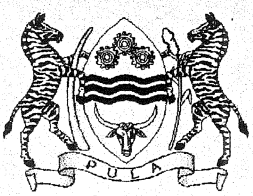

Botswana Government

Ministry of Minerals, Energy and Water Affairs

Department of Water Affairs

Environmental Impact Assessment for the Detailed Design of a Dam on the Lotsane River at Maunatlala

(TB 10/3/19/99-2000B)

EIA Review Report

27th August 2001

Geoflux (Pty) Ltd

in association with WMB

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1 INTRODUCTION

1.1 Background

This report gives a review of the work done by ARUP Botswana *et al (*1991) during the feasibility stage of the proposed Lotsane dam development. The review and scoping exercise will among other things focus on highlighting salient social and environmental issues, updating and augmenting baseline environmental information that may have become outdated over time and bringing in issues considered critical to the overall success of the current study but were omitted or not relevant during the 1990 Environmental and Social Impact study.

The Lotsane Dam site was initially identified during a study conducted by Sir Alexander Gibb and Partner (1976). ARUP Botswana *et al* further investigated this site to the preliminary design stage in 1990. The 1990 study investigated the feasibility of utilizing the surface water for irrigation purposes and other uses, including supplying villages in the region and feeding the North South Carrier pipeline at Palapye. The study concluded that the yield would only be sufficient to meet the regional water demand and that for irrigation and would not be sufficient for the raw water supply to the North South Carrier pipeline.

The ARUP Botswana *et al* report still provides a useful background to the potential impacts of the proposed dam at Lotsane. However, as highlighted above, it needs to be updated, in terms of both the latest reservoir and catchment management initiatives and more specifically, in light of the conservation initiatives in the Tswapong Hills area. In this respect every attempt should be made to integrate the benefits of the proposed dam with that of the conservation area, in order to promote conservation and tourism in the area.

The proposed Lotsane dam site is situated on the Lotsane River about 2km to the west and upstream of Maunatlala. According to the Feasibility report, the reservoir is expected to cover an area of 19km^2 (Full supply level - FSL) (ARUP Botswana *et al, 1991).* The report further recommends a zoned earth/rockfill dam with a 6m crest width and upstream and downstream face gradients of 1:2 and 1:2.5, respectively (SMEC and CPP, 2001). SMEC and CPP state that dam height is likely to range between 13.5 and 20m above the river bed depending on the storage volume adopted by current engineering design study.

In addition to the dam development, a number of associated facilities and infrastructure will be developed, e.g., water treatment plant and staff housing, access road, power line and pipelines to the target villages and proposed irrigation areas east of Maunatlala. Some of

these additional developments, i.e. water pipelines, essentially extend the impacts beyond the dam area, though such impacts will largely be confined to linear routes.

1.2 Location of Project Area

The project area is located in the Central District and falls under the jurisdiction of Ngwato Land Board through the Maunatlala Sub-Land Board. Some of the villages in the project area in order of proximity include: Maunatlala, Lesenepole/Matoposane/Matolwane, Moremi, Mokokwana, Mosweu/Goo-Tau and Seolwane. Other villages that are likely to be supplied from the dam include Lerala, Majwaneng and Ratholo in the south and Kgagodi, Mogapinyana, Tamasane, Dirolo and Mogapi in the north. Figure 1.1 below shows the location of the proposed dam site as well as its catchment.

1.3 EIA study objectives

The purpose of the study as stated in the terms of reference (ToR) is " to ***undertake a detailed EIA study of the proposed dam on the Lotsane River. The EIA should review and assess all project activities in and around the dam site and surrounding villages, possible impact on down stream sand river aquifers and traditional hand dug wells, address any compensation issues and articulate an environmental management plan for the reservoir catchment.***" In order to achieve this aim, the EIA study will address itself to the following specific objectives:

- ***To appraise the designs for the dam and associated infrastructure as well as current project activities in and around the dam e.g. geotechnical surveys.***
- ***To identify potential conflict between competing water uses.***
- ***To assess potential impacts on downstream water uses/land uses due to water curtailment***
- ***To address all potential relocation and compensation issues***
- ***To articulate a comprehensive environmental impact statement (EIS) an environmental management plan (EMP)***

These clearly defined objectives will help focus the EIA study and facilitate easier impact identification, evaluation and mitigation.

1.4 EIA Study Implementation Summary

The implementation of the EIA Study will be executed in four stages as discussed in the inception report (Geoflux and WMB, 2001). This will facilitate sequential production of outputs/deliverables at specific periods of the engineering design programme.

The study is currently at the second stage that entails a comprehensive review of the previous EIA study and information derived from the preliminary field surveys as part of scoping and substantiating on available information. Subsequent to the EIA Scoping and Review stage, the third stage (i.e. Impact Analysis and Mitigation Stage) will follow. This stage will mark the end of the EIA and entails field surveys to augment the information base as identified by the scoping and review exercise, identification and appraisal of impacts and evaluation of compensation and relocations costs for properties affected by the dam. The final stage of the study will involve the development of an Environmental Management Plan (EMP) for implementation during both construction and operational phases of the dam development.

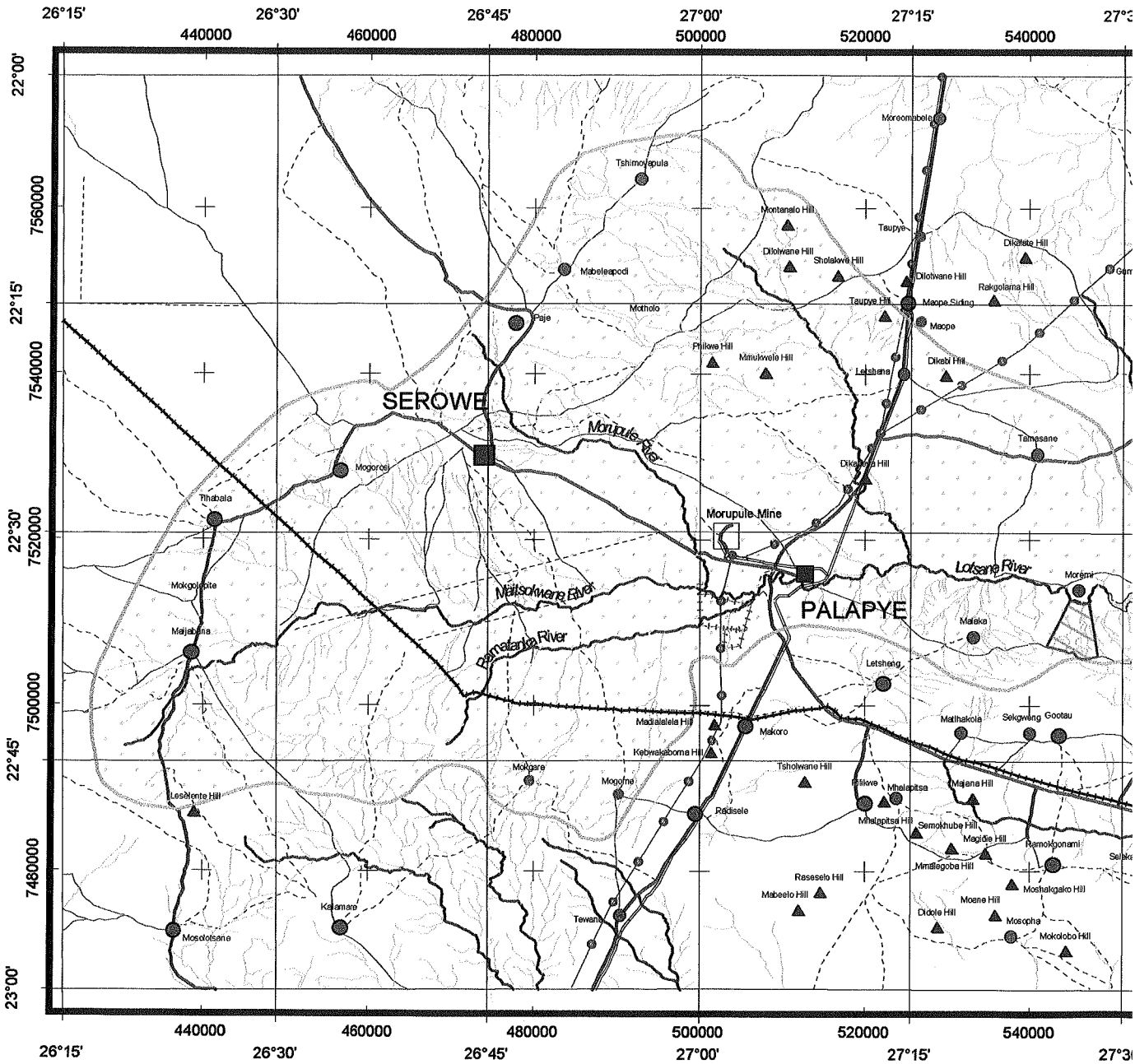
1.5 Structure of the Report

This report is composed of three chapters.

Chapter One provides a brief introduction to the study by stating the purpose of the report; overall objectives of the EIA study as well a summary of the implementation process of the study.

Chapter Two describes the natural and cultural environments (i.e. environmental setting) on which the proposed dam is going to be built, and which may be affected by such a developmental intervention and its auxiliary activities and structures.

Chapter Three highlights significant environmental issues raised by the Environmental and Social Impact component of the feasibility study carried out 1990 (ARUP Botswana *et al* 1991). Issues of concern and importance that may arise due to the proposed dam development are discussed with particular reference to the various components of the existing environment. Furthermore, a summary of salient environmental issues and their associated potential impacts is provided. This summary presents a preliminary significance evaluation of the impacts and further suggests how the issues will be addressed.



Source: Department of Surveys and Mapping Topographical Sheets 23 and 24
Landsat 7 imagery
Scale 1 : 250 000

Note: Village hierarchy and classificatio

Projection: Transverse Mercator, Clarke 1880, Zone 35

2 ENVIRONMENTAL SETTING

Environment in this context refers to the biophysical phenomena and human related aspects as well as the interaction between these two aspects. This chapter presents the environmental setting of the study area with respect to both the upstream and down stream areas of the entire Lotsane River catchment area. The environmental setting will be modified and updated in the final deliverable (Environmental Impact Statement) as information becomes available. Below is a discussion of the environmental setting of the study area with respect to the various environmental phenomena.

2.1 Biophysical Setting

2.1.2 Climate

The climate in the study area is predominantly arid to semi-arid, with dry winters and hot fairly wet summer months. As is the case in other parts of Botswana, the rainfall occurs between the months of December to March. The average annual precipitation for the region is 440mm (Figure 2.1). Rainfall is variable both temporally and spatially as depicted by the long-term monitoring at stations in Serowe, Palapye and Maunatlala (Figure 2.2, 2.3 and 2.4).

The minimum temperature in the region ranges between 12.5°C (summer months) and -6°C (winter months). Maximum temperatures are generally very high and range between 21.5°C (winter months) and 40.5°C (summer months). Like the rest of the country, evaporation is very high (up to 2512mm as per monitoring in Mahalapye weather station) and far exceeds rainfall.

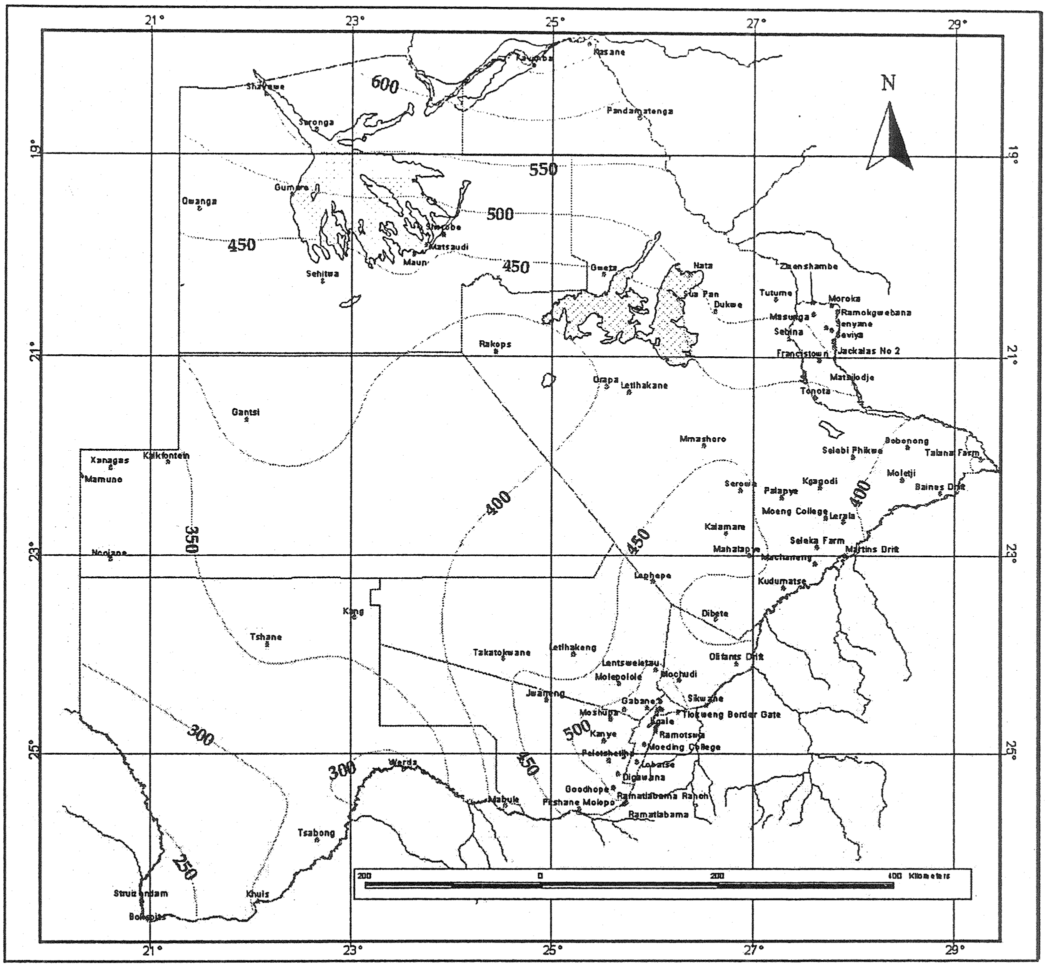


Figure 2.1: Rainfall distribution map (Bhalotra, 1977)

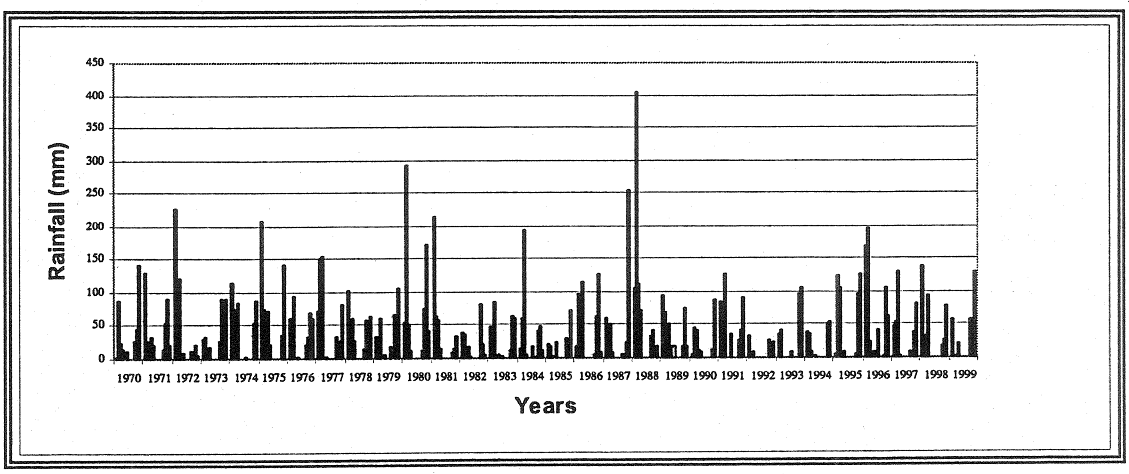


Figure 2.2: Palapye long-term rainfall record

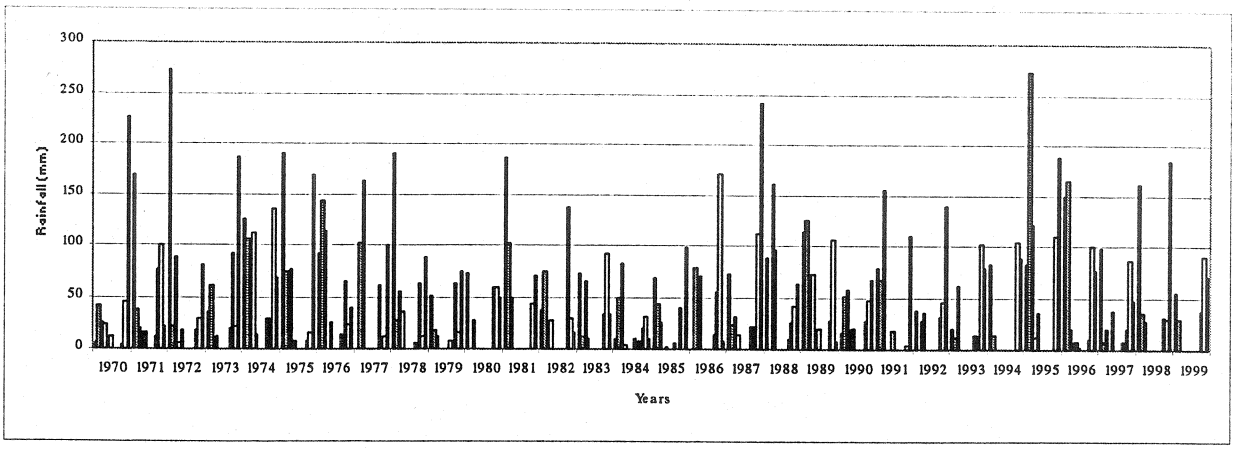


Figure 2.3 Serowe long-term rainfall record

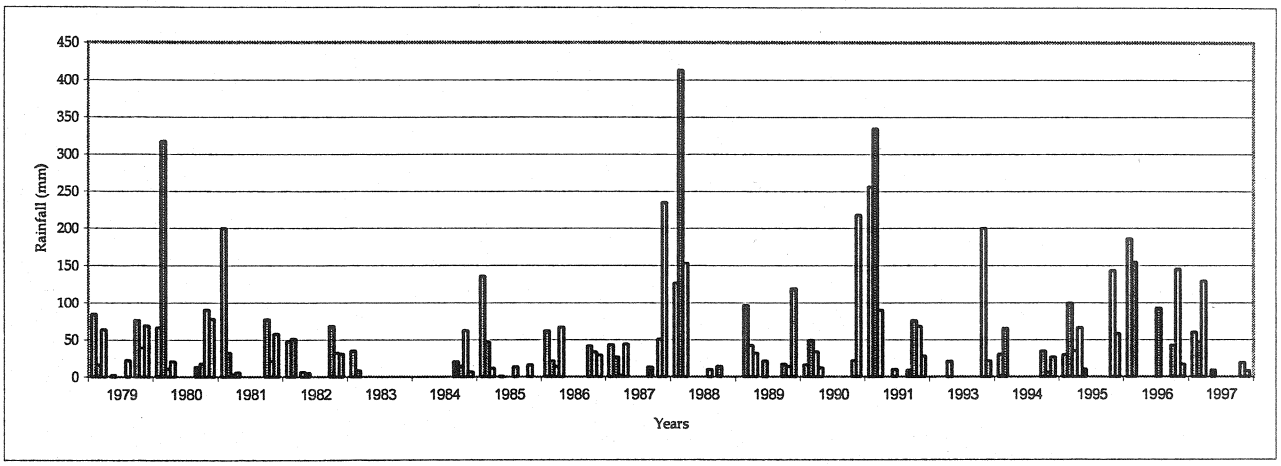


Figure 2.4: Maunatlala long-term rainfall record

2.1.3 Physiography

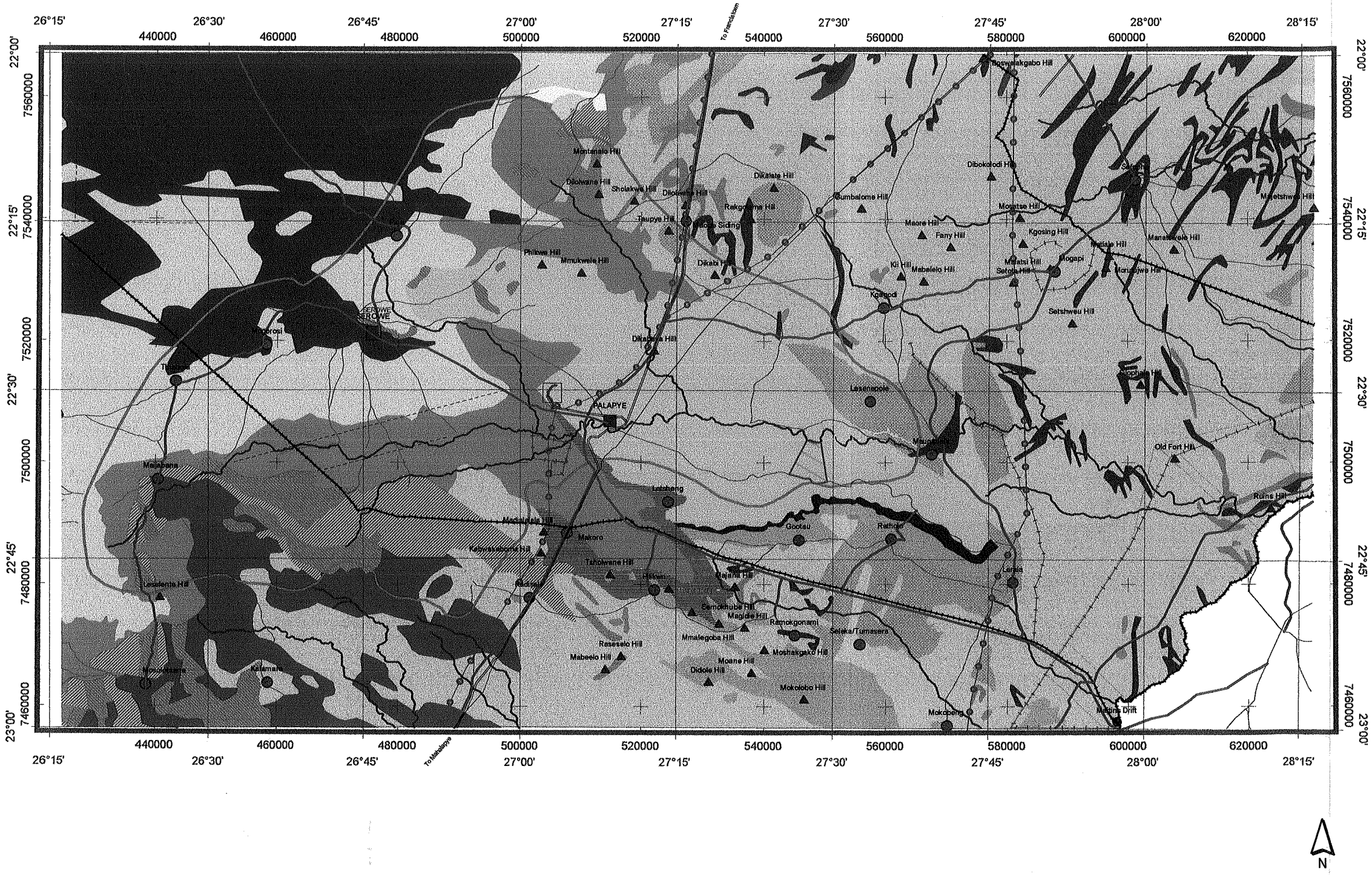
The proposed Lotsane dam reservoir occupies a section in the meandering Lotsane river channel some 2 Km upstream of Maunatlala village. This area, which occurs between Maunatlala and Moremi, is bounded to the south by steeply sloping Tswapong hills, which form a prominent range of east trending hills. From the base of these hills, the flood plains of the seasonal Lotsane River slope gently northwards, towards the river channel. A number of small washes and gullies emanating from the Tswapong hills run across the flood plains towards the Lotsane River (Timberlake, 1980). These watercourses form prominent coherent drainage channels in the vicinity of the proposed dam.

Like most part of Botswana, the slopes in the Lotsane catchment are fairly flat. The topography is undulating with a west-east slope. The relief in the area is provided by Mokgware hills in the southwest with an average of 1300 m above sea level, Mabeleapodi hills in the northwest with an average of 1250 m above sea level and Tswapong hills at an average of 915 m above sea level.

Three rivers, Morupule from the north, Ramatanka from the south and Maitsokwane in the center, provide the main surface drainage of the western part of the project area and the trio meets just before Palapye to form Lotsane River. Thus, from Palapye onwards, Lotsane River dominates the drainage and it is towards which the outlying areas drain. Between Palapye and Maunatlala the principal tributary is the Dikabeya from the north. Downstream of proposed dam site the main tributaries are the Tshokana River from the north and Sesulela River from the south.

2.1.4 Geology

The main geological units of the catchment area are Basement complex, Waterberg Supergroup, the Karoo Supergroup and Kalahari Beds. The rocks comprising these units vary in age from the Archeaen (Basement complex) through the mid to Late Proterozoic (Waterberg Supergroup) and the Triassic (Karoo) and up to the Cretaceous to Recent (Kalahari Beds). Figure 2.5, shows the generalised geology of the Lotsane catchment compiled from the 1:1 000 000 national geological map.

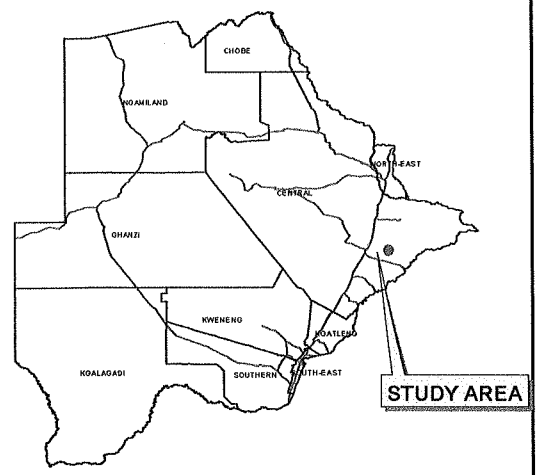


Source: Department of Surveys and Mapping
Topographical Sheets 23 and 24 (1 : 250 000)
DGS National Geology Map of Botswana (1 : 1 000 000)

Projection: Transverse Mercator, Clarke 1880, Zone 35

Note: Village hierarchy and classification adopted from National Settlement Policy (1998) and Central District Development Plan 5 : 1997 - 2003

General Location of the Study Area



LEGEND

- Primary Settlement
- Secondary Settlement
- Tertiary II Settlement
- Border Post
- Hills
- Main River
- Tarred Road
- Gravel Road
- Railway Line
- Power Line
- Veterinary Cordon Fence
- Drift Fence
- North-South Carrier Water Pipeline
- Proposed Lotsane Dam
- Lotsane Dam Catchment Area
- Proposed Moremi Gorge Conservation Area

Geology

- Ecca Group
- Karoo basalts
- Kgoro Complex
- Late Karoo dolerites
- Lebung Group
- Lotsane Formation
- Mahalapye Granite
- Mahalapye Migmatite
- Moeng Formation
- Selika Formation
- Seoka Adamellite
- Shoshong Formation
- Tswapong Formation
- Archaean amphibolite
- Archaean gneiss
- Archaean granite
- Archaean meta-anorthosite
- Archaean meta-ultramafics
- Archaean metasediments

Scale 1 : 750 000

5 0 5 10 15 20 25 30 35 Kilometers

N

FIGURE 2.5

Generalised Geology of the Lotsane Catchment

Detailed Environmental Impact Assessment of a Dam on the Lotsane River at Maunatlala

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2.1.4.1 Basement Complex

The basement rocks belongs to the tectono-metapmorphic complex of the Limpopo Mobile Belt (Key, 1979). These are the oldest rocks of Early Archaean age, and are generally described as granites or granitic gneisses. Generally the rocks have poor permeability and as thus yield water only along fractured systems (ARUP Botswana *et al*, 1991).

The basement rocks occur throughout most of the area east of the railway line. In the western areas younger rocks and the Kalahari Beds deposits overlie the basement rock. There are however some outcrops around Mokgware hills, in the southwest area of the Lotsane catchment.

2.1.4.2 Waterberg Supergroup

These are meta-sedimentary rocks that overlay the Basement Complex rocks in the eastern part of the catchment area. These rocks, which comprise mainly quartzites, shales, siltstone, sandstones form part of the Tswapong Hills, as well as the Ramokgonami-Seleka Hills range to the south of the Lotsane River. Four formations are recognised, namely the Seleka, Moeng, Tswapong and Lotsane formations in decreasing age.

2.1.4.3 Karoo Supergroup

These rocks underlie most of the central and western parts of the Lotsane catchment. The area Karoo comprises sedimentary rocks belonging to the Dywka, Ecca, and Lebung Groups. Basaltic lavas of the Stormberg Lava group, which occurs around the Serowe area and further to the west, overlie these sedimentary rocks.

Sandstones interbedded with mudstone carboniferous mudstones, coal and shales represent the Ecca group. These units are formally termed Morupule formation. Mosolotshane and Ntane Sandstone formations and Karoo basalts in turn overlie the Morupule formation. The Ntane Sandstone and Karoo basalts outcrop in the Serowe area.

2.1.4.4 Kalahari Beds

The Kalahari Beds represent a sequence of semi-consolidated to unconsolidated sediments ranging in age from the Cretaceous to Recent. These deposits typically comprise conglomerates, semi sandstone, siltstone, unconsolidated sands and 'cretes' (calcrete, silcretes, etc).

2.1.5 Water Resources

2.1.5.1 Groundwater Regime

The area around Lotsane Dam has the potential of groundwater occurring in discrete fissures that may or may not be interconnected sufficiently to constitute an aquifer (ARUP Botswana *et al* 1991). Recharge to this aquifer system is by fissure continuity to the surface through a fairly thin covering of facade materials. This is more dominant in zones where surface runoff is concentrated, especially in channel sands of the Lotsane River. Recharge to the fissures is also provided by runoff from the Tswapong Hills infiltrating the coarse hill wash at the foot of the slopes and percolating towards the valley. Some of the recharge to the fissures manifests itself in the form of springs and seepages in clayey alluvium deposits.

2.1.5.2 Sand River Regime

Nord (1985) categorized Lotsane Sand River as Small Sand River with restricted width and sand thickness of about 1.8 meters and water storage capacity of around 6 X 103 m^3/kilometre length. It is also further indicated that during the first 3 months of the dry season, evaporation causes a water level decline by 0.9 meters, which is approximately 50% of the stored water in Lotsane River. This decline and other natural losses cause the river to dry up during the dry season. However studies by Thomas and Hyde (1972), Wikner (1980) and Nord (1985) indicate that one single flow event in the sand river channel is sufficient to replace all natural losses. Currently there are insignificant losses of surface water in the Lotsane Sand River through abstraction by hand-dug wells, shallow pits and boreholes. Therefore a single flow event is sufficient to maintain the current natural losses in the sand river.

2.1.5.3 Water Quality

Lotsane Dam catchment covers a large area ranging from west of Serowe through Palapye up to Maunatlala. The water quality in the area is therefore influenced by the land uses in the catchment area especially in the urban centers. These land uses include small-scale agriculture, cattle grazing, and urban domestic drainage from places such as Serowe and Palapye and drainage from Morupule Colliery.

2.1.6 Ecology

2.1.6.1 Soils

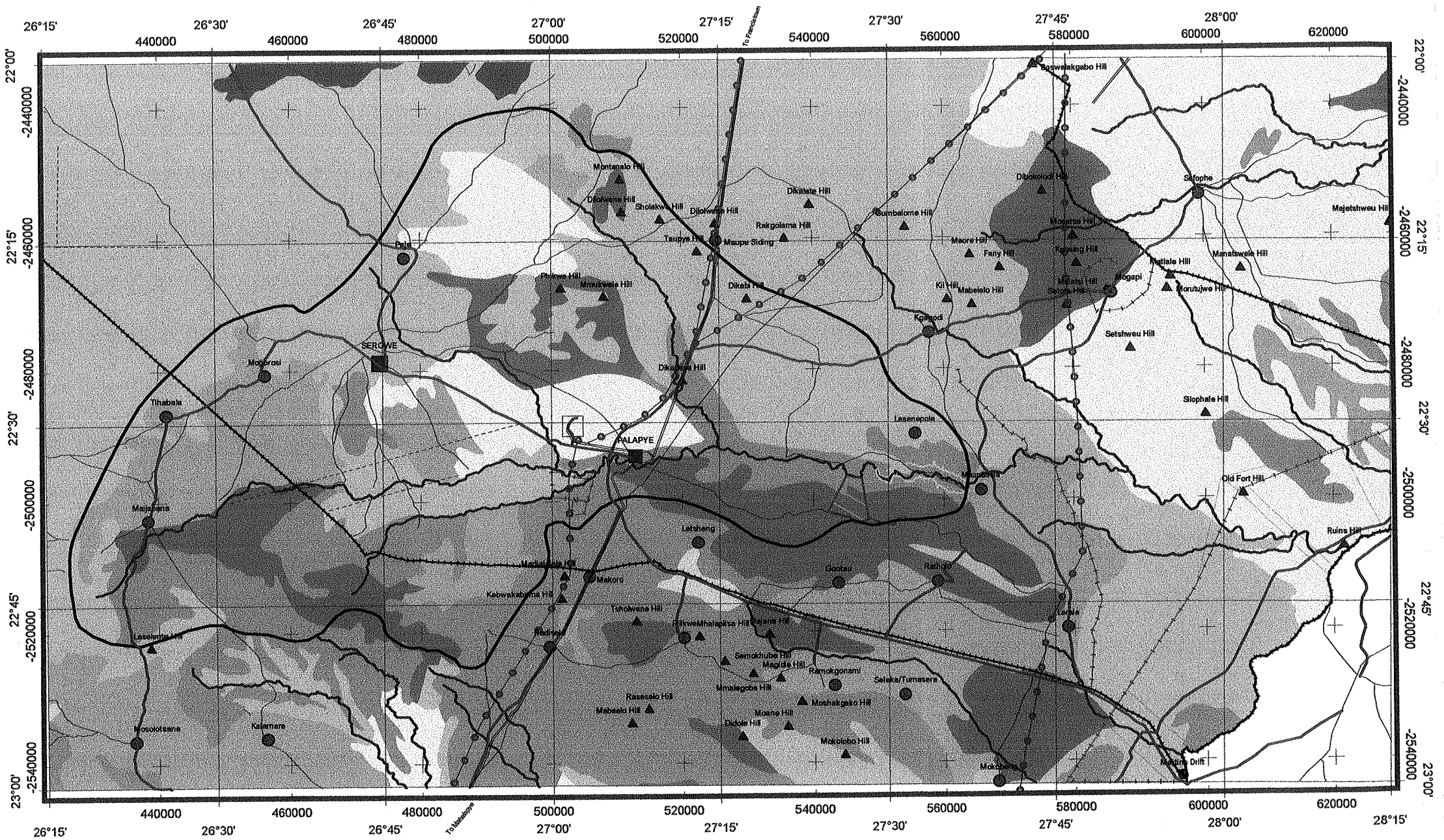
The soils of the Lotsane catchment are mostly sandy loams and loamy sands, with small areas of heavy (clay-rich) soils in depressions and valley bottoms, and shallow stony soils on hills (Timberlake, 1980).

The catchment area extends deep into the western side of the project area and indeed into the sandveld (Kalahari sands). These sands consist almost entirely of reddish or whitish well-sorted sand of aeolian origin. Exceptions are found mostly along fossil river valleys and pans where some chemical disintegration may have occurred to yield high clay content.

The soils of the project area are classified using the FAO/UNESCO/ISRC (1988) soil classification, with all exceptions being those discussed by de Wet and Nachtergale (1990). As illustrated in figure 2.6 the major soil types in the Lotsane River catchment and the region are: Arenosols, Luvisols, Leptosols, Planosols, Lixisols, Acrisols, Regosols, Calcisols and Vertisols. The descriptions of these soil types are summarised in table 2.1.

Table 2.1: Major soil types in the project area

Soil type	Major characteristics
Arenosols,	Poor profile development, moderately acidic, infertile, high electronic conductivity
Luvisols	Well developed soils, contains argillic B horizon in the subsurface soil, relatively fertile
Leptosols	Shallow soils, associated with hilly areas (unconsolidated material), and are often found in association with Regosols
Planosols	Deep to very deep, imperfectly drained, brownish in colour and sandy clay loams, sandy clay and clays in texture.
Lixisols	Deeper soils, imperfectly to moderately well drained, coarse sandy loams to sandy clay loams.
Acrisols	Moderately deep to very deep, moderately well to well drained, coarse sandy loams to sandy clays
Calcisols	Found around pan margins and drainage lines with calcrete being the underlying material,
Vertisols	Black or grey cracking soils, also called black cotton soil (Seloko), high proportion of clay in all horizons resulting in impeded drainage, attains vertical cracks in the profile and gilgai microrelief.
Regosols	Develops on foot hills or unconsolidated gravel where sand cover is thin, have shallow profiles (+ 10cm), well drained soils

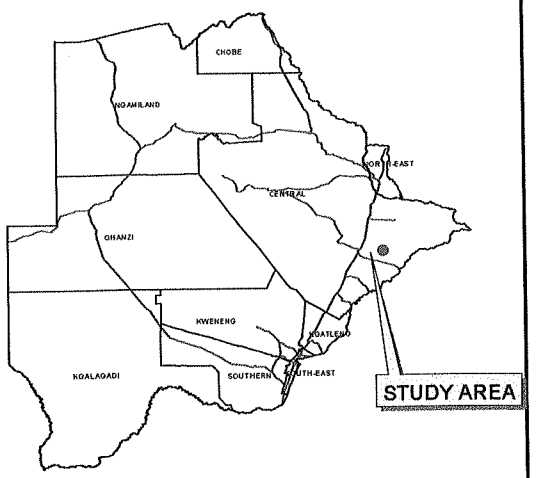


Source: Department of Surveys and Mapping Topographical Sheets 23 and 24
National Soils Map of Botswana
Landsat 7 imagery

Projection: Transverse Marcater, Clarke 1880, Zone 35

Note: Village hierarchy and classification is from National Settlement Policy and Central District Development Plan 5 : 1997 - 2003

Location of the Study Area in Botswana



LEGEND

- Primary Settlement
- Secondary Settlement
- Tertiary II Settlement
- Border Post
- Hills
- Main River
- Tarred Road
- Gravel Road
- Railway Line
- Power Line
- Veterinary Cordon Fence
- Drift Fence
- North-South Carrier Water Pipeline
- Proposed Lotsane Dam
- Lotsane Dam Catchment Area
- Proposed Moremi Gorge Conservation Area

SOILS

- ACRISOLS
- ARENOSOLS
- CALCISOLS
- LEPTOSOLS
- LIXISOLS
- LUVISOLS
- PLANOSOLS
- REGOSOLS
- VERTISOLS

N

Scale 1 : 750 000

5 0 5 10 15 20 25 Kilometers

FIGURE 2.6

Regional Soil Map of the Lotsane Catchment

Detailed Environmental Impact Assessment of a Dam on the Lotsane River at Maunatlala

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2.1.6.2 Vegetation

Climate, topography and soils as well as human activities have an influence in the structure and physiognomy of any vegetation. Within the region of study, these factors are variable; hence there is a variation in the plant communities of the area. Due to the fact that climate does not vary over a short period of time, the variation in the distribution of plant communities within the project area arises from the variation in topography and soils. Consequently, the dominating vegetation type found in the area is a mixed shrub and tree savanna with increasing tree density in connection with hills and rivers. The type of tree savanna found on hills and rocky outcrops can broadly be divided into two, on the basis of predominant tree species. These are *Croton gratissimus* and *Acacia nigrescens*, both known as hill woodland.

On the silt floodplains *Colophospermum mopane* woodland and *C. mopane* shrub occurs as mosaic with a tendency for the shrub to grow in the depressions. The shrub growth form can be attributed to both fire damage and lack of nutrients. The larger Mopane trees tend to grow on the inclines.

Most of the sandy areas within the study area are characterized by the dominance of *Terminalia sericea* sandveld vegetation. Plants growing in this vegetation type thrive on deep, loose sand. Finally there is the Riparian vegetation, which grows on alluvial silts and alluvial gravel. The abundance of *Acacia grandicornuta* and *A. nigrescens* defines this type of vegetation. These tree species are perfectly adapted to grow on alluvial soils, which are fine grained, fertile soils consisting of mud, silt and sand deposited by water (Roodt, 1998).

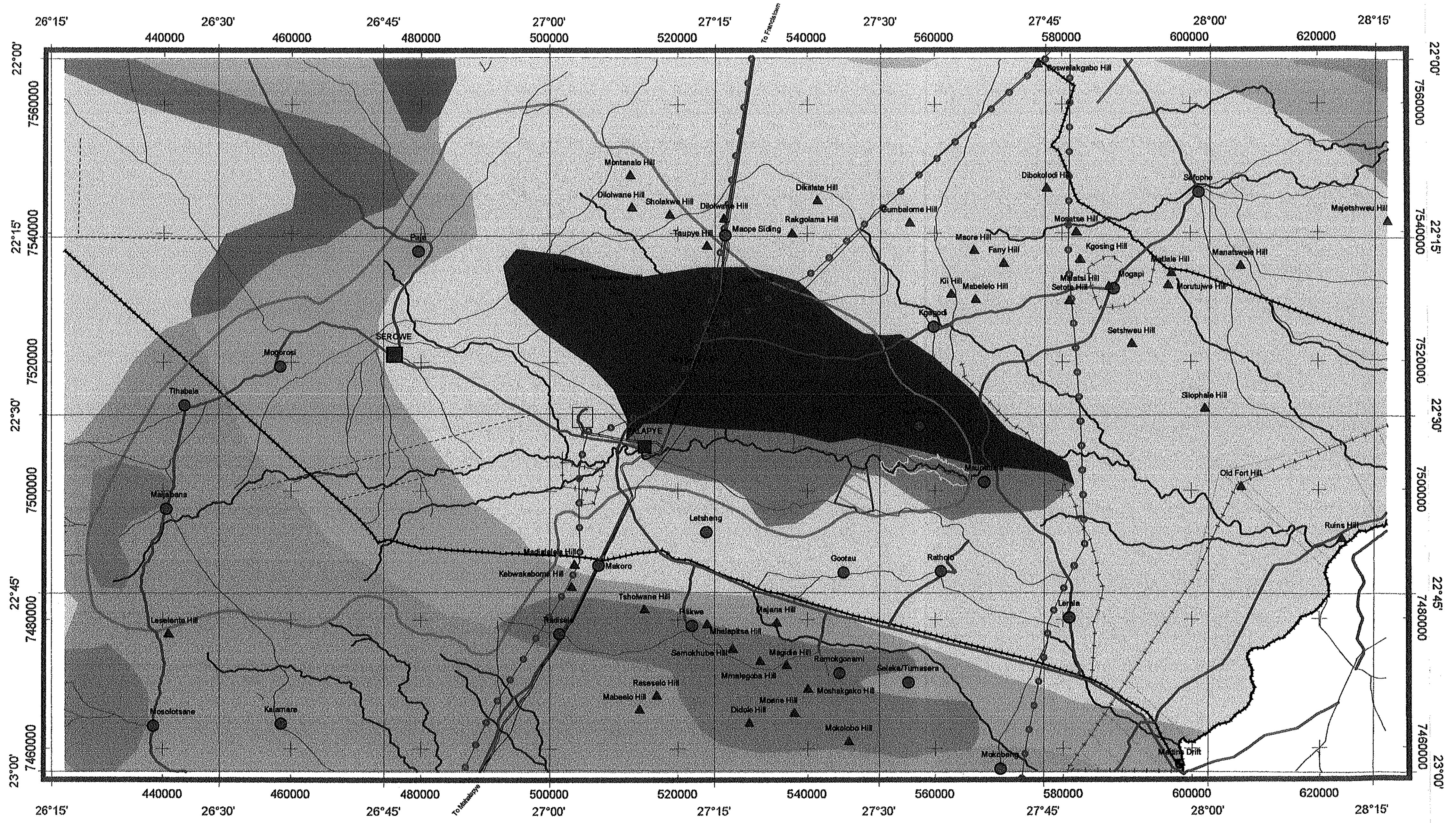
The generalised vegetation map of the catchment area is illustrated in figure 2.7. A preliminary field visit to the dam site area identified the following communities:

- **Mopane *woodland***

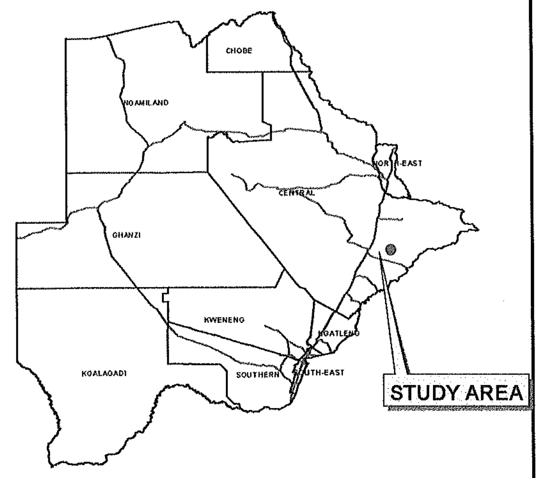
Colophospermum mopane as a shrub and/or tree savanna dominates extensive areas of the catchment. The fine sands it occupies are often heavily dissected due to heavy grazing with the herbaceous cover scarce with soil erosion that follows intensive convectional showers, likely to be pronounced. *Acacia mellifera, Dichrostachys cinerea* and *Grewia flava,* also occurs in the shrub layer.

- ***Croton gratissimus hill woodland***

The rocky escarpment slopes of the area are characterised by *Croton gratissimus,* with *Commiphora mollis, Acacia erubescens, Albizia brevifola, Kirkia acuminata , Peltophorum africanum,* with the *Combretums* and *Terminalias,* also well represented.



General Location of the Study Area



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- Proposed Lotsane Dam
- Lotsane Dam Catchment Area
- Proposed Moremi Gorge Conservation Area

Vegetation Types

- *Mixed Mopane tree and bush Savanna*
- *Northern Kalahari Tree and Bush Savanna*
- *Acacia nigrescens / Combretum apiculatum Tree Savanna*
- *Close tree, Mopane dominant*
- *Croton / Combretum Asociation*
- *Croton / Combretum Association*
- *Mopane Bushveld*
- *Thicket Woodland, Mopane dominant*
- *Tree Savanna with Mopane*
- *Tree and Bush Savanna with Mopane*

N

Scale 1 : 750 000

5 0 5 10 15 20 25 30 35 Kilometers

FIGURE 2.7

Regional Vegetation Map of the Lotsane Catchment

Detailed Environmental Impact Assessment of a Dam on the Lotsane River at Maunatlala

GEOFLUX (PTY) LTD

Source: Department of Surveys and Mapping
Topographical Sheets 23 and 24 (1 : 250 000)
National Vegetation map of Botswana (1 : 1 000 000)

Projection: Transverse Mercator, Clarke 1880, Zone 35

Note: Village hierarchy and classification adopted from National Settlement Policy (1998) and Central District Development Plan 5 : 1997 - 2003

- ***Acacia nigrescens hill woodland***

Dominating the low rocky ridge between the escarpment and the Lotsane floodplain is this type of vegetation.

- ***Talus slope woodland***

Acacia nigrescens, Acacia nilotica, Kirkia acuminata and *Combretum apiculatum,* amongst others occurs on the rocky scree slope at the foot of the escarpment.

- ***Terminalia sericea/Dichrostachys cinerea tree savanna***

On the sandy colluvial soils at the base of the rocky hill slopes dense thickets of this unit occur.

- ***Riparian woodland***

Acacia grandicornuta, Ziziphus mucronata, Acacia tortilis, Colophospermum mopane, Acacia nilotica, Combretum imberbe, Acacia nigrescens, Combretum hereoense and *Lonchocarpus capassa,* dominantly line the banks of the Lotsane River and its tributaries.

As detailed in the inception report (Geoflux and WMB 2001), the woody biomass inventory technique developed by NRP (2000) will be used to assess the nature and extent of woody biomass in the catchment area and more especially the inundated zone. This technique is based upon an initial unsupervised classification of the Landsat 7 imagery, with the strata so identified then related to the variation in woody density and structure that exists on the ground. It will complement the broader vegetation categories outlined above, which may be further expanded, depending upon the number of strata identified on the imagery. In this manner, an estimate of the amount of woody biomass (tonnes/hectare) that will be inundated can be made.

2.1.6.3 Veldt Products

All the major vegetation communities within the project area are expected to contain a diverse array of veld foods. For instance, berries such as *Ximenia species* (Meretologa), *Pappea capensis* (Mothata/Mopeneweng), *Sclerocarya birea* (Morula), *Vanguera infausta* (Mmilo) are expected a component of the hilly woodland. Whilst berries such as *Grewia* species (Moretlwa, Motsotsojane, Mogwana) are a common component of Mopane woodland, *Terminalia sericea* tree savanna and the Riparian woodland.

2.1.6.4 Fauna

Livestock (cattle, donkeys and small stock) dominates the large herbivore biomass in the project area. Apart from livestock, some few mammals have been recorded as occurring within the study area. Rodents, small insectivores or carnivores dominate these mammals. Migratory wild ungulates such as wildebeest (*Connechaetes taurinus*) and hartebeest (*Aclelaphus buselaphus*) have perished countrywide around the 1980s due to droughts and are now excluded from the area by veterinary, Game Park and National Park fences throughout the country. The low numbers of wildlife in the area can also be attributed to the fact that both people and their livestock have increasingly settled the eastern part of the country , hence the marginalisation of the latter.

Recent DWNP aerial surveys covering the project area show that the wild ungulate population is made up of kudu (*Tragelaphus strepsiceros*), impala (*Aepyceros melampus*), duiker (*Sylvicapra grimma*) and steenbok (*Raphicerus campestris*). Klipspringer (*Oreotragus oreotragus*), warthog, leopard (*Panthera pardus*), Hyena (*Crocuta crocuta*), baboon (*Papio ursinus*) and rock dassy (*Procavia capensis*) are also shown and known to occur within the project area, being ideally suited to the more remote Tswapong Hills and the lower Lotsane River drainage.

2.1.6.5 Bird Fauna

As emphasised in the Inception report, and following the 1990 Lotsane Dam Feasibility study (Arup Botswana et al, 1991), apart from the 'globally threatened' Cape Vulture, *Gyps coprotheres*, other locally rare cliff nesting birds such as the Black Stork (*Cicinia nigra*), Black Eagles (*Aquila verreauxii*) and Booted Eagles (*Hieraaetus pennatus*) are also found in the Tswapong Hills, and therefore need special consideration within this EIA study.

The Cape Vulture *Gyps coprotheres* has probably bred in the Tswapong Hills for well over a century, and currently breeds at three sites within the hills complex (Tyler and Bishop, 1998). The latter authors provide the following details: -

'The existence of some former and current breeding sites within the hills complex, Machibaba and Kukubye at Lerala and Manongnnye, was not documented until 1976. The Machibaba site was abandoned in 1984. In the same year, breeding sites at Bonwalenong and Sebale were discovered; Seolwane was colonised in 1986 but the satellite colony here dwindled and finally disappeared. In the 1980s the number of breeding pairs increased from 240 in 1984 to 325 in 1992 although the total number of birds appeared to be declining. Bonwalanong, having increased dramatically since 1989, was the most important breeding site in 1992 with over 200 pairs and Manongnnye then supported around 90 pairs. Nine nests were also found at Kukubye in 1992. It is apparent that the actual breeding sites are not fixed, and some movement between sites must occur dependent upon prevailing conditions which favour breeding successes at each site. The hills as a whole, however, probably form a

relatively closed population, although some exchange may occur with South Africa's Waterberg colony, approximately 100 kilometres away.

Tyler and Bishop (1998) point out that direct persecution and disturbance have affected breeding populations in the Tswapong Hills, with growth of the villages around the site, over the last ten years, contributing to the abandonment of small breeding sites. Currently there is concern about the small number of immature birds seen at breeding colonies, which may be due to a high mortality rate of young birds, or due to the fact that young birds may emigrate from the area (Tyler and Bishop, 1998).

2.2 Socio Economic Setting

2.2.2 Demography

The proposed dam is to be sited some 2 km upstream of Maunatlala, a small Tertiary II village with a current population estimated at 2,821 (CSO, 1997), from a 1981 population of only 264 (CSO, 1993) - indicating a rapidly growing settlement. In fact, its population was projected to grow at an annual rate of 3.2 percent between 1991 and 2001, declining to 2.6 percent by 2016 (CSO, 1997, p.94). Maunatlala will share potable water and the effects of dam construction with other localities such as those indicated in Table1 below.

Table 2.2: Demographic trends for Maunatlala and other potential project beneficiaries.

Settlement Type	**Village name**	**Pop Census**	**Pop Projections**	
		1991	**1995**	**2000**
Tertiary II	Maunatlala	2128	2414	2821
Tertiary IV	Mokokwane	352	366	390
Tertiary III	Seolwane	933	1091	1322
Tertiary II	Ratholo	984	1028	1089
Tertiary II	Goo-Tau	1137	1188	1259
Tertiary III	Majwananeng	847	899	975
Tertiary IV	Moremi	367	379	394
Tertiary II	Lesenepole/Matolwane/ Matoposane	1317	1376	1457
Tertiary IV	Malaka	424	441	467
Tertiary II	Lerala	3779	4188	4800
Tertiary III	Tamasane	724	760	806
Tertiary II	Mogapi	1278	1394	1569
Tertiary III	Mogapinyana	689	784	930
Tertiary III	Kgagodi	1127	1173	1245

Tertiary IV	Diloro	283	348	442

(Source: Population Projections, CSO, 1997 and NSP,1998).

Roughly 60 percent of the population of Maunatlala is female, far above the national average of about 52 percent. In fact, this is typical of the project catchment area population structure see Table 2.2.

Table 2.3: Gender composition (1991) for Maunatlala and associated localities

Village Name	**Male**	**Female**
Maunatlala	853	1275
Tamasane	325	402
Malaka	180	258
Moremi	150	174
Mogapi	511	767
Mogapinyana	351	518
Lesenepole	543	774
Ratholo	409	575
Goo-Tau	521	616
Village Name	Male	Female
Majwaneng	369	479
Seolwane	379	478
Matoposane	101	117
Mokokwane	152	200
Diloro		

(Source: CSO, 1992)

Traditionally mainly women and children perform the task of collecting water from water sources. Therefore, should the project result in bringing water closer to the households, it would then have alleviated hardship for the majority of the population in the catchment area. This is indeed what has happened in most villages in Botswana where water has been reticulated (Natural Resources Services, 1988). The women are said to have deployed the time freed by improved water supply into other household and economic activities (ibid).

2.2.3 Socio-economic activities

The whole Lotsane area downstream of Palapye is settled by agro pastoral society. Thus, the dominant economic activities around the proposed Lotsane Dam are dryland arable farming and livestock production. The former involves the cultivation of sorghum, maize, beans and watermelons, while the latter is dominated by the rearing of cattle and small stock, such as goats and sheep.

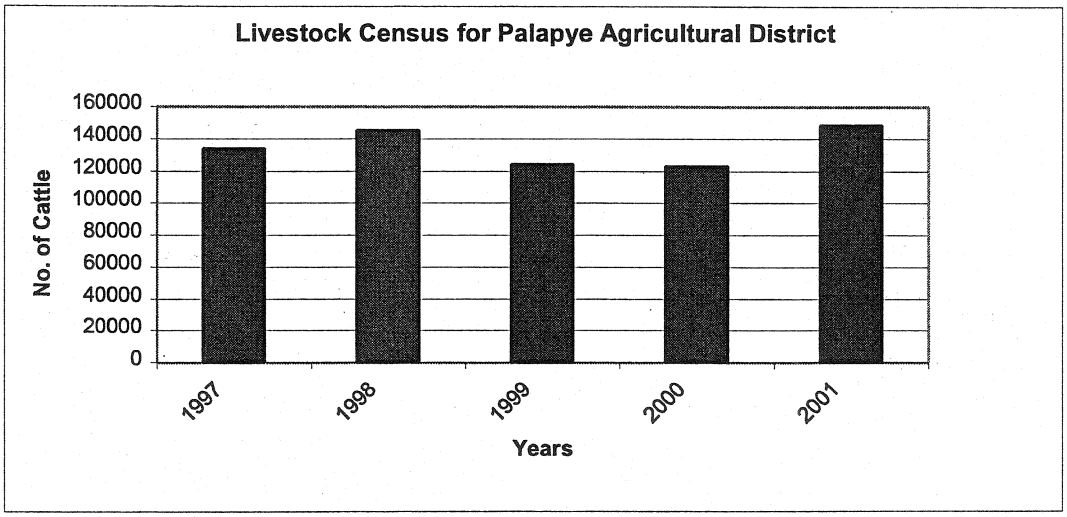
2.2.3.1 Pastoral Farming

According to ARUP Botswana et al (1991), the Lotsane River is the principal source of water for livestock in the project area (Table 2.4).

Table 2.4:Livestock using the Lotsane River stream

Area	%	Cattle	Goats	Donkeys	LSUs
Maunatlala	100	385	11250	660	1677
Mokokwane	50	415	2840	205	676
Dikgato	100	325			243
Kobalemakabe	100	1158			868
Chelaole	100	375			858
		3158	14090	865	4120

(Source: ARUP Botswana et al, 1991)



(Source: Department of animal health, Ministry of Agriculture, 2001)

Figure 2.8 Livestock Census for Palapye Agricultural District

Livestock statistics for the Palapye Agricultural District indicate that the trend in the livestock population has been generally upwards Figure 2.8. This also implies rising demand for water in the area. Water pools in the Lotsane River as well as groundwater from sand river and alluvial aquifers provide most of the water required for livestock watering, particularly for farmers living near the river. Damming the river is likely to limit the available water downstream of the dam at the dam reservoir. The latter will largely be a result of precautionary measures necessary to maintain high water quality standard by limiting cattle direct access to the waterfront. If the Department of Water Affairs decides to

fence-off the reservoir as a measure to control livestock access to the waterfront, there would be need to provide alternative water sources for livestock. Any such arrangement should, however, be based on lessons learnt from the experience at Shashe Dam (ARUP Botswana et al, 1991) where fencing failed to keep livestock away and pumping water to troughs located at a distance from the reservoir also failed due to management and maintenance problems.

According to ARUP Botswana *et al*, the Lotsane project is likely to impact more severely on the livestock sector, particularly in the grazing areas used by the villages of Lesenepole-Matolwane-Matoposane and Maunatlala. Information from the Department Animal Health and Production office at Palapye indicate that there are twenty crushes along the Lotsane River catchment area. Table 2.5 below presents estimation figures of cattle at the twenty crushes in the agricultural district as per 2000 census statistics. Figure 2.6 indicates increasing livestock numbers, which could mean more pressure on both land and water resources in the region. Livestock numbers provided below are estimates because the cattle turn out at crushes is not always 100%.

Table 2.5: Palapye Agricultural District Crushes and Estimated numbers of Livestock

Name of Crush	**Number of Livestock**
Phuduhudu	430
Jankey	138
Morupisi	118
Dikgatho North	166
Kobalemakabe	1216
Chelaole	1085
Ntsigwane	696
Dikgatho South	780
Maunatlala	991
Rasepepe	516
Bobuakwena	914
Modikela	640
Matolwane	320
Moremi	700
Sesarweng	824
Molapowadipitse	722
Senwangope	883
Mahibitswane	973
Kalakeng	1262
TOTALS	14 856

(Source: Department of Animal Health and Production-Palapye, 2000)

2.2.3.2 Arable Farming

Dryland arable production is mainly for subsistence purposes. Productivity per hectare is generally low, averaging about 3.2 bags for the period 1987-1990 (ARUP Botswana et al, 1991) varying widely depending on weather conditions see table 2.4.

Table 2.6:Yield of Grain, Maunatlala, 1988-1990 Sample of 30 farmers

	1987-8 season	**1988-89**	**1989-90**	**3 year average**
No. of 70kg Bags	1090	368	118	518
Tonnes	76.3	25.8	8.3	36.3
Bags per farmer	36.3	12.3	3.2	17.3
Kg. Per farmer	2543	859	223	1209
Kg. Per capita (farmers households	410	138	36	195
Hectares ploughed	170.5	142.8	163.2	148.6
Yield: bags per ha.	6.4	2.6	0.7	3.2
Yield: Kg per ha.	448	180	51	226.3

(Source: ARUP Botswana et al, 1991)

ARUP Botswana *et al* recommends a highly intensively managed irrigation scheme, where it is envisaged that two horticultural crops could be harvested per year. The proposed scheme involves three levels of irrigation farming: family holdings of about 200 square metres, 1-hectare and 5-hectare commercial plots. The family plots would depend entirely on family labour input and experience, while the other two levels would be run on strictly commercial basis, drawing on hired labour and expertise.

Given that the 1991 report proposes irrigation in the area east of Maunatlala, there is need to revisit the proposed irrigation scheme in the light of experience with similar schemes elsewhere in the country. A review of the impact of small dams in Botswana by Sir Alexander Gibbs (1992) has revealed that many similar irrigation schemes outside the freehold sector have been overly dependent on external support, and that they have commonly flopped after withdrawal of such support. Lack of experience, tradition and commitment accounted for this failure. It would appear therefore that these constraints would require effective tackling in the environmental management plan if the ARUP proposal is to be carried forward and bear desired results. This is imperative in an area where low-input, low-output traditional arable agriculture is prevalent. The viability of irrigation agriculture in the area has also been doubted in view of the high evapotranspiration, which could have high negative environmental implications (e.g. salinisation of the soils)

2.2.3.3 Poultry Farming

Through the Financial Assistance Policy (FAP) a total of 15 poultry projects had been implemented in the Palapye Agricultural District by December 2000. Much as these projects contribute to the growth of the employment sector in the Lotsane catchment area, indiscriminate chicken litter disposal can be a potential source of pollution to the Lotsane river waters. Therefore, the EIA study should look into how chicken litter is disposed of in the Lotsane catchment area. Table 2.7 below provides an example of the poultry farming activities within the Palapye Agricultural district, which cover part of the Lotsane catchment.

Table 2.7: Poultry Projects in the Palapye Agricultural District

Project Owner	**Place**
Palapye Development Trust	Palapye
Agnes P. Madzile	Madiela
John Puso	Setatse
Rosinah M. Lebani	Palapye
Betty Sehunelo	Setatse
Jersey Kgoreletso	Setatse
Dorcus Poloko	Lerala
Pulane Keoagile	Lecheng
Atlasaone Shashane	Mpudula Lands
Lekgobo Thomas	Goo-Tau
Onkutlule Sexaka	Mpudula Lands

(Source: Palapye Agricultural District, 2000)

2.2.3.4 Other Economic benefits

Considering that about 62 percent of Maunatlala's population was recorded to be in cash employment and a further 4 percent in business in 1991 (CSO, 1997, p.21), it could be surmised that the village has long been penetrated by the cash economy. Thus, the village seems to be well on the way towards attaining urban status, most likely within the first quarter of this century. Indeed, it is among the settlements earmarked for electricity connection during the current Central District Development Plan (CDDP5), 1997-2003 (Central District Council, 1997, p.120). The area is already traversed by an all-weather (tarred) road from Martin's Drift to Selebi-Phikwe.

The project will generate wage employment in an area with an apparently strong cash economy tradition. ARUP Botswana *et al* (1991) estimates a total labour force of 354 during the construction phase, of which 194 would be unskilled and 22 semi-skilled. It is hoped that preference would be given to the population of the project area, particularly to women. The incomes from this employment can be expected to give a temporary (3-year) boost to the local economy, with major benefits accruing to the local businesses.

2.2.3.5 Social Amenities

Presently, the village's water is supplied from 2 boreholes, reticulated to 16 standpipes and 82 private connections. The reliability and quality of water supplied are rated medium and good, respectively (CDC, 1997, p.175). Among key facilities in the village requiring a sustained supply of good quality water are the primary and community junior secondary schools, the clinic, police station, the bottle store and chibuku depot (CSO, 1993, p.146). It would be hard to maintain hygiene in these facilities without adequate and safe water.

2.2.4 Land Use and Land Capability

The proposed Lotsane Dam project and its catchment area are located within the Ngwato Tribal authority, specifically the Serowe/Palapye sub-district. The land uses and agricultural practices in the project area do not differ in any material respect from those of the entire Serowe/Palapye sub-district. The sub-district is characterised of a mixture of grazing, arable and recreation land uses (Figure 2.9). The eastern portion of the sub-district is dominated by communal arable land uses (dry land farming) interspersed with relatively smaller areas of grazing and cultural and recreation. On this portion is also found the forestry and freehold farms. Communal grazing is largest land use activity in the western portion of the sub-district coupled with relatively small areas of arable uses and TGLP ranches.

Within the project catchment area, and in areas in close proximity to the dam site the predominant use is communal arable land use. Tswapong Hills (cultural and recreation) is located in the south-easterly direction of both the dam site and the catchment area boundary. Tribal land held under lease (Government Agricultural Institutions and ranches, and Morupule Colliery) is located between Palapye and Serowe. Grazing land in relatively small portions is found in the area around Palapye and Serowe.

2.2.4.1 Agriculture

As noted in the inception report, available information shows that the project area is currently used primarily for extensive livestock grazing (cattle, donkeys, goats and sheep) for communities at Maunatlala and Matolwane. Local subsistence dry-land farming is mainly concentrated in the area lying to the east of Maunatlala. There are also some horticultural crops grown under irrigation from boreholes. However the area under horticulture is very small. Given the uncertainties associated with dry-land farming, livestock assume particular importance in the local economy providing an attractive means of investment as well as a source of income, draught power and, to a lesser extent, subsistence (ARUP Botswana *et al*, 1991). It has also been observed that the local population also utilizes Tswapong Hills for grazing purposes. There is some tendency to keep large herds of cattle some distance to the east or north-east of the villages to which they belong, a

scenario indicative of clustering of population to the south-west of the hills and availability of pasture to the north-west.

The existing seasonal agricultural pattern in the surroundings of the dam catchment area is common with most of the arable practices in Botswana. The land is ploughed following the rains, often the second rains, in November or December. The common agricultural produce are: sorghum, maize, pulses and watermelons. Although it is not uncommon to find lands that have been left fallow due to lack of ploughing, it is quite possible that there are applications for arable land use. As per the inception report (Geoflux and WMB, 2001), a common phenomenon in Botswana is the encroachment of settlements into arable land and arable land into grazing areas. It is therefore important to review the land board applications to determine the extent of the demand for arable land.

2.2.4.2 Tourism Potential

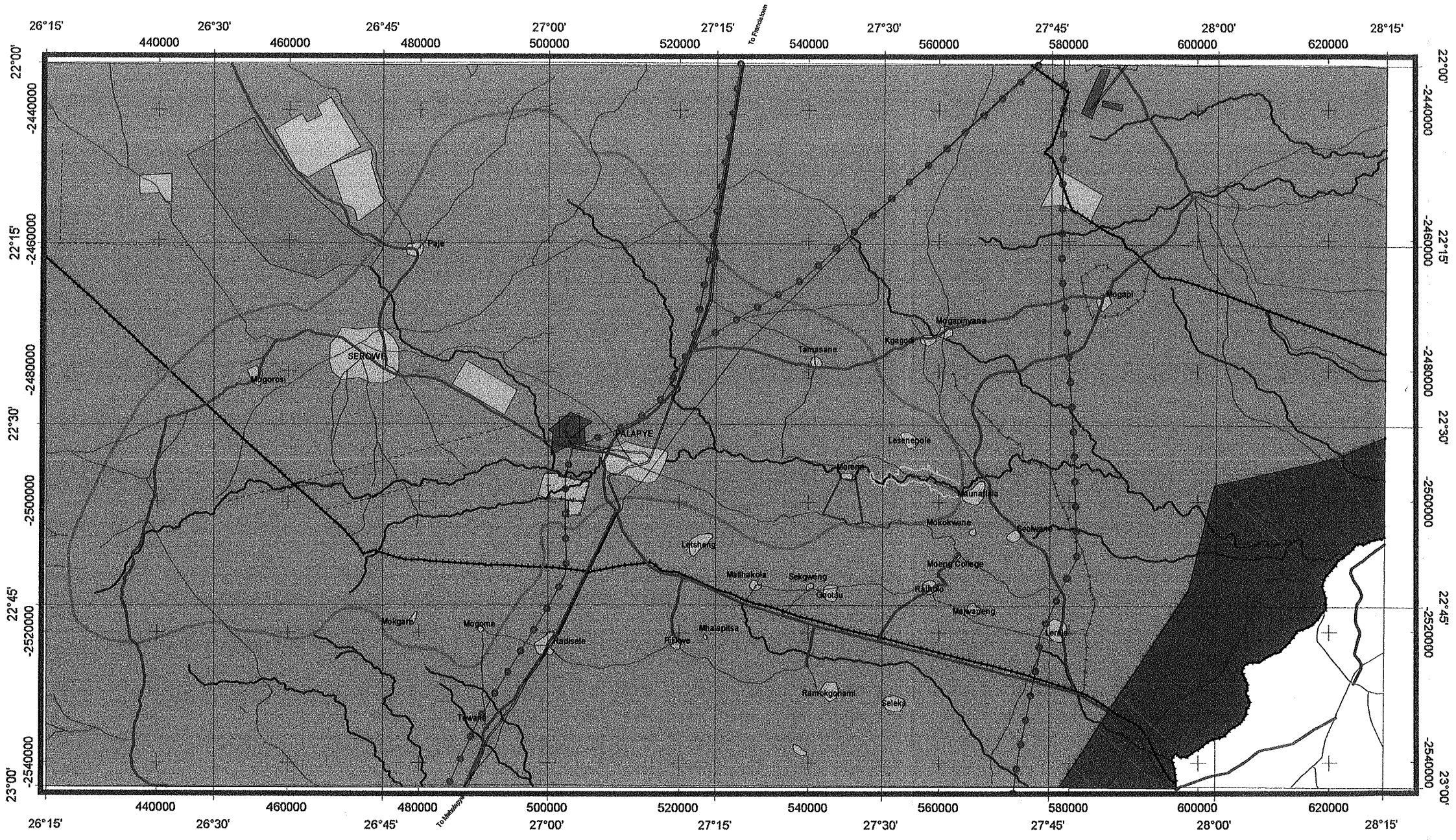
The project catchment area and its immediate vicinity are endowed with a wide variety of natural and cultural resources; some as already established tourist attractions. With the exception of the Khama Rhino Sanctuary there is insufficient wildlife within the project area to be a tourist attraction. Therefore domestic tourism activities and those based on other forms of attraction in the district need to be promoted. The protection of heritage resources and development of sites as public monuments can serve to broaden the tourism market potential. The Lotsane dam and its surroundings can become more suitable as it occurs with other environmental features summarily outlined below and their locations are shown on figure 2.10:

- ***Tswapong Hills***

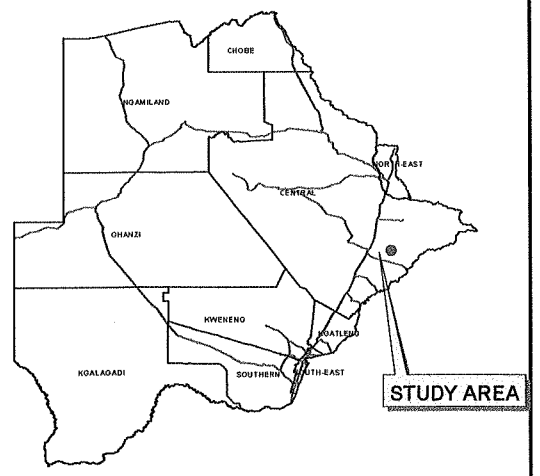
Tswapong Hills represent an opportunity for tourism due to the picturesque nature of the landscape. These Hills were the centre of the iron industry in prehistoric times. Here are also found many beautiful gorges and springs including Moremi with large trees and lush vegetation and waterfall, which attracted people to settle nearby. The Moremi community, through the assistance of Kalahari Conservation Society, is in the process of establishing the Moremi Gorge Conservation area, which seeks to preserve the gorge and its unique habitat.

Also important are several colonies of cape vultures. Tswapong Conservation Trust was initiated with the aim of helping the communities to benefit from the rich natural and cultural heritage of the Tswapong Hills. Plans are being made to have this part of the Tswapong Hills declared a natural heritage area. There is also a proposal for a nature reserve at Bonwalenong on the western side of the Tswapong Hills for protection of the largest cape vulture-breeding colony in Botswana. The Gootau community has proposed the establishment of the reserve as part of a community-based effort. Three other breeding colonies and seven roost sites and the rock paintings in the neighbourhood make the Hills

the appropriate site in the country for conservation of this endangered species. Variety of prehistoric, historic and natural features makes the Hills unique and ideal for development of tourism and public education.



General Location of the Study Area



LEGEND

- Main River
- Tarred Road
- Gravel Road
- Railway Line
- Power Line
- Veterinary Cordon Fence
- Drift Fence
- North-South Carrier Water Pipeline
- Proposed Lotsane Dam
- Lotsane Dam Catchment Area
- Proposed Moremi Gorge Conservation Area

Landuse

- Freehold Farms
- Mining Lease
- Pastoral/Arable
- Power Station
- Cattle Ranch
- Wildlife Conservation Area
- Village

N

Scale 1 : 750 000

5 0 5 10 15 20 25 30 35 Kilometers

FIGURE 2.8

Regional Land Use of the Lotsane Catchment

Source: Department of Surveys and Mapping Topographical Sheets 23 and 24 (1 : 250 000)
MoA National Landuse Map (1 : 1 000 000)
Landsat 7 Image

Note: Village hierarchy and classification adopted from National Settlement Policy (1998) and Central District Development Plan 5 : 1997 - 2003

Projection: Transverse Mercator, Clarke 1880, Zone 35

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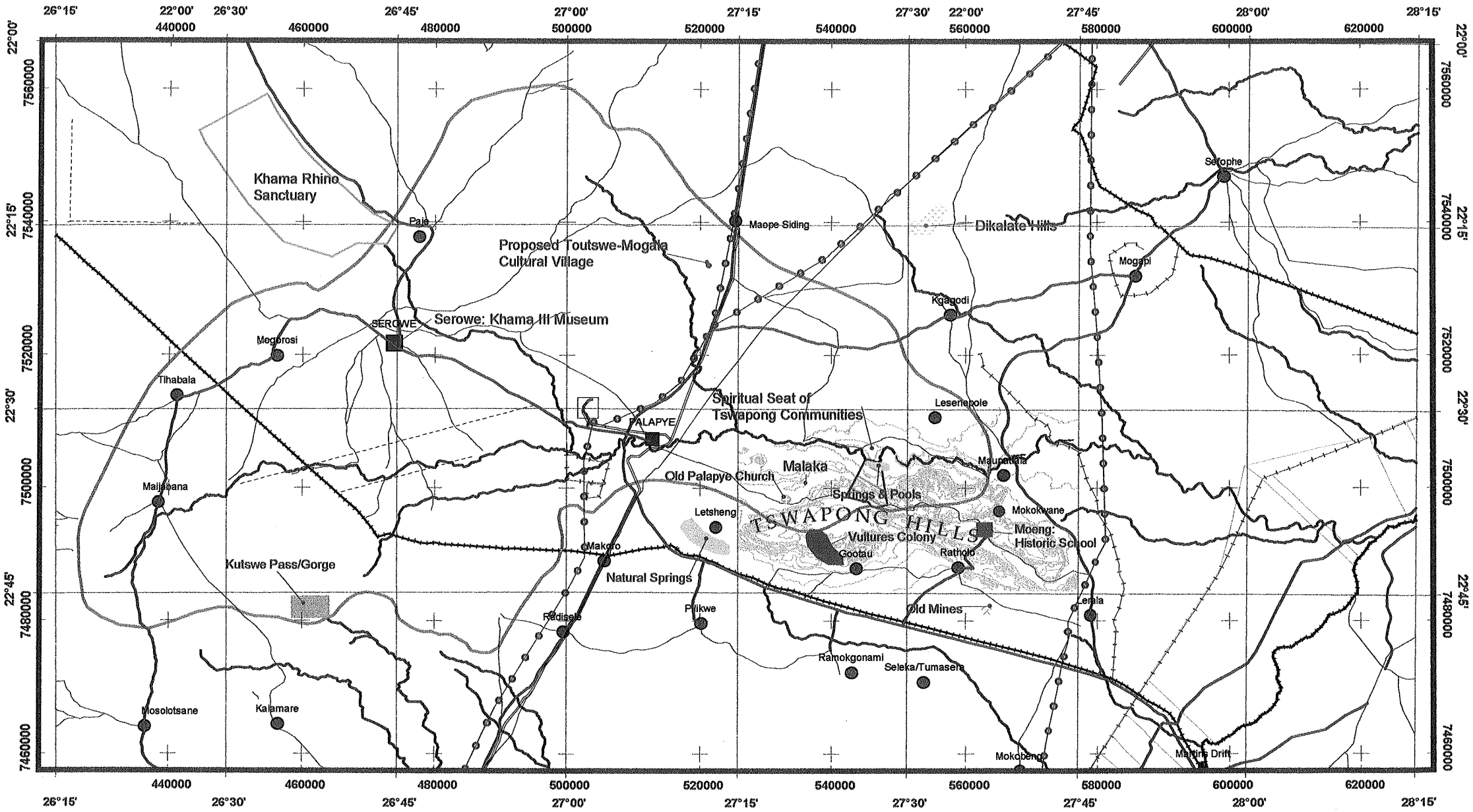
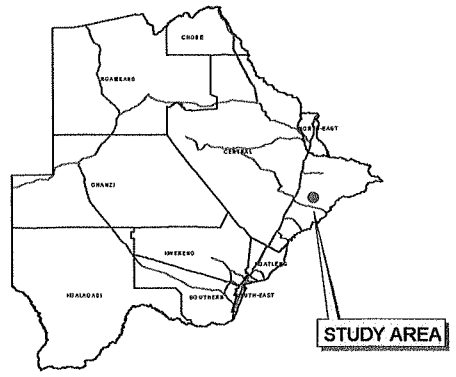


Source: Department of Surveys and Mapping Topographical Sheets 23 and 24
Landsat 7 Imagery

Projection: Transverse Marcater, Clarke 1880, Zone 35

Note: Village hierarchy and classification is from National Settlement Policy and Central District Development Plan 5 : 1997 - 2003

General Location of the Study Area



LEGEND

- Primary Settlement
- Secondary Settlement
- Tertiary II Settlement
- Border Post
- Main River
- Contours (V.I. = 25 ft)
- Tarred Road
- Gravel Road
- Railway Line
- Power Line
- Veterinary Cordon Fence
- Drift Fence
- North-South Carrier Water Pipeline
- Proposed Lotsane Dam
- Lotsane Dam Catchment Area
- Proposed Moremi Gorge Conservation Area

N

Scale 1 : 750 000

5 0 5 10 15 20 25 Kilometers

FIGURE 2.10

Location of Areas of Special Interest Within The Vicinity Of The Proposed Lotsane Dam

Detailed Environmental Impact Assessment of a Dam on the Lotsane River at Maunatlala

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- *Serowe Area*

In Serowe area are a number of monuments that are already of interest to tourists and school groups, namely the Khama Rhino sanctuary, Khama III Memorial Museum with its historic buildings, the Serowe Kgotla and the royal cemetery, Sokwe Forest and the Phineas McIntosh House. The house has historic value because of the famous flogging of its owner by Tshekedi Khama, leading to the banishment of the chief. The house is being restored and will be used as a youth centre.

- *Khama Rhino Sanctuary*

The Khama Rhino sanctuary, a wildlife reserve in Serowe encompasses 4,300ha centered on Serwe Pan. By 2000 eight white rhino have been successfully translocated to the sanctuary and this number is increasing due to natural breeding. Plans call for the introduction of Black rhino and other animals indigenous to the area. While the sanctuary was originally established for the protection of Botswana's remaining rhinoceros, it also contains a variety of other introduced species including Gemsbok, Hartebeest, Impala, Springbok, Giraffe, Eland and Zebra. Other species resident in the area such as leopard, kudu, brown hyena and duiker have settled naturally. Over 230 species of birds including a variety of raptors have been identified within the sanctuary. As an established tourist attraction, the sanctuary provides camping facilities and other amenities required by tourists.

- *Khama III Memorial Museum*

The museum is housed in the old residence of Tshekedi Khama, and is the regional museum for the Central District. The house itself is a historic building and permanent exhibitions about the Khama family and the Bamangwato form the core of the museum. The museum is a public Trust funded by Botswana Government. It is an established tourist attraction.

- *Sokwe Forest*

This is a unique forest in the area and has various types of plant species. The site is proposed for development of a small herbarium.

- *Palapye Area*

The capital of the Bamangwato between 1889 and 1902 was situated at Old Phalatswe and the historic London Missionary Society Church (Thataganyana) still stands and many house foundations can be found here. The old LMS mission comprises a number of Victorian buildings, which are now in a serious danger of collapse and a hill with a prehistoric ritual site with depressions and slides. Old Phalatswe offers a good tourism potential. However there has been some obstacles to the development of the site as the United Congregational Church of South Africa (UCCSA) , the claimant of ownership of the church would not permit

the development of the site. Father Marek who has been interested in developing Old Phalatswe church has now been transferred and there are indications that the issue will now be pursued with the National Museum acting in an advisory capacity, especially through its natural History Division (CDILUP, 2000).

2.2.4.3 Mining and Quarrying

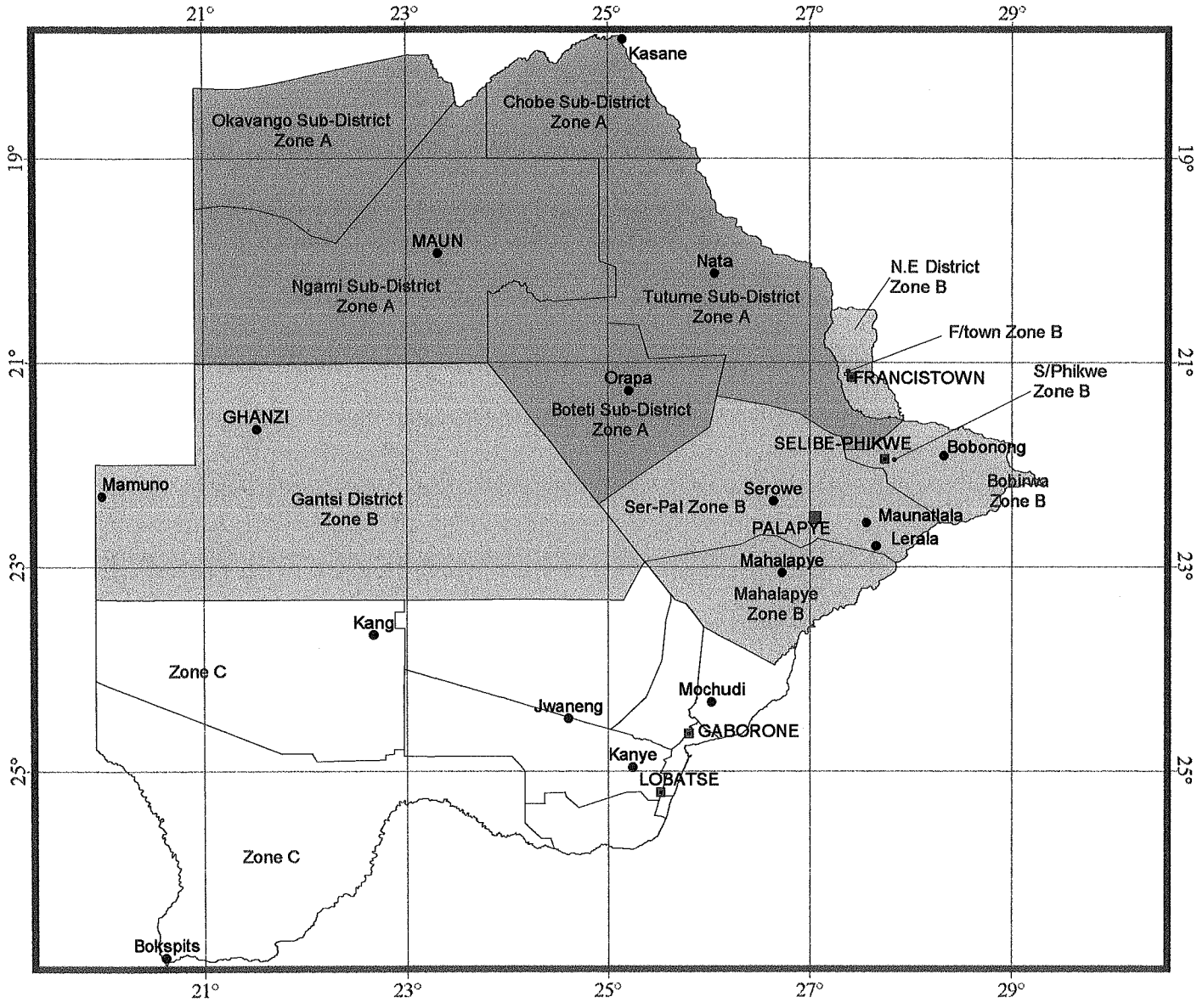
The industrial activity of the District is firmly based on mineral extraction. Important occurrences include coal in the Palapye-Serowe area. Extensive, though low quality coal deposits are mined underground at Morupule near Palapye. Current production of coal at Morupule stands at 900 000 tons per year. Minor occurrences include calcrete suitable for lime manufacture in the Serowe area, magnetite and manganese in south east of Palapye. Plans to mine lime calcrete south of Palapye for making cement are being discussed. Coal and fly ash from Morupule would be used in this process. The mining activities are critical considering their pollution potential.

2.2.5 Relocations and Compensation Issues

The 1991 EIA study indicated that the dam itself would have no effect on arable lands, although there were indications that allocations for Lesenepole residents had started in the valley bottom, an area that would be inundated as well. It is therefore possible that arable farming has since encroached into areas likely to be under dam water. The same EIA study documents more drastic disruption of arable production in the area east of Maunatlala earmarked for irrigation agriculture. This area was found to be one of the major arable production zones for the project population. The study recommends allocation of alternative arable land plots to affected households in an area about 12 kilometres northeast of Maunatlala.

2.2.6 Prevalence of Diseases

The proposed dam site falls within an area referred to as the desert fringe of malaria, an area where the malarial vector is present but with shorter periods of transmission. The Manual for Health Workers in Botswana, Epidemiology Unit has classified the country into three zones depending on the incidences and prevalence of malaria. The project area is therefore classified under zone B, an area of where malarial cases are non-endemic but significant (see figure 2.7). As far as bilharzia is concerned, there are isolated pockets in the country within which its vector occurs but the *schistosomiasis haematobium* (urinary disease) is presently endemic in the Lotsane catchment. Species of the snail *Bulinus* have been found in the Lotsane river valley and the incidence of diseases could potentially increase if conducive atmospheres are availed (ARUP Botswana *et al*, 1991).



Data Source: Manual for Health Workers in Botswana
Epidemiology Unit CHSD Ministry of Health Botswana

LEGEND

- Main Project Centre
- Main Centre
- Other Village
- Endemic areas with marked increase in malaria transmission
- Non-endemic areas with significant malaria cases
- Non-endemic areas with sporadic malaria cases

N

50 0 50 100 150 200 Kilometers

FIGURE 2.11

Malarial Distribution

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2.3 Archaeological and Anthropological Aspects

The archaeology of eastern Botswana has been well documented in a number of studies. Denbow(1986) initiated research in the area documenting over 300 sites in the Serowe-Palapye area. Research by Kiyaga-Mulindwa (1993), Segobye (1994) and more recently Reid (1999) has also documented additional sites, which are associated with the Zhizo tradition, the Toutswe tradition and the Zimbabwe tradition. Most of these sites are located on hilltops and kojpes in the area. A survey undertaken by the Archaeology Unit of the University of Botswana recorded some sites in the Lotsane valley towards the Tswapong hills, which included historic settlements of Batswapong.

The most detailed archaeological study was carried out by van Waarden, which formed part of the preliminary design project environmental impact assessment (ARUP Botswana, *et al*, 1991). The study recorded sites in Lotsane river drainage system ranging from Middle Stone Age sites to recent historic villages. An Early Iron Age site was surveyed and a plan of the site produced. The site had middens and stonewall features suggesting that it was a village. A relative date of c. 6th century AD was established on the basis of pottery affinities with the dated site of Maunatlala (van Waarden 1991).

Though the presence of these sites has been established, the chronology and details of most of these sites remains unknown. This is because only a few have been subjected to detailed archaeological research, which can provide us with a detailed occupational sequence.

An archaeological investigation was undertaken which documented a number of sites in the area. These sites range in age from the Early Stone Age to recent historic settlements. It is therefore important that some salvage work of some of them be undertaken to prevent permanent loss of information.

3 SALIENT ENVIRONMENTAL ISSUES

The 1991 Environmental and Social Impacts report (ARUP Botswana *et al*) as well as the consultations currently on-going and the preliminary opinion survey results highlight significant environmental issues that the current EIA study needs to address. Some of these issues are more relevant to the on going detailed engineering component of the project and as such need to be considered in the final engineering designs. A discussion of these issues with respect to the different environmental phenomena is presented below. Moreover, a summary of potential environmental impacts of the proposed dam development as per the 1991 report is presented in tabular form and is appended (appendix 3.1) to the report.

3.1 Biophysical Issues

3.1.2 Water Resources Issues

o *Recharge in dam areas:*

The presence of a permanent water body will promote infiltration to the underlying alluvium in the area. This effect of increased recharge will be restricted mainly to the alluvial aquifer within the vicinity of the reservoir. However, recharge to localized aquifers induced by the reservoir will over time decline because of a seal on the floor produced by siltation. There is need therefore for the current study, as per the previous EIA 's recommendations look into the rate and nature of such siltation and the implications therein.

o *Downstream Water Availability*

There are indications that the population of the project area is growing exponentially. This would not only increase household demand for potable water, it would also necessitate the provision of additional water-demanding social facilities in the medium term and water for livestock use. According to both the ARUP Botswana *et al* report and the consultations with the village elders at Maunatlala (wards headmen, members of the Village Development Committee and Village Extension Team) a sizeable number of people and livestock at present are dependent on water from water pools in the Lotsane river and hand dug wells within sand aquifer and the flood plain alluvial deposits. If water is curtailed by the dam development with limited amounts allowed to pass via a spillage, the availability of water downstream of the dam will be reduced as far east as its confluence with Tshokana River. The 1991 study posits that although there will be some replenishment from localised rainfall and minor tributaries an additional security of water supply for both people and livestock should be provided.

o *Alternative Water Provision*

As discussed above, the 1991 study indicates that localized rainfall and minor tributaries would replenish natural losses and allow continued minor abstraction from the river but would require backup during prolonged drought periods. In view of the fact that both the human and livestock populations have increased since 1991, there may be need to reassess the situation to see if alternative abstraction techniques for the provision of additional water are not necessary.

3.1.3 Water Quality

o *Eutrophication*

A permanent water body in the area is likely to trigger and or exacerbate environmental problems particularly in relation to water quality. Eutrophication, i.e., the enrichment of a water body with plant nutrients, usually phosphates and nitrates, can lead to the excessive growth of aquatic plants and result in ecological instability and consequent adverse effects on water quality. The inception report (Geoflux and WMB, 2001) emphasised the importance of this concern, necessitating: -

- A detailed assessment of woody biomass characteristics in the catchment area, and,
- paying particular attention to the inundated area and the feasibility/ necessity of clearing areas.

If it goes unchecked, eutrophication could have far reaching consequences on the possibility of provision of potable water as water treatment costs may render the project uneconomically viable (ARUP Botswana *et al* 1991).

o *Effects of Land Uses*

Closely linked to the above issue is the effect of land use on water quality. The main concern here is with respect to the availability of nutrients and agrochemicals. Livestock manure and indiscriminate disposal of chicken litter and semi-treated or untreated sewage in main centers upstream of the dam are potential major sources of nutrient inputs. According to ARUP Botswana *et al* (1991), the Lotsane catchment area is characterized by high soil erodibility and as such sedimentation should be considered a potential threat to the life of the dam as well as to the water quality. An assessment of the contribution of nutrient inputs from land uses within the catchment area – and the identification of workable mitigation measures to limit sediment/nutrient inputs to the reservoir is critical to this study.

o *Water Quality Predictions*

Apart from the need to investigate the importance of the existing woody biomass in determining the potential water quality conditions, which ultimately develop in the dam, there is also a need to look at the potential for existing, and future, land uses impacting negatively upon water quality. ARUP Botswana *et al* identified agrochemicals as a concern, particularly if small-scale irrigation is to be developed, whilst the potential contamination risks from livestock watering and dryland farming, via nutrient deposition and soil erosion, also need to be assessed and where possible, mitigated.

Recently, there has been an increase in the number of small scale poultry projects that are typically characterised by poor waste management practises particularly with respect to disposal of the chicken litter. It is likely that some of these projects or farms are located within the vicinity of active streams in the catchment, hence may pose a pollution threat to the dam.

A preliminary field visit to the area has already highlighted the importance of heavy grazing by domestic stock in causing soil erosion, particularly in the mopane bush/tree savanna areas, which as a result of grazing impacts can be heavily dissected. The overgrazing invariably exacerbates soil erosion and hence increased sediment deposition in the dam.

Livestock access to the dam, following inundation, particularly in the soft sediments of the drawdown zone, are likely to pose a hazard to domestic stock, which may become entrapped in the soft mud around the dam margins.

ARUP Botswana et al emphasise the need to control sewerage, through the provision of septic tanks or latrine systems, to avoid contamination of the local water supplies. A factor they identified to be of significance for future developments in the reservoir basin and also for existing settlements and the proposed construction camps.

3.1.4 Development of the Reservoir Resource

- ***Fisheries***

By virtue of being the only large body of water is a semi-arid area, the reservoir may provide opportunities for the development of fisheries and recreational activities provided the irrigation project requirement does not result in the reservoir water being drawn down to a two metre maximum level (ARUP Botswana, *et al* 1991). The local people could take a cue from the Shashe dam cases where some people earn a living through fishing. This would help diversify income-earning activities in the area.

- ***Tourism and Recreation***

The natural scenic attractiveness of the entire region packaged with a permanent water body will enhance and diversify the tourism potential and resource in the region respectively. There are tourism oriented community based projects initiatives in the region, which include the proposed museum at Old Palapye, a conservation and religious area near Moremi and an indigenous forestry project at Mokokwana. All these combined with the potential for sailing, boating, bird watching, hiking and recreational fishing that could come with the proposed dam would turn the Tswapong region into a possible tourist (local and international) destination area. Furthermore, the proposed dam on the Lotsane must clearly not compromise the development of a community based conservation project in the Tswapong Hills to help local people use the area in a sustainable way and develop the hills for tourism and conservation.

3.2 Ecological Issues

3.2.2 Impacts on Vegetation

- ***Loss of Habitat through flooding***

According to the 1991 study, the dam construction will result in flooding of riparian habitats and plant communities most of which were identified as not unique to the area of inundation. However a discrepancy was noticed during the current study's reconnaissance; morukuru- an endangered tree species was found to be present in the area. Morukuru (Spirostachys Africana) is said to be a versatile tree species that according to the Forestry Association of Botswana (FAB) is used by local communities for furniture making, fencing, construction material etc.

Given the 10-year lapse it is important for the current study to assess the extent of morukuru (Spirostachys Africana) and the presence of other endangered species that could possibly be in the reservoir area and come up with ways of ensuring their preservation. As for medicinal plants and veldt products such as grewia flava, the preliminary opinion survey findings tend to concur with the 1991 report in as far as their well representation through out the region is concerned.

ARUP Botswana *et al* (1991) raised particular concern over the ephemeral nature of flows in the Lotsane River and the relatively shallow nature of the alluvium deposits, features that in combination were likely to restrict the recharge characteristics of the 'sand river' aquifer. As a result considerable detrimental effects could be experienced downstream following the restriction in recharge, perhaps extending as far down as the confluence with the first tributary, the Tshokane (ARUP Botswana *et al* (1991). The study emphasised the impact upon downstream water users, namely those with shallow wells sunk in the alluvium, which are used as watering points for nearby cattleposts. This concern remains of primary importance and needs to be further evaluated in the field.

The impact on the downstream riparian communities is also an area of concern, particularly as the concept of controlled release is not considered appropriate (ARUP Botswana *et al*, 1991). The field investigation of woody biomass, should therefore extend to a description of the downstream riparian communities in order to evaluate the potential significance of reduced recharge in the sand aquifers on these communities. The nature and condition of the riparian zone should be assessed and form as an effective 'baseline' for the monitoring of possible future impacts.

- ***Fuelwood***

The construction of the proposed dam at Maunatlala will disrupt the existing pattern of firewood collection by Maunatlala residents. The loss of the inundated area will necessitate that residents find alternative sources of fuelwood, e.g., the fragile Hill slopes, etc. The population increase as of 1991 would probably intensify the extent of impact as the majority of people use wood for their energy requirements. The firewood supplies for the villages of Moremi and Matolwane will not be impacted as much as that for Maunatlala where alternative supplies may have to be sourced.

- ***Construction Materials***

Most of the people in the project area rely on the natural vegetation for construction materials, these include support and roofing poles for houses, fencing poles, thorn bush fences, bark and thatch. Long straight *C. mopane, Terminalia sericea* and *morukuru* are some of the poles required for house and fence. During the feasibility study, several stands of *C. mopane, A. grandicormuta* and *A. nigrescens* were identified as part of the vegetation that is going to be flooded when alluvial terraces and riparian fringes are inundated. However no grass species suitable for thatching were found within the inundation area. The current study will have to ascertain whether the situation with respect to the degree of impact on the availability of construction resources is still the same.

- ***Other Valuable Plant Species***

A high density of medicinal plant species is said to be centred within the riparian wooden fringe, which is going to be inundated with water. Traditional doctors based in Maunatlala who currently exploit the riparian vegetation for medicinal plants will have to source their resources somewhere. According to the 1991 report, almost all the medicinal plants found in the area of inundation are available elsewhere in the Tswapong area; therefore, the dam will affect proximity of resources rather than their availability. The EIA study will have to look further into the issue of availability lest traditional doctors lose their important resources with no alternatives made to ensure their preservation.

The riparian zone and vegetation communities that flank the river channel do contain a diverse array of veld foods, which are known to be of value to the local communities. However, for the berry and fruit species concerned, there are unlikely to be any habitats along the river that could be considered unique – this will be checked during the more detailed biomass field survey. Hence, although their abundance and availability will be decreased by inundation, they will still be available locally. Indeed, such losses must be considered against the opportunities and improvements the dam will bring, including the development of small-scale fisheries and the possibility of the increased use of fresh fish in the household diet.

3.2.3 Faunal Issues

- ***Mammals***

The invasion of the proposed project area by human settlement and livestock has resulted in the marginalisation of large mammal populations. Therefore the dam development is not expected to cause any discernable impact on large mammals. Migratory wild ungulates such as wildebeest *(Connochaetes taurinus)* and hartebeest *(Alcelaphus buselaphus)* have perished and are now excluded from the area by fencing. Elephants (*Loxodonta africana)* are not reported to occur in the area, although the possibility of small groups of bull elephants finding their way to the proposed dam should be investigated further.

However, the loss of riparian habitats due to flooding will result in the displacement of some small mammals viz: monkeys, squirrels, mice and other rodents, hares, mongooses etc. The main impact of the proposed dam development that is likely to be felt by local mammal populations is that of habitat changes. The overall habitat changes due to reduced sand river aquifer recharge downstream is likely to cause the displacement of some mammal populations, especially those dependent on sand river water sources during the dry season. The displacement of both livestock and small mammals from the riverine forage is likely to result in increased pressure on upland sites currently used to a lesser degree with wildlife.

- ***Birds***

Observation has been made that the proposed dam and reservoir will indirectly impact negatively on bird life in the project area. The envisaged indirect impacts will manifest themselves mainly through increased human activity and disturbance during the construction phase. Birds accustomed to nestling in the riparian woodland will be displaced by reservoir development. Some of the seasonal species may be encouraged to reside permanently in the area due to the presence of a permanent water body. Moreover, vulnerable species such as the Cape vultures are likely to be disturbed by the noise during construction phase of the project. The disturbances may disrupt the ecological patterns of birds especially during the breeding season.

The impacts of greatest concern undoubtedly surround the construction phase of the project, which has considerable potential to disturb the Cape Vulture colonies and the nesting sites of other locally rare cliff nesting birds. In particular the study should therefore consider the following:-

i. The siting of the quarry must receive careful consideration and the disturbance (noise and dust) from quarrying must be carefully regulated,

ii. blasting operations if necessary, must be kept to a minimum and mitigated effectively (i.e. frequency, timing and duration need careful consideration)

iii. noise disturbance and habitat disruption from road and pipeline construction must be effectively mitigated through design, construction and operation phases.

iv. Construction camps and activities related to the influx of workers/settlers must be carefully monitored and adverse impacts avoided by the optimal location of camps, waste dumps, borrow pits, vehicle parking areas etc, away from hills complex.

Consultations with the members of Bird Life of Botswana have raised concern over the potential impacts the irrigation scheme is likely to have on the bird life of the project area. According to Bird Life of Botswana, wetland farming such as the proposed irrigation scheme tends to attract birds especially the *quelea*. The study should therefore, consider the feasibility of other irrigation methods, e.g., micro-jet drip system, other than aerial spraying.

o ***Fish***

The proposed dam development at Maunatlala, could result in the increase in numbers and diversity of fish and other aquatic species in the area. However, the water impoundment could limit sand river aquifer recharge and thereby negatively affect aquatic fauna downstream as the extent of seasonal pools in the river bed would be reduced. According to the Fisheries Section of the Ministry of Agriculture, the Limpopo River system has about 250 fish species some of which could be lost due to flow reductions resulting from existing and proposed dams. Another potential impact on endemic fish species could result from the introduction of non-indigenous species for fisheries development. The current study should therefore come up with measures that could mitigate against the loss of fish species diversity.

The dam's location in a shallow open area, could present problems relating to excessive water temperature fluctuations and even the complete drying out of the water body, which affect the fishery potential of many of the country's shallow dams. This potential will be evaluated further in the next stage of the EIA, although it should be emphasised that due to the dense woody biomass the use of gillnets could be precluded, whilst fishing activities if

permitted, must not disturb the Cape Vulture colonies, such that permissible fishing areas may have to be zoned.

o *Reptiles and Amphibians*

The flooding of the riparian vegetation will result in habitat loss for the reptiles and amphibians presently occupying the riparian woodland and fringes of the Lotsane riverbed. The feasibility study did not find any rare species among the amphibians likely to lose their habitat. The presence of a permanent water body could attract other reptiles not currently present in the area. For example, crocodiles that apparently occur as far as down stream of the dam as at the confluence between the Lotsane and Limpopo Rivers could be attracted to the reservoir (ARUP Botswana *et al*, 1991).

3.3 Socio-economic issues

Several issues relevant to the socio-economic impact assessment emerge from this review and these issues specifically relate to the demographic, socio-economic, relocations and compensations, agricultural and other land use issues and public health matters.

3.3.2 Agricultural Issues

o ***Loss of Arable land in the reservoir area.***

In spite of the general unsuitability of the soils and topography in and around the proposed reservoir area some people have been allocated land for cropping in the area. According to ARUP Botswana et al there were no existing cleared fields for arable farming in the inundation areas at the feasibility study phase and this is consistent with what some of the interviewees said during the opinion surveys. This is further collaborated by the recent satellite imagery acquired for the current study, which clearly show no evidence of arable farming within the reservoir basin area. However, this does not preclude the presence of undeveloped arable fields. In view of the 10-year lapse it is advisable for the current study to investigate the situation with the help of the Land Board officials and the Lesenepole/Matolwane local authorities to establish whether land allocations for arable farming have been made in the area.

o *Loss of Grazing Land*

According to the 1991 report, loss of grazing was found to be the most significant negative effect of the dam for the local population. The report stated that, the proposed dam development would result in more grazing land (about 1000ha) for Matolwane cattle-keepers being lost due to inundation. A few cattle-keepers from Maunatlala will also lose their grazing land. This loss of land will result in increased stocking rates and pressure on existing grazing land elsewhere. The dam development will also impact on the existing seasonal movement of cattle from the cattle-posts to the land during the ploughing season as

well as make the Tswapong hills inaccessible to the cattle from Lesenepole especially during droughts. According to the Maunatlala villagers, grazing in their area is restricted by the presence of a poisonous shrub- *mogau*, which kills both cattle and goats.

The proposed irrigation scheme would not impact on livestock production as animal access is already restricted by the presence of fenced fields and drift fences that separate grazing and arable areas. The project's impacts on both the arable and livestock sub-sectors identified by ARUP Botswana et al would need to be thoroughly up-dated and verified during fieldwork under the current study.

3.3.3 Compensation and Relocation Issues

- ***Loss of Dwellings, Cattle posts, and other Structures***

At the time of the feasibility study, the old Lesenepole and old Raphiri residents had already relocated to Matolwane to facilitate efficient provision of social services and amenities by the Government. The study noted that there would not be any displacement of people from their main homes, as the area of inundation is currently not permanently settled. Loss of structures will therefore be minimal as in 1991 there were only 4 cattle-posts, 7 compounds and a few other structures. The presence of any more dwellings or structures would have to be verified by field work as it is possible that some people could have relocated to old Lesenepole and old Raphiri sites.

- ***Compensation and Relocations at the dam site***

ARUP Botswana *et al* (1991) observed nil or minimal compensations is required for land allocate for arable use at the dam site. At the time of the feasibility study most of the land allocated for arable farming had not been developed in which case they would need suitable land replacement and not compensation. This tallies with the observation on the recent satellite imagery and the opinion surveys recently carried out at Maunatlala. Both the dam and the proposed irrigation scheme would necessitate relocation and compensation and where compensations are needed normal compensation procedures will be followed using the Ministry of Lands, Housing and Environment's Compensation Guidelines for Land Boards and District Assessment Committees.

- ***Access to Water***

The preliminary findings of the opinion surveys tend to concur with the 1991 report on the issue of the reasons for dam acceptance by the local people. Most of the local people assume that their livestock would drink freely at the lake shore. Most of the livestock at Matolwane get permanent water from natural perennial springs in the Tswapong Hills e.g. the

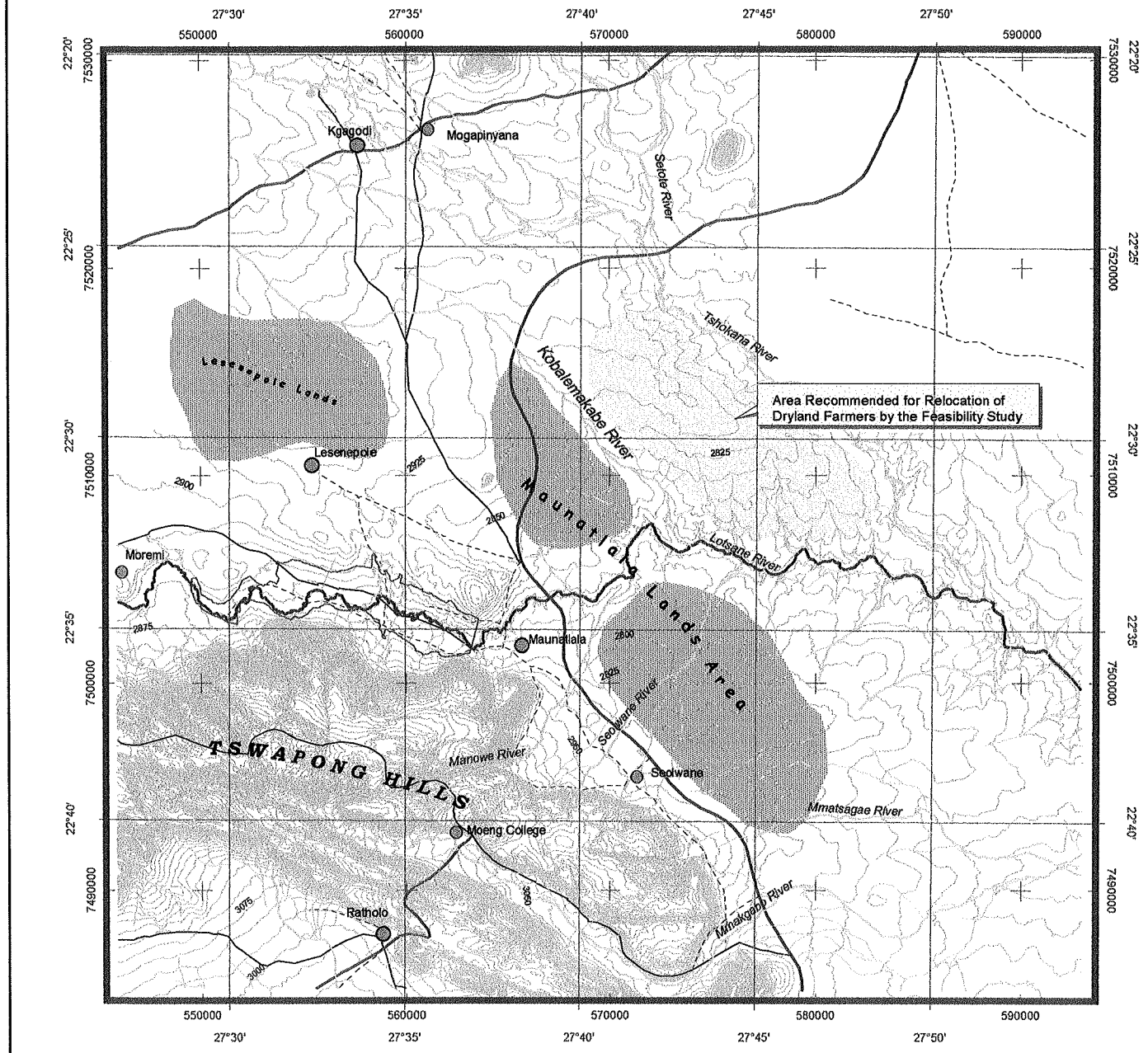
Tshawewele stream at old Lesenepole. The reservoir may result in the loss of such resources and alternatives may have to be sought. However, a Focused Group Discussion with the village elders (wards headmen), members of the Village Development Committee and Village Extension Team) holds a different view. The afore mentioned group feels that provision of an agricultural dam as a mitigation measure will only serve to encourage livestock keeping in or near villages contrary to the Government's initiative to encourage people to move their livestock away to designated pastoral (cattleposts) areas. It would therefore be very interesting for the current study to find out the views of other people in an open Kgotla forum where the two conflicting views can be debated. While the general consensus among the communities may be that access to lake water be made possible for livestock, the EIA study should seek and propose effective mechanisms for a sustainable arrangement.

- ***Displacement of Dry-Land Farmers***

About 50-70 dry-land farmers would be displaced should the proposed irrigation scheme proceed. The feasibility study identified Kobalemakabe as an area where dry land farmers could be relocated (Figure 3.1). However, Kobalemakabe is currently used mainly for cattle grazing. Furthermore, there is need to verify whether the soils will be conducive for dry-land arable farming. The other thing about Kobalemakabe according to the 1991 report is lack of water, as the Kobalemakabe stream does not provide a dry-season water source. The current study will have to establish through District Land Use Planning Unit (DLUPU) and the concerned people whether people should be relocated to Kobalemakabe or be allowed to identify pieces of land where the Land Board could allocate them. Furthermore, the study should recommend alternative ways of providing water to the displaced farmers.

- ***Socio-economic Situation of Dry Land Farmers***

Most farmers in the proposed irrigation area seem to be of the general farming population of Maunatlala, representing a mix of standards of living (ARUP Botswana *et al* 1991). Therefore very few of them can afford labourers to assist with weeding, harvesting and threshing; otherwise it is the women responsible for the farm work. The disproportionate representation of women in the population would require that their input in the EIA process is deliberately solicited, and that benefits accruing from the project reach them (including employment and involvement in irrigation agriculture).



LEGEND

- Tertiary II Settlements
- Tertiary III Settlements
- Main Road
- Secondary Road
- Tracks
- Main River
- Major Stream
- Other Streams
- Contours (V.I = 25 ft)
- Lotsane dam
- Existing Arable Lands
- Possible Relocation Area

N

Scale 1 : 300 000

2 0 2 4 6 8 10 Kilometers

FIGURE 3.1 Location of Arable Lands and Possible Relocation Area

Detailed Environmental Impact Assessment of a Dam on the Lotsane River at Maunatlala

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3.3.4 Land Use and Land Capability issues

- *Upstream activities*

Influence over the upstream land use activities and the catchment area is of significance to the reservoir system in trying to ensure the long term quality of the water body, as the quality of water entering the reservoir is dependant upon land uses in the catchment and upstream.

- *Downstream activities*

The downstream arable activities and other uses might also be impacted by the proposed development; it is therefore pertinent for the current study to determine the nature of activities downstream and the impacts that might result.

- *Areas of inundation*

Although there will be no displacements of settlements, that is, according to ARUP Botswana *et al* (1991) it is critical to consider land use in the vicinity of the area of inundation as this can lead to loss of grazing land and degradation of upstream catchment areas. If more land is inundated the cattle keepers of Matolwane would be seriously affected and loss of land would increase pressure on grazing elsewhere. The cattle keepers of Matolwane are using common grazing land. Issues of relocation and compensation for loss of grazing land need to be considered.

- *Land suitability and capability*

The current study should seek to determine the suitability of the current and envisaged land use practices in the project area. However the existing uses must be supported, where conflict between land capability and present use occurs, the study should recommend a process towards the best suitable use without adversely affecting the resident population, that is, taking into account the socio-economic considerations and the sustainability of the second best alternatives.

- *Land use intensity*

The potential of an area with regard to the intensity of use that it can support should also be explored. For example if different intensities of the same type cannot co-exist within one land use zone (high intensity tourism versus wilderness camping).

- *Multiple Land uses*

The study should consider the feasibility of more than one secondary unit (activity) within a zone, depending on the land capabilities. A zone can have a primary use and where

appropriate several secondary uses can be defined. In accordance with the inception report, mixed farming is a recognised land use in its own right, and indications are that this practice is becoming quite common in Botswana as a consequence of families who keep cattle in the village peripheries/margins or at the lands (masimo). In some instances such are small stock farmers who cannot afford cattle posts. The families also engage in arable farming. It is crucial to identify the existence and extent of mixed farming practices in the project area.

3.4 Environmental Health Impacts

According to the Epidemiology Division in the Ministry of Health, the provision of a permanent water body coupled with the right temperatures (warm to hot) and a settled population provide an environment conducive for water borne vectors and diseases that go with them.

3.4.2 Water Related Infections

- ***Water based diseases***

Given that *Schistosomiasis haematobium* (urinary disease) is presently endemic in the Lotsane valley, and that the study area lies in the desert fringe of malarial mosquitoes, where transmission is over a short period, there is likely to be an increase in the duration and prevalence of such diseases. There is concern that the high rates of evaporation and the draw down for irrigation will result in shallow water in the reservoir for up to a year. Unless there is replenishment from the rains most parts of the lake shore will provide suitable habitats for snails vectors of *schistosomiasis*. Measures should therefore be taken to limit aquatic plant growth, which could increase suitability for snail habitation. The daily drop of water levels due to evaporation will help prevent permanent snail populations in the reservoir area. The current study should consider ways of restricting access to the draw down areas and water body so as to prevent human beings from being exposed to diseases.

- ***Water Related Insect Vector Diseases***

The impoundment of water in the Lotsane valley could give rise to outbreaks of various infections not previously recorded in the area and exacerbate those presently limited. Flies and mosquitoes, which breed in water, transmit many infections. It is therefore imperative for this study to look into the possibility of rehabilitating all burrow pits where stagnant water can collect and hence mosquito breeding. As per the 1991 report malarial mosquitoes are said to be active within 1.5Km of suitable breeding ground, which make the reservoir at Maunatlala a much greater malarial risk to the Mauanatlala community. The study should therefore seek for alternative ways of stabilizing soils in the draw down areas other than the planting of torpedo grass that could provide a suitable habitat.

o *Faecal-Oral Disease*

As pointed out in the inception report (Geoflux and WMB, 2001), indiscriminate disposal of waste from sanitation facilities in the catchment area is likely to result in pollution and poor water quality. Other uses such as cattle watering, washing etc could result in diseases such dysenteries, typhoid, hepatitis etc. If the irrigation scheme is going to include the growing of vegetables; increased consumption of vegetables could result in dysenteries from contamination by faecal material in the field from washing using contaminated water. There is need for this study to look into ways of preventing or reducing contamination of the reservoir water for the benefit of the communities in the area.

3.4.3 Public Health Issues

o *Sexually Transmitted Diseases*

Of particular concern as discussed in the Inception report (Geoflux and WMB, 2001) is the influx of construction crews the in the Maunatlala area. This influx could potentially increase the spread of sexually transmitted diseases such as AIDS. According to Maunatlala residents, experience has shown that whenever construction crews come to their village they tend to engage in casual relationships with the local communities. The current study should liaise with the local communities, health teams and try to come up with measures of controlling the spread of STD's during the construction phase.

o *Accidents*

The feasibility report discusses accidents as one of the public health issues. Increased activity in the area and increased traffic movements during the construction is likely to increase the risk of accidents in the area. In addition, should the proposed irrigation schemes proceed, future use of agricultural machinery is also bound to increase the accident rate in the area.

o *Use of Agrochemicals*

Apart from contaminating water supplies, pesticides are also said to result in accidental poisoning or illnesses in personnel involved in handling the chemicals. The proposed irrigation scheme at Maunatlala should therefore take lead from the Pandamatenga commercial farming development where farm workers complained of sicknesses from handling agrochemical without suitable gear.

3.5 Archaeological Issues

The 1991 report presented a fairly comprehensive list of sites recorded in the area. It included detailed mitigation measures required at each locality with a report of the site details, status and cost of work required. The 1991 report focused on the locations of reservoirs, Dam site 4

and Dam site 5 with details of site types and estimated costs for mitigation at each site. However, it is worth bearing in mind that the study is now over ten years old and there is need to review the recommendations made in light of the reality today. A very interesting aspect of the 1991 study was the observation that there was very little systematic research in the Tswapong hills in general and more specifically the proposed dam location. As a result, the development of the dam would have a positive impact of stimulating research and bringing to light archaeological information which hitherto undocumented. Despite the elapse of ten years since this report was published, no detailed archaeological research has been undertaken either by the National Museum or by private researchers in the area of the proposed dam. As a result, the recommendations made in 1991 regarding work to be done prior to the development of the dam are still valid.

To augment the 1991 archaeological information, the current AIA will undertake the following:

- A more detailed and intensive record of archaeological sites
- Interviews focused on the impact of heritage tourism in the area with local communities to ascertain whether the renewed interest in the dam project will affect existing activities or planned ones. This will assist in developing sound recommendations for the third phase of the EIA study, which will principally aim to explore strategies for the future management of the area from an archaeological heritage perspective.
- Focus on sites in the Dam site 4 and Dam site 5 areas recommended for further work in the previous study to provide updated information on the costs of mitigation and scope of work required.

Furthermore, the archaeological component of the study will liaise closely with the ecological research team to harmonise the field research and results presentation in light of the observation that the area has great potential for eco-tourism. A balanced management plan is seen as emerging from such a strategy of synchronising the natural and cultural aspects of the research since they are interlinked as indicated by current patterns of tourist visitation to the area.

3.6 Summary of Potential Impacts

In light of the discussion above, a summary of issues considered key to the study and the envisaged degree of potential impacts on the environment, is tabulated below. The table, which is included as appendix 3.1, gives a brief detail on the identified issues and gives an indication on how such issues will be addressed by the study and or the management plan.

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APPENDIX 3.1: SUMMARY OF KEY ENVIRONMENTAL ISSUES AND HOW THEY WILL BE ADDRESSED

Appendix 3.1: Summary of Key Environmental Issues and How they will be addressed

Issue	Details	Anticipated significance rating of impact	How issue will be addressed
Water Resources: Recharge in Dam area; Downstream water availability; Alternative water provision			
Recharge in the dam area	This pertains to recharge of localised alluvial aquifer and the effect of siltation. The recharge will become less over time due to siltation. However, these aquifers will be within the inundated area therefore not accessible.	The reduction in recharge rates of the alluvial aquifer due to siltation is anticipated to have low impact significance	Not to be further investigated during the Impact analysis stage
Downstream water availability	This applies mainly to the section between the dam and the Tshokana River confluence	The curtailment of flow due to damming is anticipated to have a high impact significance on the following: ➢ Recharge potential of the sand river aquifer ➢ Livestock and domestic water requirements ➢ Riparian habitats	Potential for the significance of sub-catchment up to the Tshokana confluence should investigated. The current usage and dependency on the river by local communities should be investigated. The need for periodic releases should be assessed, particularly during the low flow years.

Issue	Details	Anticipated significance rating of impact	How issue will be addressed
Water Quality: Eutrophication; Effects of Land Uses; Water quality prediction			
Eutrophication	This will largely be a consequence of the excessive biomass in the reservoir basin, which upon decay will result in enrichment of the water body in plant nutrients.	Eutrophication is anticipated to have a high impact significance due; ➢ Excessive growth of aquatic plants resulting in ecological instability ➢ Increased water treatment costs	Detailed assessment of woody biomass characteristics in the reservoir basin area will be undertaken. Consider vegetation clearing in the inundated area (costs and feasibility). This will be undertaken as part of the impacts analysis and management plan.
Effects of land uses	This will largely result from land uses upstream of the dam which may produce potential pollutants, such as, ➢ Livestock manure, ➢ Chicken litter disposal ➢ Semi-treated or untreated sewage ➢ Agrochemicals Soil erosion particularly as a result of intensive land use.	Upstream land uses are anticipated to have a moderate impact significance on the water quality.	Assessment of sediment loads and potential pollution sources will be undertaken during the impact analysis stage.
Water quality prediction	This covers future land uses and their potential to impact negatively on the water quality. Such land uses include;	Uncontrolled usage and access to the reservoir basin is anticipated to have a high impact significance on water	This will be addressed through land zoning and reservoir management plan.

Issue	Details	Anticipated significance rating of impact	How issue will be addressed
	➢ livestock grazing and round the reservoir area ➢ poultry farms located close to the reservoir ➢ unauthorised recreation activities (motor boats, picnics, etc	quality and land degradation.	
Development of the Reservoir: Fisheries, Tourism and Recreation;			
Fisheries	The reservoir may provide opportunity for development of fisheries (recreational, angling, commercial, etc).	Fisheries may have a high impact significance due to: ➢ importation of exotic fish species which result in displacement of indigenous ones. ➢ potential pollution from motorised fishing boats ➢ diversify income earning activities by the local communities ➢ enrich and diversify protein intake of the local community's diet	This will be addressed through reservoir management plan and the necessary guidelines on fisheries.
Tourism and Recreation	This relates to the possibility of packaging the water body with other natural and cultural regional landscape.	Tourism and recreation activities is anticipated to have a high impact significance due;	The study should explore the possibility of pooling all the tourism resources in the entire region and thus turn the

Issue	Details	Anticipated significance rating of impact	How issue will be addressed
		➢ Increase potential for eco-tourism ➢ Increased income earning, especially to the local communities	Tswapong area into a renowned tourist destination.
Vegetation ecology: Loss of habitats; Fuelwood resource; construction timber materials; Valuable plants species			
Loss of habitats Loss of Fuelwood resource, Construction timber material and other valuable plant species	These will largely be a consequence of flooding the reservoir basin. Some of the endangered species such as morukuru, which occurs in the reservoir basin area, will be lost. Other species that includes medicinal and veldt foods are well represented in the region and therefore not threatened.	This is anticipated to have a low impact significance with respect to Fuelwood, construction material and valuable plants. As far as the loss of habitats and the morukuru species in the dam basin, the impact significance is anticipated to be medium to high.	The study should identify alternative areas where the local communities can source fuelwood and construction material An assessment of the extent of morukuru and the presence of other endangered species..
Faunal ecology: Mammals, birds			
Mammals	The loss of riparian habitats will result in displacement of some small mammals, e.g., monkeys, squirrels and other rodents.	This is anticipated to have a medium impact significance.	The study should recommend mitigation measures for preserving the downstream riparian habitats.
Birds	The area, particularly the Tswapong Hills, is endowed with abundant bird species, including raptors e.g., Cape vultures, Black and Booted	The anticipated the impact on birds will be of high significance and will be due to;	An identification of breeding raptor colonies sites, as well as the breeding patterns.

Issue	Details	Anticipated significance rating of impact	How issue will be addressed
	eagles.	➢ Loss of habitats ➢ Displacement due to increased human presence and dam construction activities.	Recommendations on avoidance of the sites as part of the management plan.
Socio-economic issues: Agricultural Issues, Compensation and Relocation issues and Land use and land Capability issues			
Agricultural Issues			
Loss of Arable Land	It appears some people have been allocated land for cropping in the inundation areas	Anticipated impact is minimal as most people were relocated and compensated in the 1970's.	Groundtruthing is required to rule out the possibility of any loss of land for cultivation.
Loss of grazing land	Currently the main land use activity in the proposed reservoir area is grazing mainly by Matolwane and Lesenepole communities.	The envisaged impacts are of high significance due to: ➢ Increased stocking rates and pressure on existing grazing land elsewhere. ➢ Disruption of existing seasonal movement of cattle to lands areas (masimo). ➢ Inaccessibility of Tswapong Hills grazing areas and water sources (springs) during drought years.	Alternative grazing areas should be identified for relocating cattle-posts.

Issue	Details	Anticipated significance rating of impact	How issue will be addressed
Compensation and Relocation: Loss of dwellings, cattle-posts and other structures; access to water and displacement of dry land farmers			
Loss of dwellings, cattle-posts and other structures	This relates specifically to the reservoir basin.	The loss is anticipated to have a low impact significance due to the limited number of cattle-posts in the area.	Fieldwork required to verify the presences of structures that may need compensation.
Access to water	This pertains to the community's desire to water their livestock directly at the lake.	Access to water is anticipated to have a high impact significance that may result in: ➢ Unauthorised dam usage ➢ Compromised water quality ➢ People requiring compensation for loss livestock in the muddy drawdown area.	Communities should be consulted and educated on the need to preserve water quality. Alternative livestock watering points should be identified jointly with the affected communities.
Displacement of dry land farmers	50 to 70 dry land farmers are likely to be displaced arise as result of the proposed irrigation scheme east of Maunatlala.	The displacement will have a high impact significance due to: ➢ Limited arable land in the immediate vicinity. ➢ Relocation to areas that may not be suitable for crop cultivation ➢ Availability of water in the new area ➢ Increased and costly travel distance from respective villages.	The study should assess the suitability of adjacent areas for crop production. The study should consider several options for relocations, i.e., allowing people to relocate to areas of their choice. The study should recommend alternative way of providing water to

Issue	Details	Anticipated significance rating of impact	How issue will be addressed
			the displaced farmers.
Environmental and public health: vector diseases, sexually transmitted diseases (STDs)			
Vector diseases	This covers both waterborne and water related insect diseases, especially schistosomiasis, bilharzias and malaria.	Vector diseases are anticipated to have a medium to high impact significance due to: ➢ Proximity to a settled area (Maunatlala) ➢ Location in the desert fringe areas of malarial mosquitoes. ➢ Snail vectors for schistosomiasis are endemic in the Lotsane River catchment area.	Recommendations pertaining to rehabilitation of burrow pits should be made. Guildelines on access to the water body to be provided by the reservoir basin management plan.
STDs	This relates to the potential increase in the spread of STDs, such as HIV/AIDS, especially during the construction period.	The increase in STDs is anticipated to have a high impact significance.	The study should recommend educational programmes for both the construction crew and villagers by health authorities and the Contractor(s).
Archaeological issues; Loss of cultural resources; salvage costs			
Loss of cultural resources	This pertains archaeological sites identified in the reservoir area, which will be inundated.	The loss of these sites is anticipated to have a high impact significance.	
Salvage costs	These costs are likely to be high at the current dam site, where numerous archaeological sites are known to occur.		

Issue	Details	Anticipated significance rating of impact	How issue will be addressed
Visual Disturbance: Burrow pits and rock quarries; Dam wall			
Burrow pits and rock quarries	This provides construction material for the dam and other facilities, e.g., treatment plant foundation, access road, pipe line trenches.	It is anticipated that rock quarries will have a high impact significance due to ➢ The disturbance of raptors residing in the Tswapong Hills. ➢ Exposed quarry faces on the hillside. Most burrow pits will be developed with the reservoir basin; therefore low impact significance is anticipated.	The environmental management plan should recommend measures for complete rehabilitation of all quarries. The impact analysis should appraise and evaluate alternative quarry sites. Guidelines on topsoil and Fuelwood harvesting to be developed by the environmental management plan.
Noise and dust nuisance			
Noise and dust nuisance	Construction activities (drilling, blasting, excavation, loading, material haulage, etc) is likely to result in increase noise and dust levels in the area	The nuisance factor associated with the construction activity is anticipated to have a low to medium impact significance.	The mitigation and management guidelines aimed at effective noise and dust abatement should be developed.
Construction water supply: Water source			
Water source	The available sources in the Tswapong region are limited and under considerable pressure. Therefore the water requirement for construction usage will further exacerbate this problem.	In view of the limited resources, it is high impact significance is anticipated, though short termed.	An appraisal and evaluation of alternative sources should be carried out.