance with the requirements for an Important Works as defined in the applicable legislation and the Manual on Physical Security Measures at Departmental Works and Schemes.

5.5 Land Matters

An expropriation line, depicting the minimum land purchase requirements for construction of Zalu Dam, should be determined according to the "Policy and Guidelines for the Acquisition of Land Rights at Departmental Dams" (DWAF, 2001).

Land rights (including servitudes) to implement and operate the required infrastructure must be acquired in accordance with Departmental policy and guidelines and the relevant legislation.

5.6 Advance Works

5.6.1 Preparation to construct

- Obtain licence to construct the dam from the Dam Safety Office according to Section 120 of the National Water Act.
- Develop specifications for Contractor's work area.
- Develop a detailed construction plan.
- Provide power for construction.
- Liaise with the local authority and traditional leadership regarding access to the site.

5.6.2 Construction activities

Construction activities shall be undertaken in compliance with the Project Specifications, the Environmental Authorization and related Environmental Management Plans which must have been approved by the Competent Authority. Method Statements for all construction activities must be consistent with these prescriptions so as to result in minimal and acceptable impacts on the surrounding environment. The appointed contractor must rehabilitate all disturbed areas on the construction site strictly in accordance with the relevant Specification upon completion of the works.

5.6.3 Construction housing

The contractor will be responsible for accommodation for his employees during construction. Housing needs for permanent staff shall be identified through consultations with the scheme operators, municipalities, local communities and landowners during the EIA process.

5.7 Quality Assurance and Control

Quality assurance in terms of ISO 9001-2000 or functionally equivalent standards is a requirement. All Consultants and Contractors shall be required to compile Quality Assurance Plans for the works and these shall be rigorously applied, monitored and reported on.

The quality control aspects will follow logically from the aforementioned processes where it will culminate in the production of suitable reports, drawings, specifications and manuals meeting the operational and maintenance requirements of the Project.

5.8 Operation and Maintenance

5.8.1 Operating and control philosophy

Appropriate communication, monitoring and control systems shall be provided to allow for the effective and efficient control of all components of the scheme. The normal mode will be unattended remote control, with provision for local control in case of emergency or breakdown.

5.8.2 Maintenance philosophy

The maintenance philosophy to be followed with the implementation of the project shall *inter alia* consist of the following requirements:

- Maintenance programmes should be based on a planned preventative maintenance approach to meet the system availability criteria, which requires a 98% assurance of supply for most users.
- Infrastructure at the dam and other structures must allow for the removal and loading of equipment onto vehicles for transport. Suitable maintenance and inspection procedures, including maintenance of an asset register, shall be provided as part of the operation and maintenance (O&M) manuals to ensure that the operator is able to effectively maintain all components.
- A spares philosophy for the major equipment shall be proposed and recorded in the O&M manuals.
- Determination of the time periods required to carry out all maintenance activities during scheduled downtimes and taking account of seasonal operation requirements is critical. Planning for maintenance periods, with a one to two year moving window, will ensure that inspections and repairs can be scheduled within operational and financial constraints. Plant and equipment that are easily maintainable are preferred. The maintenance work should preferably be done during periods of low water demand.
- Prior to handover, the operators shall receive training on maintenance works by the designers and relevant contractors.
- Bulk water users will be notified in advance of any shutdowns for planned maintenance, as agreed to in the off-take agreements. In case of shutdowns for emergency repairs, bulk water users will be notified as soon as possible.

6 COMPLIANCE WITH APPLICABLE LEGISLATION, REGULATIONS AND POLICIES

It is the responsibility of the Implementing and Operating Agencies to adhere to all relevant legislation when implementing or operating the Scheme.

6.1 NATIONAL WATER ACT

6.1.1 Government Waterworks

The Minister of Water and Environmental Affairs has approved the construction of the LRWSS as a Government Waterworks in terms of Section 109 of the National Water Act. Funding for building the scheme will come from National Treasury. Amatola Water has been directed to operate the water resources infrastructure on behalf of the Department of Water Affairs and the water services infrastructure on behalf of OR Tambo District Municipality.

6.1.2 Government Gazette Notice of Intent to Implement LRWSS

A notice in terms of Section 110 of the NWA was published on {Date} in the Government Gazette, announcing the Minister's intention to construct the LRWSS as a Government Waterworks and inviting comments from the public. No comments were received by the due date of {Date}. The legal requirement has been fully met and implementation can therefore commence.

6.1.3 Dam Safety Regulations

The Zalu Dam will be a large dam (over 30 m high) to be classified as a **Category III** dam in terms of the Dam Safety Regulations, Section 120 of the NWA. A license to construct must be obtained at least 120 days after the date on which the dam becomes capable of containing, storing or impounding water.

6.1.4 Water Use Licence

The owner of the proposed Zalu Dam should obtain a Water Use Licence before disturbing the water course and constructing the dam. *In terms of Section 21 of the NWA, taking of water from a water resource, storing water and impeding or diverting the flow of water in a water course are all specified as water uses*.

6.2 ENVIRONMENTAL AUTHORISATION

6.2.1 Environmental Impact Assessment

A full EIA, supported by a comprehensive Public Participation process, was undertaken as part of the overall feasibility assessment. The environmental assessment process was undertaken in accordance with the National Environmental Management Act (Act No. 107 of 1998). This process incorporated the following:

- Environmental Screening;
- Public Participation;
- Environmental Scoping; and
- Environmental Impact Assessment (including Ecological Impact Assessment, Aquatic Impact Assessment, Heritage Impact Assessment, Palaeontological Impact Assessment and Socio-economic Impact Assessment).

A copy of the Environmental Impact Report (EIR) was recently submitted to the Chief Director: Infrastructure Development under separate cover, separate from the Record of Implementation Decisions report. A copy of the Authorization is attached in **Annexure B**.

a) Relocation of graves and mitigation of impacts on cultural and historic sites

Mitigatory measures for the development of the dam include the exhumation and relocation of the affected graves and the protection of cultural and historic sites located within a 20 metre buffer around the dam basin in which no development can take place.

Due regard should be taken of the cultural sensitivities regarding grave relocation.

6.2.2 Environmental Management Plans for the Department of Mineral Resources

In terms of the Minerals and Petroleum Resources Development Act (Act No. 28 of 2002), applications to the Department of Mineral Resources (DMR) for permission to extract naturally occurring construction materials are required. The Environmental Management Plan was prepared and is attached as appendix to the EIR report.

6.3 STATUTORY REQUIREMENTS

The requirements of all relevant policies and legislation shall be strictly adhered to. This includes, *inter alia*, the Broad-Based Black Economic Empowerment Act, Sustainable Utilisation Planning, the National Water Resources Strategy, the National Development Plan, and the Public Finance Management Act.

7 Institutional and Financial Arrangements

7.1 Project Cost

The estimated capital cost of the proposed works, at 2012 prices including VAT, is as follows:

Table 7.1: Estimated capital cost of the project for the two dam sizes

	0.6MAR dam @ FSL 612 masl (R'000)	1.5MAR dam @ FSL 622.5 masl (R'000)
Development of groundwater resources	9 418	9 417
Zalu Dam	486 919	714 581
Total for water resource development	**496 066**	**723 998**
Bulk water services infrastructure*	599 212	599 212
Total integrated system	**1 095 278**	**1 322 940**
VAT	153 339	185 212
Total (incl. VAT)	**1 248 617**	**1 508 152**

* *Bulk water services infrastructure cost for 7.2 million m³/a scenario*

7.2 Funding Arrangements

In view of the fact that the envisaged beneficiaries of the proposed water resource infrastructure are mainly poor, rural communities who will receive mainly a basic level of water supply service, the scheme will not be in a position to generate sufficient income from water tariffs that can be used to redeem the capital cost. Consequently, **the project must be financed either on-budget or from the Regional Bulk Infrastructure Grant or a combination of the two.**

7.3 Institutional Arrangements

The LRWSS will comprise a large dam (at the Zalu site), boreholes, water treatment plants and bulk distribution infrastructure to convey raw and treated water within the project area to the users.

The Zalu Dam is classified as ***regional water resource infrastructure***. The Minister of Water and Environmental Affairs will make a decision before commencement of construction, assigning the responsibilities for implementation, ownership and operation of the scheme. The potential role players identified include the Department of Water Affairs, the Trans-Caledon Tunnel Authority (TCTA), OR Tambo District Municipality and Amatola Water.

While it is likely that the Department of Water Affairs would remain owner of the Zalu Dam, a water board, likely to be Amatola Water, could be mandated to operate and maintain the dam on behalf of the Department.

The water treatment plant and the conveyance infrastructure are classified as "***bulk potable distribution infrastructure***". In line with the consolidation of water boards into regional water utilities as envisaged in the new National Water Resources Strategy, a water board (likely to be Amatola Water) could be assigned ownership and the responsibility of operating the bulk potable distribution infrastructure.

Local water services infrastructure (mostly potable water infrastructure) is the responsibility of the Water Services Authorities (WSA), OR Tambo District Municipality. Whilst the focus of this report is on the LRWSS, the strong inter-dependence between the LRWSS and the water services aspects is well recognized. The WSA need to provide for adequate water services to supply all users with potable water.

8 LIST OF FEASIBILITY STUDY REPORTS

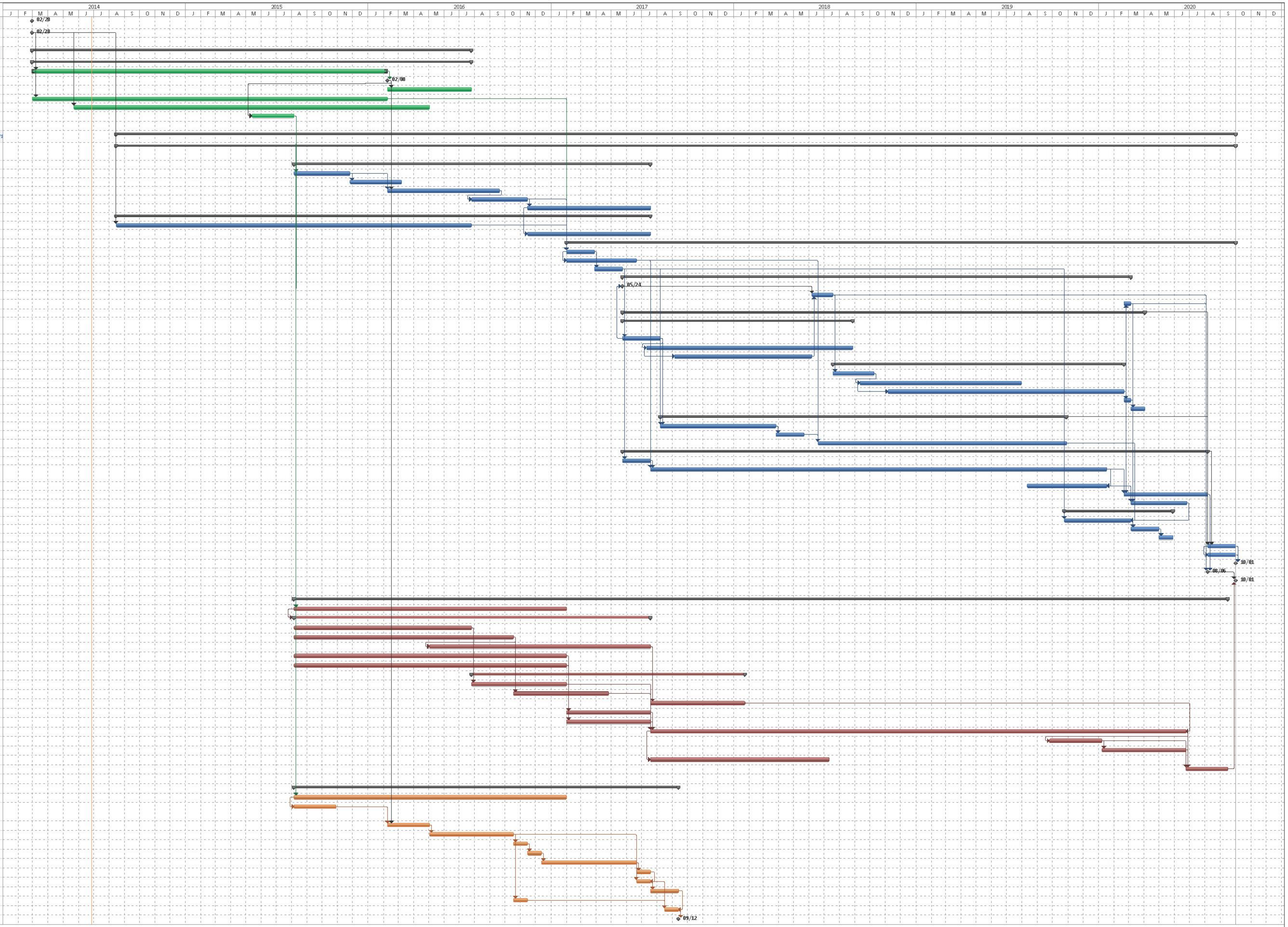
This report forms part of the series of reports, done for the ***Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme***.

Report Name	DWA Report Number
Water Resources Assessment	P WMA 12/T60/00/3711
Assessment of Augmentation from Groundwater	P WMA 12/T60/00/3811
Intermediate Reserve Determination	P WMA 12/T60/00/3911
Legal, Institutional and Financial Arrangements	P WMA 12/T60/00/4011
Domestic Water Requirements	P WMA 12/T60/00/4111
Irrigation Potential Assessment	P WMA 12/T60/00/4211
Water Distribution Infrastructure	P WMA 12/T60/00/4311
Materials and Geotechnical Investigations	P WMA 12/T60/00/4411
Zalu Dam Feasibility Design	P WMA 12/T60/00/4511
Regional Economics	P WMA 12/T60/00/4611
Environmental Screening	P WMA 12/T60/00/4711
Record of Implementation Decisions	***P WMA 12/T60/00/4811***
Main Study Report	P WMA 12/T60/00/4911

Appendix A

Proposed Implementation Programme

ID	Task Name	Duration
1	**A. Feasibility Study**	**0 days**
2	End of Lusikisiki Feasibility Study: technical component	0 days
3		
4	**B. Decision support phase**	**600 days**
5	**ENVIRONMENTAL AUTHORISATION**	**600 days**
6	Environmental Impact Assessment (including decision making phase	24 mons
7	Environmental authorisation	0 days
8	Appeal period	6 mons
9	**INSTITUTIONAL AND FINANCIAL ARRANGEMENTS**	**24 mons**
10	**DECISION SUPPORT STAGE**	**24 mons**
11	MINISTERIAL APPROVAL	60 days
12		
13	**C. Implementation programme**	**1512 days**
14	**1. IMPLEMENTATION PROGRAMME FOR THE PROPOSED ZALU DAM (FSL= 621.2 masl)**	**1512 days**
15	**1.1 DETAIL TENDER AND DESIGN PHASE**	**480 days**
16	1.1.1 Procurement of Design PSP	4 mons
17	1.1.2 Additional geotechnical investigations	3 mons
18	1.1.3 Tender design	8 mons
19	1.1.4 Tender documents and procurement	4 mons
20	1.1.5 Detail design	8 mons
21	**1.2 PRELIMINARY WORKS**	**720 days**
22	1.2.1 Electrical supply to site (ESKOM)	24 mons
23	1.2.2 Heritage assessment and Land acquisition	8 mons
24	**1.3 CONSTRUCTION PHASE**	**912 days**
25	1.3.1 Site establishment	8 wks
26	1.3.2 Mobilisation and erection of crusher and batching plant	5 mons
27	1.3.3 Site clearing	2 mons
28	**1.3.4 River diversion**	**682 days**
29	1.3.4.1 Stage 1 (no coffer dam)	0 mons
30	1.3.4.2 Stage 2 (upstream coffer dam)	1.5 mons
31	1.3.4.3 Stage 3 (Plug of intake tower)	2 wks
32	**1.3.5 Main embankment**	**702 days**
33	**1.3.5.1 Stage 1 (Left and right flank, excl. river section, from 595masl up to NOC)**	**314 days**
34	1.3.5.1.1 Excavation	2.7 mons
35	1.3.5.1.2 Curtain grouting	14 mons
36	1.3.5.1.3 Embankment fill	9.1 mons
37	**1.3.5.2 Stage 2 (River section up to 595masl))**	**386 days**
38	1.3.5.2.1 Excavation	2.9 mons
39	1.3.5.2.2 Curtain grouting	10.8 mons
40	1.3.5.2.3 Embankment fill	15.4 mons
41	1.3.5.3 Crest road construction	2 wks
42	1.3.5.4 Finishing (guardrails etc.)	1 mon
43	**1.3.6 Spillway, chute and stilling basin**	**550 days**
44	1.3.6.1 Spillway excavation (approach and return channel)	7.5 mons
45	1.3.6.2 Spillway grouting	2 mons
46	1.3.6.3 Formwork, reinforcing and structural concrete placeme	17 mons
47	**1.3.7 Outlet works (incl. conduit)**	**792 days**
48	1.3.7.1 Excavation and foundation preparation	2 mons
49	1.3.7.2 Reinforcement, formwork, concrete and unformed surfaces	30.4 mons
50	1.3.7.3 Hydro-mechanical items (stage 1)	5 mons
51	1.3.7.4 Access bridge to intake tower	6 mons
52	1.3.7.5 Hydro-mechanical items (stage 2)	4 mons
53	**1.3.8 Access roads**	**140 days**
54	1.3.8.1 Roadbed & mass earthworks	4 mons
55	1.3.8.2 Layer works	2 mons
56	1.3.8.3 Surfacing	1 mon
57	1.3.9 Fencing	2 mons
58	1.3.10 Landscaping	2 mons
59	1.3.11 Commissioning and handover	0 days
60	**1.4 RESERVOIR IMPOUNDMENT**	**0 days**
61	**1.5 EARLIEST WATER DELIVERY FROM DAM**	0 days
62		
63	**2. WATER SERVICES INFRASTRUCTURE**	**1260 days**
64	**2.1 Obtain Water Use Licences from DWA**	18 mons
65	**2.2 Detail design and specifications:**	**480 days**
66	2.2.1 Bulk supply pipelines and appurtenant works	12 mons
67	2.2.2 Refurbishment WTW	15 mons
68	2.2.3 New WTW	15 mons
69	2.2.4 Pumping stations	18 mons
70	2.2.5 New bulk supply and village reservoirs	18 mons
71	**2.3 Tendering**	**360 days**
72	2.3.1 Bulk supply pipelines and appurtenant works	6 mons
73	2.3.2 Refurbishment WTW	6 mons
74	2.3.3 New WTW	6 mons
75	2.3.4 Pumping stations	6 mons
76	2.3.5 New bulk supply and village reservoirs	6 mons
77	**2.4 Construction**	36 mons
78	**2.5 Install telemetry**	3 mons
79	**2.6 Train operators**	6 mons
80	**2.7 Security and projection of boreholes**	12 mons
81	**2.8 Final testing and commissioning**	3 mons
82		
83	**3. IMPLEMENTATION PROGRAMME FOR GROUNDWATER SCHEN**	**520 days**
84	3.1 Obtain Water Use Licences from DWA	18 mons
85	3.2 Detail design and specifications: boreholes and appurtenant works	3 mons
86	3.3 Tender	3 mons
87	3.4 Equip boreholes	6 mons
88	3.5 Pump tests	1 mon
89	3.6 Water quality tests	1 mon
90	3.7 Sourcing of appropriate water treatment package plant	6 mons
91	3.8 Connect boreholes to bulk supply system	1 mon
92	3.9 Install telemetry	1 mon
93	3.10 Train operators	2 mons
94	3.11 Security and projection of boreholes	1 mon
95	3.12 Final testing and commissioning	1 mon
96	3.13 Delivery of water from boreholes	0 days



P WMA 12/T60/00/4811: RID
Implementation programme

Task	Milestone	Project Summary	External Milestone	Inactive Milestone	Manual Task	Manual Summary Rollup	Start-only	Deadline					
Split	Summary	External Tasks	Inactive Task	Inactive Summary	Duration-only	Manual Summary	Finish-only	Progress					

Appendix B

Environmental Authorization

Appendix C

Minister's Approval