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




IRRIGATION POTENTIAL ASSESSMENT

OCTOBER 2013

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

LIST OF STUDY REPORTS

This report forms part of the series of reports, prepared for the Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme. All reports for the Study are listed below.

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

This report is to be referred to in bibliographies as:

Department of Water Affairs, 2013. FEASIBILITY STUDY FOR AUGMENTATION OF THE LUSIKISIKI REGIONAL WATER SUPPLY SCHEME: IRRIGATION POTENTIAL ASSESSMENT P WMA 12/T60/00/4211

Prepared by:

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In association with:

Executive Summary

Good soil structure and the high potential of soils are essential for healthy, resilient plants because they help develop extensive, active root systems and, if all other factors are normal, they allow the crop to realise optimum yield. Good soil structure and high potential also promotes efficient use of water and nutrients, encourages biological activity and protects plants during drought and other hardships.

The proposed procedure of "go-no-go" was thus used to assess the irrigation potential for the proposed Zalu Dam in the Lusikisiki area. Where soils with average to below-average potential were found in the study area, it was not necessary to invest much time in assessing the irrigation potential for the study area within the command area of the dam itself. The findings in this report can be summarised as follows.

NATURAL ENVIRONMENT

PHYSICAL GEOGRAPHY

The topography of the Msikaba River catchment is varied, ranging from the steep hilly area, which reaches an altitude of about 1 100 m above mean sea level and forms the northern and north-western boundaries, to sea level at the Indian Ocean, which forms the eastern boundary. The headwaters of the Msikaba River, Xura River and other tributaries are located in this hilly central plateau.

CLIMATE

The climate and temperature variations of the Xura River basin seem to be closely related to elevation and proximity to the coast. The basin has a mild temperate climate along the coast and more extreme temperature conditions are evident inland, with most rainfall occurring during the summer months.

- ***Temperature**: The temperature patterns in the catchment are largely influenced by altitude. The higher-lying regions in the north of the study area receive frost in winter, as do the minor escarpment and central plateau regions in the north, although they are generally warmer than the higher-lying areas. The lower reaches of the Msikaba River valleys and the coastal region have warm, frost-free conditions.*

- ***Rainfall:*** *The study area receives summer rainfall, although the peak rainfall period varies. The upper plateau regions fall into the mid-summer period, with rainfall peaking in January. The escarpment areas and central plateau fall into the late summer period, with rainfall peaking in February. The coastal region and the lower reaches of the main river valleys fall into the mid-to-late summer period, with rainfall peaking in January and February.*

- ***Evaporation:*** *Evaporation increases from the east to the west and from the coast to the interior. Gross mean annual Simon's Pan Evaporation increases from about 1 100 mm along the coast to 1 400 mm in the north-west.*

VEGETATION

Large tracts of the catchment area and current dry-land production areas have been over-exploited through over-grazing and the deforestation of natural bush. There are visual indications in the deep ravines and steep river valleys of what the natural state of afforestation and ground cover should have been before human exploitation.

SOIL SURVEY

The soils investigation deals with a study of the soil-landform resources of an area below the proposed Zalu Dam in the Xura River, near Lusikisiki, in order to evaluate these resources in terms of their physical suitability for irrigation development by smallholders. The study covers an area of more than 5 000 ha.

The soil-landform survey was conducted at a detailed-reconnaissance level, according to internationally accepted methods and procedures, whereas the assessment of land suitability had been done according to the author's experience, based on prescribed standards.

For land evaluation purposes, climate has been regarded as uniform over the project area, which is a high summer rainfall area with hot summers and mild winters.

Generally, the area is composed of high hills with steep slopes and a soil pattern dominated by shallow soils. In places, terraces of the Xaru River are distinct features. Landform is described according to hillslope unit and slope class, and soils are identified by means of diagnostic properties (see ***Table 3.1****).*

Shallow soils are mainly derived from sediments (map units LA1, LF1).

- *The soils of the Cartref, Glenrosa and Mispah soil forms dominate the crests and midslopes of the landscape. Except for having shallow effective rooting depths (<40 cm), most (specifically the Cartref and Glenrosa forms) also show temporary wetness in the subsoil during and after the wet season. Because they have mainly developed in parent materials derived from shale, they have loam to silty clay textures.*

Soils derived from dolerite:

- *Map unit LB1 comprises deep to very deep (100-150+ cm), well-drained, dark red, structured, clayey soil of the Shortlands form.*

- *The soil in map unit LC1, probably developed from a parent material admixture of dolerite and shale, mainly consists of deep (>100+ cm), moderately well-drained, reddish, weakly structured, loam to clay loam overlying unspecified material with signs of wetness in the deep subsoil of the Tukulu form.*

Soils mainly derived from alluvium:

- *Map unit LD1 covers slightly higher-lying terraces as well as adjoining lower footslope sites in places – possibly remnants of even older and more higher lying terraces. In general, these soils are composed of thick soil materials, although effective rooting depth is limited by subsoil wetness. The two main components are:*

    - *Soil of the Tukulu form, which comprises somewhat poorly drained, very dark greyish brown, weakly structured, loam to silt clay loam topsoil on dark greyish, weakly structured, cutanic, clay loam to silt clay B1 horizon overlying from about 60 cm greyish, weakly structured, clay loam to silt clay deep subsoil with faint mottling.*

    - *Soil of the Bonheim form, which comprises moderately well-drained, very dark coloured, strongly structured, clay loam to silt clay topsoil overlying dark coloured, strongly structured, cutanic, clay loam to clay subsoil.*

- *Map unit LE1 contains the lower-lying or relatively younger terraces, especially of the Xura River riparian land. Aspects limiting its suitability for irrigation development include temporary to seasonal soil wetness and a possible flooding hazard. The two main components are:*

    - *Poorly drained, dark coloured, weakly structured, loam to clay loam topsoil on greyish, gleyed, clay loam to silt clay subsoil of the Katspruit form.*

- *Somewhat poorly drained, dark coloured, weakly structured, loam to clay loam topsoil abruptly overlying greyish, stratified materials with contrasting textures and faint mottling of the Dundee form.*

Morphological properties and analytical records of two profiles gleaned from published records are shown in ***Appendix B****.*

*The detailed-reconnaissance soil-landform map of the study area shows the spatial distribution of six map units, while the accompanying legend (****Table 3.2****) describes the dominant soil and associated features, as well as the positions (landform and slope) they occupy in the landscape. The sizes of map units are given in* ***Table 3.3****.*

*During the land evaluation process, the soil-landform factor was subdivided into physical suitability classes for irrigation development (****Table 3.3****) based on the author's experience, along with attributes limiting their suitability (****Table 3.3****). A 5.4 ha area (map unit LB1) of highly suitable land was demarcated but, due to its limited extent and high-lying position in the landscape (about 60-70 m above river level – see attached map), irrigation development is not likely to be viable. Similarly, moderately suitable land of unit LC1 includes an area of 25 ha that is 15-30 m above river level. Marginally suitable land of class 3 covers several isolated areas (approximately 244 ha) along the terraces and, in places, lower footslope sites adjacent to the Xura River. This class 3 land is not recommended for formal irrigation development. However, only a few areas could be used for garden purposes, with technical and managerial inputs. Class 5 land usually cannot be recommended because of serious limitations. The extent and recommendations of these physical suitability classes are summarised in the following table.*

Table i: Recommendations of physical suitability classes

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	

AGRI-ECONOMICS

- *The extent of agricultural development activities in the study area have decreased since 2001 when the previous baseline study was executed.*

- *The Lambasi Cooperative, established in 1982, was closed in 2006. The cooperative consists of well-developed infrastructure.*

- *The Lambasi Dairy Project and Calf Raising Unit was established in 1982 and closed down in 2006. The project consists of well-developed fixed improvements and equipment.*

- *According to the previous baseline study for Eastern Pondoland, sugar cane is grown under dry land conditions on about 1 500 ha in the Mankenkezi / Greenville area of the Bizana district. These activities ceased, however, mainly due to a lack of finance.*

- *At the time of the site visit, the status quo of Magwa Enterprise Tea (Pty) Ltd had not changed since the previous baseline study. The planned expansion of the estate, however, did not materialise. The investigation team got the impression that the estate is experiencing cash flow problems on a regular basis and that the Department of Agriculture and Rural Development is providing cash injections to maintain production and employment opportunities.*

- *Since the site visit, Magwa Enterprise Tea (Pty) Ltd has experienced farm worker unrest and the workers have looted and vandalised the farm. Reports indicate that the farm has lost all of this year's production and permanent workers have been chased from the farm. Existing farm infrastructure and production areas have been damaged.*

- *Magwa Enterprise Tea (Pty) Ltd used to be involved with dairy, cattle, maize and chicken production projects for the communities in the region. All of these projects have ceased, mainly due to a lack of finance and effective management.*

WATER USE FOR AGRICULTURE IN THE STUDY AREA

METHODOLOGY

The estimated crop water requirement calculations were done using SAPWAT 3, a computer planning model based on the universally recognised Penman-Monteith method of estimating reference evapotranspiration (ETo) and the FAO method of linking reference evapotranspiration to any given crop by way of a crop factor (kc) and a series of efficiency factors, including irrigation method and effective rainfall.

Three principal climatic data sets were used (from SAPWAT): quaternary unit T60F, T60G and T60H, and these coincide with the quaternary data sets used with WR90.

Base data set

All water-use and crop water-use data sets used in this report are based on the climate data for quaternary T60F, available in SAPWAT 3.

Cropping Pattern

Crop production is mainly centred around the dry-land production of maize, dry-beans, Hubbard pumpkins and some sorghum, while community gardens mostly cater for own consumption and some local sales of vegetables, such as spinach and cabbage. All of these crops are traditional cropping patterns that are found in many subsistence-farming communities.

Water use for irrigation

An area-dependent crop water allocation can be developed if the areas of crops that can be expected for future irrigation development in the study area is known. As the area is fairly devoid of any intensive, commercial or even well-organised Government Schemes, it is, at best, an estimate as to what percentages of each crop may be produced.

The DWAF Water Resource Study in Support of the AsgiSA EC Mzimvubu Development Project report, Volume 2 of 5, March 2009, as prepared by BKS (Pty) Ltd for the larger Eastern Cape Region, had much larger tracts of commercial farming to consider. If it is accepted that crop production will entail producing crops for own consumption and, with an area of higher value crops, a possible crop pattern is approximately 65% vegetables (beans, tomatoes, spinach, cabbage and possibly carrots) and 35% for crops such as potatoes and, possibly, fruit trees.

The weighted irrigation requirement of 1 800 m^3/ha/annum calculated in this report shows that the high rainfall for the study area results in lower weighted irrigation requirements than expected. In drier parts of the country, weighted irrigation requirements would range from 6 600-12 500 m^3/ha/annum, compared to the less than 1 800 m^3/ha/annum for the study area.

Other water use in Agriculture

Other water uses identified in this report are:

- *Livestock water use, based on livestock numbers supplied, is estimated at 7 100 m^3/day or 2 591 500 m^3/annum.*

- *Current poultry / broiler production will require about 1 650 m^3/annum and is not expected to grow by much more than 20% to about 2 000 m^3/annum.*

- *If a red meat abattoir is considered, water use for that industry is estimated at 25 000 m^3/annum.*

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List of abbreviations

AECOM	AECOM SA (Pty) Ltd
BKS	Legacy BKS (Pty) Ltd
Ca	calcium
CASP	Comprehensive Agricultural Support Programme
CEC	cation exchange capacity
D:NWRP	Directorate: National Water Resource Planning
DM	District Municipality
DWA	Department of Water Affairs
EPBS	Eastern Pondoland Basin Study
ETo	Evapotranspiration
FAO	Food and Agricultural Organisation
K	potassium
LM	Local Municipality
LRWSS	Lusikisiki Regional Water Supply Scheme
Mg	magnesium
Na	sodium
P	phosphorus
pH	measure of the acidity
PSP	Professional Service Provider
RID	Record of Implementation Decisions
RSA	Republic of South Africa
SAPWAT 3	Software used in South Africa to estimate irrigation water requirements
S-Value	Total amount of exchangeable cations
WR90	Surface Water Resources of South Africa, 1994
Zalu Dam	Proposed dam at the Zalu site

List of units

°C	degrees Celsius
a	annum
cm	centimetre
ha	hectare
km	kilometre
km^2	square kilometre
kW	kilowatt
ℓ	litre
ℓ/ day	litre per day
m	metre
m^2	square metre
m^3/day	cubic metre per day
million m^3	million cubic metres
million m^3/a	million cubic metres per annum
Mℓ/day	megalitre per day
mm	millimetre
MW	megawatt

1 INTRODUCTION

The Department of Water Affairs (DWA) appointed **BKS (Pty) Ltd** in association with four sub-consultants (**Africa Geo-Environmental Services, KARIWA Project Engineers & Associates, Scherman Colloty & Associates and Urban-Econ**) with effect from 1 September 2010 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.

1.1 BACKGROUND TO THE PROJECT

In the 1970s 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 the 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 (Hill Kaplan Scott, 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 STUDY AREA

The study area 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 (and it's catchment) in the Xura River and the selected conveyance routes between the dam and the extended supply area. It also includes the boreholes to be 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.

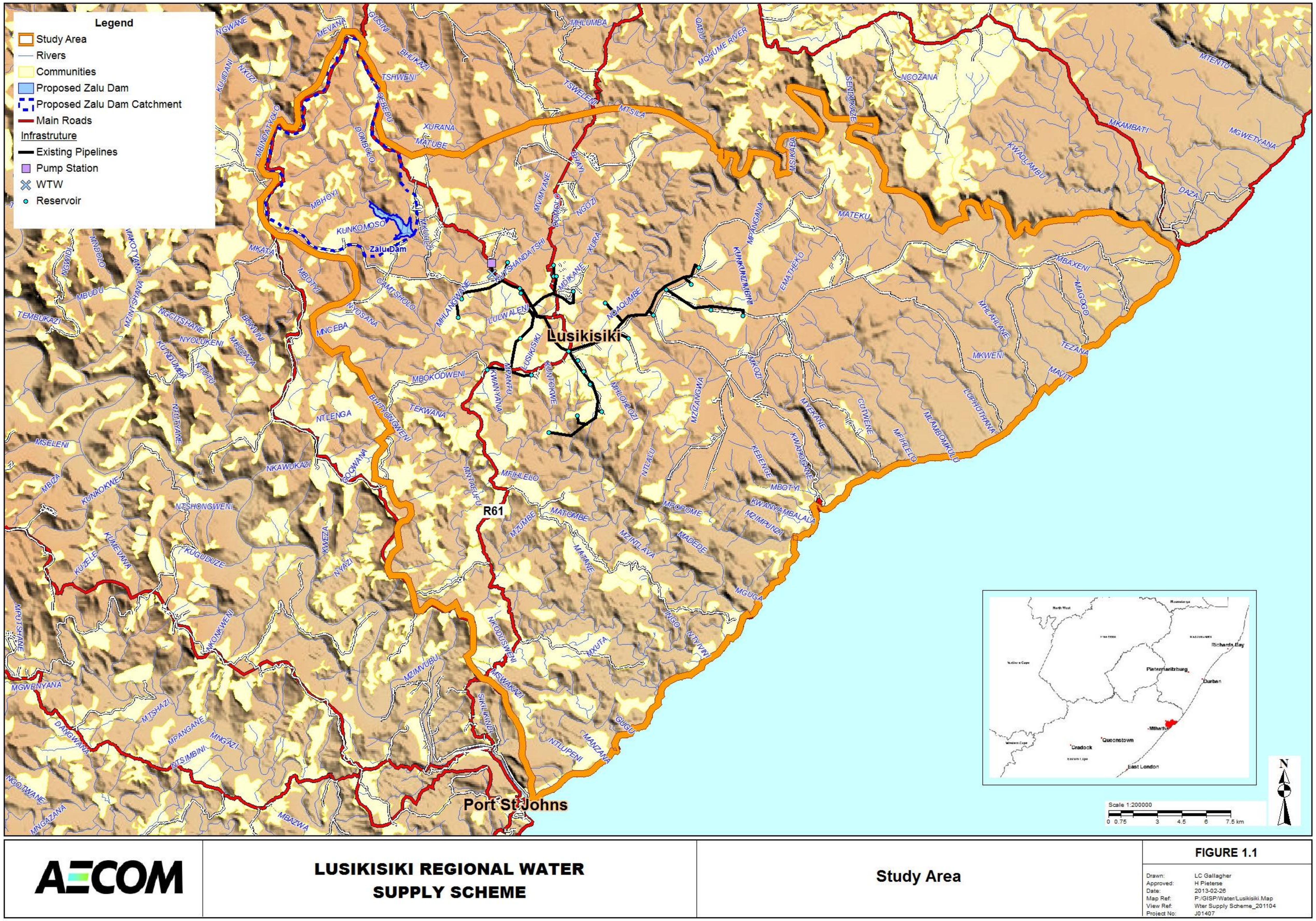

Figure 1.1: **Study area**

1.3 Objective, Scope and Organisation of the Study

The objective of this study was to complete a comprehensive engineering investigation at feasibility level for the proposed LRWSS, 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.

This feasibility study provided 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.

The required activities for this project have been grouped into 14 modules, as shown in the table below.

Table 1.1: Study structure

Modules	Deliverable
1. PROJECT MANAGEMENT 1.1 Study initiation and inception 1.2 Project management and administration	**Inception Report**
2. WATER RESOURCES	**Water Resources Report**
2.1 Hydrology	♦ Hydrology chapter
2.2 Yield analysis	♦ Yield Analysis chapter
2.3 Reservoir sedimentation	♦ Sedimentation chapter
3. GROUNDWATER AUGMENTATION	**Assessment of Augmentation from Groundwater Report**
4. RESERVE - ECOLOGICAL WATER REQUIREMENTS	**Reserve Determination Report** ♦ Reserve Template
5. WATER REQUIREMENTS	
5.1 Domestic water requirements	**Domestic Water Requirements Report**
5.2 Agriculture / Irrigation potential	**Irrigation Development Report**
6. WATER SERVICE INFRASTRUCTURE	**Water Distribution Infrastructure Report**
6.1 Distribution infrastructure	♦ Chapter in Water Distribution Infrastructure Report
6.2 Water quality	♦ Chapter in Water Distribution Infrastructure Report
7. PROPOSED ZALU DAM	
7.1 Site investigations	**Materials & Geotechnical Investigations Report**
7.2 Dam technical details	**Dam Preliminary Design Report, including design criteria, dam type selection, dam sizing**
8. COST ESTIMATE AND COMPARISON	**Cost Estimate and Economic Analysis report**
9. REGIONAL ECONOMICS	**Regional Economics Report**
10. ENVIRONMENTAL SCREENING	**Environmental Screening Report** ♦ Scope of work for EIA
11. PUBLIC PARTICIPATION	♦ Included in Environmental Screening Report
12. LEGAL, INSTITUTIONAL AND FINANCIAL ARRANGEMENTS	♦ Legal, institutional and financing arrangements chapter in Main Study Report
13. RECORD OF IMPLEMENTATION OF DECISIONS	**Record of Implementation Decisions**
14. MAIN REPORT AND REVIEWS	**Main Study Report**

1.4 SCOPE OF THIS REPORT

This **Irrigation Potential Assessment Report** is the deliverable for **Module 5.2** of the *Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme*. It discusses the specific findings prepared by the specialist group that was tasked with investigating the agriculture and irrigation aspects of this project. The specialist group's objectives were covered in the project proposal and have been provided in this section.

1.4.1 Rapid irrigation potential assessment

A scoping process was proposed during the Inception Phase of the project for a rapid assessment of the irrigation potential downstream of the dam. The intention was to obtain a broad picture of soil potential (the main driver for carrying on with an intensive investigation into irrigation potential) and to understand the present agricultural activities in the area.

1.4.2 Short irrigation decision analysis

The "go-no-go" decisions for irrigation are to be documented as part of the Inception Report. If the findings are positive regarding the potential for irrigation, the need for further investigative work will be detailed in the Inception Report. The process followed by the specialist team comprised the following activities:

- Visually assess soils found within the command area of the dam and demarcate the extent of the soils land form on maps;
- Assess current irrigation operations (if any) and ascertain stakeholders' current irrigation experience and preferred irrigation method;
- Identify crops that are currently produced within the study area;
- Obtain production figures, including costs of production and prices obtained for produce;
- Provide gross margin analyses of major crops using group discussion techniques;
- Determine any major constraints that limit crop production;
- Identify markets where farmers sell their produce (size and position of the markets).

1.4.3 The objectives of this report

This report discusses the findings of the rapid assessment of the potential for irrigation in the command area below the proposed Zalu Dam (refer to **Figure 1.2**). It combines the reports from the soils assessment, the agricultural-economic assessment and the irrigation engineering assessment, and makes recommendations for the irrigation potential in the study area.

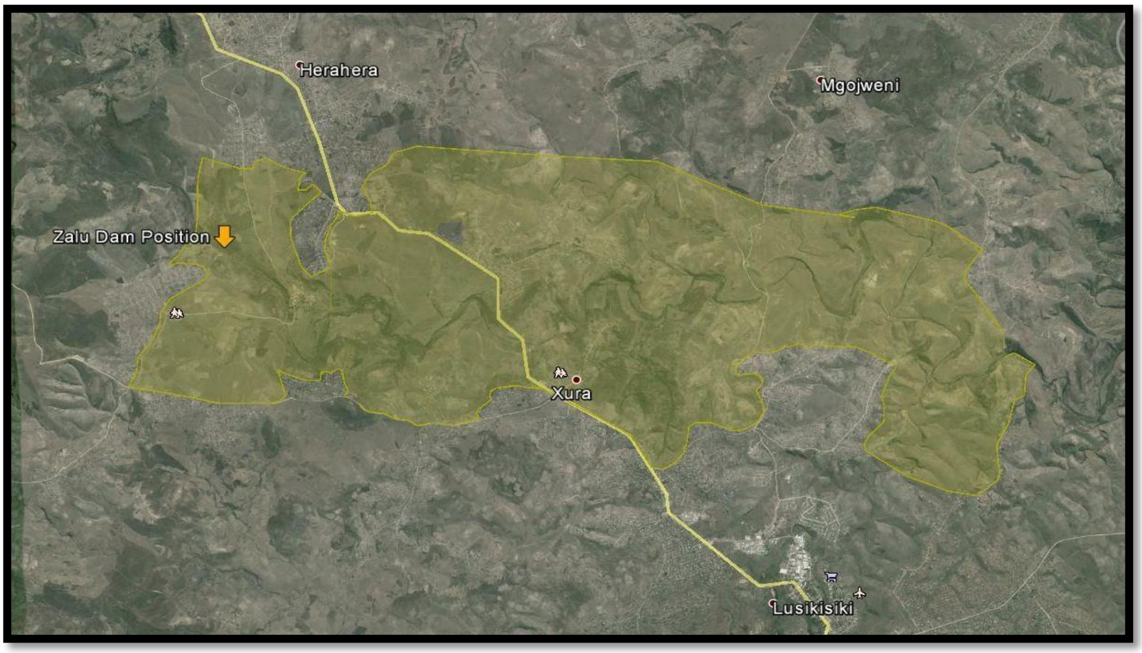

Figure 1.2: Rapid assessment area for soils

2 NATURAL ENVIRONMENT

In assessing the natural environment, the specialist group has used data from SAPWAT 3, a software program utilised to calculate crop water requirements. It has a database of rainfall, temperature, prevailing winds, radiation, sunshine hours, humidity and evapotranspiration for stations based on the quaternary division of the country's rivers as per WR90 (*Surface Water Resources of South Africa, 1994*). Data was also downloaded from *Google Earth* (satellite images and topography detail) to assess general slopes and current land use. The group also had access to aerial images from the Surveyor General and, during site visits, they noted general land use as observed on the ground.

2.1 PHYSICAL GEOGRAPHY

The topography of the Msikaba River catchment is varied, ranging from the steep hilly area, which reaches an altitude of about 1 100 m above mean sea level and forms the northern and north-western boundaries, to sea level at the Indian Ocean, which forms the eastern boundary. The headwaters of the Msikaba and Xura Rivers and other tributaries are in this hilly central plateau. After descending through the central escarpment, the tributaries and the Msikaba River flow through deep river valleys incised into the coastal belt, before discharging into the Indian Ocean at Mkabati.

The catchment can be divided into the following three physiographic zones:

- The minor escarpment, which separates the high plateau to the north of the study area from the central plateau and which consists of steep and broken country at altitudes of 800-1 100 m.
- The central plateau, which consists of undulating country at altitudes of 600-800 m.
- The coastal belt, which generally consists of steep and broken country that extends 8-15 km inland from the sea and rises to an altitude of approximately 600 m.

The main aspect of the study area is toward the southeast and beyond, down to the Xura River valley, which is deep and mild to steep sided, flowing across the central plateau and becoming deep and steep side valleys through the coastal belt section before it joins the Msikaba River.

In the *Woods & Van Schoor* (*1976*) study, a slope analysis revealed that at least 60% of the study area has a slope greater than 15%, while only 10% of the study area has a slope of less than 5%. This was confirmed by a slope analysis using Google Earth base data of the study area below the dam and the Xura River tributaries.

2.2 CLIMATE

The climate and temperature variations of the Zalu River basin seem to be closely related to elevation and proximity to the coast. The basin has a mild temperate climate along the coast to more extreme temperature conditions inland and most rainfall occurs during the summer months.

2.2.1 Rainfall

Mean annual rainfall in the Xura River basin varies over short distances, because of the broken topography, from 874-1 385 mm. It is generally above 1 000 mm, and the areas of lower rainfall are confined to the Zalu Dam catchment area. **Table 2.1** indicates the rainfall data of the study area.

Table 2.1: Average Monthly Rainfall in the Study Area

Quaternary No:	Average Monthly Rainfall (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
T60F	113	166	139	71	51	40	38	35	60	105	119	127	1 064
T60G	129	163	151	85	57	34	34	43	87	105	136	154	1 178
T60H	145	203	165	107	66	47	47	48	93	141	160	158	1 385
T60J	123	180	141	89	53	36	36	47	83	120	136	138	1 184
T60K	127	137	158	91	49	27	27	40	77	107	131	116	1 090
T33K	106	120	110	66	39	34	34	31	56	81	100	107	874

Source: SAPWAT 3 database

The study area receives summer rainfall, although the peak rainfall period varies within the study area. The upper plateau regions (T33K) fall into the mid-summer period, with rainfall peaking in January. The escarpment areas and central plateau fall into the late summer period, with rainfall peaking in February (T60G & T60H). The coastal region and the lower reaches of the main river valleys fall into the mid-to-late period, with rainfall peaking in January-February.

2.2.2 Temperature

The temperature patterns in the catchment are largely influenced by altitude. The higher-lying regions in the north of the study area receive frost in winter, with mean daily minimum temperatures ranging from -2°C to 4°C in July. Mean daily maximum temperatures in January range from 20°C to 24°C.

The minor escarpment and central plateau regions in the north also experience frost in winter, but are generally warmer than the higher lying areas with mean daily minimum temperatures of 2-6°C in July and mean daily maximum temperatures of 24-26°C in January.

The lower reaches of the Xura River valleys and the coastal region experience warm, frost-free conditions, with mean daily minimum July temperatures of 8-10°C (and higher) and mean daily maximum January temperatures of 26-28°C.

2.2.3 Evaporation

Evaporation increases from the east to the west and from the coast to the interior. Gross mean annual Simon's Pan Evaporation increases from about 1 100 mm along the coast to 1 400 mm in the west.

2.3 VEGETATION

Large tracts of the catchment area and current dry-land production areas have been over-exploited over the years. There are visual indications of what the natural state of afforestation and ground cover was before any human exploitation, especially in the deep ravines and steep river valleys. Over-grazing of large tracts of land seems to be the norm, which is the case for most rural areas in southern Africa.

3 SOILS SURVEY

In support of the required irrigation potential assessment of an area below the proposed Zalu Dam (refer to **Error! Reference source not found.**) on the Xura River near Lusikisiki, specialist studies of the agricultural resources (climate, landform and soil), among other things, had been requested. Since meso-climate may be regarded as uniform over the project area, a soil-landform survey was undertaken to:

- Identify and classify the soil-landform resources and map them at a **detailed-reconnaissance level**; and
- Evaluate these factors in terms of irrigation suitability.

This soil survey investigation only deals with the physical suitability of the soil-landform component for irrigation. Whereas the main part of this report deals with general aspects of the investigation, such as methodology, the description of soil-landform patterns and land evaluation, morphological and analytical properties of previously published soil profiles are given in **Appendix A**. The **Detailed-Reconnaissance Soil-Landform map of the Study Area** is also included as an appendix to this report.

3.1 METHODOLOGY

It was decided to exclude land steeper than about 8% and more than 60 m above river level from soil surveying to determine irrigation suitability. The steep slopes degrade soil potential in that good top soil has been eroded over time due to over-exploitation by humans. A 60 m limit is a practical technical limitation due to available pumping head from most standard off-the-shelf pumps.

The soil survey area, covering more than 5 000 ha, was selectively traversed on foot and by vehicle while the soils were examined at designated sites (to comply with detailed-reconnaissance survey intensity) by means of deep augering (to at least 1.5 m or to a hard non-soil layer). About 80 soil profile observations were marked by GPS. A field map, comprising orthophoto sheets (scale 1:10 000) with 5 m contour intervals was used. The landform and lithology, as well as other relevant surface features, such as slope, type and degree of soil erosion by water and potential for flooding, were also noted during the field investigation. The soils were identified, described and classified in accordance with the South African Taxonomic System (*Soil Classification Working Group, 1991*). The subdivision of the landform into hillslope units and river terraces was done according to the *Soil Classification Working Group* (1991) and the author's own experience. The soil map was digitised and the sizes of each map unit were measured.

Representative soil profiles were not sampled and analysed. Analyses, as given in **Appendix B**, were gleaned from Land Type Survey Staff (2001), and were conducted by the Institute of Soil, Climate and Water (Pretoria) using the following standard methods and techniques:

- Pipette method with Calgon as a dispersing agent for particle size distribution;
- Ammonium acetate method at pH7 for exchangeable cations and cation exchange capacity (CEC);
- pH in a 1:2.5 soil to water suspension – a saturated paste used for electrical resistance; and
- Walkley-Black method for organic carbon.

The broad principles outlined in the Food and Agricultural Organisation Guidelines for irrigated agriculture (FAO, 1985) were followed to evaluate the suitability of the soils. A physical suitability classification for irrigation, based on the author's experience, was used to classify the soils of the project area into five classes as follows: Class 1 = highly suitable; Class 2 = moderately suitable; Class 3 = marginally suitable; Class 4 = conditionally suitable (none encountered during this study); and Class 5 = not suitable.

3.2 BRIEF ASSESSMENT OF CLIMATE

In the absence of recorded climatic data, estimated data documented by Land Type Survey Staff (*2001; climate zone 2975S*) were used to characterise the climatic conditions of the project area. The estimated long-term mean annual rainfall is 970 mm, varying from 126 mm in November to 30 mm in June. The summer temperatures are hot, with an average long-term daily maximum temperature for January of 26°C. The winters are mild, with an average long-term daily minimum temperature for July of 3°C. Frost occurrences are probably very rare in low-lying areas.

3.3 SOIL-LANDFORM RESOURCES OF THE LUSIKISIKI PROJECT

Generally, the project area is composed of high hills (terrain type B4 - Land Type Survey Staff, 2001 with local relief varying from 100 m to 150 m) and a soil pattern dominated by shallow, non-calcareous soils (*land type Fa1107 – Land Type Survey Staff, 2001*). Parent materials for the present-day soils were probably derived from Ecca Group shale, mudstone, sandstone, dolerite (*Geological Survey, 1984*) as well as alluvium.

3.3.1 Description of the landform

On a meso-scale, the project area consists of a crest-midslope-footslope-valley bottom hillslope sequence. Of these, midslopes cover about 70% of the area and footslopes cover about 2%. In places, terraces of the Xura River are distinct features (see map units LD1 and LE1). The latter also includes the incised channel of the Xura River, where bank and gully erosion are evident, with the latter especially along tributaries. The assorted hillslope units and their slope classes, comprising each map unit, are listed in **Table 3.1**.

Table 3.1: Classification Diagnostic Horizons and Morphological Properties of Selected Soils in the Lusikisiki Study Area

Soil Form and Family	Profile Description	Located as Dominant Component in Map Unit
Glenrosa 1121, 1221 loam to silt loam	♦ Orthic A horizon: 10-30 cm thick, very dark greyish brown, weak fine sub-angular blocky, friable, loam to silt loam (clay content 20-30%; silt >40%), many gravel to small stones of shale; clearly overlying ♦ Lithocutanic B horizon: >20 cm thick, grey brown, many distinct mottles, weakly to moderately structured, slightly firm to firm, clay loam to silt clay; tonguing into ♦ C horizon: not hard and hard weathered layered shale	LA1, LF1
Shortlands 1110 clay	♦ Orthic A horizon: 20-40 cm thick, dark reddish brown, moderate fine sub-angular blocky, firm, sandy clay to clay (clay content 35-50%); gradually overlying ♦ Red structured B horizon: 20-80 cm thick, dark red, strong fine sub-angular blocky, firm, clay (clay content >45%); merging into ♦ C/R horizon: weathered dolerite	LB1
Tukulu 1210 loam to clay loam	♦ Orthic A horizon: 20-30 cm thick, dark brown, weak medium blocky; friable, loam to clay loam (clay content 20-35%; high in silt); gradual transition to ♦ Neocutanic B horizon: 30-40 cm thick, reddish brown, weak medium blocky, friable to firm, many clay cutans, clay loam (clay content 25-35%; high in silt); gradual transition to ♦ Unspecified material with signs of wetness: greyish brown, common faint red mottles, weak blocky, firm, clay loam to silt clay (clay content 25-45%; high in silt); clear transition to ♦ C horizon: weathered shale	LC1

Soil Form and Family	Profile Description	Located as Dominant Component in Map Unit
Tukulu 1110 loam to clay loam	♦ Orthic A horizon: 20-30 cm thick, very dark grey brown, weak medium blocky; friable, loam to silt clay loam (clay content 20-35%; high in silt); gradual transition to ♦ Neocutanic B horizon: 30-40 cm thick, dark grey brown, weak medium blocky, friable to firm, many clay cutans, clay loam to silt clay (clay content 30-45%; high in silt); gradual transition to ♦ Unspecified material with signs of wetness: >40 cm thick, greyish brown, common faint red mottles, weak blocky, firm, clay loam to silt clay (clay content 30-45%; high in silt); clear transition to ♦ C horizon: weathered shale or stratified alluvium	LD1
Bonheim 1110 clay loam to silt clay	♦ Melanic A horizon: 30-40 cm; dark grey brown or black, strong medium sub-angular blocky, firm, clay loam to silt clay (clay content 40-50%; high in silt); gradual transition to ♦ Pedocutanic B horizon: >40 cm thick, dark grey, strong sub-angular blocky, many clay cutans, firm, clay loam to clay (clay content 40-60%; high in silt); ♦ C horizon: underlying material unknown	LD1
Katspruit 1000 loam to clay loam	♦ Orthic A horizon: 30-50 cm thick, very dark greyish to black, massive to weakly structured, firm, loam to clay loam (clay content 25-45%; high in silt); gradually overlying ♦ G horizon: >50 cm thick, dark greyish to greyish, weakly to moderately structured, firm, clay loam to silt clay (clay content 30-50%; high in silt)	LE1
Dundee 1210 loam to clay loam	♦ Orthic A horizon: 30-40 cm thick, very dark greyish to black, massive, weakly structured, firm, loam to clay loam (clay content 25-45%; high in silt); clearly overlying ♦ Stratified alluvium: >60 cm thick; greyish, layers with varying texture; stone layers in places, faint mottling	LE1
Mispah 1100 loam to silt loam	♦ Orthic A horizon: 10-30 cm thick, very dark greyish brown, weak fine sub-angular blocky, friable, loam to silt loam (clay content 20 -30%; high in silt), many gravel to small stones of shale; abruptly overlying ♦ R horizon: slightly weathered, layered shale	LF1
Cartref 1100 loam to silt loam	♦ Orthic A horizon: 20-30 cm thick, very dark greyish brown, weak fine sub-angular blocky, friable, loam to silt loam (clay content 20 -30%; silt >40%), many gravel to small stones of shale; clearly overlying ♦ E horizon: 10-40 cm thick, grey to grey brown, massive, friable to firm, loam to silt clay loam (clay content 20-30%; silt >40%), many gravel to small stones of shale; clearly overlying ♦ Lithocutanic B horizon: >20 cm thick, grey brown, many distinct mottles, moderate blocky, slightly firm, clay loam to silt clay; tonguing into not hard and hard weathered layered shale	LA1, LF1

3.3.2 Description of the soils

Profile descriptions of the dominant soils are summarised in **Table 3.1**, whereas a generalised description of soils is provided in the soil-landform legend (**Table 3.2**).

a) Shallow soils mainly derived from sediments (map units LA1, LF1)

The soils of the ***Cartref***, ***Glenrosa*** and ***Mishap*** soil forms dominate the crests and midslopes of the landscape. Except for having shallow effective rooting depths (<40 cm), most forms (specifically Cartref and Glenrosa) also show temporary wetness in the subsoil during and after the wet season. Because they had largely developed in parent materials derived from shale, they have loam to silty clay textures, i.e. with high silt contents (see profile 11950 in **Appendix B**).

For the Cartref form, one soil family (1100) has been recognised on account of greyish E horizons and not hard B1 horizons; for the Glenrosa form two families due to signs of wetness in the B1 horizons – the one with not hard (family 1121) and the other with hard (family 1211) consistency; and for the Mispah form the 1100 family due to not-bleached A horizons.

b) Soils derived from dolerite

- Map unit LB1 comprises deep to very deep (100-150+ cm), well-drained, dark red, structured, clayey soil of the ***Shortlands form***, associated with dolerite occurrences in the landscape. Water permeability is rapid to moderate throughout the profile and the sustained infiltration rate is moderate. The 1110 soil family has been differentiated by its dystrophic to mesotrophic, non-luvic, fine sub-angular blocky structured B1 horizons (see profile 11946 in **Appendix B**).
- Soil of map unit LC1, which probably developed from a parent material admixture of dolerite and shale, consists of mainly deep (>100 cm), moderately well-drained, reddish, weakly structured, loam to clay loam overlying unspecified material with signs of wetness in the deep subsoil of the ***Tukulu form***. Water permeability is rapid through topsoil and subsoil, but moderate through the deep subsoil, whereas the sustained infiltration rate is moderate. The 1210 soil family has been recognised due to its not-bleached A horizons, plus red and non-luvic B1 horizons.

c) Soils mainly derived from alluvium

- Map unit LD1 covers slightly higher-lying terraces as well as, in places, adjoining lower footslope sites – which could be remnants of even older and more higher-lying terraces. In general, these soils are composed of thick soil materials, although effective rooting depth is limited by subsoil wetness. The two main components are:

- Soil of the ***Tukulu form***, which comprises somewhat poorly drained, very dark greyish brown, weakly structured, loam to silt clay loam topsoil on dark greyish, weakly structured, cutanic, clay loam to silt clay B1 horizon overlying from about 60 cm a greyish, weakly structured, clay loam to silt clay deep subsoil with faint mottling. Water permeability is moderate to rapid through the topsoil and subsoil, but moderate through the deep subsoil, whereas the sustained infiltration rate is moderate to slow. Two soil families have been identified, both with non-red and non-luvic properties, but the 1110 soil family has non-bleached A horizons and the 2110 soil family has bleached A horizons.
- Soil of the ***Bonheim form*** comprises moderately well-drained, very dark coloured, strongly structured, clay loam to silt clay topsoil overlying dark coloured, strongly structured, cutanic, clay loam to clay subsoil. Water permeability is moderate through the topsoil and subsoil, whereas the sustained infiltration rate is moderate to slow. The 1110 soil family has been recognised by dark coloured, strongly developed sub-angular blocky B horizons.

- Map unit LE1 contains the lower-lying or relatively younger terraces, especially of the Xura River riparian land. Aspects that limit its suitability for irrigation development include temporary to seasonal soil wetness as well as a possible flooding hazard. The two main components are:

  - Poorly drained, dark coloured, weakly structured, loam to clay loam topsoil on greyish, gleyed, clay loam to silt clay subsoil of the ***Katspruit form*** and 1000 family (i.e. non-calcareous G horizons).
  - Somewhat poorly drained, dark coloured, weakly structured, loam to clay loam topsoil abruptly overlying greyish, stratified materials with contrasting textures and faint mottling of the ***Dundee form***. The 1210 soil family was recognised, comprising wetness in the subsoil and without calcareous accumulations.

3.3.3 Detailed-reconnaissance soil-landform map

The distribution of the soil-landform resources is shown on the **Detailed-Reconnaissance Soil-Landform** map of the project area (see Annexure A). The map legend (**Table 3.2**) summarises the description of the dominant soil components and associated features, as well as the position (landform unit and slope class) they occupy in the landscape.

Table 3.2: Map Legend of Soil-Landform Resources of the Lusikisiki Study Area

Map Unit	Landform and Dominant Slope Class	Brief Description of Dominant Soil and Associated Features	Soil Form and Family	
			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
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	
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
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
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
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
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
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	

Map Unit	Landform and Dominant Slope Class	Brief Description of Dominant Soil and Associated Features	Soil Form and Family	
			Dominant	Other
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
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

3.4 LAND EVALUATION

Land evaluation is the selection of suitable land and suitable cropping, irrigation and management alternatives that are physically and financially practicable and economically viable (FAO, 1985). This part of the investigation deals with the ***physical suitability*** of the soil-landform components for irrigation.

Table 3.3 lists the most important attributes of each map unit limiting their suitability, the rating of these map units into the 5-class suitability classification and the extent of these units.

Table 3.3: Suitability of Map Units for Production in the Lusikisiki Area

AP Unit	Generalised Physical Irrigation Suitability Class	Dominant Limitations	Size (ha)	% of Total
LA1	5 (Not suitable)	Restricted soil depth; temporary soil wetness	1 629.0	31.0
LB1	1 (Highly suitable)	Mainly higher lying land	5.4	0.1
LC1	2 (Moderately suitable)	Temporary soil wetness in deep subsoil	25.5	0.5
LD1	3 (Marginally suitable)	Temporary soil wetness; flooding	244.4	4.7
LE1	5 (Not suitable)	Temporary to seasonal soil wetness; flooding; riparian land	122.9	2.3
LF1	5 (Not suitable)	Steepness of land; restricted soil depth	3 225.8	61.4
TOTAL			**5 253.0**	**100.0**

3.5 Soils Summary

The soil-landform resources of the Lusikisiki project were identified, classified and mapped with the aid of a detailed-reconnaissance investigation. **Table 3.4** summarises the suitability of soil-landform resources for sustainable irrigation.

Table 3.4: Soils Summary

Irrigation Suitability Class	Gross Area (ha)	% of Total Area
Class 1 - Highly suitable	5.4	0.1
Class 2 - Moderately suitable	25.5	0.6
Class 3 - Marginally suitable	244.4	4.7
Class 5 - Not suitable	4 977.7	94.7

In summary, a 5.4 ha area of very limited extent of highly suitable land was demarcated. Irrigation development would probably not be viable due to its limited extent and high-lying position in the landscape (about 60-70 m above the river level).

Similarly, moderately suitable land of map unit LC1 includes a gross area of only 25 ha that is 15-30 m above the river level. Before irrigation development is considered in unit LC1, a detailed soil survey needs to be undertaken. Marginally suitable land of Class 3 covers several isolated areas (approximately 240 ha) along the terraces and, in places, the lower footslope sites adjacent to the Xura River. This Class 3 land is not recommended for formal irrigation development; however, limited areas could be utilised for garden purposes with the required technical and managerial inputs. Class 5 land cannot be recommended because of serious limitations.

4 AGRI-ECONOMICS

The Task Team visited the project area on 29 November 2010 to obtain a better understanding of the present agricultural activities in the area.

This section of the report addresses the following aspects:

- Extent of current agricultural activities;
- Number of farmers / stakeholders;
- Farm sizes;
- Cropping programmes;
- Intensity of agricultural activities;
- Potential and capacity of the local markets;
- Stakeholders within the agriculture industry;
- Relevance of the land tenure system;
- Current irrigation (if any), stakeholders' irrigation experience their preferred irrigation method;
- Crops currently produced within the study area;
- Production figures, including costs of production and prices of produce;
- Gross margin analyses of major crops;
- Major constraints regarding crop production and proposals of realistic yields should constraints be removed; and
- The size and position of markets where farmers sell their produce.

4.1 LOCATION

The study area is located in the OR Tambo District Municipality (DM) (DC 15) of the Eastern Cape Province. The study area, including Lusikisiki, is also located in the Ingquza Hill Local Municipality (EC154).

Distances from strategic points are as follows:

- Randfontein to Bergville[1] 388 km
- Bergville to Lusikisiki 459 km
- Randfontein to Lusikisiki 838 km
- Lusikisiki to Durban 321 km

[1] *Randfontein is included as reference to distance from the central cost calculation centrum. All commodities such as maize, wheat etc. are priced for deliverance at Randfontein throughout the RSA.*

- Lusikisiki to Mthatha 140 km
- Lusikisiki to Port St. Johns 40 km
- Lusikisiki to Port Shepstone 200 km

The nearest railway station is at Mthatha.

4.2 DISCUSSIONS WITH EXTENSION OFFICERS

On ***29 November 2010***, the Task Team met with the agricultural extension officers of the Department of Agriculture and Rural Development who are responsible for the project area. Their names are listed in **Table 4.1** (see **Figure 4.1**). The meeting was held at the office of the Department of Agriculture and Rural Development in Lusikisiki.

Table 4.1: Extension Officers for the Lusikisiki Area

Officer Name
Mr N Matshangane
Mr M Mfundisi
Mr LJ Sileyo
Mr MP Mjali
Mr M Camagukuvu

Figure 4.1: Extension officers

A list of questions was compiled and made available to the extension officers for answering pr

ior to the meeting. The answers were handed to the Task Team at the meeting and the Task Team noted them.

No formal statistics are available for the study area. The extension officers were thus requested to make an estimate to quantify the *status quo* of the area. A map of the project area was displayed and they were requested to relate their answers to the area indicated on the map.

Parts of the area were visited to determine the *status quo* of agriculture. The Magwa Tea Estate, Lambdas Cooperative, Lambdas Dairy and a farmer, Mr. Albert Hughes, were visited. Livestock numbers were obtained from the Division Veterinary Services of the Department of Agriculture and Rural Development.

4.3 CURRENT LAND USE

The current land use is as shown in **Table 4.2**.

Table 4.2: Current Land Use

Land Use		Area Covered (ha)
Communities		44 000
Vacant unspecified		67 200
Pondoland scrap forest		6 400
Transkei Coastal Plantation Forest		9 200
Thicket bush		35 600
Plantation		2 100
Cultivated land		1 510
♦ Dry land	1 500	
♦ Irrigation	10	
Magwa Tea Estate (dry land)		4 500
♦ Commercial tea production	1 700	
♦ Emerging farmers	100	
♦ Other	2 700	
	Total	**214 510**

Source: BKS (GIS Department)

Subsistence farming is the main type of farming in the project area, which means very little surpluses are produced.

4.4 IRRIGATION

Irrigation in the study area mainly consists of irrigated community gardens. It is estimated that only 10 ha is irrigated within the project area. A small area is equipped with a drip irrigation system. Other areas are irrigated by water carried in buckets from the river. There are mainly two areas involved:

- Nkunzimbini area 200 community members
- Lambasi area 400 community members
- **Total area** **600 community members**

Figure 4.2: Typical community gardens

The average plot size per community member is 166 m^2 (an area of approximately 13 m x 13 m). The community gardens are operated collectively, and community members mainly produce vegetables such as cabbage and spinach. A typical community garden is shown in **Figure 4.2**.

4.5 DRY-LAND CROP PRODUCTION

4.5.1 General

Dry-land crop production is practiced on approximately 1 500 ha (excluding Magwa Enterprise Tea, which is discussed later in this section). The patches of cultivated land are distributed over the project area (see **Figure 4.3**). It is estimated that, on average, each farmer cultivates one hectare. Approximately 80% of the area is used to cultivate maize, and the remaining area could be used to grow sorghum, dry beans and Hubbard pumpkins.

Maize yields vary from <1-4 tons per hectare, the average yield is estimated to be 1 t/ha. Average dry bean production is estimated to be 0,5 t/ha.

Figure 4.3: Dry land cultivation

4.5.2 Magwa Enterprise Tea (Pty) Ltd

The Task Team visited Magwa Enterprise Tea (Pty) Ltd on 29 November 2010 (see **Figure 4.4**). The General Manager, Mr Ian Crawford, was not present but was interviewed telephonically on 5 January 2011 to obtain basic information.

Figure 4.4: Aerial view of Magwa Enterprise Tea's lands (Deep River Gorge)

The Magwa Enterprise Tea estate was established between 1963 and 1970 by the former Transkei Government. It is currently the largest tea estate in South Africa, covering 4500 ha, of which 1 800 ha is used as tea plantations, including 100 ha that is allocated to out-growers. Tea production, under dry land conditions, averages 2 800 tons of leaves per year. The tea factory is located on the site.

According to discussion with the General Manager, the estate is marginally viable and its closure was considered. The estate is structured as Magwa Enterprise Tea (Pty) Ltd, and the Eastern Cape Department of Agriculture and Rural Development is the owner and financier of the project. The financial structure is not known.

The estate employs 1 200 permanent workers, and 2 400 temporary workers for nine months per year (September to May). The permanent farm workers stay in 13 villages on the project. The affected communities extend over an area of approximately 32 000 ha.

There are 100 emerging tea farmers established near the estate on 1 ha farms. Magwa Enterprise Tea (Pty) Ltd provides supporting and extension services to these farmers.

The estate used to have a dairy, as well as cattle, maize and chicken production projects for the communities in the region, but all of these projects were terminated, mainly due to a lack of finance.

Since the Task Team's visit and subsequent telephonic discussion with the General Manager in January 2011, the farm workers went on strike over wage issues, and when their demands were not met, they systematically looted the farm, destroying infrastructure and holding the management staff hostage. Officials from the Department of Agriculture tried unsuccessfully to resolve the various issues. The current situation is that the workers have lost their jobs, no further production is viable, and a possible R65 million annual turnover is lost.

4.5.3 Sugar production in Mankenkezi/Greenville area

According to the previous baseline study for Eastern Pondoland, sugar cane was grown under dry-land conditions on about 1 500 ha in the Mankenkezi / Greenville area of the Bizana District (*Department of Water Affairs, 2001*).

The Illovo Sugar Mill at Port Shepstone was contacted to confirm the *status quo* of this project. According to Illovo, production has ceased for several reasons, such as low yields and lack of finance. It also confirmed that sugar cane production in the study area is not viable due to the relatively long distance from the nearest sugar mill at Port Shepstone (*Mdelu, Mandla. January 2011*).

4.5.4 Forestry

An area of 2 100 ha is currently under afforestation. Large areas of the old Transkei are ideally suited to afforestation and much has already been done to develop this industry. It is currently one of the fastest growing sectors in the economy.

The choice of location is limited to areas that receive in excess of 800 mm of annual rainfall. Within these boundaries, the choice can be made based on soil and slope. Deep soils on fairly level areas are preferred as they produce the highest yields and the least extraction costs when mature.

As the study area is located in a high rainfall zone, it could be an ideal area for forestry (*Department of Water Affairs, 2001*). However, the pristine quality of the estuary should be weighted against any development consideration of the Msikaba River and its tributaries.

Forestry companies have designed a model whereby emerging farmers are settled successfully on forestry units. The expansion of forestry in the region should be promoted and the settlement of emerging farmers needs further investigation.

4.6 LIVESTOCK NUMBERS

Livestock numbers from the National Department of Agriculture and Rural Development: Division Veterinary Services for the OR Tambo DM are shown in **Table 4.3**. Cattle mainly consist of Nguni breed although cross-breeds were also observed.

Table 4.3: Livestock Numbers

Livestock Type	Number
Cattle	89 000
Sheep	77 000
Goats	84 000
Horses	3 000
Donkeys	1 000
Mules	900

4.7 VISIT TO A FARMER

Mr Albert Hughes (see **Figure 4.5**) was visited on his farm near Lambasi Cooperative. He is a retired Eskom official and is currently farming on 8 ha of land.

Figure 4.5: Mr Albert Hughes on his farm

Mr Hughes produces the following crops:

♦ Potatoes (irrigated)	1 ha
♦ Dry-land crop production	5 ha
♦ Tree crops	1 ha
♦ Other	1 ha
Total	**8 ha**

The condition of the potato planting is excellent (see **Figure 4.6**). The potatoes are irrigated, but he lacks proper borehole equipment. He is experimenting with tree crops and has planted small quantities of citrus, macadamias, mangoes and bananas, which, according to him, are well adapted.

Figure 4.6: Excellent potato crop

4.8 CURRENT INFRASTRUCTURE

4.8.1 Lambasi Cooperative

The Lambasi Cooperative (310°22’9.0”S, 290°34’54.0”E) was established in 1982 and closed in 2006 due to mismanagement and cash flow problems (see **Figure 4.7**). However, infrastructure is developed and includes sheds, three silos, a small broiler production unit and a number of buildings.

Figure 4.7: Lambasi Cooperative (closed down)

4.8.2 Dairy project

The Lambasi Dairy Project and Calf Raising Unit are close to the Lambasi Cooperative. The project was established in 1982 and ceased activity in 2006 due to mismanagement and cash flow problems. The facilities consist of a well-built structure and the equipment is sufficient to milk 30 cows at a time (see **Figure 4.8**). The purpose of this project was to supply the community with fresh milk and to supply milk cows to the community.

Figure 4.8: Lambasi Dairy Project

4.8.3 Poultry projects

According to the extension officers, approximately 100 broiler farmers each have 100 broilers in the study area. It was not possible to see any of these projects. There are no egg production units.

4.9 SUPPLIERS OF INPUTS

4.9.1 Private sector

The following two private businesses in Lusikisiki supply inputs to the farmers in the project area.

- Lusikisiki Agric Supplier
- FSC

Virtually all types of inputs are available from these suppliers. The farmers buy their inputs for cash and they hire a vehicle to transport the inputs to their farms. Most of the farmers do not buy seed as they keep seed from the previous harvest.

Some farmers use draught animal power (cattle, donkeys and mules) for land cultivation, and some farmers use tractor contractors to cultivate their fields.

The current tariffs charged by contractors are as follows:

- Plough R600 per ha
- Disc R400 per ha
- Spray R350 per ha
- Plant R400 per ha
- Transport from field to house R200 per ha

These tariffs are high and the negative impacts of these tariffs on the profitability of crop production are covered later in this report. Approximately 10 tractor contractors are operating in the project area. Massey Ferguson 350 tractors with approximately 40 kW engines, are popular.

Some of the farmers have implements, such as ploughs and one-row planters that have been adapted to draught-animal power. Farmers who use draught-animal power generally use hand hoeing to control weeds. All the farmers use knapsack sprayers for crop and herbicide spraying.

4.9.2 Extension services

The Regional Office of the Department Agriculture and Rural Development (31°22’08.8”S; 29°34’54.4”E) is located in Lusikisiki (refer to **Figure 4.9**). Another local office is located in the Lusikisiki College of Education. Three extension officers are allocated to the area. Their qualifications vary from graduates to diplomas.

Figure 4.9: Regional Office for Department of Agriculture and Rural Development

4.10 MARKETING

4.10.1 General

There are few marketing facilities because very little surpluses are produced. Virtually all the production is consumed by the households in the project area. Farmers thresh their maize manually.

There are no auction facilities in the project area, possibly because animals are traded among inhabitants. The nearest auction facility and abattoir is in Mthatha. The size of the abattoir could not be established.

There is also no fresh produce market in or close to the project area – the nearest fresh produce market is in Mthatha. According to the extension officers, fresh produce from Mthatha Fresh Produce Market is not distributed in the area. Fresh produce from the vicinity of Kokstad and the South-Coast of KwaZulu-Natal is distributed in the project area. Retail outlets are important distributors of fresh produce, but wholesalers are pivotal as they also provide hawkers with fresh produce.

Because insufficient quantities of maize are produced locally, maize is imported to the region. Other products such as eggs, broilers and milk are also imported.

4.10.2Prices

The prices of fresh produce were obtained at Spar in Lusikisiki and compared with prices at Spar in Ballito to determine if prices tend to be higher in the project area than in developed areas. The results are shown in **Table 4.4**.

Table 4.4: Produce Prices at Local Commercial Markets

Produce	Packing	SPAR, Lusikisiki (29 November 2010) (R/kg)	SPAR, Ballito (30 November 2010) (R/kg)
Carrots	5 kg	5.20	10.99
Cauliflower	Cob	11.99	11.99
Onion	10 kg	3.45	2.30
Potatoes	10 kg	3.45	3.30
Tomatoes	Kg	8.99	11.99
Maize meal	10 kg	3.45	4.01

Source: Project Task Team survey

Produce prices in the project area were expected to be higher than in metropolitan areas due to supply and demand factors, but this was not the case as prices are generally lower in the study area. For example, the retail price of cabbage traded by hawkers is currently R6 per head, while prices in Gauteng are as listed in **Table 4.5**:

Table 4.5: Cabbage Prices by Traders in Gauteng

Month	Average Produce Price R/head
November 2010	5.00
December 2010	3.00
January 2011	2.50

Source: Mr. Henning Pretorius, vegetable farmer, Hartbeestpoort Dam

The decreasing trend in cabbage prices is due to poor quality. Hawkers are mainly interested in large heads as they can be divided into four or more pieces. The retail price per head in the townships is approximately R12.

Maize for grain retails at R100 per 50 kg or R2 000 per ton. The grain maize price is also in line when considering the SAFEX spot price at Randfontein plus the transport cost to the project area.

It was expected that product prices may be very high in remote rural areas, but the information collected indicates that prices are, in some cases, lower than those in developed areas.

4.11 GROSS MARGINS

The gross margin for dry-land maize production for current subsistence farming was compiled in cooperation with the extension officers. Analyses were done for a conventional tillage system and for a minimum tillage.

The project area is a net importer of maize. An indication of a household price for maize is derived from the SAFEX future price for July 2011. The cost of transport from Randfontein to Lusikisiki, and the cost of transport to households were added to the future price to calculate a household price. This is more or less in line with the current maize grain price in Lusikisiki.

Using information provided by the extension officers and the Task Team's own calculations, direct costs were subtracted from gross income to calculate gross margins. Negative gross margins for conventional and minimum tillage systems of R863 (**Table 4.6**) and R363 (**Table 4.7)**, respectively, were calculated.

Table 4.6: Income and Cost Budget per Hectare of Dry Land Maize Production (Conventional Tillage)

Item	Unit	Quantity	Price per Unit	R/Ha
Household Price	Ton	1.00	1 931	2 181
SAFEX future: July 2011	Ton	1.00	1 403	1 403
Transport Randfontein to Lusikisiki	Ton	1.00	528	528
Transport Lusikisiki to house	Ton	1.00	250	250
Marketing Costs				0
Bags	Ton	0		0
Nett Value Farm Gate			1 931	2 181
Pre-Harvest Direct Costs				2 844
Seed				19
Purchased seed	Kg	.00	.00	0
Own seed	Kg	10.00	1.93	19
Fertiliser				1 400
2:3:4(30)	Kg	200.00	7.00	1 400
Trace elements				0
Lime				0
Herbicides				0
Pest and disease control				25
Stalk borer	Ha	1.00	25	25
Casual labour				0
Hand hoe (family labour) 2 x	Md	10.60		0
Crop insurance				0
Tractor costs (contractors)				1 400
Plough	Ha	1.00	600	600
Disc	Ha	1.00	400	400
Plant	Ha	1.00	400	400
Harvesting Costs				200
Hand harvest	Mandays	3.25		
Transport to house contractor	Ha	1.00	200	200
Total Direct Costs				3 044
Gross Margin (Excluding Family Labour)				-863

Table 4.7: Income and Cost Budget Per Hectare Dry Land Maize Production (Minimum Tillage)

Item	Unit	Quantity	Price per unit	R/Ha
Household Value	Ton	1.00	1 931	2 181
SAFEX future: July 2011	Ton	1.00	1 403	1 403
Transport Randfontein[2] to Lusikisiki	Ton	1.00	528	528
Transport Lusikisiki to house	Ton	1.00	250	250
Marketing Costs				0
Bags	Ton	1.00		0
Nett Value Farm Gate			1 931	2 181
Pre-Harvest Direct Costs				2 304
Seed				19
Purchased seed	Kg	.00	.00	0
Own seed	Kg	10.00	1.93	19
Fertiliser				1 400
2:3:4(30)	Kg	200.00	7.00	1 400
Trace elements				0
Lime				0
Herbicides				60
Roundup	Litre	1.00	60.00	60
Pest and disease control				25
Stalk borer	Ha	1.00	25	25
Casual labour				0
Hand hoe (family labour) 2 x	Md	10.60		0
Crop insurance				0
Tractor costs (contractors)				800
Plough	Ha	.00	600	0
Disc	Ha	1.00	400	400
Plant	Ha	1.00	400	400
Harvesting Costs				200
Hand harvest (family labour)	Mandays	3.25		
Transport to house contractor	Ha	1.00	200	200
Total Direct Costs				2 504
Gross Margin (Excluding Family Labour)				-323

[2] *Price of maize based on cost to transport to Randfontein throughout RSA.*

4.12 CONSTRAINTS

The extension officers were requested to list current constraints experienced by farmers in the project area. The main constraints are a lack of finance and occasional drought. The lack of finance is a very common problem in all rural areas in South Africa as well as throughout Africa.

Other constraints, which were not listed by the extension officers, are:

- Exceptionally high tractor costs. Tractor costs are high due to relative small patches of cultivated land distributed over large areas. Transport costs from one farmer to the next also contribute to high tractor costs.
- Farmers use their own seed, which indicates that extension officers cannot persuade farmers to use the latest seed cultivars that are suitable for the area. It is expected that yield will increase substantially if the latest seed cultivars are used.
- A lack of marketing infrastructure. Farmers are not motivated or educated to produce surpluses, so there is no need to develop market infrastructure.
- A lack of auction facilities for cattle and silos. Although silos are available at Limbasi Cooperative, they are currently not operational.
- Lack of or poor availability of inputs such as fertilisers within a reasonable distance. A system of secondary and primary cooperatives may be a solution.

4.13 AGRI-ECONOMICS IN SUMMARY

- Agricultural development activities in the study area have decreased since 2001 when the previous baseline study was executed.
- The Lambasi Cooperative, which was established in 1982, was closed in 2006, but consists of well-developed infrastructure.
- The Lambasi Dairy Project and Calf Raising Unit was established in 1982 and closed in 2006, but has well-developed fixed improvements and equipment.
- According to the previous baseline study for Eastern Pondoland, sugar cane is grown under dry-land conditions on about 1 500 ha in the Mankenkezi / Greenville area of the Bizana district. These activities ceased, however, mainly due to a lack of finance.
- At the time of the site visit, the *status quo* of Magwa Enterprise Tea (Pty) Ltd had been maintained since the previous baseline study. The planned expansion of the estate, however, did not materialise. The estate appears to have cash flow problems on a regular basis and the Department of Agriculture and Rural Development is making cash injections to maintain production and employment opportunities.

- Magwa Enterprise Tea (Pty) Ltd used to have a dairy, cattle, maize and chicken production projects for the communities in the region. All of these projects have ceased, mainly due to a lack of finance.
- The reasons for the failure of agricultural development projects in the study area need to be investigated. Magwa Enterprise Tea (Pty) Ltd is favourably positioned to serve as a platform from where agricultural development projects can be launched.
- The need for a cooperative in the area and the reinstatement of the cooperative and other development projects need to be investigated.
- The establishment of a demonstration farm to demonstrate the results of appropriate farming techniques (such as new seed cultivars, cultivation practices and weed control) must be investigated.
- Maize, vegetables, milk, eggs and broilers are imported into the region, so there are opportunities for the production of these commodities in this area. A marketing study needs to be done to quantify consumption.
- Sugar production is not viable in the study area because of the relatively uneconomic distance from the nearest sugar mill in Port Shepstone.
- The lack of support services, particularly of a rural finance facility, is a significant constraint with respect to the establishment and operation of agricultural development projects. The government has recognised these needs and has introduced programmes such as the Comprehensive Agricultural Support Programme (CASP) to fulfil these needs.
- The strengthening of natural grazing should be investigated to increase carrying capacity.
- The area has a high potential for the development of commercial forestry plantations, tourism and dry-land agriculture due to favourable climatic and natural conditions. There are, thus, agricultural development opportunities, and these should be investigated to determine the level of desire and the availability of capacity to support these developments.

5 WATER USE FOR AGRICULTURE IN THE STUDY AREA

5.1 CROP WATER USE

Although the reconnaissance soils investigation found soils with high potential only in an area covering less than 5 hectares above the dam command level, crop water use for irrigation should still be addressed as part of this investigation. This section contains the discussion and calculations for water use of crops that were found in the study area.

5.1.1 Methodology

The estimated crop water requirement calculations were made using SAPWAT 3, a computer model used for the estimation of crop water requirements and irrigation requirements for a wide range of commercial crops grown in a wide range of climatic conditions.

The model is based on the internationally recognised Penman-Monteith method of estimating reference evapotranspiration (ETo) and the FAO method of linking reference evapotranspiration to any given crop by way of a crop factor (kc) and a series of efficiency factors, including irrigation method and effective rainfall.

The data units are derived climatic data sets used in SAPWAT. Three principal climatic databases were used (from SAPWAT): quaternary unit T60F, T60G and T60H. These coincided with the quaternary data sets used with WR90.

5.1.2 Base Climate data

The irrigable area under consideration is the command area below the proposed Zalu Dam wall in the quaternary catchment T60F. All water-use data sets used in this report are based on the climate data for T60F, which are available in SAPWAT 3.

5.1.3 Cropping pattern

The agriculture-economic assessment showed that crop production is mainly centred around dry-land production of maize, dry-beans, Hubbard pumpkins and some sorghum, while community gardens cater mostly for own consumption and some local sales of vegetables, such as spinach and cabbage. All of these crops are traditional cropping patterns that are found in many subsistence-farming communities.

For this study, the specialists used the cropping patterns and added a selected list of crops that could be produced successfully by entrepreneurs in the near future. **Table 5.1** lists the cropping pattern used for this study.

Table 5.1: Crops Produced in the Study Area

Crop	Community Garden	Commercial	Season
Vegetable Crops			
Beans (green)	**	**	Early summer
Beetroot	*	**	Summer
Cabbage	**	**	Autumn
Carrots	*	**	Autumn
Pumpkin	**	**	Early summer or Autumn
Spinach	**	**	Late summer
Tomatoes	*	**	Late winter/Early summer
Permanent Crops			
Bananas	*	**	Year round
Citrus	*	**	End Autumn
Litchi	*	**	Late summer
Mango	*	**	Late summer

Notes:

* *In community gardens, this is a less frequently produced crop. In permanent crops, single or multiple trees of this crop type are sometimes planted.*

** *In community gardens, this is a frequently produced crop. In commercial use, this is a high-income crop.*

The crop pattern listed in **Table 5.1** coincides with the cropping pattern proposed / investigated in *DWAF Water Resource Study in Support of the AsgiSA EC Mzimvubu Development Project* (Volume 2 of 5, March 2009), prepared by BKS.

5.1.4 Crop water requirements

In assessing crop water requirements, it is customary to assess water use, taking factors such as soils, rooting depth and irrigation management practices into consideration. A more generalised process was adopted for calculating the crop water requirements for this project.

Some of the governing factors are outlined in the following points.

a) Irrigation system efficiencies

In developing the different models for crop-water use in the study area, the following efficiencies were used to calculate gross water requirements:

Conveyance and application efficiencies:

- For community garden irrigation, water will typically be applied by hand or furrow, and an efficiency of 65% was accepted.
- For commercial consideration of permanent crops, water will typically be applied by sophisticated irrigation systems, and an efficiency of 90% was accepted.

Wind and other efficiencies:

- No efficiencies were considered for the influence of wind, although where wind is a definite factor, the designer of a scheme will usually adapt the spacing of irrigation applicators and applicator height above ground, but will also allow for some additional inefficient application of water.

b) Soil type and depth

The models have allowed for the selection of soil types. The dominant soils found in the study area (generally loamy sand) were used. Soil depths were accepted as deep enough for the 80% rooting depth of crops under consideration. In most cases, soils were defined as at least 1.0-1.2 m deep.

c) Irrigation management

The standard method of irrigation management was used throughout the calculation of crop water requirements, where allowance is made for crops to abstract water from the soil until 70% of readily available soil moisture content was used, and irrigation was applied up to field capacity. With a well-managed system, irrigators will usually fill soils to 90-95% of field capacity to have some “storage” available in the soil for rainfall that might occur between irrigations. Water used in the simulations, therefore, has some inefficient use of available rainfall.

Table 5.2 summarises the calculations for community garden type crops obtained from SAPWAT3. The program data sheets produced are, however, too voluminous to include in this report. The water requirements for permanent tree crops are reflected in **Table 5.3**.

Table 5.2: Water Requirements for Community Garden Crops (calculated in 2010)

Crop	Planting Date	Gross monthly crop water requirement (m3/month/ha)												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Beans (gr)	Mid Sep									83	80	130		293
Beetroot	Mid Jan	19	54	79	9									161
Cabbage	Mid Apr				128	88	130	167	78					591
Carrots	Mid Sep									95	52	79	75	301
Pumpkin	Mid Mar			94	60	128	125	109						516
Spinach	Begin Jan	204	198	137	160	173	171	109						1 152
Tomatoes	Mid Aug	144	54						75	61	52	90	176	652

Table 5.3: Water Requirements for Permanent Tree Crops (calculated in 2010)

Crop	Harvest Date	Gross monthly crop water requirement (m3/month/ha)												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Bananas	Year round	245	262	217	189	182	174	186	126	103	73	70	189	2 016
Citrus	End autumn	127	96	78	72	82	86	106	163	146	101	90	138	1 285
Litchi	End summer	114	98	63	73	72	55	170	134	191	86	123	172	1 352
Mango	End summer	252	190	165	123	140	157	157	205	216	153	197	278	2 233

5.1.5 Water use for irrigation

An area that is dependent on a crop water allocation can be developed if the areas of crops that can be expected for future irrigation development in the study area are known. As the area is fairly devoid of any intensive, commercial or organised governmental schemes, the percentages of each crop that may be produced are based on estimates. The *DWAF Water Resource Study in Support of the AsgiSA EC Mzimvubu Development*

Project (Volume 2 of 5, March 2009), prepared by BKS for the larger Eastern Cape Region, considered much larger tracts of commercial farming land.

If it is accepted that crop production will, primarily be used to produce crops for rural consumption and have an area of higher value crops, a possible crop pattern is approximately 65% vegetables (beans, tomatoes, spinach, cabbage and possibly carrots) and 35% for crops such as potatoes and possibly fruit trees.

The **Table 5.4** outlines the possible cropping scenario and shows a water use for irrigation in the study area.

Table 5.4: Weighted Crop Water Requirements for Study Area

Crop	Vegetable Combination	Mango	Citrus	Totals
Percentage Planted	66	17	17	100
Irrigation requirement (m^3/ha/annum)				
Gross	2 050	2 231	1 284	
Nett	1 333	2 008	1 156	
Irrigation system used				
Flood (50%)	666			
Sprinkler (50%)	666			
Drip (0.9)	0	2 008	1 156	
System efficiencies				
Flood (0.65)	1 025			
Sprinkler (0.85)	784			
Drip (0.9)	0	2 231	1 284	
Weighted irrigation requirements (m^3/ha/annum)	1 194	379	218	1 791

The weighted irrigation requirement shows that the high rainfall for the study area results in lower weighted irrigation requirements. In drier parts of the country, weighted irrigation requirements would range from 6 600 m^3/ha/annum to 12 500 m^3/ha/annum, compared to an expected use of less than 1 800 m^3/ha/annum in the study area.

5.1.6 Water storage required for irrigation

The client instructed the consultant to include water-use for irrigation in the balancing of the dam volume, though the soil specialist found only marginal soils in the area below the dam and the soil specialist cautioned the use of these marginal soils for irrigation practices.

Based on the crop pattern used in **section 5.1.3** above, further simulations were run on SAPWAT but with adapted parameters.

- The consultants based their calculations on crop water use on similar parameters as discussed in **section 5.1.4** with the exception, that all efficiencies are based on efficiencies obtained by proficient, knowledgeable commercial farming practices.
- With irrigation management, crop irrigation was simulated being triggered when 75% of the readily available soil water was depleted.
- Average rainfall conditions were used in the initial simulations and then were adapted to simulate average effective rainfall conditions.
- Cropping pattern are based on 65% vegetable crops and 35% permanent crops. Cropping practise will have three vegetable crops per 2 year cycle while the permanent crops were simulated for 30 years without replacing any of the trees.
- The consultant simulated the water requirements based on the 270 ha of low potential soils as per the soil scientist. The irrigable area was seen as a block and in the simulation, groups of crops were used to simulate blocks/areas of irrigation on this contiguous irrigation land. In practice though, it is expected that areas of irrigation will be scattered across the study area, below the Zalu dam command limits, as discussed earlier in the report. This could possibly reduce the effective irrigable area due to losses of conveyance and have further ramifications with small areas irrigated by hand and many other possible scenarios.
- Crop planting dates are based on discussions with the local extension office feedback (**section 4.2** of this report) and commercial farmers from Kwa-Zulu Natal. (If more accurate estimates are required, an agronomist needs to be appointed and consulted to confirm optimal crop pattern and planting dates).

The tables below summarise the simulation results.

Table 5.5: Adapted Crop Irrigation Requirement (mm/month)

No	Crop	Jan	Feb	Mch	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Beans (gr)									37	52	66	
	Beetroot	23	67	93	8								
2	Pumpkin			50	36	53	52	44					
	Tomato	138	41							65	48	83	159
3	Spinach	87	104	69	71	77	74	56					
	Carrot							52	64	90	75		
4	Mango	100	89	78	56	58	59	58	73	89	72	82	121
5	Citrus	62	56	51	50	49	47	53	68	68	54	51	74

The results of the simulations as a block of irrigated area, is summarised in **Table 5.6** below.

Table 5.6: Water Storage Requirement (m^3/month)

Group	Area (ha)	JAN	FEB	MCH	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
1	29.7	6 831	19 889	27 621	2 386					10 989	15 444	19 602		102 762
2	29.7	40 986	12 177	14 850	10 692	15 741	15 444	13 068		19 305	14 256	24 651	47 223	228 393
3	29.7	25 839	30 888	20 493	21 087	22 869	21 978	32 076	19 008	26 730	22 275			243 243
4	45.9	45 900	40 851	35 802	25 704	26 622	27 081	26 622	33 507	40 851	33 048	37 638	5 539	429 165
5	45.9	28 458	25 704	23 409	22 950	22 491	21 573	24 327	31 212	31 212	24 786	23 409	33 966	313 497
TOTAL MONTHLY		148 014	129 519	122 175	82 809	87 723	86 076	96 093	83 727	129 087	109 809	105 300	136 728	1 317 060

As depicted in the table above, the estimated annual water-use required, calculates to 1.317 $x10^6$ m^3 per annum and this equates to 4878 m^3/ha/annum for the 270 hectare development block.

5.2 OTHER AGRICULTURAL WATER USE

5.2.1 Livestock water use

Based on the reported number of animals in the study area (see **section 4.6**), **Table 5.7** lists the expected water use.

Table 5.7: Livestock Water Use

Livestock Type	Daily Water Use (ℓ/day)	Number	Volumes (m^3/day)
Cattle	51	89 000	4 539
Sheep	9	77 000	693
Goats	10	84 000	840
Horses	323	3 000	969
Donkeys	28	1 000	28
Mules	28	900	25.2
Total Daily Use (m3/day)			**7 094**

5.2.2 Poultry-housing water use

It is reported that about 10 000 broilers are produced by 100 outgrower farmers in the study area. Daily consumption for these production figures is about 4 500 ℓ/day (4.5 m^3/day). The quoted production figures are to cater for an estimated 50% of the study area's population (based on average national poultry consumption). It is not expected that the daily poultry use will increase by much more than 20%, based on better market penetration of the existing poultry farmers.

5.2.3 Abattoir water use

There are currently no registered red meat abattoirs (goats, sheep, pigs and cattle) in the study area. Based on national consumption for red meat and a population of about 100 000 people, red meat consumption should be approximately 3 100 tonnes of meat per annum in the study area, which equates to about 13 000 large slaughter units per annum. For 50% slaughtering inside the study area alone, water use for an abattoir could be 25 000 m^3/annum.

Similarly, there is no registered poultry abattoir in the area and, based on national consumption figures for poultry, there is an opportunity for an entrepreneur to process approximately 1 300 tonnes of poultry per annum, which will require about 27 000 m^3 of water per year.

The abattoir industry could require about 52 000m^3 of water per year if this industry is exploited and an entrepreneur develops it.

6 CONCLUSIONS

From the natural resources perspective, the following points are noted.

- The natural climatic conditions in the study area indicate relatively high average rainfall conditions with mild to hot temperatures. Overall, the study area is a mild, humid area with hot summers.
- A 5.4 ha area of highly suitable land in terms of irrigable soils was demarcated, but its limited extent and high-lying position in the landscape (about 60 – 70 m above the river level) means that large-scale irrigation development would not be viable.
- Moderately suitable land of map unit LC1 includes a 25ha area lying about 15-30 m above river level. Before irrigation development is considered in unit LC1, a detailed soil survey needs to be undertaken.
- Marginally suitable land of Class 3 covers several isolated areas (approximately 240 ha in total) along the terraces and, in places, lower footslope sites adjacent to the Xura River. This Class 3 land is not recommended for formal irrigation development, but limited areas could be used for garden purposes with technical and managerial inputs.

From an economic perspective, the following points are noted.

- Agricultural development activities in the study area have decreased since 2001, when the previous baseline study was done. The Lambasi Cooperative and Lambasi Dairy Project and Calf Raising Unit closed in 2006.
- According to the previous baseline study for Eastern Pondoland, sugar cane was grown under dry-land conditions on about 1 500 ha in the Mankenkezi / Greenville area of the Bizana District. These activities ceased mainly due to lack of finance.
- The *status quo* of Magwa Enterprise Tea (Pty) Ltd was maintained since the previous baseline study but the planned expansion of the estate did not materialise. It used to have a dairy, as well as cattle, maize and chicken production projects for the communities in the region, but they ceased operation, mainly due to a lack of finance.
- The reasons for the failure of agricultural development projects in the study area need to be researched. Magwa Enterprise Tea (Pty) Ltd is favourably positioned to serve as a platform from where agricultural development projects can be launched.
- The need for a cooperative in the area and the reinstatement of the cooperative and other development projects should be investigated.

- The establishment of a demonstration farm to demonstrate the results of appropriate farming techniques, such as new seed cultivars, cultivation practices, weed control and others needs to be investigated.
- Maize, vegetables, milk, eggs and broilers are imported in the region, which means there are opportunities for the production of these commodities within the area.
- The lack of support services and, in particular, a rural finance facility is a significant constraint for the establishment and operation of agricultural development projects. The government has recognised these needs and introduced programmes such as the Comprehensive Agricultural Support Programme (CASP) to fulfil them.
- The area has a high potential for the development of commercial forestry plantations, tourism and dry-land agriculture due to the favourable climatic and natural conditions. Agricultural development opportunities, as well as the desire for them and the capacity to support them should thus be investigated.

7 REFERENCES

Volume 2 of 5, March 2009, BKS (Pty) Ltd. DWAF Water Resource Study in Support of the AsgiSA EC Mzimvubu Development Project

Appendix A

Detailed-Reconnaissance Soil-Landform Map of the Study Area

MAP UNIT	LANDFORM AND DOMINANT SLOPE CLASS	BRIEF DESCRIPTION OF DOMINAT SOIL AND ASSOCIATED FEATURES	SOIL FORM	
			DOMINANT	OTHER
LA1	Level to gently sloping crest, mid- and foot slope, foot slope of limited extend 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 (100-10cm) well drained, dark red, fine sub-angular blocky structured, clay associated with dolerite occurrences	Shortlands 1110	
LC1	Gently sloping mid slope, 2-5% lope	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

MAP UNIT	GENERALISED PHYSICAL IRRIGATION SUITABILITY CLASS	DOMINANT LIMITATIONS	SIZE (ha)
LA1	5 (not suitable)	Restricted soil depth; temporary soil wetness	1629
LB1	1 (highly suitable)	Mainly higher laying land	5.4
LC1	2 (moderately suitable)	Temporary soil wetness in deep subsoil	25.5
LD1	3 (marginally suitable)	Temporary soil wetness; flooding	244.4
LE1	5 (not suitable)	Temporary seasonal soil wetness; flooding; riparian land	122.9
LF1	5 (not suitable)	Steepness of land; restricted soil depth	3225.8
		Total	5253

Scale 1:20000

0 3 6 9 12 15 km

KARIWA PROJECT ENGINEERS & ASSOCIATES (Pty) Ltd

FEASIBILITY STUDY OF THE LUSIKISIKI WATER AUGMENTATION PROJECT

DETAIL RECONNAISSANCE SOIL-LANDFORM MAP OF THE STUDY AREA

MAP No: P10-014-00-02

COMPILED BY : G BLOEM

DATE : 03 NOVEMBER 2010

PROJECT NUMBER

P10-014

Appendix B

Morphological Properties and Analytical Data of Selected Soils Gleaned From Land Type Survey Staff (2001)

Profile No	11950			
Soil form and family	Cartref 1200 silt loam			
Horizon	A1 (Orthic)	E	B1 (Lithocutanic)	
Depth (cm)	0-25	25-60	60-120	
Colour	7.5YR3/0 very dark grey	10YR5/1 grey	7.5YR4/4 brown to dark brown	
Mottling	None	None	Common medium distinct yellow, red, black geogenic	
Structure	Weak fine sub-angular blocky	Weak fine sub-angular blocky	Moderate medium sub-angular blocky	
Consistency	Slightly firm	Slightly firm	Firm	
Cutans	None	None	Common clay	
Nodules	None	None	None	
Material >2 mm	Few flat stones: shale	Common rounded gravel	Many stones and weathered remnants of shale	
Transition	Gradual smooth	Abrupt wavy		
Textural class	Silt loam	Loam	Clay	
Particle size (%):				
Clay <0.002 mm	17.3	19.4	53.2	
Silt 0.002-0.05 mm				
Sand 0.05-2.0 mm				
Coarse sand 2-0.5 mm	1.2	20.9	6.8	
Med sand 0.5-0.25 mm	1.3	1.0	0.6	
Fine sand 0.25-0.106 mm	2.4	8.6	0.9	
V F sand 0.106-0.05 mm	11.3	12.0	2.8	
Coarse silt 0.05-0.02 mm	36.9	18.3	11.4	
Fine silt 0.02-0.002 mm	27.2	17.0	23.3	
Exchangeable cations				
(cmol(+)/kg soil)				
Na	0.36	0.79	2.27	
K	0.37	0.17	0.20	
Ca	2.90	1.96	4.96	
Mg	3.34	4.05	9.74	
S-value	6.97	6.97	17.17	
CEC (soil)	10.24	8.55	20.70	
CEC (clay)	58.2	44.1	38.9	
Base saturation (%)	68	81	83	
pH.H20	6.07	7.44	7.26	
Resistance (ohms)	2600	2200	1600	
P (mg/kg)				
C%	1.9	0.85	0.63	

Profile No	11946			
Soil form and family	Shortlands 1110 clay			
Horizon	A1 (Orthic)	B1 (Red structured)		
Depth (cm)	0-30	30-120+		
Colour	2.5YR3/4 dark reddish brown	10R3/2 dusky red		
Mottling	None	None		
Structure	Strong fine sub-angular blocky	Strong fine sub-angular blocky		
Consistency	Firm	Very firm		
Cutans	None	Common clay		
Nodules	None	None		
Material >2 mm				
Transition	Diffuse smooth			
Textural class	Clay	Clay		
Particle size (%):				
Clay <0.002 mm	71.3	76.8		
Silt 0.002-0.05 mm				
Sand 0.05-2.0 mm				
Coarse sand 2-0.5 mm	0.1	0.1		
Med sand 0.5-0.25 mm	0.5	0.5		
Fine sand 0.25-0.106 mm	2.3	1.3		
V F sand 0.106-0.05 mm	2.4	2.3		
Coarse silt 0.05-0.02 mm	8.3	4.7		
Fine silt 0.02-0.002 mm	13.6	12.2		
Exchangeable cations (cmol(+)/kg soil)				
Na	0.28	0.16		
K	0.10	0.05		
Ca	4.13	2.19		
Mg	4.16	3.04		
S-value	8.67	5.44		
CEC (soil)	16.01	13.15		
CEC (clay)	22.5	17.1		
Base saturation (%)	54	41		
pH.H20	5.9	6.1		
Resistance (ohms)	2200	3400		
P (mg/kg)	4.35	3.29		
C%	3.32	1.89		