Republic of Botswana

DEPARTMENT OF WATER AFFAIRS

Detailed Environmental Impact Assessment (EIA) Study for Botlhapatlou Groundwater Exploration and Wellfield Development Project

Tender No. PR 10/3/1/08 (II)

FINAL REPORT

November 2012

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DETAILED ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY FOR BOTLHAPATLOU GROUNDWATER EXPLORATION AND WELLFIELD DEVELOPMENT PROJECT	
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LIST OF ACRONYMS

AIA	Archaeological Impact Assessment
AVC	Alive Vegetative Cover
BDF	Botswana Defence Force
Bh	Borehole
BGEWDP	Botlhapatlou Groundwater Exploration and Wellfield Development Project
BPC	Botswana Power Corporation
BTC	Botswana Telecommunication Corporation
CSO	Central Statistics Office
DEA	Department of Environmental Affairs
DEM	Digital Elevation Model
DGS	Department of Geological Survey
DLUPU	District Land Use Planning Unit
DMS	Department of Meteorological Services
DTRP	Department of Town and Regional Planning
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EIS	Environmental Impact Statement
GIS	Geographic Information Systems
GOB	Government of Botswana
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
IAPs	Interested and Affected Parties
ITCZ	Inter-Tropical Convergence Zone
KDC	Kweneng District Council
KDSS	Kweneng District Settlement Strategy
MMEWR	Ministry of Minerals Energy and Water Resources
na	not available
NSC	North-South Water Carrier
NSP	National Settlement Policy
NDP	National Development Plan
NGO	Non- Governmental Organisation
NWMPR	National Water Master Plan Review
pa	per annum
PAM	Project Activity Matrix
RAC	Rural Administration Centre
RFP	Request for Proposals
RIAM	Rapid Impact Assessment Matrix
RNPRD	Revised National Policy on Rural Development
TDS	Total Dissolved Solids
TOR	Terms of Reference
VTC	Vocational Training College
WAB	Water Apportionment Board
WHO	World Health Organisation
WVC	Woody Vegetative Cover

MEASUREMENTS

ºC	degree Celcius
km	kilometre
m^3/day	cubic metre per day
m^3/hr	cubic metre per hour
mbgl	metres below ground level
mm	millimetre
mamsl	metres above mean sea level

1 EXECUTIVE SUMMARY

1.1 Introduction and Background

Aqualogic (Pty) Ltd was engaged by the Department of Water Affairs (DWA) in the Ministry of Minerals, Energy and Water Resources (MMEWR) to carry out consultancy services for the Detailed Environmental Impact Assessment (EIA) Study for Botlhapatlou Groundwater Exploration and Wellfield Development Project, Tender No. PR 10/3/1/08 (II). The project area covers most of the eastern half of the Kweneng District. The project commenced in December 2008 and was completed in October 2012.

As explained in the project's Request for Proposals (RFP), the DWA had commissioned a separate project entitled "Botlhapatlou Groundwater Exploration and Wellfield Development Project (BGEWDP), Tender No. PR 10/3/3/08 (XII)". The aim of the BGEWDP was to investigate, assess and develop potable groundwater resources to supply the villages of Botlhapatlou, Molepolole, Thamaga, Thebephatshwa BDF Camp and the surrounding villages such as Letlhakeng, Khudumelabjwe, Salajwe, Ngware as well as their localities. Wellfield Consulting Services (Pty) Ltd was appointed by DWA to undertake the BGEWDP.

The aim of the Detailed EIA Study was to ensure that the BGEWDP resulted only in minimal disturbance to the socio-economic and bio-physical environment of the area. The EIA was carried out in accordance with the Environmental Assessment Act of 2011 and other relevant pieces of legislation and guidelines. It ensured that the views of the Interested & Affected Parties (IAPs) are incorporated into the project implementation as much as was practical. The positive and negative impacts of the project were comprehensively identified to enable a balanced analysis of the project's impact on the environment. The critical outputs of the EIA Study are the Environmental Management Plans (EMP) in which the mitigation measures to the project's negative impacts are outlined for the various phases of the groundwater project.

1.2 Project Description

The main objective of the BGEWDP was to study the groundwater resources in the Botlhapatlou area in detail in order to identify adequate resources to supply the water demand centres in the region. The groundwater consultant utilized a number of data gathering techniques such as desktop studies, field reconnaissance and geophysical techniques in order to site the required 10 exploration and 25 production boreholes which were then drilled using appropriate machinery (drilling rigs). After the boreholes were drilled they were subjected to pumping tests to ascertain their sustainable yield potential. This was followed by quantification of the identified resources through hydrogeological modeling. The groundwater project was undertaken in three main phases as follows:

- Phase 1: Inception Study
- Phase 2: Exploration (and Production)
- Phase 3: Resources Quantification and Recommended Infrastructure Development

The EIA Study was conducted in line with the phasing of the BGEWDP and consisted of the following main activities:

- conducting a scoping exercise for the BGEWDP and preparing a Scoping Report and TOR
- preparing EMP and Code of Conduct for Phase 2 of the BGEWDP
- monitoring adherence to the EMP by the contractor(s) undertaking Phase 2 of the BGEWDP
- undertaking a Detailed EIA focussing on Phase 3 of the BGEWDP

This report is the Detailed EIA Report and focuses on Phase 3 of the BGEWDP. The Scoping Report and TOR as well as the EMP and Code of Conduct have previously been submitted to and approved by DEA. This report however includes a summary of the findings of the previous phases of the EIA Study, namely the Scoping phase and the assessment of Phase 2 impacts and their mitigation.

1.3 Detailed EIA Methodology

The EIA study utilized several techniques in order to achieve its objectives. The main techniques utilized are:

(i) Public consultation
(ii) Additional consultation with a wide array of key stakeholders including government departments
(iii) Geographic Information System (GIS) - for spatial data management and analysis
(iv) Remote Sensing - for data extraction and attribute mapping
(v) Project Activity Matrix (PAM) - for confirmation of the predicted impacts using
(vi) Rapid Impact Assessment Matrix (RIAM) - for a quantitative assessment of environmental impacts
(vii) Gathering of information from secondary sources and relevant organisations
(viii) Field surveys were undertaken in order to confirm the secondary data obtained and fill in the identified information gaps

1.4 Description of the Baseline Environment

The project area lies in a predominantly sandveld physiographic unit and has a small strip of the hardveld on the extreme eastern part as well as an area of transition between the two. The vegetation in the sandveld is mostly tree and shrub savanna. The sandveld slopes westwards and has common land forms such as pans and fossil river valleys.

The project area is underlain mostly by Stormberg lava of Karoo Supergroup and Karoo Group. The bedrock geology is covered by Kalahari sands. The groundwater in the project area generally flows to northwest direction towards the Central Kalahari Game Reserve. The topography of the project area can be described as flat with intersections of ephemeral river systems and a number of isolated pans. The dominant soil type is the sandy soil which is generally poor for cultivation.

The project area is characterized by a semi-arid climate with generally 2 seasons: winter and summer. Rainfall can reach a maximum of 350mm per annum and summer temperatures can reach 35ºC while winter temperatures can go as low as 2ºC.

In terms of socio-economic activities, the project area is predominantly rural with the major land uses being livestock grazing and subsistence ploughing. The occupation of the majority of people in the project area is subsistence ploughing and livestock rearing. The whole area relies on groundwater for all its needs. The western part of Kweneng is lacking some infrastructure such as tarred roads as compared to the eastern part. The western part of the district is therefore lacking in major investment activities.

1.5 Stakeholder Consultation Process

A comprehensive Interested and Affected Parties (IAP) consultation strategy was adopted in order to ensure that all those who may be affected by the project were informed about it and had an opportunity to air their views regarding it. Relevant central and local government organisations were consulted in different ways such as one-on-one meetings, correspondence, e-mail and telephones. The public was consulted through the use of public kgotla meetings in 11 villages in the project area where the residents expressed the following main issues:

- The critical shortage of water in the project area
- The impact the project will have on their ploughing fields
- The impact the project will have on their boreholes
- The importance of consulting the affected parties before the project commences
- The inadequacy of compensation amounts paid to affected property owners from similar projects
- Preference needs to be given to local residents during employment
- The EIA process should ensure that the proposed project's negative impacts are greatly minimised

1.6 Identified Phase 2 (Exploration) Impacts

The assessment of the activities associated with the groundwater project showed a variable range of effects, from major negative changes to major positive changes. Although most of the impacts were negative, they would occur during the field (exploration) phase of the project and were temporary and reversible.

The most significant environmental impacts of Phase 2 of BGEWDP were:

- Soil structural damage (erosion)
- Oil spillage
- Waste generation
- Fire hazard
- Loss of vegetation
- Influx of job seekers
- Noise generation
- Increased risk of spread of HIV/AIDS
- Poor aesthetic value
- Impact on existing privately-owned boreholes
- Stimulation of land use changes
- Change to chemistry of the soil
- Habitat destruction
- Land use conflict
- Boost to the local economy
- Employment creation

1.7 Mitigation Measures of Phase 2 Impacts

The EIA study provided a comprehensive set of mitigation measures for all the negative impacts from all of the components as well as the enhancement measures for the positive impacts from the project. The contractors who were engaged to carry out Phase 2 of the groundwater project were required to implement the recommended mitigation measures fully so as to ensure that the negative impacts of the project on the environment were greatly minimized. These included adhering to stipulated guidelines and Code of Conduct, taking pre-emptive action in some cases, as well as responsible moral behaviour of all concerned. The main mitigation measures that guided the contractors were:

- Ensuring the use of machines and vehicles that were in good working condition at all times
- Encouraging the site personnel to adhere to environmental health and safety policies in place to minimize littering and generation of other forms of waste
- Keeping the working areas and camp sites clean at all times and disposing of waste at designated landfills
- Avoiding the use of flammable materials (candle lights, uncontrolled cigarette smoking) with potential for starting fires as much as possible
- Keeping flammable fuels away from open flames
- Installing fire extinguishers on site
- Keeping the size of cleared areas to a minimum during site clearing for drilling to minimize both soil and vegetation removal and/or loss
- Care should be taken to avoid having multiple tracks around the camp sites
- Heavy machinery should only be on one site; where it is needed most
- Vegetation removal should be limited to lines of operation only
- Where possible big trees should be avoided; rare species must be avoided
- Use gas stoves encouraged to reduce harvesting of fuelwood and fire risks
- Where nesting places are encountered, recording of species and possible damage/disturbance caused should be done
- Where possible such nesting places should be spared to avoid forced migration of the species
- Minimise noise by drilling during the day (to keep tranquillity at night)
- Introduction of relevant contractor employees to the District Health Team (DHT) and health personnel in any nearby health facility
- Promotion of HIV/AIDS awareness campaigns
- Strengthen Public Education on HIV/AIDS related programmes that include HIV routine testing and counselling, and the ARV programme
- Provide condoms at the camp sites
- Prompt and adequate compensation to be paid to affected property owners according to stipulated guidelines
- Minimise the project's footprint on the local environment
- Immediate reporting of any finds of archaeological interest to DNMM

- Project-related job opportunities should be advertised locally
- Speed limits and other road signs to be observed
- Findings should be recorded and archived for public use
- Ensure that procurement is done locally as much as is possible
- Avoid drilling close to existing boreholes
- Encourage and/or assist owners to register unregistered and new boreholes with WAB at DWA
- Strict adherence to the district integrated land use plan

1.8 Key aspects and findings - Detailed EIA

A positive impact brought by the project is the availability of additional groundwater knowledge. For example, the knowledge base of the groundwater distribution has been increased as a result of the project and the groundwater distribution map of the area can be produced with a much improved level of confidence. Additional research on the hydrogeological dynamics of the project area can benefit from and build on the invaluable project data. On the other hand the additional groundwater knowledge could trigger changes in land use patterns. It is normal that once the areas that have better potential for groundwater development are mapped, then farmers would apply in large numbers to exploit the mapped areas. In order to avoid a haphazard approach to allocating drill sites and boreholes to cattle farmers, a proactive and holistic approach in developing an integrated land use plan, which will be centred on the principle of sustainable development, will be imperative for the authorities responsible for land use and development.

1.9 Identified Phase 3 (Infrastructure Development) Impacts

The identified impacts associated with Phase 3 of BGEWDP are:

- Dust pollution
- Noise pollution
- Contamination due to oil spillages
- Draw-down effect
- Increased potential of soil erosion
- Impact on private properties
- Risk of accidents
- Impact on existing infrastructure
- Waste generation
- Aesthetic impacts on the landscape
- Archaeological impacts
- Loss of vegetation
- Employment opportunities
- Reliable water supply
- Added impetus to the economy
- Spread of HIV/AIDS

1.10 Mitigation Measures of Phase 3 Impacts

The EMP proposed in this report presents the mitigation measures that are targeted to address impacts associated with the Infrastructure and Development (Phase 3) of the BGEWDP. The EMP has been divided into 2 sections i.e. the Mitigation Plan detailing how the impacts would be mitigated and the Monitoring Plan which shows in detail the monitoring technique, the frequency of monitoring, and the monitoring agency per individual environmental aspect. The EMP also highlights the importance of the roles played by the project proponent, the contractor and the environmentalist who will be appointed to ensure that the EMP is fully implemented in the whole set up.

1.11 Conclusions and Recommendations

The detailed EIA Study of the BGEWDP comprehensively undertook a pre-development environmental baseline study of the project area using appropriate approaches and techniques. The study also identified and assessed the likely impacts of the BGEWDP on the environment, taking into account the major phases of the BGEWDP, namely the Exploration Phase (Phase 2) and the Resources Quantification Phase (Phase 3).

The EIA Study found out that there are a number of significant adverse environmental impacts that require mitigation. The most significant negative impacts the project will cause in the area include possible increase in the spread of HIV/AIDS; generation of noise, dust, waste and a possible

contamination of soil and groundwater with leaking oil as well as an interruption of infrastructure facilities within the project area. The negative impacts will mostly occur during the construction phase while most of the impacts of the operation phase are positive. The positive outcome from the project will be employment opportunities during construction as well as improved water supply in the villages in the area during operation. Mitigation measures for the identified impacts were developed and their implementation is described in the main EMP for the planned utilization of the identified groundwater resources (the Malwelwe Wellfield). It should be noted that the planned utilization is a separate project that will be commissioned in the future.

The contractors who would be engaged to carry out the planned infrastructure will have to implement the recommended mitigation measures fully so as to ensure that the project's negative impact on the environment is greatly minimized. These include adhering to stipulated guidelines, taking pre-emptive action in some cases, as well as responsible moral behaviour of all concerned.

The following recommendations are made with regard to the implementation of the construction of the planned infrastructure development:

- Environmental monitoring services (EMP Supervision) should be engaged during implementation of infrastructure development
- The detailed design of the proposed pipe lay-out and other associated infrastructure should be cleared with DEA prior to implementation
- The proposed water lines should be located within the road reserves as much as possible in order to minimise issues of relocation and damage to existing properties
- The contractor should consult the Department of Roads and the KDC to seek permission to use the road reserves
- The contractor should take all precautionary measures to avoid damage to existing services on sections where these are located within the vicinity of the project works
- Any borrow pits used by the contractor should be appropriately licenced with the relevant authorities
- The contractor should rehabilitate any camp sites at the end of project implementation

2 INTRODUCTION

2.1 Background

Aqualogic (Pty) Ltd was engaged by the Department of Water Affairs (DWA) in the Ministry of Minerals, Energy and Water Resources (MMEWR) to carry out consultancy services for the "Detailed Environmental Impact Assessment (EIA) Study for Botlhapatlou Groundwater Exploration and Wellfield Development Project, Tender No. PR 10/3/1/08 (II)." The aim of the EIA project was to understand and manage the impacts associated with a groundwater development project in the area, namely the Botlhapatlou Groundwater Exploration and Wellfield Development Project (BGEWDP), Tender No. PR 10/3/3/08 (XII). The project area covers most of the eastern half of the Kweneng District as shown in Figure 2-1 and Figure 2-2.

The aim of the Botlhapatlou Groundwater Exploration and Wellfield Development Project (BGEWDP) was to investigate, assess and develop potable groundwater resources to supply the villages of Botlhapatlou, Molepolole, Thamaga, Thebephatshwa BDF Camp and the surrounding villages such as Letlhakeng, Khudumelabjwe, Salajwe, Ngware as well as their localities. The specific objectives of the groundwater project were to evaluate the hydrogeological regime and to site, drill and test at least 10 exploration and 25 production boreholes within the project area and develop the identified wellfields for village water supply schemes. Wellfield Consulting Services (Pty) Ltd was appointed by DWA to undertake the BGEWDP. The BGEWDP project started in November 2008 and was completed in April 2012. The EIA project started in December 2008 and was completed in November 2012.

The groundwater project was divided into several phases (see Table 2-1) that directly affected how the overall EIA study for the project was conducted. The inception stage was largely a desktop study that did not involve any activity that would have an impact on the environment. The construction stage involved two sub-phases (exploration and production) that constituted the main field activities of the groundwater project. This phase had numerous activities that directly impacted the environment and was thus a core focus of the EIA study. The last phase of the groundwater project, the groundwater resources quantification phase, involved the identification of wellfields that are ready to be utilized for the supply of water to the demand centres targeted by the BGEWDP project. Thus, even though the actual connection of the wellfields to the demand centres (reticulation) is not part of the BGEWDP, the impacts that would emanate from the recommended utilization of the wellfields were a major focus of the present EIA study.

Phase 3 of the BGEWDP necessarily had to be preceded by Phase 2 as it (Phase 3) depended on the outcome of the investigations in Phase 2. On the EIA front it was necessary to have an Environmental Management Plan (EMP) in place before the commencement of Phase 2 field activities in order to manage the predicted and identified impacts of that Phase. This EMP would necessarily be separate from the EMP that would govern the implementation of the wellfield utilization programme recommended by Phase 3 of the BGEWDP.

Based on precedents from the Kang-Phuduhudu and Bobonong groundwater development projects (both commissioned by DWA) and the similarity of the BGEWDP project to these, the Department of Environmental Affairs (DEA) advised Aqualogic (Pty) Ltd (who had also conducted the EIA studies for the Kang-Phuduhudu and Bobonong projects) to complete the following sequential tasks in undertaking the EIA Study for the BGEWDP:

- conduct a normal scoping exercise for the BGEWDP and prepare a Scoping Report and TOR
- prepare EMP and Code of Conduct for Phase 2 of the BGEWDP
- monitor adherence to EMP by the contractor(s) undertaking Phase 2 of the BGEWDP
- undertake a Detailed EIA focussing on outputs of Phase 3 of the BGEWDP

This report is the Detailed EIA Report and focuses on Phase 3 of the BGEWDP. The Scoping Report and TOR as well as the EMP and Code of Conduct have previously been submitted to and approved by DEA (see Appendices E and F respectively).

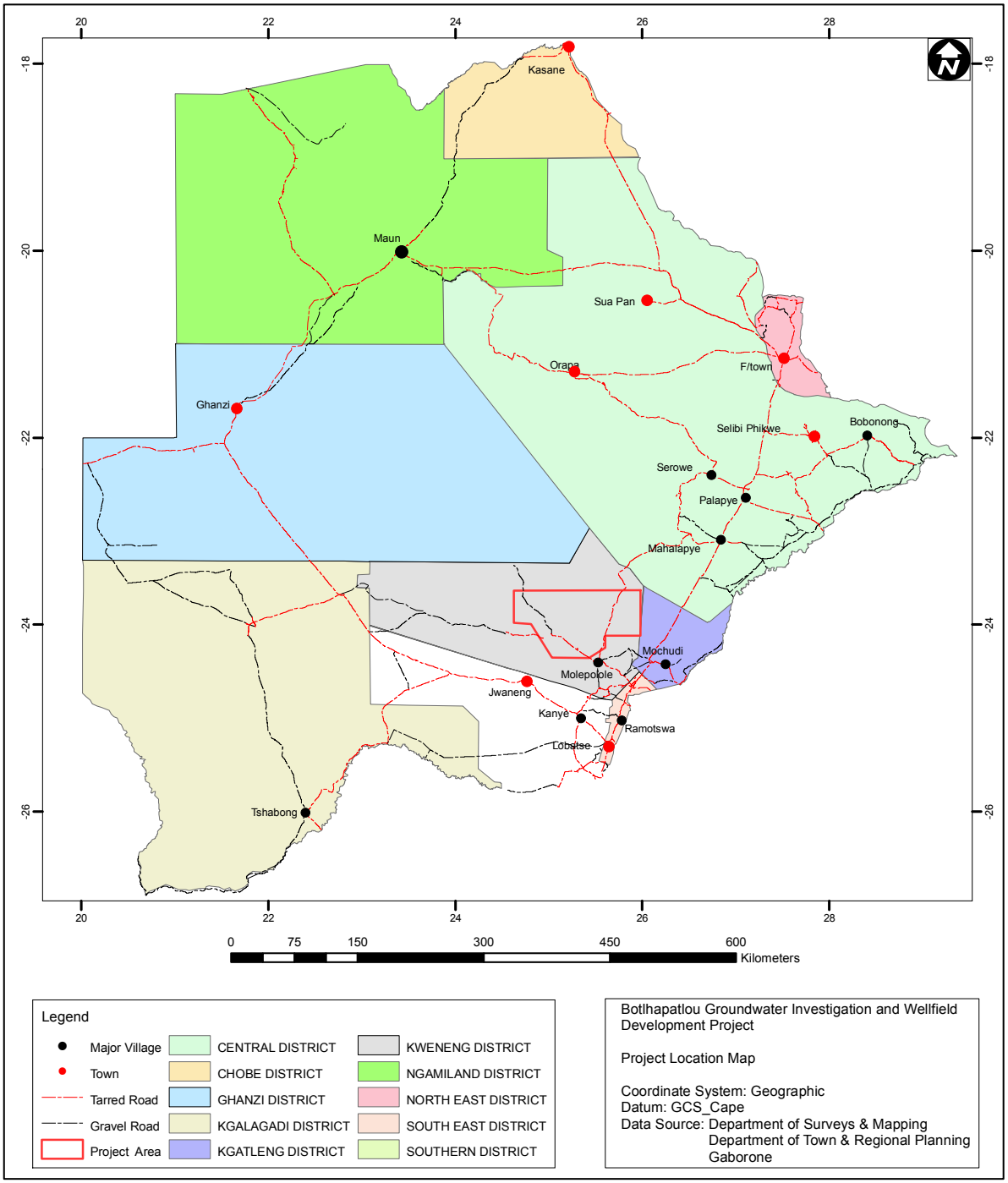


Figure 2-1: Location of the project area in Botswana

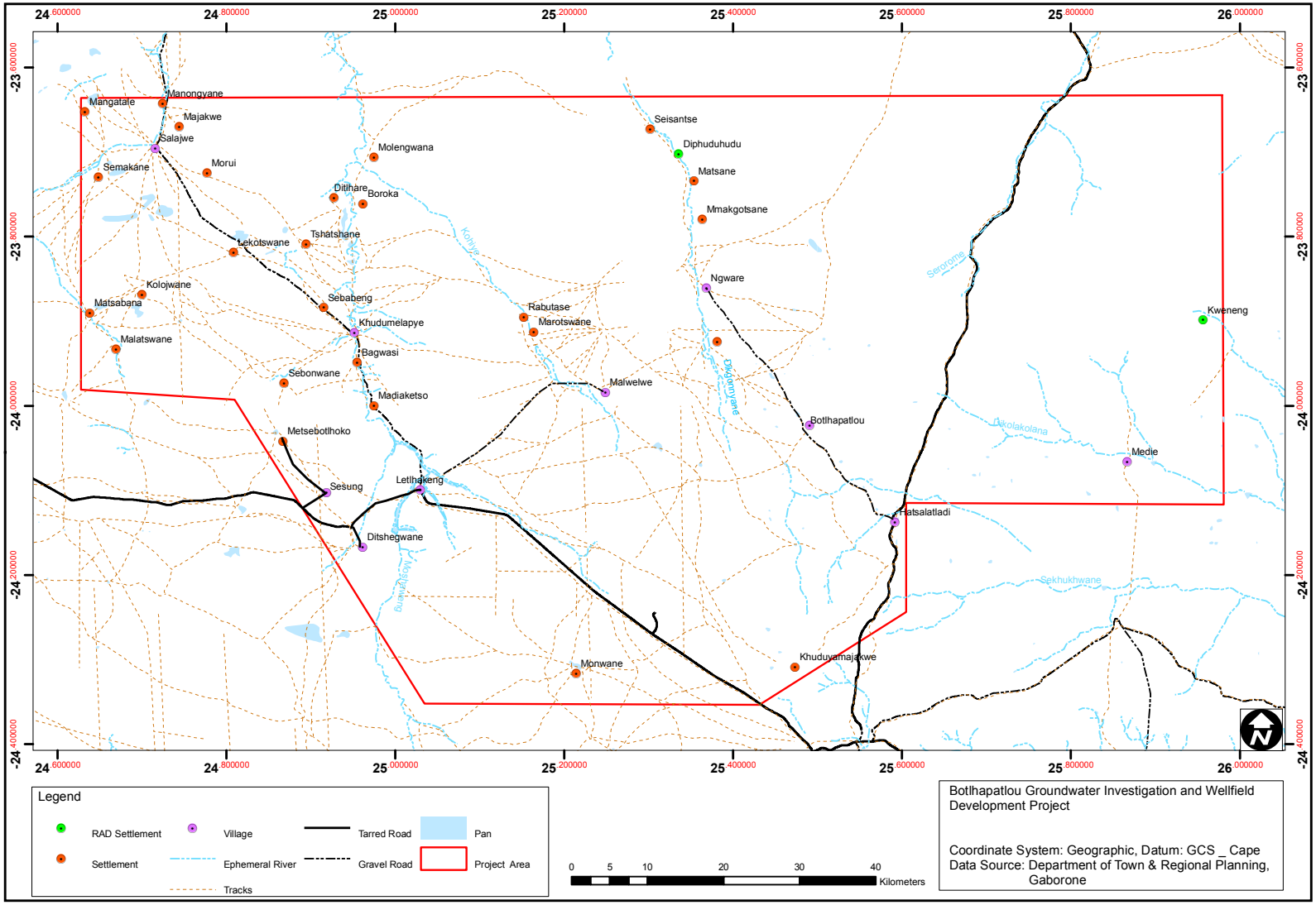


Figure 2-2: The project area

Table 2-1: Phases of the BGEWDP project

STAGE	TASKS
1. PROJECT INCEPTION	Collection and Collation of Existing Data Project Database and Base Map Development Field Reconnaissance Survey Review of Groundwater Resources Data Review of Existing Groundwater Model Preparation of Tender Documents for Contracting Works Purchase of Equipment Data Analysis and Conceptual Model Establishment Selection of Exploration Target Areas Inception Report and Construction Phase Planning
2A. CONSTRUCTION - EXPLORATION	Ground Geophysical Surveys Exploration Borehole Drilling (**10 boreholes**) Geophysical Borehole Logging Exploration Borehole Aquifer Testing Recharge Studies Groundwater and Climatological Monitoring Hydrochemical and Microbiological Sampling Target Zone Selection for Production Borehole Midterm Review Report
2B. CONSTRUCTION - PRODUCTION	Ground Geophysical Surveys Production Borehole Drilling (**25 boreholes**) Geophysical Borehole Logging Production Aquifer Testing Surveying and Leveling of Production Boreholes Groundwater and Climatological Monitoring Hydrochemical and Microbiological Sampling
3. GROUNDWATER RESOURCES QUANTIFICATION	Conceptual Model Review Numerical Groundwater Model Design and Calibration Resources Quantification and Scenario Modeling Groundwater Pollution Potential Assessment Reticulation System Planning and Cost Appraisal Final Reporting and Liaison Resources Monitoring and System Operations Optimization

2.2 Methodology and approach of the EIA Study

The primary goal of any EIA Study is to ensure that all activities required to achieve the objectives of a planned development project are undertaken in an environmentally acceptable manner. The main activities of the BGEWDP project included bush clearing; creation of access routes; ground geophysical surveying; borehole drilling; test pumping of boreholes; camping; wellfield utilization planning and water infrastructure development planning. These groundwater exploration and development activities affect the surficial and underlying strata, impacting on soils, vegetation, streams, cultural/historic resources, aquifers and can cause land use conflicts. It is noted in the EIA project tender documents that initially unforeseen environmental factors emanating from water projects may produce negative effects that often outweigh the benefits of those projects. Indeed, some projects have demonstrated the benefits of carrying out an EIA, whereupon the initial development option was foregone in favour of a more cost effective and environmentally sound alternative. It is thus imperative to identify all the impacts that may arise from all stages of the BGEWDP project and ensure that they are comprehensively assessed.

The specific objective of the present EIA Study was to identify and assess all potential impacts of the BGEWDP in order to maximize positive impacts (benefits) and minimize negative impacts. As noted earlier, the EIA study was carried out in three distinct parts, namely (i) the Scoping Report and Terms of Reference, (ii) Preparation of EMP and Code of Conduct for Construction and monitoring thereof, and (iii) the Detailed EIA. This report pertains to the third and final phase, the Detailed EIA.

The main tasks covered in the Detailed EIA Report are:

- A desktop study and environmental appraisal of the project area
- Liaison with key interested and affected parties and relevant government departments on issues relating to the proposed development (Regulatory Consultation)
- Public Consultation
- Ecological Study of the project area
- Archaeological Impact Assessment
- Identification and evaluation of the potential impacts of the proposed project on the environment
- Examination of environmental impacts of additional groundwater resources development
- Analysis of impacts of additional groundwater abstraction
- Analysis of impacts from infrastructure
- Wellfield protection Zones
- Evaluation of water supply alternatives
- Identification and description of procedures and activities that will mitigate the negative impacts and enhance the positive effects of the development
- Development of Environmental Management Plan (EMP) and Monitoring Plan covering the construction and operational phases of the proposed project

The desktop study and environmental appraisal of the project site included collating and compiling archived data on the general study area. A literature review was conducted to develop an initial understanding of the study area. The data compiled includes spatial and attribute features such as soils, vegetation, built up areas, roads and infrastructure. The Kweneng District Settlement Strategy (2000 – 2024) proved invaluable in this aspect of the study. The spatial data in raster and vector formats were obtained from Department of Town and Regional Planning.

As part of the impact identification process, a stakeholder analysis was carried out to ensure that Interested and Affected Parties were included in the project decision-making process. A public consultation meeting was the preferred consultation method as most impacts of the proposed development are localized. The consultant presented the project brief (goals, objectives, and activities) to the locals and allowed them to express their views, concerns, objections, suggestions and expectations. The team also identified special interested and affected parties who were consulted on a one-on-one basis.

Identifying all impacts worthy of consideration was carried out by the whole team and this was based on knowledge and information derived from previous projects of similar scope and those covering the project area, literature review and stakeholder consultation. The core tasks entailed the systematic and exhaustive identification and assessment of the significant environmental impacts of the proposed project.

Once the impacts were identified they were assessed to determine their level of significance. The Rapid Impact Assessment Matrix (RIAM) technique was used for the assessment. RIAM is a computerized matrix-based technique that was developed by Pastakia and Jensen (1998) for the assessment of environmental impacts from development projects and activities. It is based on the knowledge that certain specific criteria (e.g. magnitude, temporal status, reversibility and cumulativeness of impacts) are common to all impact assessments, and by scaling these criteria it is possible to record the values of judgments in a matrix in an objective and transparent way. It is a transparent approach that helps move away from subjective impact assessments that have characterized many past EIAs.

Once the significance of the identified impacts was assessed, mitigation measures were developed to minimize or avoid the negative impacts. On the basis of the significant adverse impacts and the relevant mitigation measures, an environmental management plan (EMP) was developed. A monitoring plan was also developed for the EMP.

A number of previous reports have to some extent covered some of the tasks listed above. The Scoping Report and Terms of Reference (TOR) covered the initial phase of the EIA process, focusing in particular

on the baseline information, public and regulatory consultation, potential impacts of the groundwater project and the proposed mitigation measures of the negative impacts and enhancement measures of the positive effects. The TOR provided a framework for conducting the detailed phase of the EIA. The Scoping Report and TOR were approved by the Department of Environmental Affairs (see Appendix E).

Specialist studies were also conducted as part of the EIA study. These included the Archaeological Impact Assessment (AIA) Study and the Ecological Study. The AIA was undertaken as part of the initial phase of the EIA study, focusing on the likelihood of the BGEWDP project having impacts on cultural and/or historical material that may be present in the project area. The AIA Report was prepared under separate cover for submission to the relevant authority, namely the Department of National Museum and Monuments (DNMM), in line with the requirements of the Monuments and Relics Act (2001). The DNMM approval letter is provided in Appendix G while a copy of the AIA Report is appended as Appendix H. The Ecological Study focussed on the flora and fauna in the project area. Its results have been incorporated into the EIA Report.

The EMP and Code of Conduct for the second stage of the BGEWDP were prepared to guide the contractors involved in the exploration (construction) phase of the BGEWDP. The DEA approval letter for these is provided in Appendix F.

This report, the Detailed EIA Report, being the final key deliverable of the EIA Study of the BGEWDP, presents a synthesis of the results of the critical components of the entire EIA Study. It describes the baseline environment of the project area. It also presents the results of the consultative process with the public and the Interested and Affected Parties (IAPs). It highlights the impacts for Phase 2 of the BGEWDP as well as the mitigation measures developed for these. It discusses in detail the likely impacts from Phase 3 of BGEWDP, particularly the impacts associated with abstraction of water from the established production boreholes (wellfields) and the likely impacts of the distribution of water from the wellfields to the various demand centres within the district. It presents a detailed Environmental Management Plan (EMP) which stipulates how the impacts emanating from Phase 3 of the BGEWDP would be managed.

3 DESCRIPTION OF THE PROPOSED PROJECT

3.1 Project Motivation

The Government of Botswana, through the Ministry of Minerals, Energy and Water Resources (MMEWR) and the Department of Water Affairs (DWA), commissioned the Botlhapatlou Groundwater Exploration and Wellfield Development Project (BGEWDP) in 2008. The BGEWDP was prompted by the realization that the existing supply from Gaotlhobogwe Wellfield will not meet the future water demand in the area. Thus the BGEWDP was undertaken in the Kweneng District over an area of approximately 8,500km^2 with the goal of identifying adequate water resources to address water shortages at the following water demand centres: Molepolole, Thamaga, Thebephatshwa BDF camp and the surrounding villages of Letlhakeng, Khudumelabjwe, Botlhapatlou, Hatsalatladi, Salajwe, Ngware, Malwelwe and others. The project area is depicted in Figure 2-2.

3.2 Project Alternatives

An important aspect of any EIA Study is to consider alternatives to the proposed project in order to make a well informed decision on which option to pursue. The preferred option would be the one with least negative environmental impacts on the area as well as the most benefits or positive impacts. The preferred option will also be the one that effectively meets most of the objectives of the proposed project in the most technically feasible and cost effective manner. The three project alternatives that were considered are (i) the no-project alternative, (ii) supply of villages from dams and (iii) the current project (i.e. the BGEWDP).

i) The 'No-Project' Alternative

The 'no project' alternative would mean DWA not undertaking the BGEWDP in the area. The 'no project' alternative means a situation where the groundwater resources of the area are not developed further and therefore no additional abstraction for the current demand within the project area. DWA would not incur any costs in the short term should this alternative be adopted. However, this alternative would not provide solutions to the persistent problem of acute shortage of water and lack of water of acceptable quality to meet the present and future demands of the area.

Adopting the 'no project' alternative will not induce any negative social or environmental impacts on the project area. The 'no project' alternative will however affect the mandate of DWA as a water supply authority of developing a reliable water supply scheme and wellfield for potable water supply that will sustain the water requirements for villages within the project area in the short and long terms. The DWA's main aim is to ensure that all the residents of the country have access to potable water at all times in a most cost effective manner. Currently, it is practically impossible to meet the ever-increasing water demand in the area from the few operating boreholes as the population and urbanisation of the area are increasing rapidly. The economic and social benefit of the proposed project is comparatively higher than keeping the status-quo and not realizing the project. Therefore the 'no project' alternative was not a viable option.

ii) Supply of villages from dams

There are no surface water resources for supplying villages within the whole of the project area and groundwater has proved to be the only viable source of potable water for the area for the current period and the foreseeable future. The other alternative is supplying the villages from surface water sources in the north of the country. The implementation of this alternative is restricted by the huge cost implications involved as well as the technical hurdles in the form of the long distances over which the water will have to be piped. However the DWA has long-term plans of connecting some of the huge demand centres in the area, like Molepolole, to the North South Carrier (NSC) II Project which is still at its infancy. Indeed, the DWA has commissioned several design projects for considering the connection of major villages in Botswana to the NSC, among them Serowe, Molepolole, Thamaga and Kanye. Thus, for the present and immediate future, this option will not provide a solution to the water shortage in the area.

(iii) The Botlhapatlou Groundwater Exploration and Wellfield Development Project (BGEWDP)

Implementation of the BGEWDP would result in improved water supply in terms of both quality and quantity for the current and future needs of the people in the project area. The development of groundwater resources in the area will add impetus to the economy of the area as there will be adequate water supply to support investment activities. The knowledge of groundwater resources availability is likely to attract interest from farmers from communal livestock farming areas as well as commercial farmers and it may also boost the arable farming sector. However, developing mitigation measures to minimise and avoid the potential impacts would lessen the effects of the project on the environment and social well-being of the community.

Combining the BGEWDP option with demand management reforms being embarked on by the DWA will ensure sustainable use of the water resource in the area. As part of implementation of the Revised National Water Master Plan of 2006, more emphasis is being placed on the demand side of the water distribution sector in the country. Current pre-occupation with the supply side does not provide the whole picture of the water sector in the country. DWA has moved to embark on water conservation programmes, including public awareness campaigns. The measures that are to be adopted here include rainwater harvesting, recycling of water where possible, drastically reducing losses through leakages and using water sparingly. Adopting this option would result in decreased volume of consumed water and increased volume of available potable water in the project area. It is also the policy of DWA to supply demand centres with water from both surface sources as well as groundwater sources through "conjunctive use" of the resource in order to achieve efficiency. It is therefore prudent that the wellfields in the area be fully identified and developed for purposes of supplying the local communities sustainably and augmenting any future supply from dams.

Thus this project alternative has more advantages in comparison to the others. Considering the baseline analysis conducted and alternatives considered it is concluded that under the present circumstances it was important for the BGEWDP to be adopted. Implementation of the proposed project would ensure reliable water supply, and improved potential for commercial and industrial investment in the project area at a minimal cost to the environment provided the recommendations of the EMP are implemented.

3.3 Water Supply and Demand Situation

There are no surface water resources in the area and groundwater is the only source supplying Molepolole, Thamaga, Thebephatshwa, BDF camp and neighbouring localities. Some of the production boreholes are reported to be experiencing operational and construction problems such as decline in yield, silting and bacterial infestation. As a result, it became necessary for the water supply authority (DWA) to initiate plans to identify additional sources of water for the region.

3.4 Demand Status

The total water demand in the project area for the year 2016 (as per the RFP) was estimated at 14,000m^3/day. Using the CSO 2004 & 2002 population figures (since the 2011 census had not yet been undertaken when the BGEWDP started in 2008) and the "domestic water demand" of 100litres/capita/day and making an allowance of 13.2% to cater for institutional, commercial, industrial and other demands, the water demand was calculated as 12,351.8m^3/day by the groundwater consultant. Thus the RFP figure of 14,000m^3/day was deemed a reasonable guide. The calculated water demand figure has however since been updated to 15,754m^3/day (WCS, 2012). Table 3-1 shows the population projections for the years 2016 and 2026 for some of the demand centres in the project area.

Table 3-1: Population projections for the demand entres in the project raea

Village	Enumerated	Projected Population	
	Year 2011	Year 2016	Year 2026
Botlhapatlou	1,223	1,077	1,240
Hatsalatladi	726	753	862

Village	Enumerated	Projected Population	
	Year 2011	Year 2016	Year 2026
Khudumelabjwe	2,080	2,163	2,489
Letlhakeng	7,229	7,102	8,173
Malwelwe	930	1,095	1,260
Molepolole	66,466	67,494	77,253
Ngware	919	675	776
Salajwe	2,440	2,007	2,310
Thamaga	21,471	22,411	25,652
Thebephatshwa	2,690	3,044	3,503
Total	**106,174**	**107,821**	**123,518**

(Source: CSO 2011, 2004 and 2002)

3.5 Water Supply Status

Currently the major centres are supplied from the Gaotlhobogwe Wellfield which is comprised of 14 production boreholes (BHs 6875, 7858, 7860, 7864, 7914, 7931, 7966, 9571, 9572, 9573, 9574, 9378, 9379 and 8132). There are 42 observation boreholes that are used to monitor the production boreholes on a regular basis. Water abstraction monitoring data is available from 1997 to 2007 and in some cases up to 2008. Of the 42 observation boreholes only 8 boreholes have regular monitoring data. The analysis of the monitoring data indicates that the water levels have been declining over the past 17 years (from 6.29mbgl to 15.48 mbgl) and this is attributed to poor borehole construction and biofouling of screens. The area has a significant number of privately owned boreholes that are used by cattle farmers to water livestock.

3.6 Project activities - BGEWDP

As noted earlier (see Table 2-1), the BGEWDP was divided into distinct phases as follows:

- Stage 1: Project Inception
- Stage 2: Construction
- Stage 3: Groundwater Resources Quantification

However, from experience on projects of this nature, Stage 2 is best divided into two parts, namely Stage 2A (Exploration) and Stage 2B (Production) with a brief hiatus period between them to facilitate a review of the data gathered during the Exploration sub-stage and presentation to and consultation with the Client before the Production sub-stage is carried out. It should be noted however that the time period between the sub-stages is short such that there will be a continuous and smooth transition of activities between the two sub-stages.

With regard to the EIA process, Stage 1 did not have any environmental implications while Stage 2 and Stage 3 had significant impacts that were however separated in time and needed to be addressed separately. The tasks for Stage 2 and 3 are as given in Table 3-2. Stage 2 involved the more immediate significant impacts on the environment (example shown in Figure 3-1 while Stage 3 involved significant impacts that would only arise in the long-term. In fact, Stage 3 can be treated as a Design Phase for another project to be implemented in the future. As explained earlier in Chapter 2, the Stage 2 activities were guided by an Environmental Management Plan and a Code of Conduct that were prepared (by Aqualogic) before the commencement of Stage 2 works to guide the contractors carrying out those works. Following the Stage 2 works, the groundwater consultant has completed Stage 3, the results of which include recommendations on the sustainable utilization of the identified groundwater resources.

Table 3-2: Detailed Project Activities – Stages 2 & 3

STAGE	TASKS
2a. CONSTRUCTION - EXPLORATION	Ground Geophysical Surveys Exploration Borehole Drilling (**10 boreholes**) Geophysical Borehole Logging Exploration Borehole Aquifer Testing Recharge Studies Groundwater and Climatological Monitoring Hydrochemical and Microbiological Sampling Target Zone Selection for Production Borehole Midterm Review Report
2b. CONSTRUCTION - PRODUCTION	Ground Geophysical Surveys Production Borehole Drilling (**25 boreholes**) Geophysical Borehole Logging Production Aquifer Testing Surveying and Leveling of Production Boreholes Groundwater and Climatological Monitoring Hydrochemical and Microbiological Sampling
3. GROUNDWATER RESOURCES QUANTIFICATION	Conceptual Model Review Numerical Groundwater Model Design and Calibration Resources Quantification and Scenario Modeling Groundwater Pollution Potential Assessment Reticulation System Planning and Cost Appraisal Final Reporting and Liaison Resources Monitoring and System Operations Optimization

Figure 3-1: Typical borehole drilling in progress and its byproducts

As a result of the phasing of the various activities of the BGEWDP, the "project description" component for the present report necessarily must focus on the outcome of Phase 3 works, that being the planned or recommended utilization of the identified resources (i.e. abstraction of water from the wellfields and its reticulation to the demand centres). Also, additional related issues to be considered include protection of the wellfields from pollution (protection zones) and land use changes arising from the very availability of the resources.

As reported in the Final Report of the BGEWDP (WCS, 2012), significant groundwater resources have been identified by the groundwater consultant (Wellfield Consulting Services (Pty) Ltd) in the project area. A map depicting the project area and the project boreholes is appended as Appendix I. The map is provided courtesy of Wellfield Consulting Services.

Two major wellfields have been identified in the project area: the Malwelwe Wellfield and the Sorilatholo/Salajwe Wellfield. The Malwelwe Wellfield is located in the central part of the project area while the Sorilatholo/Salajwe Wellfield is located in the northern part of the project area. The wellfields are about 60km apart. Malwelwe Wellfield is the higher-yielding of the two and comprises 14 production boreholes (6 existing and 8 new) with a combined yield of 11,800m^3/day at a 15hr/day pumping period. Sorilatholo/Salajwe Wellfield comprises 11 new boreholes with a combined yield of 3,885m^3/day at a 15hr/day pumping period.

In terms of future utilization, the Malwelwe Wellfield has been recommended for immediate utilization to augment the water supply from Gaotlhobogwe Wellfield while the Sorilatholo/Salajwe Wellfield has been earmarked for future use. The recommended utilization of Malwelwe Wellfield is depicted in the proposed pipe layout shown in Figure 3-2. Two of the 14 available boreholes have been reserved for local supply to the villages of Malwelwe (BH 10784) and Ngware and Botlhapatlou (BH 10748). The rest of the boreholes are to be connected to a new collector tank at Malwelwe. A new Water Treatment Plant (WTP) has also been recommended for Malwelwe at which the water pumped in from the boreholes will be treated before being piped into the regional water supply network at Gaotlhobogwe Wellfield.

It should be noted that only a schematic layout of the recommended utilization and reticulation scheme has been provided through the BGEWDP (Figure 3-2). Thus it is not possible to do an in-field assessment of the pipeline routes or other infrastructure such as pump stations, reservoirs (collector tank), WTP and access roads as their exact locations are not presently known. The final design will only be completed once the infrastructure development project is commissioned in the future. It is however estimated by the groundwater consultant that about 47km of new pipeline will be required and that the whole infrastructure development will cost in the region of P290 million.

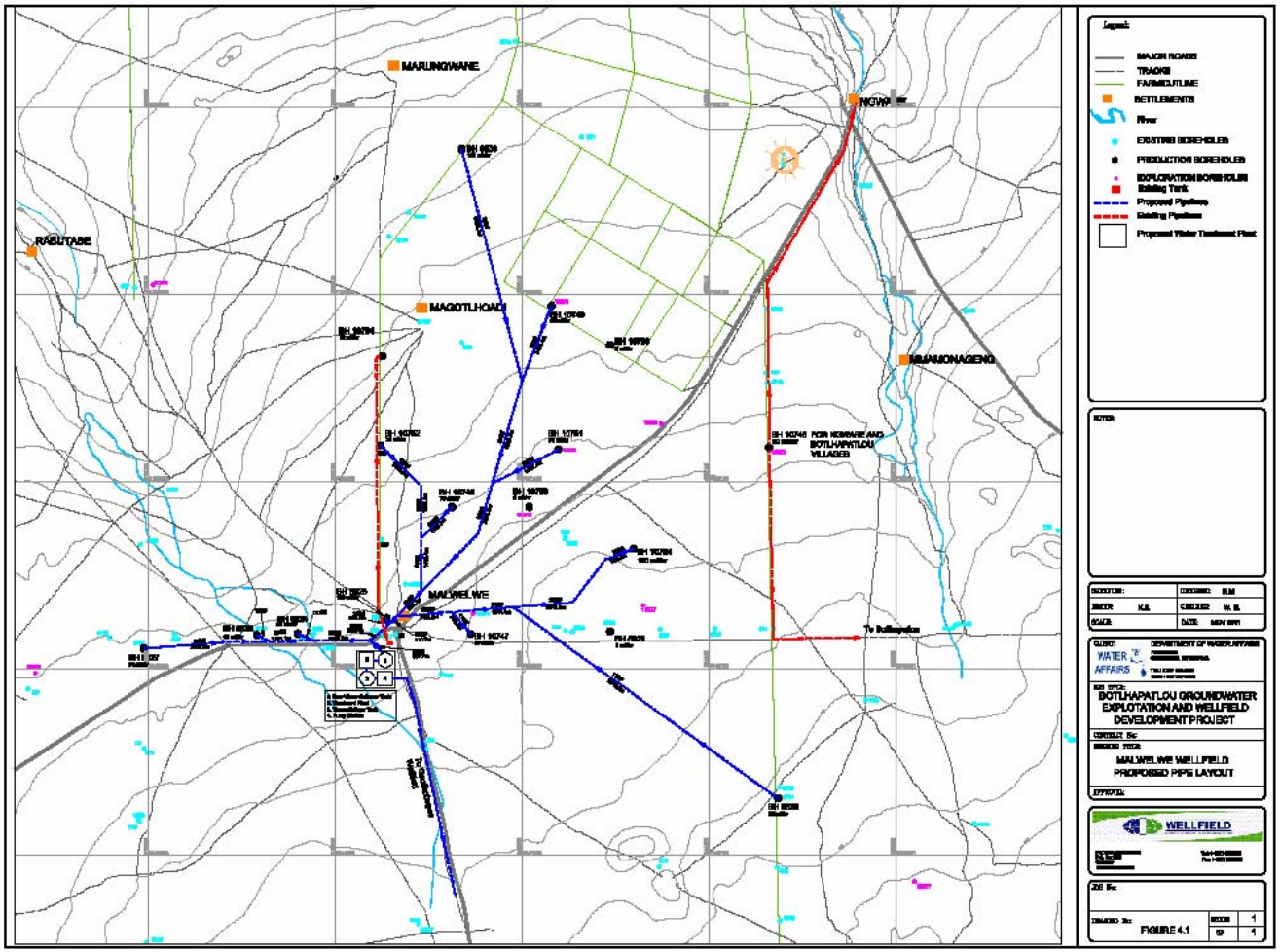


Figure 3-2: Proposed pipe layout for utilization of the Malwelwe Wellfield

(Figure excerpted from WCS (2012))

4 ADMINISTRATIVE, LEGAL AND POLICY FRAMEWORK

4.1 Administrative Framework

Administratively Botswana is divided into 10 District Councils (Kgalagadi, Southern, Ghanzi, South East, Kweneng, Kgatleng, Central, North East, Chobe and North West) and 6 town councils (Gaborone (City), Francistown (City), Selibe Phikwe, Lobatse, Jwaneng and Sowa Township). Each District comprises four local institutions: District Council, Tribal Administration, Land Board and District Administration. These four institutional frameworks are charged with rural development and also serve as a direct link with local communities in terms of identifying and addressing their needs and aspirations.

The proponent of the BGEWDP is the DWA which is within the MMEWR. The DWA is responsible for securing water sources for domestic purposes for the whole of the country. The BGEWDP area is wholly within the Kweneng District, whose headquarters are in Molepolole. The Kweneng District Council's Water Unit is responsible for water supply in all the villages in the project area while the DWA is responsible for water supply to Molepolole and Thamaga. These centres, although outside the project area, are planned to be supplied with water from the BGEWDP in the future. After the production boreholes are drilled and developed, the responsibility of reticulating water to the various consumers will be taken up by the authority responsible for the different demand centres.

Note: Water Sector reforms currently being undertaken by the government will eventually transfer water supply functions from DWA and the District Councils to the parastatal Water Utilities Corporation (WUC).

4.2 Legal framework

The successful implementation of the EIA Study of the BGEWDP hinges on the comprehensive consideration of applicable pieces of legislation and relevant policies to the project. Amongst other legal requirements the study is guided by the Environmental Assessment (EIA) Act of 2011. The EIA Act requires that Environmental Impact Assessments should be undertaken for all the projects that may have negative impacts on the environment. Section 9 (2) of the Act states that an environmental impact assessment shall identify and evaluate the environmental impact of an activity with particular reference to the:

- Health, safety or quality of life of people
- Archaeological, aesthetic, cultural or sanitary conditions of the environment, and
- Configuration, quality and diversity of natural resources

In line with the spirit of the Act, the aim of the current EIA Study was to identify and assess all the environmental and social impacts that would arise out of the implementation of the BGEWDP and propose mitigation measures to minimize adverse impacts.

Several pieces of legislation must be observed for proper implementation of the project and to ensure that the right procedures are followed during implementation. Table 4-1 summarises the pieces of legislation relevant to the BGEWDP.

Table 4-1: Legislation relevant to the project

LEGISLATION	RESPONSIBLE GOVERNMENT ENTITY	COMMENTS
Tribal Land Act, 1968	Kweneng Land Board	The Act governs access to and administration of land within all tribal areas of Botswana. It sets out regulations and procedures for land allocations. Land Boards handle the administration of land in tribal areas and oversee land allocation and development of all land in all their areas of jurisdiction. The Kweneng Land Board has been adequately informed about the BGEWDP.

LEGISLATION	RESPONSIBLE GOVERNMENT ENTITY	COMMENTS
Environmental Assessment Act, 2011	Department of Environmental Affairs (DEA)	The Act provides for the carrying out of an EIA for all projects that may have adverse effects on the environment. DEA is mandated to review the Scoping Report, Terms of Reference (TOR) and Final Report (this report). DEA has previously approved the Scoping Report and TOR for the BGEWDP.
Monuments and Relics Act, 2001	Department of National Museum & Monuments	The Act ensures preservation and protection of ancient monuments, ancient workings, relics and other objects of aesthetic, archaeological, historical or scientific interest. It requires that any activity which may result in the disturbance of the land through excavation and extraction should be subjected to an Archaeological Impact Assessment to ensure that no archaeological sites are destroyed during excavation. A detailed AIA for the BGEWDP has been undertaken within the scope of this project
The Forest Act, 1968	Department of Forestry and Range Resources	The Act provides for the utilisation and protection of forest produce. It serves to declare certain areas as forest reserves and provides for regulations for such reserves. Recognition is given to the use by local communities of forest resources for firewood, building materials, medicine and utensils through the forest. The project implementation will ensure adequate protection of the forests within the project area
Water Act, 1968	Department of Water Affairs	The Act defines the ownership of any rights to the use of water and provides for the grant of water rights and servitudes. The Act states that there will be no right of property in public water including groundwater and water in any natural streams, rivers, lakes and dams. It covers all aspects of water abstraction and disposal of effluent into natural streams. The proposed BGEWDP project will be implemented in a manner that conforms to the regulations of this Act.
Wildlife Conservation and National Parks Act, 1992	Department of Wildlife and National Parks.	The Act provides for the protection of wildlife and conservation of National Parks. Even though most of Kweneng District supports more livestock than wildlife, wildlife is concentrated in Kweneng West which is around the area south of the Central Kalahari Game Reserve. Other large species are found mostly in Khutse Game Reserve. The project area is close to the mentioned conservation areas that are controlled by the Act and the proposed project will be carried out within the terms of the Act.
Waste Management Act, 1998	Department of Waste Management and Pollution Control	The Act provides for the minimization of pollution of the environment, and the conservation of natural resources; the planning, facilitation and implementation of advanced systems for the regulation of trans-boundary movements of waste and its disposal. Any waste produced during the project should be managed in accordance with the Act.
Herbage Preservation (Prevention of Fires) Act, 1977	Department of Forestry and Range Resources	This Act aims to prevent and control bush and other fires with Sections (4, 6 and 9) concerning fire control and firebreaks, and the penalties for contravention (Section 14). Since the project is implemented in a bushy area, it is important that the provisions of this Act are followed in order to to prevent bush fires
Agricultural Resources (Protection) Act, 1973	Department of Forestry and Range Resources	The Act provides for the protection of Botswana's agricultural resources which are defined as animals, birds, plants, soils, vegetation, veld products, fish etc. There will be some form of vegetation clearance during the project hence the Act applies.
Borehole Act, 1956	Department of Water Affairs	Provides guidelines on the manner in which boreholes in the country need to be drilled and the extraction rates. The project involves the drilling of about 35 boreholes which needs to be done in line with the provisions of the Act.
Road Traffic Act, 2008	Department of Road Transport and Safety	Many sections of this Act are relevant to the proposed development just as they are to everyday life on the roads of Botswana, with general compliance clearly essential to the health and safety of all road users including project contractors.
Atmospheric Pollution (Prevention) Act, 1971	Department of Waste Management and Pollution Control	The Act provides a regulatory framework for industrial activities and other activities that have emissions into the atmosphere in order to reduce pollution. Since the proposed project involves excavation for water supply network installation it must be implemented within the provisions of the Act to minimise the dust impact
Mines and Minerals Act, 1999	Department of Mines	Provides guidance on the licensing procedure for extraction of all minerals including water, which is the main aim of the current project

LEGISLATION	RESPONSIBLE GOVERNMENT ENTITY	COMMENTS
Public Health Act, 1981	Kweneng District Council	The Act ensures that good public health is maintained throughout any work environment. During the BGEWDP, the general health of the public and the employees would need to be protected through the implementation of the provisions of the Act

4.3 Policy Framework

There are a number of policies, strategies, plans and programs to be considered when conducting the EIA of the BGEWDP. This is because they have a bearing on the outcome of all developments. Policies and plans relevant to the BGEWDP are discussed in Table 4-2 below.

Table 4-2: Policies Relevant to the project

Policy	Notes
The National Water Master Plan Review (2006)	The NWMPR provides overall revised institutional, legislative and policy approach to the water sector in the country. Volume 4 provides an outline of the Groundwater Resources availability in the country. Volume 9 spells out the environmental considerations that need to be observed during exploitation of water resources in the country. It spells out the procedure in detail of carrying out an EIA for water development projects. The Plan points out ways and means of ensuring that water of sufficient quantity and acceptable quality is supplied to all the country residents in a sustainable and cost effective manner. This water development project is part of the country wide implementation of the Plan
Vision 2016 (1997)	The Vision provides for a situation that each and every resident of the country can access sufficient amount and good quality water by the year 2016. BGEWDP is one of the important vehicles towards realizing the noble aim of the Vision
Kweneng District Development Plan 6 (2003)	The plan presents all significant approved development projects for Kweneng District in the Plan period. The projects' costs and schedules are indicated in the plan. The BGEWDP is one of the district's projects in the plan
Kweneng District Integrated Land Use Plan (2003)	The Plan ensures that land and all natural resources are used in a sustainable manner for the benefit of current and future generations. A detailed study of the land resources in the whole district came up with different land use zones depending on the land suitability and capability. The zones assist the Land Board in land allocations. The recommended sustainable use of groundwater resources identified through the BGEWDP will assist in the realization of the plan.
National Development Plan 9	Under the theme "Towards realization of Vision 2016, Diversified and Sustainable Development through Competitiveness in Global Markets", NDP 9 emphasizes the need for the concept of sustainable development to be put into practice. The BGEWDP is a result of the implementation of one the planned developments of NDP 9.
Revised National Policy for Rural Development (RNPRD) (2003)	The RNPRD recognizes that rural settlements such as those within the project area need to be developed in such a sustainable manner that the phenomenon of rural-urban migration would be minimized as much as possible. By ensuring that rural areas have reliable water supply, projects such as the BGEWDP contribute to the realization of this Government policy by enhancing development in rural areas
National Policy on Natural Resources Conservation and Development (1990)	The policy has put into place the environmental management framework in the country. The preparation of a Detailed EIA for the proposed water development project is part of the fulfiment of this policy.
National Settlement Policy (1998)	Provides a comprehensive set of guidelines for national physical planning and to provide a framework for guiding the distribution of investment in a way that reflects the settlement's size, population, economic potential, level of infrastructure and their role as service centres. The decision to develop a water development project in this area was informed partly by the NSP as the level of infrastructure needed to boost other development pursuits in the district.

Policy	Notes
Kweneng District Settlement Strategy (KDSS) (2000)	The KDSS is a planning document that seeks to guide the District Council and Central Government in locating and prioritising development opportunities within the objectives of the National Settlement Policy (NSP). The overall goal of the strategy is to provide a framework for the equitable distribution of investment, services, development efforts and resources throughout the district. The settlement development is heavily dependent on the availability of sustainable water sources in different tiers of settlements in the district which will be made possible by the implementation of the proposed project
National Policy on HIV/AIDS (1992)	The policy emphasizes a multi-sectoral approach and international human rights approach for addressing stigma and discrimination against people living with HIV/AIDS. Its key elements include prevention of HIV/AIDS transmission, reduction in the personal psycho-social impact of HIV/AIDS, mobilization of all sectors and communities for HIV/AIDS prevention and care for the affected and reduction of socio-economic consequences of HIV/AIDS. The policy has influenced the project's EMP especially on measures to be adopted by the contractor during implementation of HIV/AIDS prevention strategies during the construction phase.

5 ENVIRONMENTAL BASELINE OF THE PROJECT AREA

This chapter presents the results of the pre-development baseline environmental study of the project area. The purpose of undertaking the baseline study was to record the pre-project environmental status of the project area so as to establish an environmental benchmark against which the impacts resulting from the project can be measured. The chapter describes the physical, biological and the socio-economic environment of the area where the BGEWDP will be implemented. An understanding of the baseline environment assisted in a more accurate evaluation of the predicted impacts and in an accurate formulation of mitigation measures.

5.1 Vegetation

The project area is dominated by tree and shrub savanna (Bekker and De Wit, 1991). The project area consists of three major vegetation groupings of sandveld, hardveld and transitional sandveld-hardveld (Table 5-1) with sandveld being the dominant group, as shown in Figure 5-1. The sandveld covers about 90% of the project area and is on the Kalahari sands in the lower rainfall areas of the project area. It is composed of grassland and low shrub-savanna. On the east a patch of hardveld vegetation streches from Khuduyamajakwe to Medie village covering about 5% of the project area. The eastern part has generally best conditions for plant growth. Its vegetation structure is mostly shrub-savanna to savanna. A strip of transitional sandveld-hardveld is found around Kweneng village extending a few kilometers into the project area and also along Serorome River. It is composed of mainly savanna. A list of major vegetation groupings and tree species found in the project area is presented in Table 5-1 while Figure 5-1 shows the vegetation map.

The vegetation is dense to the east of Malwelwe village. Towards the west the vegetation is essentially grass (DGS, 1991). The distribution and structure of vegetation units in Kweneng District is related to the availability of water and rainfall regime. Local variations within the vegetation units are determined by the soil type, topography and surficial geology (Kweneng District Settlement Strategy 2000-2024). The western parts of the district are covered by sands and receive lower rainfall while the hardveld covers the eastern part of the district where rainfall figures are higher.

Vegetation cover of the area could be divided into four main density categories based on the sum of woody vegetation cover (WVC) and alive herbaceous cover (AHC), (Ringrose et al., 1997). These are relatively dense (>35%), medium dense (25-35%), medium sparse (15-25%) and sparse (<15%). Mostly the vegetation is designated as *Pelptophorum africanum* dominated tree/shrub savanna in the east (hardveld), with *Terminalia sericia* associations in the hardveld-sandveld transition and *Acacia mellifera/erioloba* associations becoming more prevalent in the sandveld.

Table 5-1: List of tree species found around the Botlhapatlou project area

Major Vegetation Grouping	Tree Species/scientific name	Local name	Use
Sandveld	*Terminalia sericea*	Mogonono	Fire wood, building material, making tools
	Lochocarpus nelsii		
	Acacia erioloba	Mogotlho	Fire wood, fencing
Hardveld	*Peltophorum africanum*	Mosetlha	Fire wood, tools
	Acacia tortilis	Mosunyana	Fencing material, browse
	Terminalia sericea	Mogonono	Fire wood, building material, making tools
Transition Sandveld – Hardveld	*Terminalia sericea*	Mogonono	Fire wood, building material, making tools
	Acacia tortilis	Mosunyana	Fencing material, browse
	Acacia melifera	Mongana	Fencing material

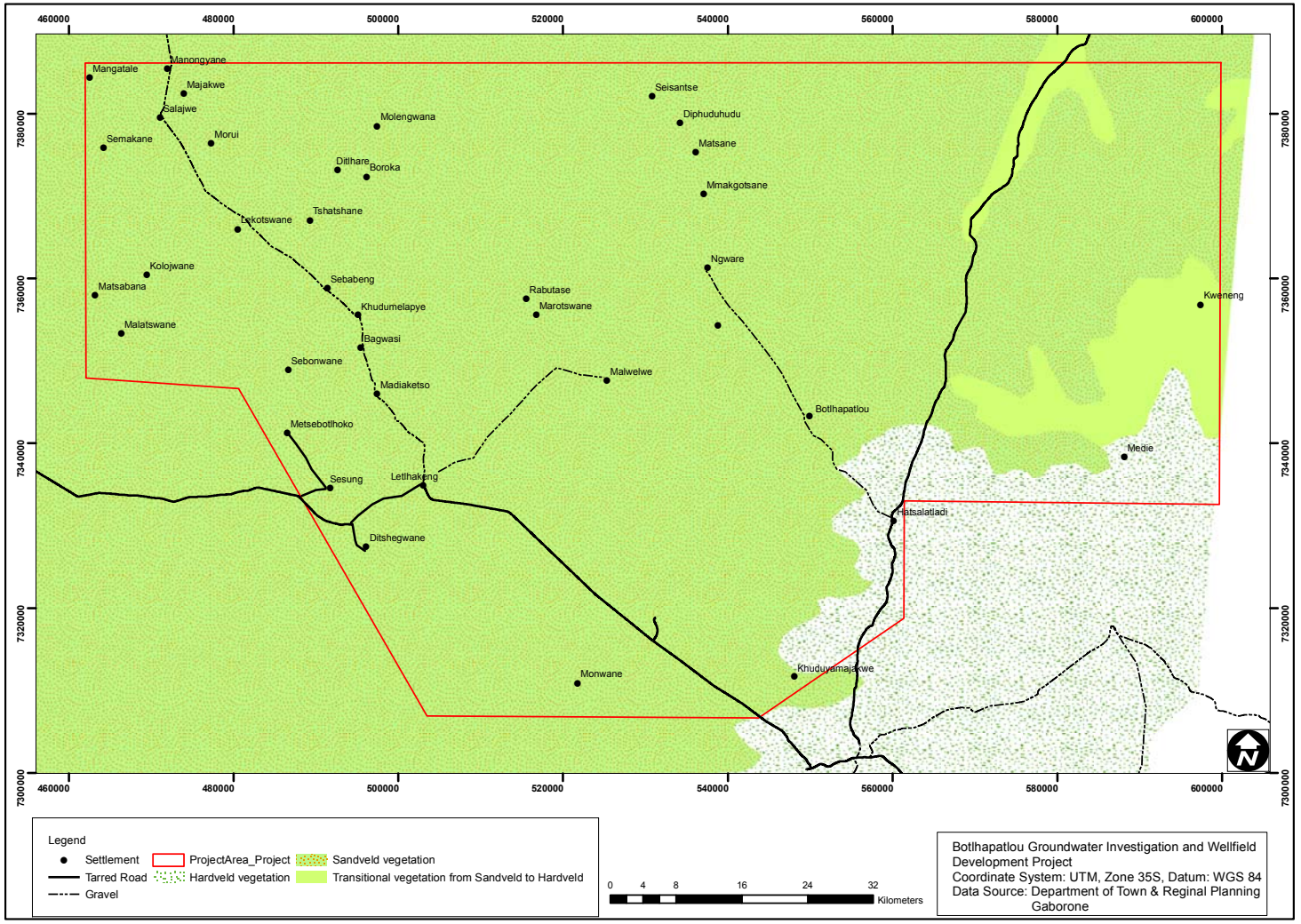


Figure 5-1: Vegetation within the project area

5.2 Wildlife

According to Kweneng District Settlement Strategy (2000), wildlife populations have declined over the years in the Kweneng District. Species such as giraffe, eland and wildebeest have declined drastically and others including gemsbok, hartebeest and springbok are few and confined to the northern part of Khutse Game Reserve and pans along the project area boundary. There are several factors that contributed to the decline of wildlife populations. These include the recurring drought which resulted in low carrying capacities, displacement by livestock (especially in western Kweneng) and human settlement. Hunting pressure has also contributed significantly to the decline in wildlife population. Wildlife is however concentrated in Kweneng West, particularly around the area lying directly south of the Central Kalahari Game Reserve. The rest of the district supports more livestock than wildlife. Only kudu, ostrich, steenbok, and duiker are found in the central part of the district because they can tolerate livestock and human activities.

Other large species such as eland, gemsbok and giraffe are found mostly in Khutse Game Reserve, which is in the northwestern part and reasonably far from livestock and human activities. These species are mostly a spill over of the animal population from the Central Kgalagadi Game Reserve. Hartebeest and springbok are common in the western and some parts in the east. Wildlife Management Areas (WMA) in Kweneng district covers an area of about 5,300m^2.

5.3 Topography

Kweneng is divided into two main regions, the hardveld to the east and the sandveld to the west. The regions are divided by a watershed west of Molepolole which is about 1,200mamsl. The hardveld is characterized by varied relief consisting of range of hills around Molepolole and Thamaga to Lentsweletau. There are also escarpments and flat plains in between. The sandveld located to the west of the district slopes westwards to 1,050mamsl west of Kweneng district and northwards to 900mamsl at Lephephe in the north. The common landforms in the sandveld are pans and fossil river valleys.

The Botlhapatlou project area lies predominantly in the sandveld region of the district. The topography of the project area is presented with a digital elevation model (DEM) shown in Figure 5-2. The highest point in the area is about 1,247mamsl around Monwane and lowest point is about 970m around Kgope/Medie on the south east. The topography of the BGEWDP area is characterized by a gentle slope with an average gradient of 2.5m/km. Two major ephemeral fluvial systems transverse the area. Dikgonnyane River on the western side of Botlhapatlou and the Meratswe River that passes through Letlhakeng. Both systems drain northwards. The Kohie and Gaotlhobogwe valleys are tributaries to the Meratswe River. The area is generally featureless with pans scattered in the western part along Letlhakeng-Motokwe road. Fossil valleys are fairly distributed throughout the project area, those in the west draining to the north and those in the east draining to the south east into the Limpopo basin.

5.4 Geomorphology

The geomorphologic features of Kweneng district follow the major physiographic units: the hardveld, which includes hills and escarpments associated with the prevailing rock types and structures and the sandveld, which is generally flat. It consists of pans and dry fossil valleys typical of calcrete formations. Most of the pans are located along the Letlhakeng-Motokwe road and in the extreme west around Tsetseng. Valleys have their origins in the hardveld or areas where the sand is limited (Kweneng District Settlement Strategy 2000-2024). Unlike other rivers they do not carry surface flow but rather transfer groundwater.

Pans in the project area are confined to the west between Khudumelapye and Mangatale. Dry river valleys are distributed in the project area. Those in the west of the project area drain into Central Kalahari Game Reserve whilst those to the east drain to the southeast into the Limpopo basin.

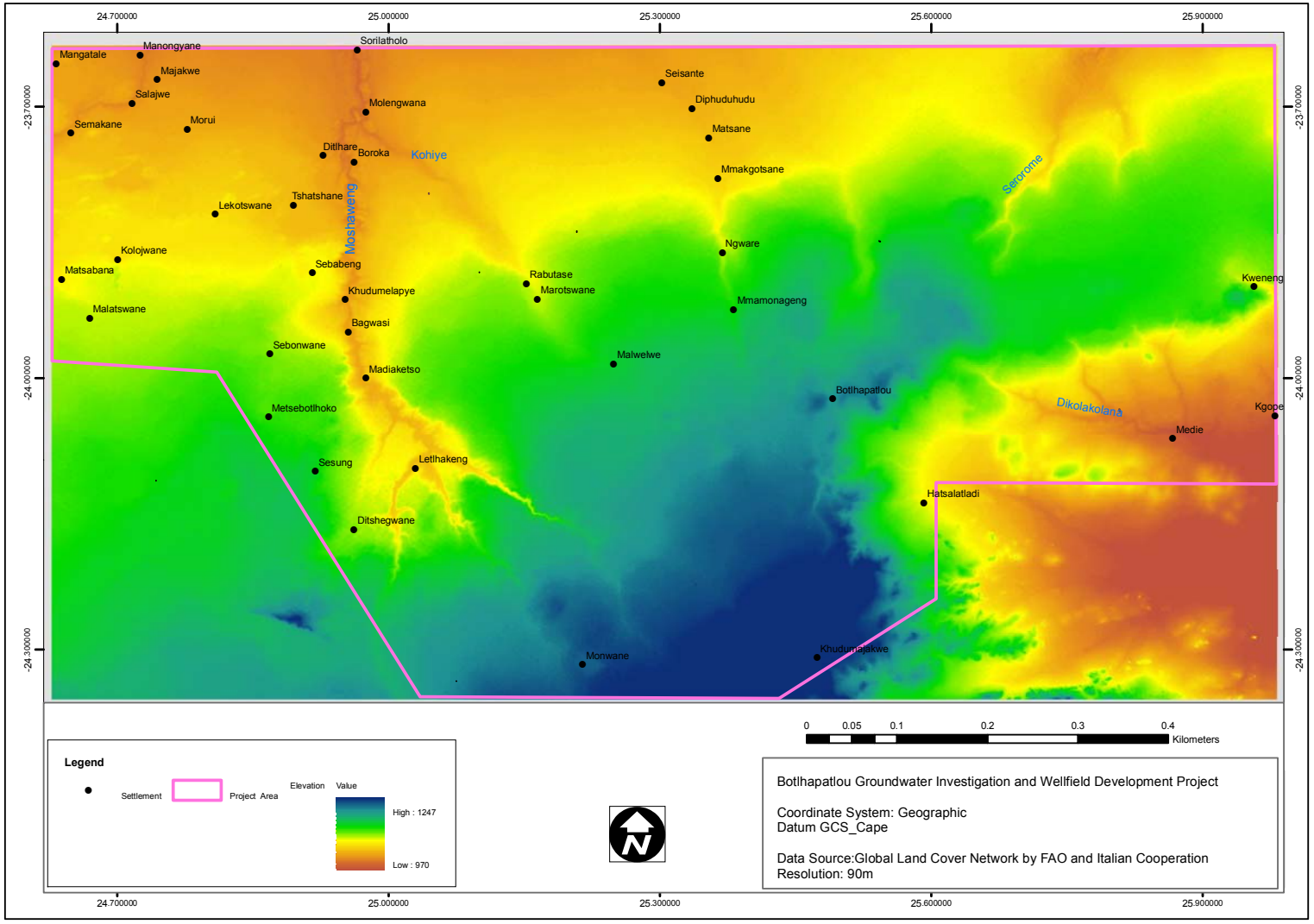


Figure 5-2: DEM of the project area

5.5 Hydrology/Drainage

The hardveld region of Kweneng district is generally of lower elevation than the sandveld and is dissected by a number of seasonal watercourses. Metsimotlhabe River (located south of the project area) and its tributaries are the main surface water resources in the district. The sandveld is characterized by low rainfall and lacks surface watercourses save for pans.

The BGEWDP area is characterized by a flat topography intersected by ephemeral river systems (fossil valleys). The main rivers are Dikgonnyane (passing near Seisante, Diphuduhudu, Mmakgotsane and Ngware villages), Kohiye (near Malwelwe), and Moshaweng (near Letlhakeng and Khudumelapye villages). These rivers drain to the northwest of the project area into Okwa valley in Central Kalahari Game Reserve. Serorome River, along the Molepolole-Shoshong road, drains to the northeast. Dikolakolana River (near Medie village) in the eastern part of the project area drains to the southeast feeding the Limpopo basin. Fossil river valleys and streams depend entirely on the local rainfall, therefore are very seasonal. None of these rivers is gauged.

There are a number of small isolated pans in the BGEWDP area. Generally the pans have clay soils that have good moisture retention capacities and relative mineral contents (Kweneng District Integrated Land Use Plan, June 2003). These pans are not fed by any river or stream hence depend on local rainfall and surface runoff for the water they hold. Because they depend entirely on local rainfall, they do not contain water for any appreciable length of time after the rains because they are subject to high evaporation losses (ca. 2000mm/year). Pans constitute an important component of the area attracting a variety of both mammals and birds during the wet season. Figure 5-3 shows the hydrology of the project area.

5.6 Hydrogeology

5.6.1 Groundwater occurence

Groundwater is known to occur in all the geological units present in the project area, with the sandstones of the Upper Karoo Lebung Group (Ntane) and Middle Karoo Ecca Group known to constitute major productive aquifers (WCS, 2012). The Ecca Group contains the most prolific aquifers and is believed to be present throught the whole project area while the Lebung aquifer occurs only to the north of the Zoetfontein Fault. Minor aquifers include the shallow Kalahari Group deposits and the Stormberg basalt. The principal aquifer units exhibit confined conditions even in the absence of clear confining layers (DWA, 1998). This is due to the heterogeneous character of the units. Water strikes are generally shallow (50-60mbgl) within the Gaotlhobogwe Valley and deeper (80-95mbgl) outside the valley. Groundwater flow in the Kweneng district (including the project area) is to the northwest towards the Central Kalahari Game Reserve, with two major changes or divides, one in the Boatlaname-Lephephe area, and another one around Magagarape where there are major wellfields (Kweneng District Integrated Land Use Plan, June 2003). At a regional level the groundwater gradient is from the southeast to the northwest and tends more to the north as flow approaches the Zoetfontein Fault located within the study area (WCS, 2012). The gradient is steeper in the southeast which is expected as this is the recharge zone.

5.6.2 Current water points

The Kweneng District comprises 411 boreholes: 89 of these boreholes belong to the Department of Water Affairs, 4 to the Department of Roads, 40 to Kweneng District Council for supplying small villages and associated localities and the rest belong to either individual farmers or syndicates mainly for watering cattle. The deepest borehole in the project area is 2,425m at Moselele owned by DWA, while the shallowest borehole is about 8m at Takatokwane owned by the Department of Geological Survey. Within the project area there are 14 production boreholes in Gaotlhobogwe Wellfield that supply the main demand centres in the project area. There are also 7 production boreholes in the Malwelwe area that supply Malwelwe and the surrounding villages. There are 42 observation boreholes that are used to monitor water levels on a regular basis. All production and monitoring boreholes belong to the DWA.

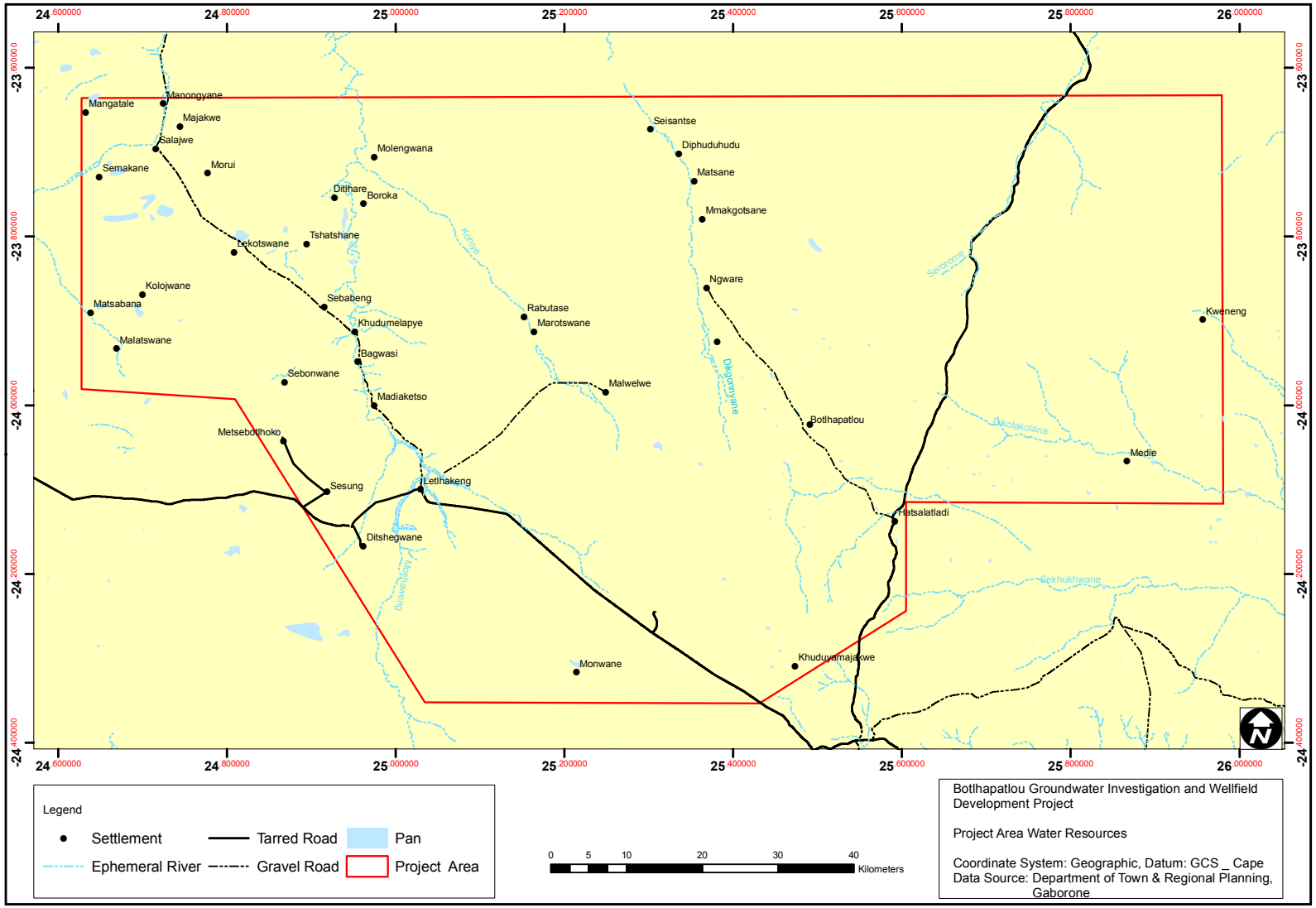


Figure 5-3: Hydrology of the project map

The area has a significant number of privately owned boreholes that are used by cattle farmers to water livestock. Their number is unknown as many of them are not registered with the WAB at DWA. However, about 9 such boreholes are registered and were drilled to tap the shallow Kalahari aquifer. Depths are recorded for only two of them (6m and 40m). Their static water levels are less than 20mbgl. The BGEWDP has now drilled an additional 35 boreholes in the project area, comprising 20 exploration boreholes and 15 production boreholes.

5.6.3 Water quality

Water quality assessment in the study area previously performed by BRGM (DGS, 1991) led to the following conclusions:

- The groundwater in all the boreholes in the study area is of potable quality. No noticeable changes of quality had been measured in the previous years.
- The TDS concentrations fall within the desirable Botswana guidelines, with a median of 470mg/l.
- Except calcium, which exceeds the desirable guidelines, all the parameters are within the acceptable limits of World Health Organisation (WHO).

As a result of the known widespread occurrence of relatively fresh groundwater and very little saline groundwater in the project area (there is a general increase in salinity down gradient to the northwest), the primary objective of the hydrochemistry component of the BGEWDP was more to address the composition of water types and their possible origin and evolution than to define the distribution of the various parameters. Still, the BGEWDP hydrochemical analyses confirmed the known water quality (very fresh), indicating that the Ecca and Lebung (Ntane) aquifers, the main aquifers in the project area, contain fresh groundwater, with TDS values ranging between 400-700mg/l and between 500-1,000mg/l, respectively (WCS, 2012). A substantial body of low TDS (<350mg/l) groundwater exists in the Ecca aquifer in the Malwelwe area, possibly indicating that the area is an area of direct recharge.

Table 5-2 shows the regional ranges of some hydrochemical parameters in the project area. The nature of the different aquifers in the area and the major hydrogeological barrier present in the project area, the Zoetfontein Fault, are thought to directly influence this diversity in the hydrochemistry of the project area.

Table 5-2: Range of selected hydrochemical parameters in the Botlhapatlou project area

Parameter	Minimum (mg/l)	Maximum (mg/l)	Average Value (mg/l)
Basalt Aquifer			
Total Dissolved Solids (TDS)	400	600	500
Chloride (Cl-)	116	238	177
Sodium (Na)	103	200	150
Bicarbonate (HCO_3)	66	256	160
Lebung Sandstone Aquifer			
Total Dissolved Solids (TDS)	400	1000	580
Chloride (Cl-)	64	447	170
Sodium (Na)	114	286	180
Bicarbonate (HCO_3)	65	563	250
Ecca Sandstone Aquifer			
Total Dissolved Solids (TDS)	313	730	475
Chloride (Cl-)	11	112	60
Sodium (Na)	34	343	190
Bicarbonate (HCO_3)	100	520	300

(Source: WCS, 2012)

Nitrate values in the Lebung/Ntane aquifer show elevated values (e.g. as high as 42mg/l in BH10685) compared to the levels in the Ecca aquifer (average 2.7mg/l). However, all recorded values to date are withing the BOS 32:2009 Standards upper limit of 50mg/l.

In summary, available water quality data show that many of the boreholes in the project area provide water that is within the BOS 32:2009 Drinking Water Specifications. A parameter that often does not meet these specifications in the project area is iron, with water from less than half of existing boreholes (usually tapping the Ecca aquifer) exceeding the specification and being classified as very hard. This often results in the encrustation of pipes, water heaters and many components of the water reticulation systems as well as the growth of iron bacteria which blocks screens and aquifer fissures, thereby reducing the overall borehole yield. This biofouling due to iron bacteria may also cause a decrease in the standard of water quality, with adverse effects on taste, colour and odour, in addition to undesirable staining.

Detailed water quality assessment and data display products can be found in Technical Report No. 5: Hydrochemistry and Recharge Report (a part of the overall groundwater project report: WCS, 2012).

5.7 Geology

5.7.1 Regional geological setting

A summary of the lithology of the sub-region in which the project area falls is presented in Table 5-3 while the geological map is shown in Figure 5-4. More detailed accounts of the lithology and geology can be found in various volumes of the BGEWDP groundwater report (WCS, 2012).

Table 5-3: **Generalized stratigraphic sequence of the sub-region**

Age	Supergroup	Group	Formation	Lithology
CENOZOIC		Kalahari	Kalahari Beds	Loose sands, cretes, calcareous sandstones and mudstones
MESOZOIC	**KAROO**	Stormberg	Ramoselwana Volcanics	Crystalline, massive amygdaloidal basalts
		Lebung	Ntane	Fine to medium grained, clean, friable sandstone, brownish red/pink. Often calcretized in zones
			Mosolotsane	Red/brown greenish mudstones and siltstones with fine to medium, occasionally coarse, intercalated sandstones. Basal conglomerate in places.
		Beaufort	Kwetla	Grey mudstones and siltstones with minor sandstones. Non-carbonaceous. Occasionally arenaceous.
		Ecca	Boritse	Fine to coarse, white, feldspathic sandstone interbedded with coal, carbonaceous mudstone and siltstone
			Kweneng	Predominantly medium to coarse grained feldspathic sandstone, grits with subordinate siltstone and mudstone. Minor coals.
			Bori	Dark, micaceous siltstone/mudstone and minor sandstone
		Dwyka	Dukwi	Purple siltstone and very fine sandstone. Massive, dark grey, sandy mudstone and siltstone. Purple mudstone rythmites/varvites with dropstones. Tillite, conglomerate with quartzite/granite clasts in sandstone matrix
PROTEROZOIC	**WATERBERG**			Reddish siliciclastic sedimentary rocks, mostly quartzitic sandstone and conglomerate
	TRANSVAAL			Interbedded reddish, grey and purple quartzite, carbonaceous siltstone and shale, chert, limestone, ironstone and volcanic.

(Source: WCS, 2012)

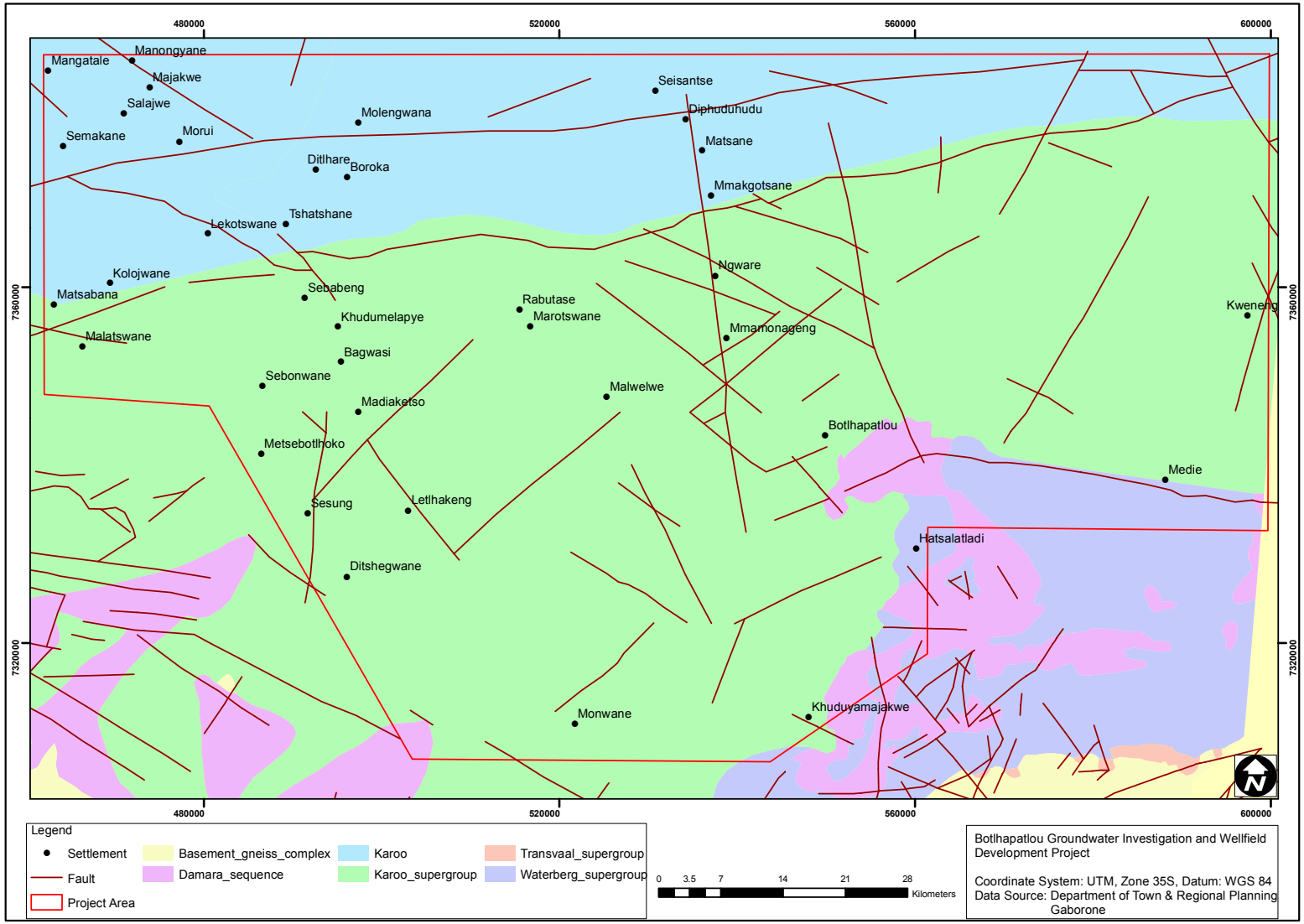


Figure 5-4: Geology of the project area

The project area is located on the northern margin of the Archaean Kaapvaal Craton which is marked by the sub-continental Zoetfontein Fault zone (WCS, 2012). The cratonic basement of the region consists of granite batholiths that dominate the geology of south east Botswana (Gaborone Granite). Overlying the ancient cratonic body are sedimentary and volcanic sequences of the Ventersdorp, Transvaal and Waterberg Supergroups. This continental shield is overlain by strata of the central Kalahari Karoo Basin consisting of various units of the Karoo Supergroup (Ecca and Dwyka Groups) that are themselves overlain by the aeolian units of the Kalahari Beds.

5.7.2 Pre-Karoo Basement

The Waterberg Supergroup is considered the basement in the Botlhapatlou project area, together with pre-Karoo gabbroic and doleritic intrusions. The Waterberg Group is the most widespread of the pre-Karoo geological units and largely comprises fractured, dark purple/pink ferruginous feldspathic and quartzitic meta-sandstone, siltstone and shale thought to have been deposited in a semi-arid continental lacustrine to fluvial environment. These strata have been subjected to lower green schist metamorphism.

5.7.3 Karoo Supergroup

The Karoo sedimentary strata of Late Palaezoic to Late Mesozoic age lie unconformably on the Proterozoic basement rocks. The strata comprise a sequence of tillite, mudstone, siltstone, sandstone and coal that vary both spatially and with depth. This sedimentary succession indicates variation in the depositional environment from the lowermost Dwyka glacial deposits, through to lower to middle Ecca coal forming environment to the upper Ecca non-carbonaceous, lacustrine, argillaceous deposition. The uppermost Karoo surface is a major erosional unconformity obscured by variable thickness of the Kalahari Group deposits.

The Dwyka Group is the basal unit of the Karoo Supergroup and is represented by the Dukwi Formation. Boreholes in the project area that penetrate the pre-Karoo basement show that the Dwyka unit is laterally impersistent in the project rea. The upper units of the Karoo Group (i.e. the Lebung and Stormberg) occur almost exclusively to the north of the Zoetfontein Fault. The Lebung unit is divided into the lower Mosolotsane Formation and the upper Ntane Sandstone Formation. The Ntane Sandstone Formation is the most widespread and most understood aquifer in Botswana and is the principal target for groundwater exploration in many parts of the country, including the BGEWDP.

The Ecca Group is divided into the Lower Bori Formation, the middle Kweneng Formation and the upper Boritse Formation. Borehole data suggests that the Ecca Group is present throughout the project area. The uppermost unit of the Karoo Supergroup is the Stormberg Lava Group, also known as Stormberg Basalt, consisting of a very extensive and often very thick sequence of flood basalts that mark the end of the Karoo sedimentary succession. Within the project area the Stormberg Basalts occur almost exclusively to the north of the Zoetfontein Fault.

5.7.4 Kalahari Group

The Kalahari Group (also known as Kalahari Beds) consists of post-Karoo superficial deposits that are widespread in Botswana. In the project area the Kalahari Beds comprise a discordant and highly variable sequence of loose to poorly consolidated aeolian sand, silcrete and calcrete intercalations of variable proportions, ferricrete, silcretized/calcretized sandstones, poorly cemented sandstones and silty to sandy clays (WCS, 2012). The thickness of the group in the area is generally in the range 2-25m.

5.8 Soil

Kweneng District is generally flat and displays three ecological regions: the hardveld, sandveld and transitional hardveld-sandveld. Soil groups include leptosols, vertisols, arenosols, regosols, calcisols, luvisols and lixisols. The soil distribution depends on the parent material and topographic position. The soil map for BGEWDP area is shown in Figure 5-5 and the explanatory notes are shown on Table 5-4.

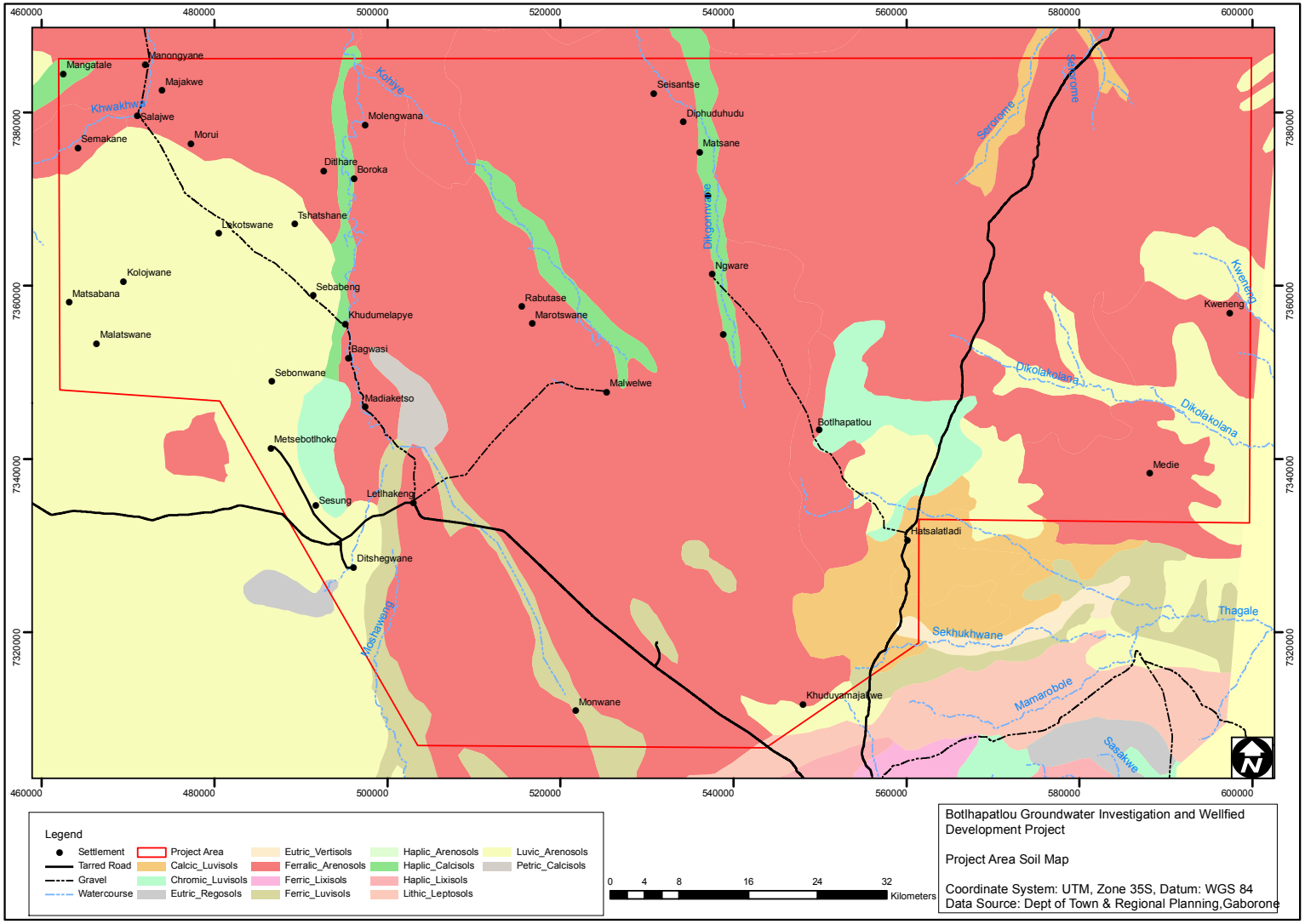


Figure 5-5: Soil map of project area

Table 5-4: Explanatory notes of the soil types

FAO 88 (Name)	Soil description and Topography
Calcic Luvisols	Deep to very deep, imperfectly to moderately well drained, dark to strong brown sandy clay loams to clay. Flat to slightly undulating
Chromic Luvisols	Moderate deep to deep. Moderate well drained to well drained. Dark red to strong brown sandy loam to sandy clayloam. Almost flat to undulating
Eutric Regosols	Very shallow to shallow. Well drained, yellowish red to dark reddish brown, sandy loam to clay loam. Undulating to almost flat
Eutric Vertisols	Clayey soils that form deep (>50 cm), wide (>1 cm) cracks when dry
Ferralic Arenosols	Deep to very deep, well to somewhat excessively drained, red to strong brown fine sand to loam fine sands. Flat to undulating. Other Arenosols showing ferralic properties within 125 cm of the surface and colouring of the B-horizon expressed by chromass of 5 or more and/or hues redder than 10
Ferric Lixisols	New soil class, formerly Luvisols, with clays with low cation exchange capacity
Ferric Luvisols	Moderately deep to deep. Well to well drain. Strong brown to red sandy loam to sandy clayloam. Undulating.
Haplic Arenosols	Sandy soils with little profile development.
Haplic Calcisols	New class of soils with accumulation of calcium carbonate
Lithic Leptosols	New class of soils that is shallow in depth and with weak profile development.
Luvic Arenosols	Deep to very deep, well to somewhat excessively drained, red to strong brown fine sand to loam fine sands but showing lamellae of clay accumulation. Flat o undulating.
Petric Calcisols	New class of soils with accumulation of calcium carbonate

Source: FAO (1988)

The project area is largely covered by ferralic arenosols. Strips of haplic calcisols within the arenosols (ferralic) are confined to the north of the project area along Moshaweng River after Letlhakeng village and along Dikgonnyane River through Ngware village. Luvic arenosols border the western and eastern sides of the project area. Patches of luvisols arenosols, chromic luvisols and calcic luvisols are visible to the south of the project area around Botlhapatlou to Hatsalatladi. Ferric luvisols stretch from Letlhakeng southward to Monwane village.

5.9 Climate

Kweneng district falls within the subtropical zone. It has a semi-arid climate. The rainfall is almost the same throughout the district. There are two main seasons; winter and summer. The winter period is between May-August while the summer is usually from October-March, with April and September as autumn and spring transition months. Droughts are common and vary spatially and temporally.

5.9.1 Rainfall

Rainfall patterns in Kweneng district are influenced by the westerly winds that affect the region during the first and third part of the rainy season between October and December, and March and April. The Inter-Tropical Convergence Zone (ITCZ) brings moisture on its southwards migration between January and March. Figure 5-6 shows the rainfall pattern of the period between 1997 and 2007. Ninety percent of the rainfall in Kweneng district falls between October and March. The lowest rainfalls are experienced between April and August.

5.9.2 Temperature

Temperatures are high during the summer months with an annual highest maximum temperature of 35ºC and mean maximum temperature of 27ºC. Peak summer temperatures occur during dry spells. Winter temperatures are relatively low with the annual lowest minimum temperature of 2ºC and an annual mean minimum of 11ºC. Minimum and maximum temperatures for the district are shown on Figure 5-7 and

Figure 5-8. According to the Kweneng District Settlement Strategy (2000) high rates of evapotranspiration are experienced during summer months when temperatures are high.

5.9.3 Wind

Wind speeds are relatively low between May and July and they are highest in October. For most of the district, the mean annual wind speeds are 3-3.5m/s with a small fall in the eastern parts. During thunderstorm wind speeds can increase up to 25m/s. The most predominant winds in the region are easterly and north easterly. Southerly winds normally accompany summer thunderstorms, and cold fronts in winter come with southeasterly winds. Figure 5-9 shows the wind speed and direction in Kweneng district. Due to lack of synoptic stations in the project area data from Sir Seretse Khama Airport weather station was used.

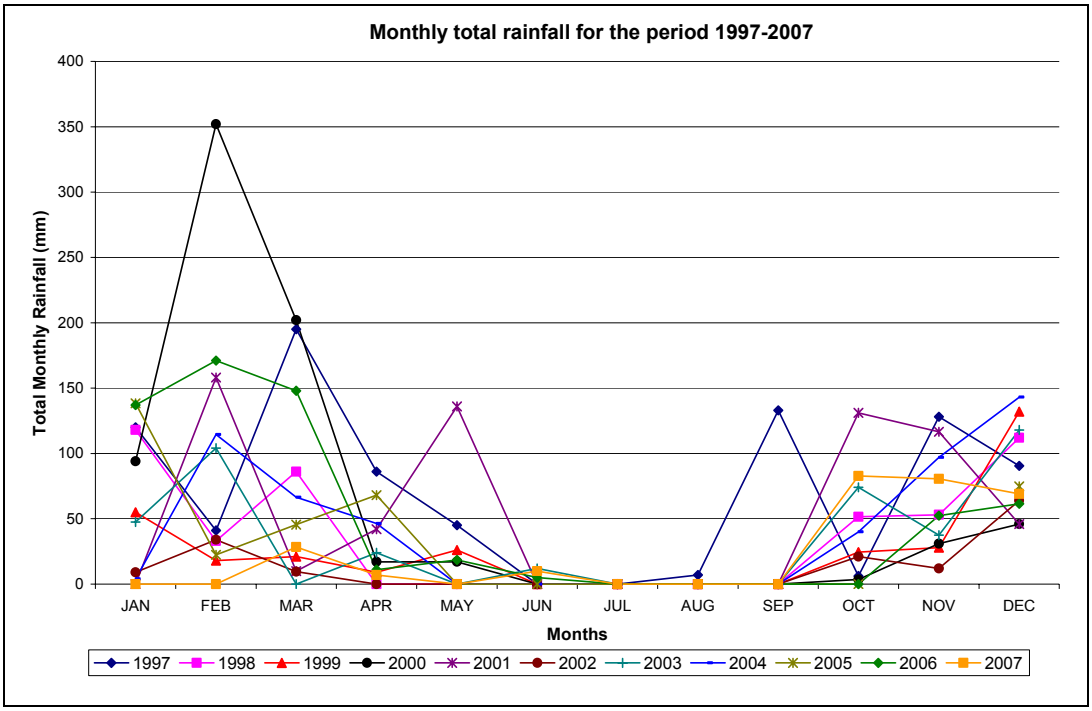


Figure 5-6: Total monthly rainfall for the period between 1997 and 2007

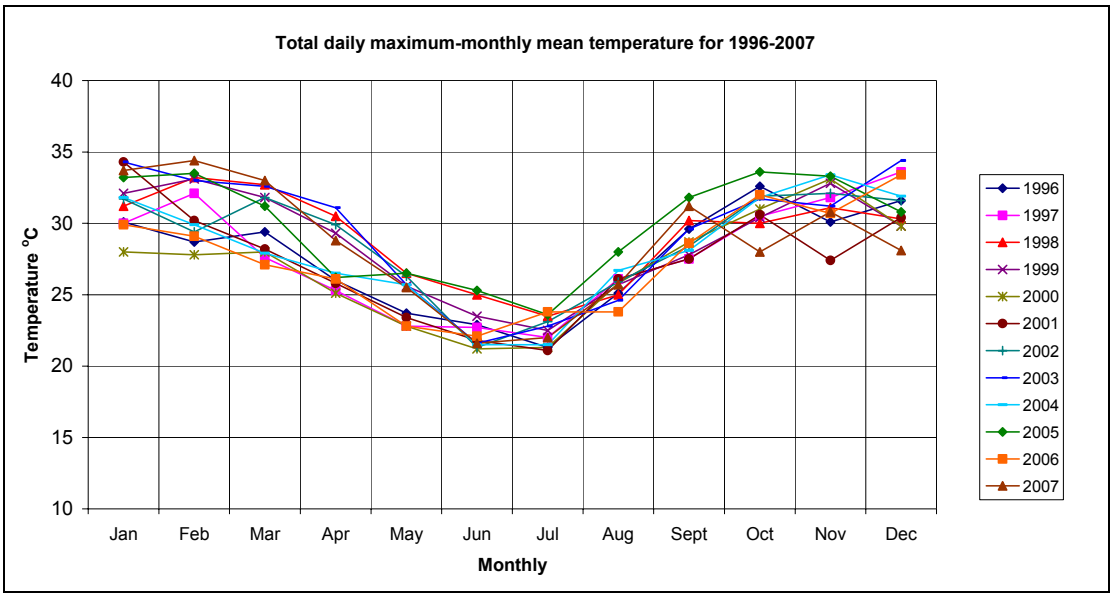


Figure 5-7: Total maximum-monthly mean temperature for 1996-2007

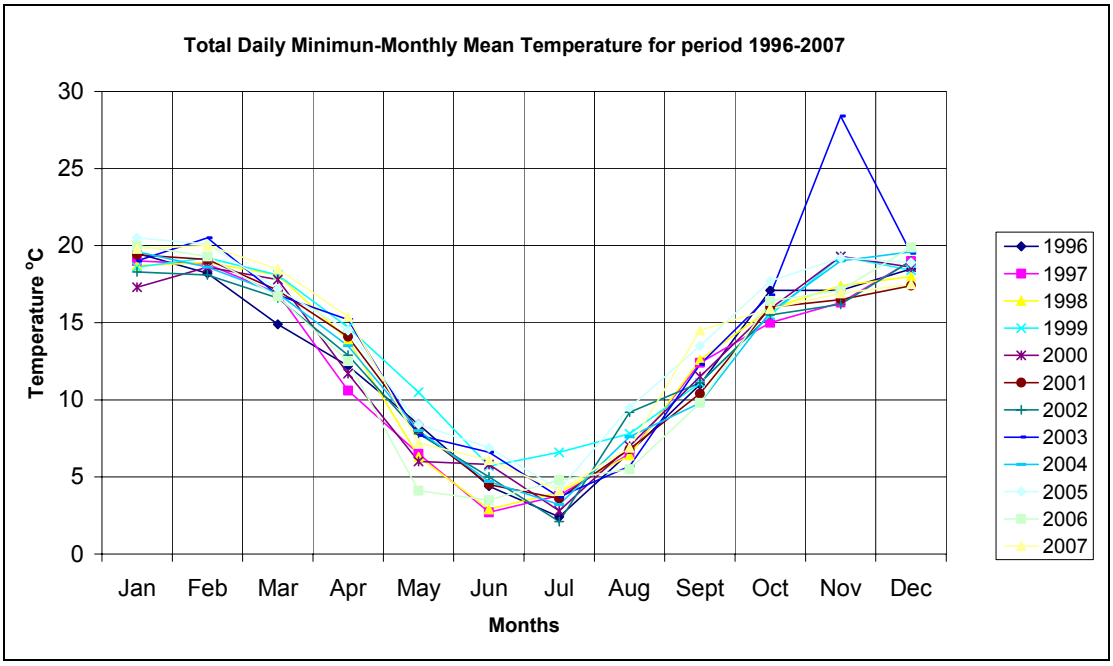
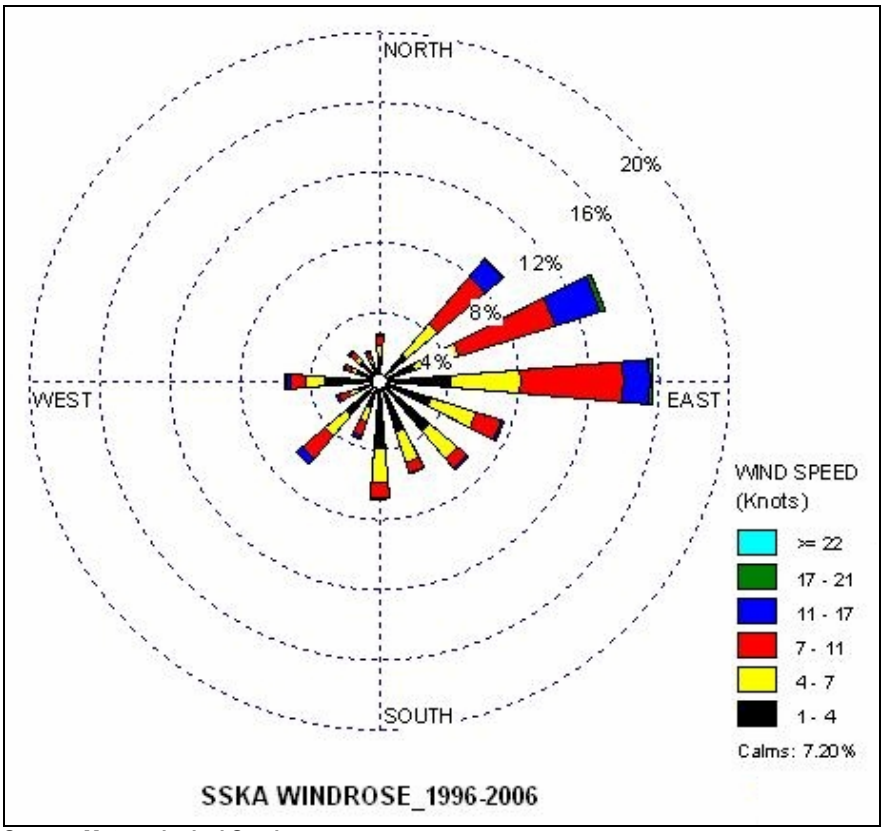


Figure 5-8: Total minimum-monthly mean temperature for 1996-2007



Source: Meteorological Services

Figure 5-9: Windrose

5.10 Dust and ambient air quality

Ambient air quality is typical for the Kalahari savanna and only affected negatively by periodic fires and dust in dry season.

5.11 Noise and vibrations

The area is peaceful with noise (defined as an unwanted sound, an unsolicited intrusion of one's peace and quiet) almost entirely absent.

5.12 Socio-cultural characteristics

5.12.1 Population characteristics

According to the 2011 Population and Housing Census, Kweneng District has a total population of 304,549 which represents about 15% of the total population of the country. The female population accounted for 50.9% of the total population compared to 49.1% for males. The majority of the population is concentrated in Kweneng East region that includes the major settlements of Molepolole, Gabane, Mogoditshane and Thamaga and their respective localities. The latest census shows Kweneng East to have a population of 256,752 which represents 84.3% of the total population for the District.

5.12.2 Population density

With a population of 304,549 in 2011 and an area of 38,122km^2, Kweneng District has a population density of 8 persons/km^2 compared to the national population density of 3.5 persons/km^2. This represents an increasing population density compared to 2001 when the population was 229,755 people with a

resultant population density of 6 persons/km^2. People in the district are concentrated in the eastern region. It would thus be expected that this region, including Molepolole and surrounding villages and the areas near Gaborone City, would have a significantly higher population density than the west.

5.12.3 Population growth trend

Table 5-5 shows the population growth trends in Kweneng District for the last few census periods. Kweneng District exhibits an annual growth rate that is consistently higher than the national rate. The main reason for this is the district's proximity to the capital city Gaborone and the related town push factors. According to the 2011 census, Molepolole is the largest village in Botswana in terms of population. In general, however, the population of Botswana continues to increase at diminishing growth rates. Table 5-6 shows the current (2011) populations as well as projected populations for a number of villages within the project area.

Table 5-5: Recent Kweneng District population growth trends

Census Period	Population growth		Annual growth rate (%)	
	from	to	Kweneng District	National
1971-1981	72,093	117,127	5%	4.6%
1981-1991	117,127	170,437	3.8%	3.5%
1991-2001	170,437	229,755	3.0%	2.4%
2001-2011	229,755	304,549	Not yet available	1.9%

Source: CSO (2011, 2002)

Table 5-6: Population projections for Botlhapatlou and associated localities from 2011-2021

Locality Name	Census Results	Population Projections	
	2011	2016	2021
Molepolole	66,466	67,494	72,388
Botlhapatlou	1,223	1,077	2,021
Ditshegwane	2,114	2,079	2,228
Boatlaname	1,049	953	1,022
Letlhakeng	7,229	7,102	7,610
Salajwe	2,440	2,007	2,151
Ngware	919	675	723
Khudumelapye	2,080	2,163	2,318
Hatsalatladi	726	753	808
Diphuduhudu	535	658	705
Malwelwe	1,146	1,095	1,173
Sesung	1,481	1,508	1,616
Kgope	368	627	673

Source CSO (2011, 2002)

5.12.4 Ethnicity

Kweneng District consists of various ethnic groups with distinct norms, customs and beliefs that are specific to each group. Bakwena are the most predominant group. Other groups include Bakgalagadi, Basarwa, Bakgatla, Bahurutshe and Balete. Like elsewhere in the country, the ethnic groups live in harmony with each other.

5.13 Local Economy and Employment

The western part of the district commonly referred to as the sandveld has poor resources base and very low population density and no significant industrial activity. Lack of telecommunications infrastructure and other services makes this part of the district unattractive to investors hence hampering commercial and industrial development in many villages. The district has tourism potential as a gateway to Khutse and

Central Kgalagadi Game Reserves. The number of tourists visiting the area has not improved due to lack of basic infrastructure and economic development, lack of overnight accommodation facilities and tourist guides dealing specifically with the district.

The active labour force of the district is engaged in two major activities, namely subsistence agriculture and wage employment. The formal sector is the leading employer in the district with the government sector being the biggest employer. Broad categorization of employment in Kweneng district is depicted in Table 5-7 by sector and sex.

Table 5-7: Kweneng district employees by sector and sex

Sector	Male	Female	Total	%
Central Government	1788	2188	3979	26.22
Local Government	1633	1316	2949	19.43
Parastatal	240	105	345	2.27
Private	2198	478	2676	17.63
Informal	835	1680	2515	16.57
Other	1648	1063	2711	17.86
Total	**8342**	**6830**	**15172**	**100**

Source: Labour Force Survey, CSO

5.14 Historical sites

Kweneng District is rich in areas of pre-historic, historic, cultural, natural and scenic interests, few of which are protected from being destroyed and have permanent custodians. For instance, the aloe forest west of Molepolole is of botanical and historical importance, yet the aloes are not protected. There also exists Sechele's Cave, located high in a rock outcrop along the Molepolole-Thamaga Road, which needs preservation. The cave is said to have once housed tribal medicines.

5.15 Land Tenure and Land Use

5.15.1 Land Tenure

There are two types of tenure in the Kweneng District, communal or tribal land and state land. Almost all of the land in the district is communally owned. Khutse Game Reserve is the only piece of land in the district that is under state land ownership. The project area is wholly within tribal land. Table 5-8 shows the land disposition within the Kweneng District.

The tribal land in the district consists of communal grazing, mixed farming, arable areas, Wildlife Management Areas (WMA), Botswana Defence Force (BDF) Air Base and Tribal Grazing Land Policy (TGLP) commercial ranches. Tribal land is allocated by Kweneng Land Board and held under either customary grants or common law tribal leases. Land held under customary grants includes lands areas, borehole sites and residential plots in villages. Land held under common law tribal leases includes commercial and industrial plots and some residential plots in settlements, and government ranches.

Table 5-8: Land Dispositions within Kweneng District

Land Use	Tenure	Area (km^2)	Percentage (%)
Communal land and villages	Communal or held under customary grants or common law tribal lease	28,133	73.8
Commercial Ranches	Common law tribal lease	2,250	5.9
Khutse Game Reserve	State Land	2,440	6.4
Wildlife Management Areas	Tribal	5,300	13.9
	Total	**38,123**	**100**

Source: Kweneng District Planning Study, 1991

5.15.2 Land use

The general three tier Tswana settlement pattern of home, lands and cattle post is a common practice in Kweneng, although there are instances where lands and cattle posts are within one area, as is the case in the western parts of the district. There is encroachment of residential areas into other land uses especially arable land in many villages in the eastern part of the district, including most of the project area. Of all the land in the district, 73.8% is used for arable agriculture, grazing mixed farming and residential purposes under the tribal land tenure system. Figure 5-10 shows the area's land use.

5.15.2.1 Arable Agriculture

Arable farming is practised throughout the Kweneng district. It is however more intensive in the southeastern hardveld, which is the Metsimotlhabe catchment area and in the northern hardveld around Lephephe, Sojwe and Shadishadi. The rains in the area are however unreliable, resulting in low crop yields. According to the Kweneng Settlement Strategy (2000-2024) arable agriculture production has declined over the years mainly because of drought and poor farming practices. Many fields have remained fallow or abandoned for many years because of the recurrence of drought.

5.15.2.2 Communal grazing

Communal grazing is a predominant form of land use in Kweneng district particularly in the western, northern and north east part of the district. Access to water is a major constraint to livestock production in some parts of the district particularly for farmers who do not have boreholes. Farmers who do not have boreholes resort to wells and pans to water their cattle. Boreholes are often too close to each other resulting in increased overgrazing making such areas susceptible to soil erosion and land degradation.

5.15.2.3 Commercial Ranches

The Tribal Grazing Land Policy (TGLP) was introduced in Kweneng in 1980. Under the TGLP, 24 commercial ranches were established in the south central part and 11 commercial ranches in north eastern Kweneng between Sojwe and Ngware. The establishment of these ranches was to reduce the pressure on communal land from cattle grazing by promoting the movement of cattle from communal grazing areas to ranches. Most of the commercial ranches were not developed and suitable water for cattle was not found hence farmers took their cattle back to communal areas. Many of the ranches are as equally overgrazed as communal areas due to overstocking and bad management practises. Cattle graze in both the ranches and communal areas. Consequently, the aim of reducing land pressure from communal lands by removing large herds has not been realised.

5.16 Infrastructure

5.16.1 Telecommunications

Most villages in the Kweneng district have been provided with major telecommunication infrastructure to expand Botswana Telecommunication Corporation (BTC) network. These include Molepolole, Mogoditshane, Thamaga, Gabane, Metsimotlhabe, Lentsweletau, Letlhakeng, Kumakwane, Kopong and Thebephatswa. Other villages with telecommunication infrastructure and services include Gakgatla, Gamodubu, Mantshwabisi Moshaweng, Ditshegwane, Maboane, Takatokwane, Salajwe, Khudumelapye, Ngware, Malwelwe, Mahetwe, Boatlaname, Sojwe and Lephephe. Mobile telephone service provided by Mascom, Orange and Be-mobile have also been introduced in most of these villages to further improve the telecommunication services.

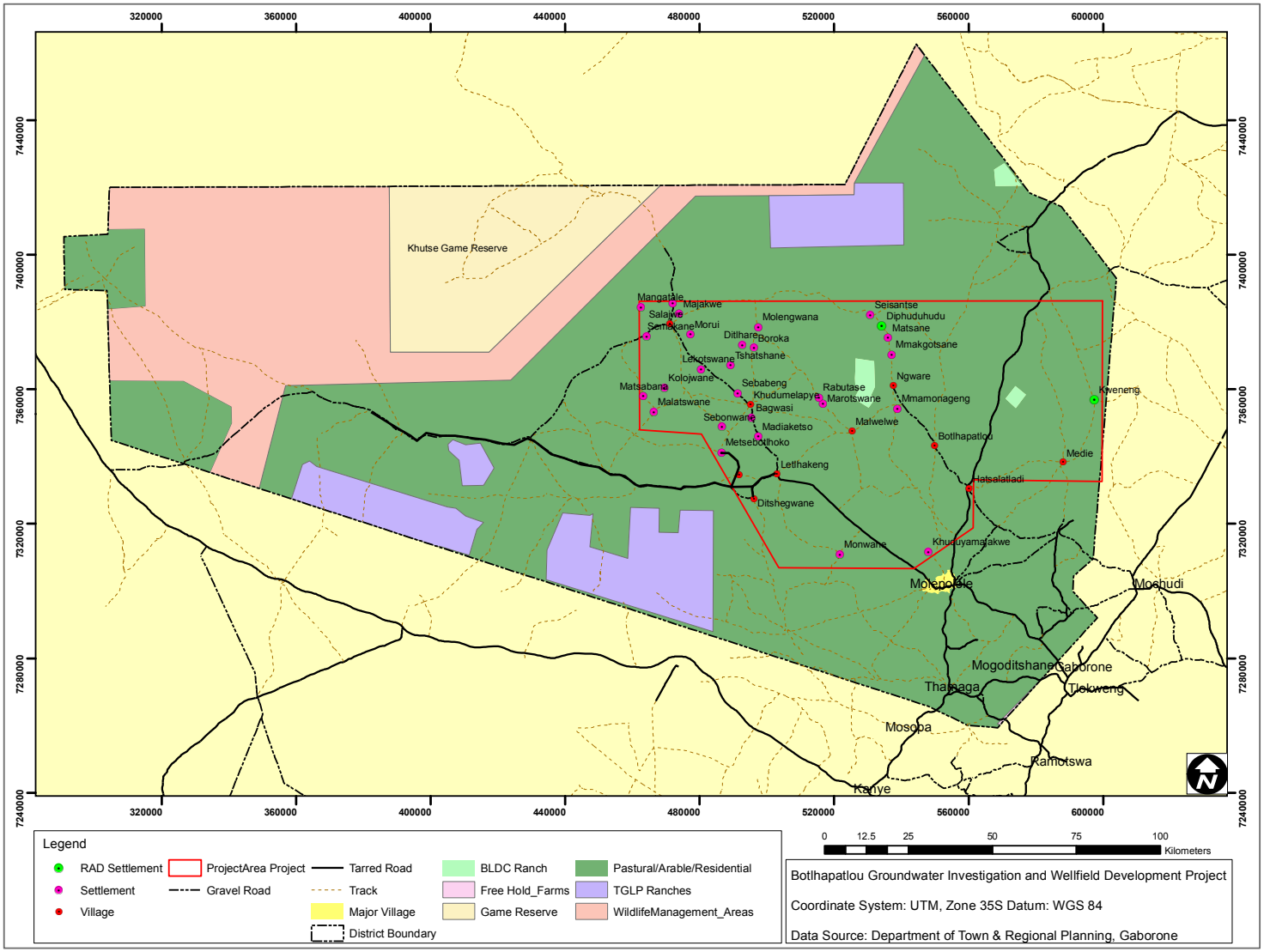


Figure 5-10: The Kweneng District Land Use map

5.16.2 Roads network and transport

There are six major tarred roads in Kweneng district. The first is the Gaborone-Mogoditshane-Molepolole road which connects the district headquarters to Gaborone, the nation's capital and major commercial centre. The second one is the Gaborone-Gabane-Moshupa-Kanye road which runs through the southern part of the district connecting Thamaga and its localities to Gaborone and Kanye. The third is the Molepolole-Letlhakeng road which connects the district headquaters to the sub district centre of Letlhakeng. The fourth tarred road is the Thamaga-Molepolole-Lephephe road. The fifth road is the Metsimotlhabe-Kopong road. Lastly there is the Letlhakeng-Morwamosu road which connects the district to the Trans-Kgalagadi Highway. Figure 5-11 shows the road network and other services in Kweneng District.

5.16.3 Power supply

Settlements in the district which have access to electricity supplied by the Botswana Power Corporation (BPC) are Molepolole, Mogoditshane, Thamaga, Gabane, Letlhakeng, Metsimotlhabe, Kopong, Kumakwane, Mmopane, Mmankgodi, Sesung, Salajwe, Khudumelapye, Takatokwane and Sojwe. There are very few people in the district with electricity connections to their houses due to high costs of private connections, particularly when their plots are located far from the main lines. Fuelwood forms an important source of energy for cooking and heating in the district.

5.16.4 Water supply

There are two authorities which are responsible for the provision of water in the district. There is the Department of Water Affairs which is responsible for the major villages water supply (Molepolole, Mogoditshane and Thamaga) and the Kweneng District Council Water Unit is responsible for water supply for the rest of the villages. The villages where DWA supplies water are declared water works areas. In the smaller villages with storage and reticulation systems, DWA designs and constructs the village water supply system and subsequently hands them over to the Council to operate. Within the project area, all the small villages are supplied by the Kweneng District Council Water Unit. The water demand in Kweneng district has increased over the years leading to increased pressure on the supply.

Note: Water Sector reforms currently being undertaken by the government will eventually transfer water supply functions from DWA and the District Councils to the parastatal Water Utilities Corporation (WUC).

5.17 Social Amenities

5.17.1 Education Facilities

The provision of education facilities in Botswana is the responsibility of the Ministry of Education and Skills Development (secondary schools) and the various District Councils. The Ministry of Education and Skills Development has the responsibility of designing the primary education curriculum, providing and paying teachers, school inspection and arranging examinations. The Kweneng District Council is responsible the administration and supervision of primary schools including provision of school buildings, furniture, equipment and books.

5.17.1.1 Primary Education

According to current figures provided by the Regional Education Office in Molepolole, Kweneng District has a total of 102 primary schools: 91 government primary schools (operated by the council) and 11 private primary schools. The government primary schools have a total enrolment of 44,650 pupils in 1,434 streams, with 1,682 teachers. The private primary schools have a total enrolment of 4,245 pupils in 152 streams, with 217 teachers.

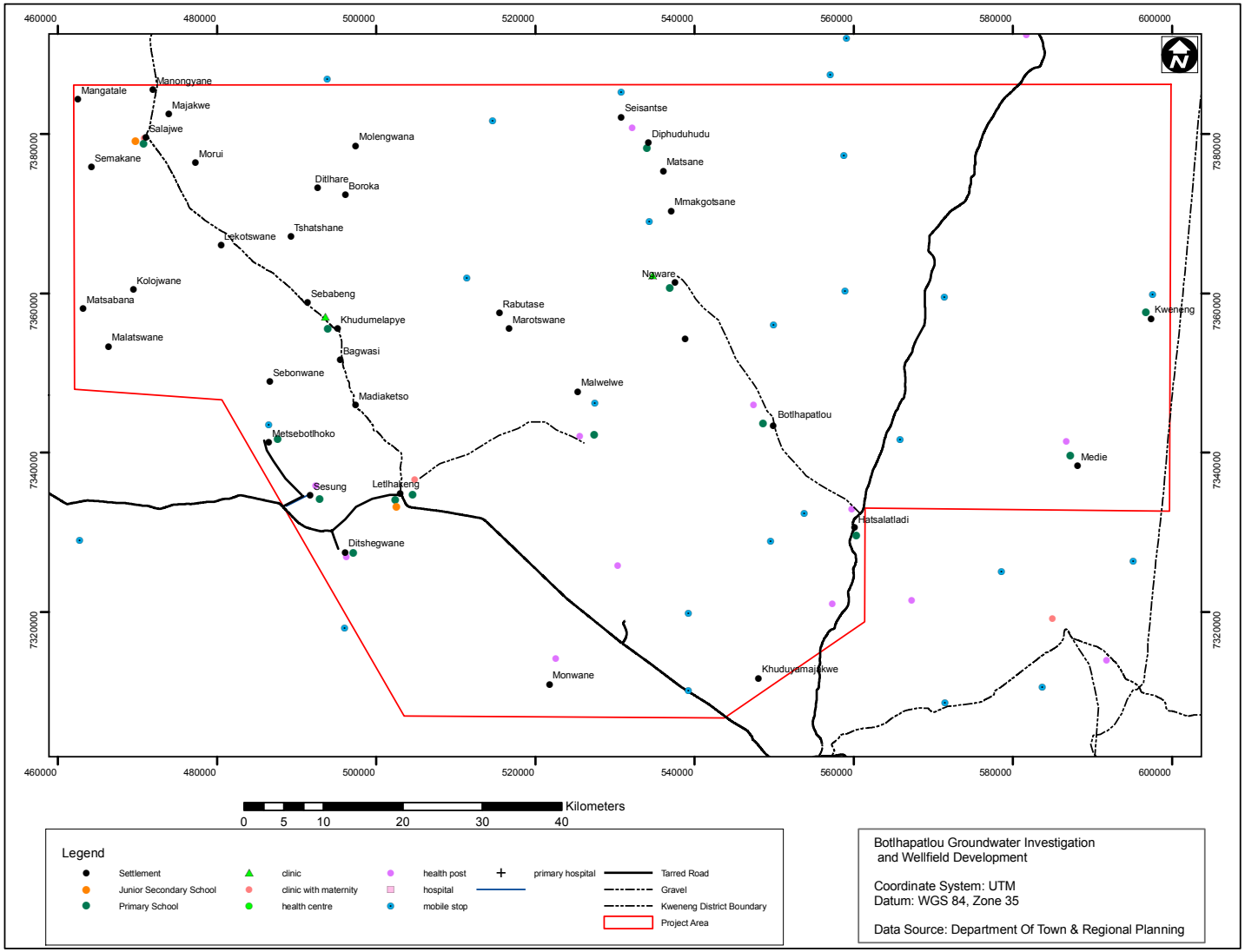


Figure 5-11: The infrastructure facilities and amenities within the project area

5.17.1.2 Secondary Education

According to current information from the Ministry of Education and Skills Development, Kweneng District has a total of 30 secondary schools: 24 junior secondary schools, 2 senior secondary schools and 4 private secondary schools. The 2012 figures for the government secondary schools (i.e. all except the private secondary schools) show that enrolment stands at 21,801 students in 476 streams, with 1,293 teachers. The 2 senior secondary schools, located in Molepolole and Mogoditshane, have a combined enrolment of 6,195 students in 92 streams, with 236 teachers. Junior secondary schools have an enrolment of 15,606 students in 384 streams, with 1,057 teachers.

5.17.1.3 Other Education Institutions

There are other education facilities in Kweneng District, namely Molepolole College of Education (MCE) which specialises in training teachers for the secondary schools. The district also has schools for the disabled, such as the Mogoditshane Rehabilitation Centre run by Cheshire Foundation.

5.17.2 Sanitation

According to the 2001 statistics, which are the latest available for these parameters, out of 52,578 households in the district, 24% did not have access to toilet facilities. About 11% used flush toilets, 16% used ventilated pit latrines, 33% used own pit latrine, 8% used communal pit latrine and about 7% used neighbours toilet in Kweneng. Within the Kweneng District, only Mogoditshane has an operating village wide reticulated sewerage system while Molepolole has a limited sewerage scheme which only caters for public institutions such as schools and health facilities.

The Kweneng District Council is responsible for the provision of solid waste management services. This is achieved through regular collection and disposal of refuse. Kweneng district is vast and there are several government and private sector developments taking place in the district. A regional landfill has been constructed in Gamodubu and is expected to cater for the district's solid waste disposal issues. There are a lot of activities that indicate that there is a lot of waste generated and the district requires proper refuse storage receptacles and adequate vehicles.

5.17.3 Health Services

The Kweneng District Council is responsible for the provision of primary health services in the district. The provision and maintenance of Primary Hospitals, District Hospitals and National Referral Hospitals is the responsibility of the Ministry of Health. The health service criterion is based upon the concept of referral system with the highest being a district hospital and the lowest being a health post. Figures for 2012 show that Kweneng District has a total of 77 health facilities: 1 district hospital in Molepolole, 2 primary hospitals in Thamaga and Thebephatshwa, 1 private hospital near Metsimotlhabe, 8 clinics with maternity wards, 24 clinics without maternity wards and 41 health posts.

6 STAKEHOLDER AND PUBLIC CONSULTATION PROCESS

This section describes the mechanisms that have been used to facilitate consultations with Interested and Affected Parties (IAPs) as part of the EIA Study for the Botlhapatlou Groundwater Exploration and Wellfield Development Project (BGEWDP). The consultation approach is presented together with the views of the relevant stakeholders.

6.1 Stakeholder identification

The stakeholders indicated on Table 6-1 have been identified through a stakeholder analysis process. The approach involved a systematic methodology of identifying all those who are directly affected by the project and those who may assist in the project's smooth implementation. A comprehensive process of engaging the public was followed with the aim to identify issues and concerns and to establish the effective working relations with the community, national and local government authorities, Non Governmental Organisations (NGOs) and any other parties that expressed interest in the proposed project. The IAPs were consulted in order to brief them about the impending project before commencement of public consultation meetings. This activity was also meant to seek their views, concerns and perceptions about the proposed project. One-on-one interviews and telephone interviews were conducted with various government officials. The aim was to establish ongoing and planned developments in the area.

Table 6-1: **List of Interested and Affected Parties**

Stakeholder	Name	Contact Details	Reason for consultation
Bakwena Paramount Chief	Kgari Sechele (III)	5920246	Key community leaders who should be consulted to inform and mobilize the community on any developments in their areas
Malwelwe Chief	Mr J. Mokgwapha	-	
Ditshegwane Chief	Mr S. Morwaanare	5943300	
Botlhapatlou Chief	Mr P. Omphitlhetse	-	
Ngware Chief	Mr K. Kobelwane	5932007	
Sesung Chief	Mr. T. Tsietso	5943393	
Boatlaname Chief	Mr. O. Mojalemotho	5931411	
Hatsalatladi Chief	Mr. S. Gabanamotse	72255428	
Molepolole - Chief's representative	Mr. N. Bakwena	5920246	
Salajwe Chief	Mr. M. Gaerupe	71407703	
Khudumelapye - Chief's representative	Mr. O. Mosimane	5931809	
Letlhakeng Chief	Mr. I. Gaonowe	5943051	
Village Development Committees (VDCs)	(various)	-	Responsible for village development programmes
Kweneng Land Board/DOL	Mr. M. Shatera	5920355	Because they are the land custodians in Kweneng District. Establish if there are any outstanding issues connected to land allocation and planned developments in the area.
District Land Use Planning Unit (DLUPU)	Mr. G. Malatsi	5920355	
Department of Water Affairs (Molepolole Station Manager)	Mr. G. Mohutsiwa	5920263	Responsible for water distribution in Molepolole and maintenance of the network.
Meteorology Officer	Ms M. Ntsosa	3956281	To obtain meteorological data for Botlhapatlou project area.
Department of Water Affairs (project proponent)	Messrs O. M. Moehadu & K. Keetile	3607100	Client representatives: responsible for the implementation and supervision of the project.
DEA (Gaborone office)	Ms N. Motshubi	3902050	For the review of the EIA reports for the purpose of approval.

Stakeholder	Name	Contact Details	Reason for consultation
The public	See Appendix C2		To inform them about the project and solicit their views, concerns and expectations regarding the project.
Members of Parliament	Hon. D. Kwelagobe Hon. G. Matlhabaphiri Hon. M. Pheto Hon. F. Nagafela Hon. G. Mokgwathi	5921162 5999436 5779201 5943177 5932456	To inform them about the project and solicit their views, concerns and expectations regarding the project.

The formal engagement with other interested and affected parties continued throughout the BGEWDP in order to ensure that the EIA project team has captured all significant issues concerning the project.

6.2 The public consultation approach

Disclosure to the public was done in accordance with the EIA legislation, which requires a 21-day notice period prior to the undertaking of consultation sessions. The 21-day notice commenced with placement of an advertisement in the local newspaper. The advertisement was placed in both English and Setswana in *Mmegi* newspaper dated 16th January 2009 (See Appendix B). Information sharing presentations were conducted in the 11 villages shown in Table 6-2. The meetings were addressed by representatives of DWA, Wellfield Consulting and Aqualogic, using multi-media, flip chart and maps to allow for a comprehensive understanding of the proposed development. In all the 11 villages the meetings followed a similar process: introduction of the visiting team, a background to the project, proposed project activities and the expected positive and negative impacts from the project. After the presentations attendees were offered the opportunity to raise issues and concerns regarding any aspect of the proposed project. Attendance registration forms were circulated during the meetings in order to capture the number and names of people who attended the meetings. Minutes of the proceedings of the public consultative meetings and attendance registers are provided in Appendix C2. Minutes of meetings with other stakeholders are provided in Appendix C1. Pictures of some of the people who attended the public meetings are shown in Appendix D.

Table 6-2: Regulatory public meetings held in the 11 villages

Village	Date	Time	Venue
Molepolole	06/02/09	0900hrs	Village Main kgotla
Botlhapatlou	09/02/09	0900hrs	Village kgotla
Hatsalatladi	09/02/09	1400hrs	Village kgotla
Letlhakeng	10/02/09	0900hrs	Village kgotla
Malwelwe	10/02/09	1400hrs	Village kgotla
Ditshegwane	11/02/09	0900hrs	Village kgotla
Sesung	11/02/09	1400hrs	Village kgotla
Khudumelapye	12/02/09	0900hrs	Village kgotla
Salajwe	12/02/09	1400hrs	Village kgotla
Ngware	13/02/09	0900hrs	Village kgotla
Boatlaname	13/02/09	1400hrs	Village kgotla

6.3 Issues raised by the IAPs during consultation

In general the IAPs including the directly affected communities held a positive view of the project. This is largely because shortage of water in the district affects everyone. The outcomes of the public meeting sessions in the various villages are summarized in Table 6-3.

Table 6-3: Summary of the outcomes of the public consultation meeting

ISSUE/QUESTION RAISED	RESPONSE
HEALTH AND SAFETY	
Provisions to deal with public health issues, with specific reference to HIV/AIDS	The EIA Study will culminate with an EMP which will detail mitigation measures to lessen or avoid the identified impacts
Concern about the possible spread of HIV/AIDS	HIV/AIDS has been identified as one of the possible negative impacts that will be addressed in the EMP
NATURAL ENVIRONMENT	
Environment is adversely impacted during construction	An EMP will be developed and would present mitigation measures of the expected impacts
Concern over potential impacts like possibility of oil spillages and waste management	The EMP would includes specific measures that will address the issue of waste management in general and oil waste in particular
WATER	
Shortage of water is a major concern in the project area	Replacement of the 7 boreholes at Gaotlhobogwe Wellfield and rehabilitation of the distribution network will alleviate the current situation. Botlhapatlou project will ensure adequate water supply for the next 10 years.
Permission to the members of the public to use some of the project boreholes that the DWA does not use	Confirmed that some of the remaining boreholes might be leased to the general public. Locals advised to form syndicates and apply for boreholes which will not be connected to supply the villages.
Intended use of water that will be supplied from boreholes drilled during Botlhapatlou project	The water that will be supplied from the boreholes which will be drilled during the Botlhapatlou project will supply people
Watering livestock from the same source supplying people	The responsibility of DWA is to provide water for domestic purpose only. Locals should check Ministry of Agriculture for possible provisions on water for livestock
Whether there is a possibility that indigenous groundwater surveyors could be engaged in the project	The current government policy is to use the expertise of professionals such as geophysicists with traceable academic background only.
The government should consider building dams in Kweneng district	The DWA has found out that the southern part of the country including Kweneng district have no sites for building dams of sizes big enough to supply the villages with water sustainably. The hydrology of the area does not allow it.
Locals cheated by people who claim to be groundwater surveyors. How can they verify that the people they contract are legitimate	Local people are advised to use registered groundwater companies. The list of legitimate companies can be obtained from the DWA offices in Gaborone.
LAND USE	
Concern about impact of the project on existing properties especially ploughing fields and boreholes.	The groundwater project would try by all means to avoid people's properties. However when properties are affected, the owners are adequately consulted and properly compensated in line with the Land Board guidelines.
The amounts of compensation are normally too low	Since the Land Board is responsible for assessment of affected properties and recommending the compensation amounts using its guidelines, they are the ones who could take the matter up
Drying of privately owned boreholes due to the project boreholes.	DWA generally drill their boreholes some significant distance from existing boreholes; however there are certain instances where it cannot avoid affecting the boreholes. Locals advised to contact DWA if their boreholes dry due to the proposed project.
PUBLIC PERCEPTION ON CONSULTATION	
DWA commended on consulting the public about the proposed project.	Comment noted and emphasis made on importance of the EIA Act and its main requirement of consulting the public before project commencement.

ISSUE/QUESTION RAISED	RESPONSE
RECRUITMENT AND EMPLOYMENT	
DWA advised to ask contractors to hire locals.	Comment was noted. The EIA Study makes recommendations of preferential employment of locals in the EMP.
EIA team advised to closely monitor construction to ensure that the contractor adheres to the EMP.	There will be an environmentalist and archaeologist on site to ensure that the EMP is followed.
Duration of the project	The groundwater project is scheduled to take 20 months.

The issues raised by the IAPs were found to be important and needed to be addressed in both the EIA study as well as during the actual BGEWDP implementation. The issues were thus taken into consideration in the overall assessment of potential impacts of the project and in developing both the Code of Conduct and the mitigation measures encompassed in the EMP.

7 IDENTIFICATION OF THE PHASE 2 IMPACTS

7.1 Impact Identification

This chapter presents the results of the process of identification of the potential impacts of Phase 2 of the BGEWDP, namely the Exploration and Production Phase. The key techniques used in the identifying potential impacts of the proposed project were (i) Project Activity Matrix (PAM), (ii) consultation with the Interested and Affected Parties (IAPs) and (iii) field surveys. A comprehensive approach to environmental impact assessment was adopted in the process as different specialists were engaged. The advantage of using PAM was that it linked the identified impact to the associated project activity and provided the required description. The BGEWDP Project Activity Matrix is shown on Table 7-1.

7.1.1 Project activities

The project activities that are associated with Phase 2 of BGEWDP are:

- Camping (not more than 20 people at any point) with associated storage and workshops
- Ground geophysics (line cutting – to create working space and surveying)
- Drilling – involves at least 4 heavy trucks (rig, compressor, water truck, support truck)
- Test pumping (test pumping unit and support truck) - water continuously pumped from a borehole and released into the environment

Table 7-1: Project Activity Matrix of BGEWDP - Phase 2

Project aspect	Environment affected by the project aspect	Description
Camping / Storage / Workshop	• Soil structural damage (erosion) • Oil spillage • Waste generation • Fire hazard • Loss of vegetation (trampling) • Fuel wood collection • Influx of job seekers • Noise • Increased risk of spread of HIV/AIDS • Social ills • Boost to the local economy	Setting up of temporary accommodation for project staff and their equipment
Ground Geophysics	• Loss of vegetation • Habitat destruction • Land use conflict • Boost to the local economy • Employment creation	Involves clearing of vegetation along cutlines at the target areas for the geophysical work to be done easily
Drilling	• Loss of soil • Oil spillage • Noise • Fire hazard • Poor aesthetic value • Boost to the local business • Impact on existing privately-owned boreholes • Stimulation of land use changes • Provision of environmental information (including geophysical and hydrogeological data)	The process involves drilling of several holes on the ground for purposes of extracting water resources to supply the project area. Heavy machinery which includes rigs and trucks will be used during the process. Drilling muds and noise are the major negative impacts but are expected to be on a short term basis.
Test Pumping	• Change to chemistry of the soil • Temporary source of drinking water for livestock and wildlife • Boost to the local economy	Refers to continuous pumping from a borehole to test its capacity and potential for recovery. Pumping can be up to a period of 7 days.

7.2 Description of Impacts

7.2.1 Soil structural damage (erosion)

Heavy vehicular traffic would undoubtedly destroy soil structure thus creating surface sealing and dense compact soil with subsequent effects of reduced water infiltration and increased runoff. These have further consequent effects on soil erosion with the following significant impacts:

- gully developments that will eventually restrict road transport accessibility (especially for small vehicles)
- loss of surface soil especially organic matter loss with consequent effects of reduced biological activity, low water-holding capacity and low nutrient retention
- uprooting of local vegetation

The removal of soil by drilling operations has major impacts of reduced productive potential and food security threats. Consequent effects of soil loss include:

- loss of organic matter essential for maintaining soil structure and nutrient supply
- low water holding capacities and nutrient capacities
- destruction of habitat for soil fauna and vegetation

Once there is less vegetation cover, the surface soil will be exposed to wind, with a potential problem of fine particles being blown over distance to negatively affect human life and similarly the fine particles will transfer airborne diseases to plant foliage.

7.2.2 Oil spillage

Oil spilled from machinery and storage facilities can drain into the soil or be washed into streams and rivers by surface runoff. This would result in contamination of the soil, surface water and groundwater. The oils leached into the soil can affect soil biochemistry and productivity. Light crude oil in particular may also vaporise into the atmosphere and return to the soil or surface waters as acid-rain. Interactively these factors can disrupt reproduction in birds and cause cancer and hormone effects in humans and other animals.

7.2.3 Waste generation

Waste generated either from machinery and human littering is likely to result in the build up of heavy metals and other harmful chemicals in soils. Metals like lead and nickel are additives to petrol and can be leached into the soil through rainwater. Heavy metals such as zinc, copper and lead are a serious threat to human health and may kill some soil organisms besides rendering the soil unproductive. Similarly the burning of fuel wood can release some toxic elements into the atmosphere which can later be deposited on the soil where they will ultimately find their way into the vegetation.

7.2.4 Fire hazard

Outbreak of fires through use of candle lights, volatile gases (e.g. petrol, paraffin) or human error will lead to increased temperatures with that can have a negative impact through increased loss of water from soil and reduced rainfall in dry areas and consequent changes in hydrological water regime. There will also be loss of soil fauna and some vegetation species thus creating an ecological imbalance.

7.2.5 Changes to chemistry of the soil

Pumping of water especially of low quality (especially in contaminated sites) to the surface will undoubtedly increase the risk of acidification and salinization (salt accumulation) problems to inhibit the soil productivity capacity. Mobile pollutants will find their way through groundwater flow to distant places. These pollutants will reduce local vegetation growth and as well as soil suitability to pastoral and arable farming thus affecting the livelihoods of the inhibiting communities.

7.2.6 Boost to the local economy

The appearance of camping facilities in the neighbourhood might invite informal traders to start selling their wares near the camps. Employees of the companies commissioned to undertake the groundwater investigations and drilling would contribute significantly to boosting the local business. Both informal and formal businesses would benefit immensely from these salaried employees. It is expected that these employees would buy some of their foodstuffs, toiletry and other necessities from the local grocers and other shops.

7.2.7 Employment Creation

The project would create a few employment opportunities for minor jobs such as line cutting during ground geophysics and trench excavation during infrastructure development.

7.2.8 Provision of water security

Communities in the project area have complained over serious shortages of water and the poor quality of available water in their villages during public consultation meetings. Since communities have been informed of the impending groundwater project, the project would bring hope in alleviating water shortages in the project area.

7.2.9 Influx of job seekers

Due to the general high unemployment level in rural areas, the project brings hope of employment to the local young adults and other job seekers from within and from outside the project area. The groundwater investigation and development project is not expected to provide jobs to many locals. The level of unemployment in the project area would compel local job seekers to influx the project sites which might in turn increase the crime levels in the area.

7.2.10 Noise

Camping and more especially drilling bring along unfamiliar and strange noise to the neighbourhood and/or to the animal ecosystem depending on where the activity is located; the usual tranquillity of the environment would be disturbed. Such noise results from the human activity of workers who have camped at the site as well as from drilling operations and other project activities.

7.2.11 Risk of spread of HIV/AIDS

It has been noted from previous experiences that emergence of camping activities invites the occurrence of risky sexual behaviours between those camping and the host communities, and within and among those camping. A concern was raised in the project area regarding the experiences of young girls' incursion into camps mainly in search of men employed by companies involved in these developments. Such activities significantly contribute to an increase in the HIV/AIDS epidemic.

7.2.12 Increased pressure on social amenities

Due to the influx of job seekers into the area, there will be added demand for provision of public services such as health and justice. This will continue during all stages until the end of the project. Various public services will also be sought by employees who have camped.

7.2.13 Land use conflicts

The proposed project activities involve going through private land properties. There is a possibility of meeting resistance in accessing land property for this activity. Although permits are acquired to access such properties, some land property owners might claim infringement on their land rights. It is possible that they may refuse access to such land which might destabilise groundwater investigations and development activities.

7.2.14 Loss of vegetation

Line cutting involves cutting down some vegetation to create working space for surveying. Although vegetation is not uprooted, part-removal of vegetation disturbs the balance of the ecosystem. Certain areas with thick vegetation would be affected and would have a different visual appearance. Such vegetation would usually grow back after the project.

7.2.15 Impact on existing privately-owned boreholes

There are two scenarios to the situation of existing privately owned boreholes. The situation mainly stems from the subject of Water Rights. It should be noted that privately owned boreholes with water rights would not be affected as long as the BGEWDP follows DWA guidelines and procedures for drilling a borehole in the vicinity of an existing privately owned borehole. All consultants engaged by DWA for water exploration are contractually required to follow these guidelines. The first scenario is that there is evidence to indicate that several boreholes are being utilized without Water Rights from the Water Apportionment Board (WAB) based at DWA in Gaborone as a result of lack of knowledge. This came out clearly from the public consultations in which several individuals wanted to understand how a Water Rights certificate is sought. Some community members were concerned that the current project borehole drilling would interfere with their water levels in their privately drilled boreholes. They brought to light the lack of knowledge they had regarding Water Rights of boreholes. It should be noted that boreholes without Water Rights might be affected by this project since DWA would not be aware of their existence. The second scenario is that of hand-dug wells used to water livestock in the project area. Some community members pleaded with the DWA during the public consultations to consider avoiding drilling boreholes near areas where such wells exist.

7.2.16 Poor aesthetic value

The original appearance of the drilling area is usually disturbed by clearing and drilling activities. The drilling muds contribute a lot to the area's non-appealing aesthetics. Visual appearance of the surrounding environment will be affected by the proposed project activities.

7.2.17 Stimulation of land use changes

The drilling of boreholes in the area might have both negative and positive impact to the land use. Some people may decide to move as a result of the drilling exercise. Some may decide to switch use of land for business purposes due to the impending water source. Usually, such developments create land use conflicts.

7.2.18 Impact on Archaeological Resources

The drilling may have negative impacts on the buried archaeological resources in the area, if any. Prior to the drilling exercise however, a detailed archaeological assessment exercise was conducted on the individual drilling sites so as to ensure that the particular site does not have any significant material that could be destroyed. A copy of the approved AIA Report is appended to this report as Appendix H. A summary of the AIA Report is given in the next chapter.

8 FINDINGS OF THE AIA COMPONENT

The Department of Water Affairs in the Ministry of Minerals, Energy and Water Resources (MMEWR) engaged Aqualogic (Pty) Ltd to carryout consultancy services for the Detailed Environmental Impact Assessment (EIA) for the Botlhapatlou Groundwater Exploration and Wellfield Development Project (BGEWDP), Tender No. PR 10/3/1/08. The aim of the BGEWDP was to investigate, assess and develop potable groundwater resources to supply villages of Botlhapatlou, Molepolole, Thamaga, Thebephatshwa, BDF camp and the surrounding villages such as Letlhakeng, Khudumelabjwe, Salajwe, Ngware as well as other localities. An Archaeological Impact Assessment (AIA) was conducted as part of the EIA Study and an AIA Report submitted under separate cover to the Department of National Museum and Monuments.

The BGEWDP intended to study in detail the groundwater resources in order to supply demand centres in the area. A number of data gathering techniques have been utilized such as desktop studies, field reconnaissance and geophysical techniques in order to site the exploration and production boreholes. Thereafter the drilling of the boreholes using appropriate machinery was done. The drilled boreholes were tested by use of test pumping techniques to determine their sustainable yield and utilization potential.

Archaeological Impact Assessments (AIA) studies are carried out in response to development proposals that have a potential to disturb or alter archaeological sites. The archaeological site assessment process is usually composed of the following three components: (i) identification and documentation of archaeological resource, (ii) assessment of significance and (iii) assessments of effects.

Most development proposals go through a number of stages of planning and implementation; therefore archaeological assessments done in the early stages of the project produces the best outcomes. The stage the development proposal has reached will have an effect on the type of archaeological work that has to be carried out, the level of detail required and relevant reporting requirements. This report represents the stage where site significance has to be determined so as to come up with appropriate mitigation requirements.

Various sources of information were reviewed before and after the site survey was carried out. The field work included site surveying, examining visible ground disturbance spots and previously drilled boreholes for information. Due to the huge extent of the survey area, no ground invasive examinations were carried out to identify sub-surface deposits. Site evaluation involved site location, extent, nature and importance of archaeological values present and determining the likely impact during project site establishment and development stages. Sufficient information was gathered to form a view of the significance of the area in terms of exposed archaeological resources. The result of the assessment have shown that the proposed project area has no archaeological material of any significance (see Table 8-1) and that the project can go ahead on the condition that the proposed archaeological management plan (see Table 8-2) is implemented.

Table 8-1: AIA findings for the BGEWDP project area

Location	Archaeological Occurrences	Significance and Comments	National Museum Ranking
Proposed Boreholes	None	No significance	DNMM 5
Proposed Campsites	None	No significance	DNMM 5
Possible Pipeline Connection Routes	None	No significance	DNMM 5

Table 8-2: Archaeological Management Plan for the BGEWDP project area

Archaeological Impact	Mitigation Measure	Key Performance Indicator	Implementing Organization	Responsibility	Timeline
Groundwater Exploration Phase					
Damage to Archaeological Resources	Educate contractor(s) on the type of artifacts or features to look for. Engage an on-site archaeologist to clear all future drilling sites (e.g. for production boreholes)	Archaeologist to be on site when required. Site reports compiling discovery	Client, with assistance and guidance from the Department of National Museum and Monuments	Consultant Archaeologist	During earthworks or as may be required if/when occurrences are uncovered
Wellfield Development Phase (Reticulation)					
Damage to Archaeological Resources	Engage an archaeologist during excavation for pipe laying	Archaeologist to be on site when required. Report with results from the construction phase	Client, with assistance and guidance from the Department of National Museum and Monuments	Consultant Archaeologist	During earthworks or as may be required if/when occurrences are uncovered

As an effort to better protect and safeguard the national heritage, it was recommended that:

- A watching brief by an archaeologist should be conducted for the duration of the exploration, production and supply construction period. Some intrusive sites might be exposed during the exploration activities and as such the presence of an archaeologist would ensure that immediate mitigation procedures are in place as well as executing a proper archaeological management plan.
- The construction of the possible supply routes be limited to or aligned with the already existing services of roads, pipelines and power lines.
- Should the Contractor encounter any archaeological material during excavation, they should stop immediately and inform the project archaeologist or DNMM at the following telephone number: +267 3974616. This could be made easier by inducting the workers and machine operators about archaeology and archaeological material in general. This should be done before any work commences on the site.

9 ASSESSMENT AND MITIGATION MEASURES OF PHASE 2 IMPACTS

This chapter provides a summary of the RIAM results and the recommended mitigation measures for the negative impacts and enhancement measures for the positive effects of Phase 2 of the BGEWDP (for an explanation of RIAM see RIAM Notes under Appendix A). The contractors involved in Phase 2 of the BGEWDP were required to implement these measures in totality in order to ensure that the environment is protected.

Most impacts under the economic and operational component are positive with the exception of the impact the project boreholes would have on individually owned existing ones and hence needed to be enhanced. The two significant positive impacts are the provision of environmental information which the EIA project has done which will result in the better environmental conservation efforts in the area as well as the improved water supply which was the main aim of the groundwater project. The boost to the local economy is also a positive change as it is long term and cumulative. Employment creation will be short term hence falls within the slight positive range band. However the drilling of boreholes may result in the land use changes as a result of the newly extracted water resource resulting in a slight negative change.

A summary of the RIAM results for the assessment of impacts of Phase 2 of the BGEWDP is given in Figure 9-1 (to be read in conjunction with Table 9-1 which describes the different range bands (RB)). The figure shows cumulative number of impacts in each Range Band. The component classes are colour coded for easy reference.

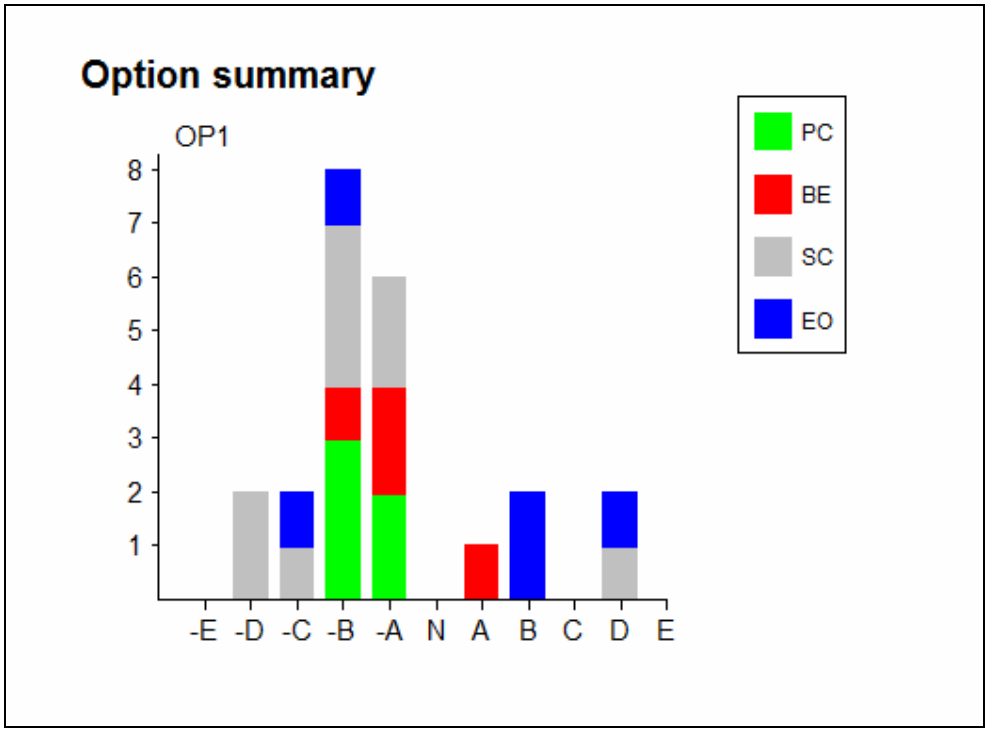


Figure 9-1: Summary of RIAM results for BGEWDP Phase 2 Impacts

As can be noted from Figure 9-1, most of the positive impacts are in the economic-operational category. All impacts of the physical-chemical category are negative with a minor to moderate environmental score. The biological-ecological category has several negative impacts but most of the impacts of this component are minor in significance. The socio-cultural component has several significantly negative impacts and this is where the mitigation measures were focused.

The mitigation measures recommended for the various impacts in each of the four components are given in Table 9-1, Table 9-2, Table 9-3 and Table 9-4. In addition to the above suggested mitigation measures, the Drilling Contractor was given a Code of Conduct which completed the efforts of ensuring that the

area's environment was effectively protected from the possible negative impacts of the project during the implementation of the phase. The recommendations from the AIA Report on how to preserve and protect the significant archaeological sites and artefacts were also availed to the Contractors.

Table 9-1: Recommended mitigation measures for physical/chemical impacts

Code	Impact	RB	Mitigation measures
PC1	Oil spillages	-A	• Regular checks and maintenance/service of vehicles to minimize potential oil leakage and spills
PC2	Waste generation	-B	• The site personnel are encouraged to adhere to environmental health and safety policies in place to minimize littering and generation of other forms of waste • DWA to liaise with Project Contractors to ensure proper disposal of waste generated in the camp by providing waste receptacles to Contractors. Waste should not be burnt or thrown in dug pits but onto waste receptacles which are then emptied in a gazetted landfill
PC3	Fire hazards	-B	• Use of flammables (candle lights, uncontrolled cigarette smoking) with potential for starting fires should be avoided where possible • Fire to be used only when staff is on site • Flammable fuels to be kept away from open flames • Fire extinguisher to be installed on site
PC4	Loss of soil	-A	• As minimum clearance space as possible is recommended to minimize losses of soil removal/loss during site clearing for drilling
PC5	Change to soil chemistry	-B	• Drilled soil material should be kept in one place to minimize lateral spread and down stream pollution. This will reduce the potential problem of soil salinity and acidity

Table 9-2: Recommended mitigation measures for biological/ecological impacts

Code	Impact	RB	Mitigation measures
BE1	Loss of vegetation	-A	• Care should be taken to avoid multiple tracks around the camp • Heavy machinery should only be on one site; where they are most needed • Vegetation removal should be limited to lines of operation only • Where possible big trees especially of rare species should be avoided
BE2	Fuelwood collection	-B	• Use gas stoves as much as possible to reduce harvesting of fuelwood and fire risks.
BE3	Habitat destruction	-A	• Where nesting places are encountered recording of species and possible damage/disturbance caused should be done. • Where possible such nesting places should be spared to avoid forced migration by the species.
BE4	Temporary source of water for livestock and wildlife	A	• No mitigation necessary

Table 9-3: Recommended mitigation measures for sociological/cultural impacts

Code	Impact	RB	Mitigation measures
SC1	Generation of noise	-B	• Minimise noise by drilling during the day (will keep tranquility at night).
SC2	Spread of HIV/AIDS	-D	• Introduction of Relevant Contractor employees to the District Health Team and health personnel in the nearby health facility. • Promotion of HIV/AIDS awareness campaigns • Strengthen public education on HIV/AIDS related programmes that include HIV routine testing and counselling, and the ARV programme. • Introduction of an HIV/AIDS workplace programmes which will ensure availability of HIV/AIDS related commodities and IEC materials.
SC3	Land use conflict	-C	• Prompt and adequate compensation to be paid to affected property owners according to stipulated guidelines
SC4	Loss of aesthetic appeal	-A	• Minimise the project's footprint on the local environment
SC5	Increased pressure on the social amenities	-B	• Contractor to provide extra services beyond those that can be provided by the local amenities.
SC6	Destruction of cultural and archaeological artefacts	-D	• Archaeologist on site to monitor excavation activities • DNMM notified of finds
SC7	Influx of job seekers	-A	• Jobs advertised locally
SC8	Increased traffic	-B	• Observation of speed limits and other road signs
SC9	Provision of geophysics and groundwater data	D	• Findings should be recorded and archived for public use

Table 9-4: Recommended mitigation measures for economic/operational impacts

Code	Impact	RB	Mitigation measures
EO1	Boost to the local economy	B	• Ensure that procurement is done locally as much as is possible
EO2	Creation of employment	B	• Use preferential recruitment in favour of locals
EO3	Impact on existing privately owned boreholes	-C	• Avoid drilling close to existing boreholes (i.e. follow DWA guidelines of minimum spacing from existing boreholes) and encourage the registration of boreholes with DWA
EO4	Stimulation of land use changes	-B	• Strict adherence to the district integrated land use plan
EO5	Provision of water security	D	• No mitigation necessary

10 IDENTIFICATION OF PHASE 3 IMPACTS (WELLFIELD UTILIZATION)

10.1 Introduction

The Detailed EIA phase focused on the environmental impacts that would emanate from the planned or recommended utilization of the groundwater resources that were identified during Phase 2 of the BGEWDP. For such utilization to occur, the existing water reticulation system needs to be expanded to connect to the newly identified production boreholes. The expansion is expected to include construction of pump stations, water transmission pipes and reservoirs as well as the erection of power lines and equipping of production boreholes. A water treatment plant (WTP) has also been recommended as part of the reticulation system upgrade.

It must be noted that the detailed design of the proposed water reticulation from the production boreholes to the demand centres within the Kweneng District was not included in the scope of work of the BGEWDP project and will instead be undertaken as a separate project in the future. The absence of the detailed design layout drawings thus limited the EIA team from being able to survey the proposed pipeline routes in the area or the areas where the other infrastructure components would be located. Also, the absence of design specifications for the WTP also meant that the impacts of the WTP cannot be evaluated as part of the present study. However the impact assessment presented is based on the knowledge of the project area from the activities of Phase 2 of the project and experience of the project team from similar projects in the past (notably the EIA Studies for the Kang-Phuduhudu and Bobonong groundwater projects). It is important that the implementation of the infrastructure component be preceded by an EMP report based on the detailed design. Thus it may be necessary to update and review the current EMP once the detailed design has been completed.

10.2 Results of predictive groundwater modelling for sustainable utilization

Following the identification of productive areas through exploration and the drilling and test pumping of a large number of boreholes in the project area, the final step in the BGEWDP was to evaluate various pumping scenarios that would be required to meet the water demand in the specified demand centres (Molepolole, Thamaga, Thebephatshwa Air Base and surrounding villages). The primary tool for this evaluation was predictive groundwater modeling. One of the key objectives of groundwater modeling in the present study was to simulate groundwater abstraction from aquifers in the project area and assess the potential of each individual borehole, and the groundwater resources as a whole, in meeting the water demand in the demand centres to the year 2020. Another key objective of the modeling was to verify the recommended abstraction rates (as interpreted from test pumping data) and assess the regional groundwater flow regime as a result of the abstraction to the year 2020. Five (5) abstraction scenarios were designed and modeled by the BGEWDP, as shown in Table 10-1. The scenarios were simulated from the year 2012 to the year 2020 (the planning horizon).

One of the key parameters in groundwater modeling is the model extent. In the present study the model extent was based on the interpretation of geology and various hydrogeological characteristics. The Ecca Group (Boritse and Kweneng Formations) were used to define the spatial extent of the model. Other boundaries were further selected to coincide with surface water divides, groundwater divides and groundwater inflow, outflow and no-flow zones. In this regard the model area covered aquifers identified as part of the BGEWDP (Malwelwe Wellfield) as well as previously existing aquifers (Jwaneng Wellfield and Gaotlhobogwe Wellfield). Thus the model area actually extends beyond the project area to the west. The various scenarios were also designed to assess any interference between Jwaneng Wellfield to the west and Gaotlhobogwe/Malwelwe Wellfield to the east. The latest data available for Jwaneng Wellfield shows the lowest abstraction at 7.13Mm^3/yr for 2008-2009, down from a peak of 11.7Mm^3/yr in 2005. The drop was attributed to the global recession which forced Jwaneng Mine to reduce mining output and hence its water demand. The latter figure was used as the base for modeling purposes. Abstraction from Gaotlhobogwe Wellfield (which currently supplies the demand centres in the project area) was estimated at 3.48Mm^3/yr. Based on population growth, water demand in these centres will rise from 15,000m^3/d in 2011 to 18,000m^3/d in 2020 (WCS, 2012). Other abstraction nodes considered in the project area included private boreholes (8-75m^3/d) and Malwelwe village (270m^3/d).

Table 10-1: Predictive modeling scenarios for BGEWDP and their results

Scenario	Description	Abstraction design	Results
1	Meet water demand growth for Molepolole, Thamaga and Thebephatshwa and others to 2020 (Molepolole system) Jwaneng abstracts at 11.7Mm^3/yr	Pumping from both Malwelwe and Gaotlhobogwe wellfields, optimizing the recommended abstraction rates: pumping each borehole at most 15 hr/day to meet demand of 15,574m^3/d in 2012-2016 (first stress period) and 18,006m^3/d in 2017-2020 (second stress period). Assess interference between Jwaneng and Gaotlhobogwe/Malwelwe wellfields	• Due to low abstraction rates in Gaotlhabogwe Wellfield, 57% of boreholes (i.e. 8) are shut off and the remaining 6 boreholes pump at reduced rates • Water levels recover by 22m in boreholes in Gaotlhobogwe Wellfield • Maximum drawdown in Malwelwe Wellfield is 14m while in Jwaneng Wellfield it is 5m
2	Meet water demand for Molepolole system and 10% additional water demand. Jwaneng increasing pumping from wellfield by 50% to cater for increased demand due to their CUT 8 project	Assess possibility of all boreholes pumping at a maximum of 15 hr/day. Assess interference between Jwaneng and Gaotlhobogwe/Malwelwe wellfields.	• Water levels recover in Gaotlhobogwe 5m less than in scenario 1 due to increased abstraction (10%) • Maximum drawdown is 17m in Malwelwe Wellfield and 18m in Jwaneng Wellfield
3	Meet predicted demand growth for Molepolole system to 2020 Jwaneng abstracts at 11.7Mm^3/yr	All abstraction to come from Malwelwe Wellfield, with no pumping in Gaotlhobogwe (to allow water levels in Gaotlhobogwe to recover).	• Malwelwe Wellfield boreholes pump a minimum of 20 hrs in 212-2016 and 22-24 hrs in 2017-2020 • Water levels recover by an average of 35m in 2020 in Gaotlhobogwe • Drawdown in Malwelwe Wellfield will increase to 23m while in Jwaneng Wellfield it will be 5m
4	Meet predicted demand growth for Molepolole system to 2020 Jwaneng abstracts at 11.7Mm^3/yr	Demand to be met from Gaotlhobogwe Wellfield with Malwelwe Wellfield phased in to meet shortfalls (developing the wellfield infrastructure in Malwelwe in phases would save immediate costs of developing a new wellfield).	• All boreholes in Gaotlhobogwe Wellfield to pump for 24 hrs (as is the case currently) to supply a total of 14,000-15,000m^3/d • Deficit met from Malwelwe Wellfield, which will supply 3,000-4,800m^3/d • Maximum drawdown in Gaotlhobogwe Wellfield will be 26m in 9 yrs (ie. 2.8m/yr)
5	Meet predicted demand growth for Molepolole system to 2020 incorporating supply from NSC which is predicted to connect to the area in 2017 Jwaneng abstracts at 11.7Mm^3/yr	Both Gaotlhobogwe and Malwelwe wellfields to meet water demand of 15,574m^3/d in 2012-2016 and then NSC coming on stream in 2017 to supply 15,252m^3/d with the 5,148m^3/d deficit being met from the two wellfields (pumping out much less than previously) or increasing NSC supply to meet the total demand of 18,006m^3/d.	• Water levels in Gaotlhobogwe Wellfield will recover fully (20-47m, average 35m) by 2020 and there will be no drawdown impact in Malwelwe Wellfield • Drawdown in Jwaneng Wellfield will be 5m

(Adapted from WCS, 2012)

Groundwater recharge in the model area is expected to be through the Kalahari Beds, although the recharge rates are minimal, estimated at 1.7mm/yr over the sandveld covering the entire project area (WCS, 2012). Higher recharge (17mm/yr) is expected along Gaotlhobogwe valley, where the overlying mudstones have been deeply incised exposing or nearly exposing the Ecca aquifer. This allows infiltration of surface water into the aquifer during flash floods or high rainfall events. Within Gaotlhobogwe Wellfield the recharge was estimated at 1.5mm/yr.

It should be noted that Sorilatholo/Salajwe Wellfield, north of the Zoetfontein Fault, is not within the model spatial extent and thus was not part of the predictive modelling. Only Malwelwe Wellfield was considered for immediate development to alleviate the water supply deficit in the project area.

The key conclusions and recommendations of the BGEWDP groundwater study (WCS, 2012) are as follows:

- Scenario 1 is the recommended option for abstraction. This option utilizes both the existing (Gaotlhobogwe) and new (Malwelwe) wellfields, allowing Gaotlhobogwe to recover and pumping Malwelwe for a maximum of 15 hrs/day.
- The 26 boreholes available between Gaotlhobogwe and Malwelwe will allow variation of pumping clusters and back-up for downtime in other boreholes
- While Malwelwe Wellfield has good potential groundwater resources, it will not meet all the demand by 2020 even if pumping for 24 hrs. Scenario 3 utilized only 25% of the available drawdown which means that abstraction rates could still be increased to utilize the available drawdown though this will require strict operational monitoring before such an increase can be undertaken.
- Gaotlhobogwe Wellfield cannot continue to be pumped for 24 hrs without depleting the groundwater resources and the wellfield must be allowed to recover
- The predictive modelling has revealed that joint utilization and effective management of Gaotlhobogwe and Malwelwe wellfields is the key to sustainably meeting the water demands in the project area up to 2020.

Additionally, it is worth noting that though Scenario 5 is attractive, it is subject to a rather big project (NSC connection to major villages) that may or may not materialize within the planning horizon of the current project. Another fact worth noting is that drawdown in Jwaneng Wellfield appears to be influenced only by changes in abstraction in Jwaneng Wellfield and not by abstraction in either Gaotlhobogwe or Malwelwe wellfields. Most importantly, the predictive modelling has shown that the projected water demand up to 2020 for the population centres in the project area will be easily met through utilization of the boreholes that have been developed as part of the BGEWDP.

In order to safeguard the precious groundwater resources identified, and to further enhance the sustainability of their utilization, a wellfield protection strategy has been developed by the groundwater consultant for the BGEWDP. The modelling exercise used contaminant particle tracking to define three distinct zones of wellhead protection that are generally required by DWA. These are Zone 1 (the Inner Source Protection Zone) which is related to the distance covered in a 100-day travel time, Zone 2 (Fracture Flow Protection Zone) and Zone 3 (Outer Source Protection Zone) which is related to maximum distance covered in a 100-year travel time.

Due to insufficient data on fractures, the BGEWDP did not delineate Zone 2. Zone 1 was delineated at 100m from each of the wellfields in the project area. Zone 3 was dileneated as 10km for Malwelwe Wellfield and 5km for Gaotlhobogwe Wellfield. Therefore, the overall protection zone for each wellfield corresponds to a 10km buffer zone around Malwelwe Wellfield and a 10km buffer zone around Gaotlhobogwe Wellfield. These buffer zones will minimize the possibility of anthropogenic pollution of the groundwater resources.

The groundwater resources in Gaotlhobogwe and Malwelwe wellfields are vital for the long term existence of the population and sustainability of water users in the region for the planning horizon. It is therefore imperative that systems are put in place for effective and proper management of the wellfields. The BGEWDP study has recommended a groundwater monitoring system that will provide the following:

- groundwater levels, water quality and pumping data (volume and period) at every production borehole

- groundwater levels and water quality information outside the immediate wellfield areas as background control data and hydrogeological evaluation purposes
- hydrometeorological information at several sites in and adjacent to the wellfields to continue the assessment of recharge

The monitoring regime to achieve the above will be as follows:

- manual monitoring of existing monitoring boreholes at monthly intervals using the normal electric contact gauge; data to be digitized for compilation and evaluation with other digital data
- data from the digital logging units as well as rain gauges to be downloaded every 3 months
- flowmeter readings at each production borehole to be recorded monthly or more frequently if possible

This constant monitoring of the behaviour of the regional and individual borehole water levels and water quality will lead to early recognition of any yield or quality deterioration and hence timely remedial action (WCS, 2012).

10.3 Descriptions of predicted impacts and other key issues

The severity of environmental impacts that would emanate from groundwater reticulation should be negligible at best or manageable at worst. The cost and/or benefits of groundwater reticulation should thus be seen in a holistic context that should include impacts on the following components of the environment: Physical/Chemical, Biological/Ecological, Sociological/Cultural and Economic/Oprerational.

The most direct impacts of implementing the proposed water transfer scheme are likely to be on the soils and vegetation along the pipeline routes. The general principle in that should guide the infrastructure provision is that the pipes should be aligned along the existing routes and road reserves in order to minimise the negative environmental impacts

This chapter focuses on the anticipated environmental impacts based on the different phases of the planned infrastructure development (i.e. the planning, construction and operation phases). The key techniques utilized in identifying impacts related to the proposed project were (i) Consultation with Interested & Affected Parties (IAP), (ii) Field Survey and (iii) Project Activity Matrix (PAM). All issues, concerns and suggestions raised by the IAPs (including competent authorities such as DEA) have been included in the overall assessment and are fully documented in this report.

10.3.1 Physical / Chemical Impacts

10.3.1.1 Dust Pollution

Dust will be generated during construction activities (bush clearing, excavation and backfilling and by trucks moving along the dusty roads). This will be a health hazard particularly to the construction workers and the general public.

10.3.1.2 Noise Pollution

Evidently construction works such as excavation and associated activities will generate noise. This will mostly affect the construction workers and wildlife within close proximity to the pipeline route. However it must be noted that this will be a temporary problem because the noise will end once construction is completed.

10.3.1.3 Contamination due to oil spillages

The use of machinery to clear vegetation and other activities that require mechanical power could result in oil spillages. There is a possibility of soil, surface water and groundwater pollution from litter, fuels and lubricants along the pipeline route and at campsites.

10.3.1.4 Draw-down effect

It is inevitable that groundwater abstraction from a borehole will result in reduced water levels (drawdown) in the area surrounding the borehole. However, effective management of the abstraction from a network of boreholes allows such drawdowns to be minimized and often reversed through recovery. The predictive groundwater modelling exercise has been utilized by the BGEWDP groundwater consultant to select and recommend the optimal abstraction scenario that will ensure sustainable utilization of the groundwater resources by all users. It is important to note that the recommended abstraction regime (Scenario 1), involving the joint utilization of Gaotlhobogwe and Malwelwe wellfields, will actually result in the recovery of water levels in Gaotlhobogwe Wellfield of up to 22m while the drawdown in Malwelwe will be only 14m (see Table 10-1). This is achieved through reduced abstraction rates in Gaotlhogwe and optimized abstraction rates in Malwelwe. This is a positive impact that will no doubt be welcomed by all users in the area, including private users. Abstraction from the new boreholes in the area may have a negative effect on the existing boreholes if the abstraction rates exceed the recommended rates that are meant to ensure sustainable use of the available groundwater resources. It is important to ensure that the new scheme does not entail any additional groundwater abstraction rates that are higher than the recommended rates. With regard to neighbouring aquifers, the modelling exercise has shown that there are no drawdown impacts in Jwaneng Wellfield due to abstraction in either Gaotlhobogwe Wellfield or Malwelwe Wellfield.

10.3.1.5 Increased potential of soil erosion

The soils found in the project area mainly comprise aeolian sands which are susceptible to wind erosion. Project activities like excavation, blasting and vegetation removal will loosen the soil and increase its vulnerability to wind erosion.

10.3.2 Sociological / Cultural impacts

10.3.2.1 Impact on private properties

The detailed design of the wellfield utilization scheme is not part of the final deliverables of the BGEWDP. It is thus important that an environmental appraisal be carried out before implementation of the envisaged work of water reticulation expansion. Such assessment could either be in the form of an EMP or a fully fledged EIA depending on the Preliminary EIA (PEIA) that will be undertaken by the responsible water authority. It has not been established at this stage whether the proposed pipelines would traverse any private properties as the full design is still to be undertaken. An EIA 'informed' design would minimize this potential impact. Indeed it has been recommended by the groundwater study that alignment and route selection should be done in a manner that minimizes land use conflicts.

10.3.2.2 Risk of accidents

Occupational hazards are likely to occur during construction phase if safety precautions such as wearing protective personal equipment and are not followed. Pipeline trenches left open for a long time will be hazardous to both people and animals. Avoidance of such hazards can be aided by regular risk assessment exercises conducted by personnel undertaking the project.

10.3.2.3 Impact on existing infrastructure

There is possibility to encounter existing services (roads, storm water drains, power lines and telecommunication lines) along the various planned pipeline routes. It will be important for the contractor to know exactly where such services are located so as to minimize interference with them. In fact, knowing their location might lead to a re-alignment of the pipelines to avoid them totally.

10.3.2.4 Spread of HIV/AIDS

Normally the introduction of a mobile work force in a community impacts negatively on public health. Sexual relationships that are likely to emerge between the workers and the villagers have the potential of spreading communicable diseases, particularly Sexually Transmitted Infections (including HIV/AIDS).

10.3.2.5 Waste management

Waste will be generated on site and this will invariably include solid waste and liquid waste. Waste would not only impact the aesthetics of the area but has potential to pollute soil and water resources over prolonged periods. Inadequate solid and waste water disposal around the work areas and campsites may also lead to an environment conducive for diseases to spread.

10.3.2.6 Aesthetic impacts on the landscape

Project activities will likely change the appearance of some parts of the study area especially the excavated area along the length of the pipes, pump station and reservoirs construction areas. This is expected to be a temporary impact because the natural environment has mechanisms to restore itself.

10.3.2.7 Archaeological impacts

The pre-drilling AIA study did not identify any archaeological resources in the project area. However, buried archaeological resources may still exist in the area and hence any excavation activities must follow the proposed archaeological management plan.

10.3.3 Biological / Ecological Impacts

10.3.3.1 Loss of Vegetation

Clearing of access paths and construction sites will involve removal of vegetation and tree species. Although vegetation removal is expected to occur temporarily during the construction phase and at a local scale, there is still a need to keep vegetation clearance to the minimum possible.

10.3.4 Economic / Operational impacts

10.3.4.1 Employment opportunities

It is envisaged that local people will benefit from the job opportunities presented by the construction phase of the project, especially for duties that do not require special professional knowledge. Although this will be short term, it would be helpful as the unemployment rate is high in rural areas, including the Kweneng region.

10.3.4.2 Reliable water supply

The most significant factor related to the BGEWDP in the project area is the improvement that will occur to existing water supplies. Once the project is operational, demand centres in Kweneng would be assured of reliable water supply. This could result in commercial and industrial expansion in the project area.

10.3.4.3 Added impetus to the economy

Construction workers may provide temporary employment to local people especially women. They may also increase the market for small business like sale of food stuff leading to a boost to the local economy.

10.3.4.4 EMP Monitoring (Protection of the environment)

EMP supervision during the construction and operational phases will result in environmental protection and increased awareness on environmental issues within the project area.

10.4 Project Activity Matrix (PAM)

PAM is a useful technique in linking the expected project works and their potential environmental impacts. PAM assisted team members in understanding the implications of the project and developing detailed

plans for more extensive impact analysis. Table 10-2 shows the PAM for the construction phase of the planned infrastructure.

Table 10-2: PAM for the construction aspects

Aspect of construction	Impact	Description
Work-force	• Creation of temporary employment • Boost to the local economy	• It is expected that during construction local people will get short-term employment • The project represent a significant injection of cash into the area hence a boost to existing businesses. New businesses will be developed to service the project personnel
	• Potential spread of HIV/AIDS infections	• The introduction of a mobile work force and job seekers in a community is likely to impact negatively on public health. Sexual relationships that are likely to emerge between the workers and the villagers have the potential of spreading communicable diseases, particularly Sexually Transmitted Diseases (including HIV/AIDS)
	• Occupational hazards	• Construction workers are likely to be involved in work related accidents during project implementation
Setting up Contractor's camp site	• Generation of dust • Generation of noise • Generation of waste	• Noise and dust will be generated during the process of clearing the vegetation in preparation for setting up camp • Waste will be generated during construction of the camp site. If not disposed of at designated points waste (both solid and liquid) may result in serious environmental consequences (e.g. contamination of water and the soil)
Excavation	• Generation of dust	• The earth moving activities for laying of pipes could result in the dispersion and settling of dust which could result in a nuisance to the surrounding areas
	• Generation of noise	• Machinery, equipment and trucks will generate noise
	• Loss of vegetation	• Construction activities will necessitate the removal of vegetation
	• Loss of aesthetic appeal	• Untidy construction sites may disturb the aesthetic beauty of the surroundings
	• Possibility of destruction of historical artifacts	• Unexposed cultural artifacts may be damaged during excavation for pipe laying
	• Risk of accidents	• Accidents involving humans and livestock may occur as a result of construction activities (open trenches are likely to cause accidents especially at night)
	• Oil spillages	• Oil spillages from machinery and vehicles is likely to contaminate the soil and groundwater
	• Disruption of existing infrastructure	• Existing infrastructure like roads, power lines, sewer lines, telephone lines and water lines are likely to be affected during excavation for pipe laying
Pipe laying, Backfilling and compaction	• Generation of dust • Generation of noise	• Noise and dust will be generated during backfilling and compaction of the trenches
Construction of the pump station and reservoirs	• Generation of dust	• The earth moving activities for excavation for foundation could result in the dispersion and settling of dust which could result in a nuisance to the surrounding areas
	• Generation of noise	• Machinery, equipment and trucks hauling material to site will generate noise
	• Loss of vegetation	• Construction activities will necessitate the removal of vegetation
	• Possibility of destruction of archaeological artifacts	• Unexposed cultural artifacts may be damaged due to construction activities

Aspect of construction	Impact	Description
Decommissioning of the Contractors camp site	• Generation of dust • Generation of noise • Contamination due oil spillages • Generation of waste	• Machinery used to demolish temporary structures will generate dust and noise for a short period during the decommissioning process • Transportation of potential pollutants like, oil, and diesel from site poses a danger of spillages that may result in soil and groundwater contamination • Construction rubble will be produced during knocking down of temporary structures • Planting of trees will contribute to restoration of the area's vegetation and aesthetic appeal

The operation phase will comprise aspects listed in Table 10-3 that could impact on the economic and operational environments.

Table 10-3: PAM for the operational aspects

Aspect of Operation	Impact	Description
Operation of the expanded water supply system	• Boost to the local economy • Improved water supply • Draw-down effect • Potential groundwater contamination	• When an area has a reliable water supply it becomes attractive to commercial and industrial investment • Once the project is operational, the project area would be assured of a reliable water supply • Additional groundwater abstraction from the new production boreholes may have negative impacts on the boreholes in the area that are owned by local farmers if the recommended optimal and sustainable abstraction rates are not adhered to • The effect may cause some of these boreholes to dry up or make it more costly for the local farmers to pump water from greater depths. • If the borehole protection zones are not properly or clearly delineated or are not being actively enforced there is possibility of the groundwater being polluted by the land uses that can take place very close to the boreholes
EMP Monitoring	• Improved environmental protection • Improved awareness of environmental issues	• Implementation and monitoring of compliance with the EMP will result in environmental protection • EMP process will result in enhanced awareness on environmental issues

All the identified and predicted impacts were subjected to thorough assessment and evaluation as described in the next chapter.

11 EVALUATION OF PHASE 3 IMPACTS

11.1 Background

The impacts expected from the construction and operation phases of the planned utilization of the groundwater resources (i.e. wellfields) that have been found during Phase 2 of the BGEWDP have been assessed using the Rapid Impact Assessment Matrix (RIAM). In accordance with the RIAM approach, the identified impacts for each phase were categorized into the physical/chemical; biological/ecological; sociological/cultural; and economical/operational components. RIAM recognizes that certain criteria (i.e. magnitude, temporal status, reversibility and cumulativeness) are common to all impacts, and by scaling them it is possible to evaluate the significance of the impacts in an objective and transparent way. Table 11-1 shows the criteria for evaluating the significance of environmental impacts. The resultant composite score, known as the Environmental Scores (ES), varies between +108 and -108 and signifies the severity of the impact as shown in Table 11-2. Detailed RIAM notes are annexed as Appendix A.

Table 11-1: Criteria for evaluating the significance of environmental impacts

Group	Code	Criterion	Scale	Description
A. Criteria that are of importance to the condition, that individually can change the score obtained	**A1**	Importance of condition	4	Important to national/ international interests
			3	Important to regional/ national interests
			2	Important to areas immediately outside the local condition
			1	Important only to the local condition
			0	No importance
	A2	Magnitude of change/ effect	+3	Major positive benefit
			+2	Significant improvement in status quo
			+1	Improvement in status quo
			0	No change/status quo
			- 1	Negative change to status quo
			- 2	Significant disbenefit of negative change
			- 3	Major disbenefit or change
B. Criteria that are of value to the situation, but should not individually be capable of changing the score obtained	**B1**	Permanence	1	No change/ Not applicable
			2	Temporary
			3	Permanent
	B2	Reversibility	1	No change/ Not applicable
			2	Reversible
			3	Irreversible
	B3	Cumulative	1	No change/ Not applicable
			2	Non-cumulative/ single
			3	Cumulative/ Synergistic

Source: Pastakia, C. and Jensen, A. (1998)

Table 11-2: RIAM scheme for rating the severity of environmental impacts

Environmental Score (ES)	Range Band (RB)	Description of Range Band
+ 72 to +108	+ E	Major positive change/impacts
+36 to + 71	+ D	Significant positive change/impacts
+19 to +35	+ C	Moderately positive change/impacts
+10 to +18	+ B	Positive change/impacts
+1 to +9	+ A	Slightly positive change/impacts
0	N	No change/Status quo/Not applicable
-1 to -9	- A	Slightly negative change/impacts

Environmental Score (ES)	Range Band (RB)	Description of Range Band
- 10 to -18	- B	Negative change/impacts
-19 to -35	- C	Moderately negative change/impacts
-36 to - 71	- D	Significant negative change/impacts
-72 to - 108	- E	Major negative change/impacts

Source: Pastakia, C. and Jensen, A. (1998)

11.2 Construction phase impacts

Table 11-3 shows the impacts identified for the construction period. Most of the impacts are in the sociological/cultural category where both less significant negative and significantly negative scores were recorded. All the physical/chemical impacts are negative but not significantly negative. The lone biological/ecological impact is negative but of minor significance while all economic/operational impacts are positive to significantly positive. Figure 11-1 is a graphical representation of the evaluation of impacts of the construction phase.

Table 11-3: Impacts of the construction phase

Code	Components	ES	RB	Description
Physical and Chemical components (PC)				
PC1	Increased potential for soil erosion	-7	-A	Removal of vegetation during site clearance will expose the top soil to wind leading to wind erosion.
PC2	Contamination due to oil spillages	-8	-A	Oil leakages are expected to occur from the construction machinery and vehicles.
PC3	Generation of noise	-12	-B	Noise generated during construction will be a nuisance to neighbouring land users and animals.
PC4	Generation of dust	-16	-B	The use of big machinery for creating access roads, trenching and pipe laying will generate dust.
Biological and Ecological components (BE)				
BE1	Loss of vegetation	-7	-A	Vegetation will have to be removed to give way to construction activities.
Sociological and Cultural components (SC)				
SC1	Interference with existing infrastructure	-21	-C	Some existing infrastructure will be affected by construction activities.
SC3	Loss of aesthetic appeal	-14	-B	Untidy working areas may cause an eye sore
SC4	Possibility of the spread of HIV/AIDS	-42	-D	Introduction of a mobile work force to the community is likely to spread the HIV/AIDS infection and other communicable diseases.
SC5	Risk of accidents	-18	-B	Accidents involving local people, construction workers and animals are likely to occur due to construction activities.
SC6	Generation of waste	-7	-A	Both solid and liquid waste will be produced from the construction site and the contractor's camp.
SC7	Destruction of cultural artifacts	-12	-B	Archaeological artifacts may be destroyed during excavation activities.
Economical and Operational components (EO)				
EO1	Creation of employment	12	B	Local people will benefit from the temporary employment that will be created during the construction phase.
EO2	Boost to the local economy	42	B	The construction phase presents an injection of cash into the district economy hence an improvement of the local economy.

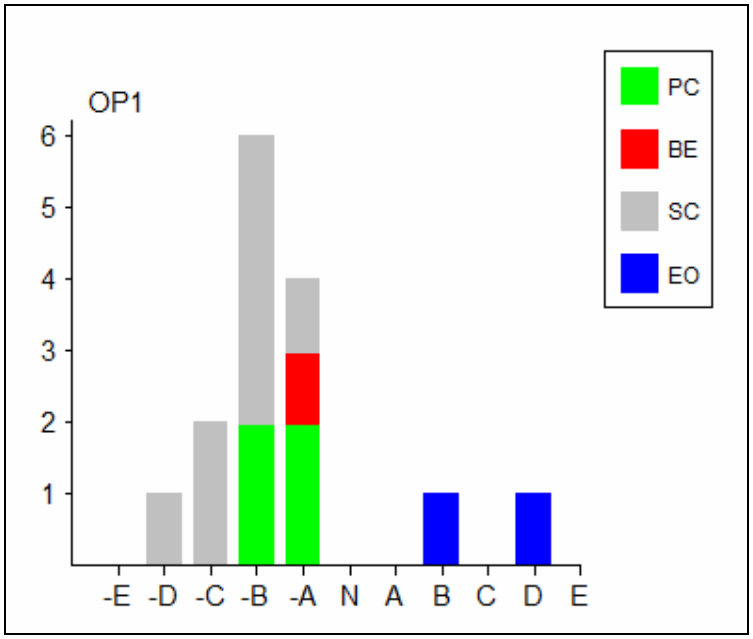


Figure 11-1: Summary of RIAM results for the construction phase

11.3 Operation phase impacts

A total of 6 impacts were identified for the operation phase: 4 were classified under the sociological/cultural category and 1 each under the economical/operational and physical/chemical categories. No biological/ecological impacts were identified for the operation phase. Table 11-4 presents the description of potential impacts of the operation phase.

Table 11-4: Impacts of the operation phase

Code	Components	ES	RB	Description
Sociological/Cultural components (SC)				
SC1	Improved water supply	54	D	Operation of the project will improve the water supply in the district.
SC2	Improved environmental protection	42	D	EMP monitoring will contribute to environmental protection.
SC3	Improved awareness of environmental issues	42	D	The EIA process helps in sensitizing the locals about environmental issues.
SC4	Potential for groundwater contamination	-8	-A	Permission of certain land uses very close to the operating boreholes may pollute the aquifer
Physical/Chemical components (PC)				
PC1	Draw-down effect	-10	-A	Abstraction of water from the Malwelwe Wellfield will contribute to a decline in the levels of the water table in the immediate area. However, joint utilization with Gaotlhobogwe Wellfield (Scenario 1) will actually lead to water level recovery in Gaotlhobogwe wellfield thereby minimizing the overall impact.
Economical/Operational components (EO)				
EO1	Boost to the local economy	21	C	Availability of adequate water supply in the area will attract investors into the sub-district hence an improvement of the local economy.

Figure 11-2 is a graphical representation of the evaluation of impacts of the operation phase. Four out of the six impacts of the operation phase are positive and they lie within the moderately positive to significantly positive range band. The remaining two impacts are slightly negative.

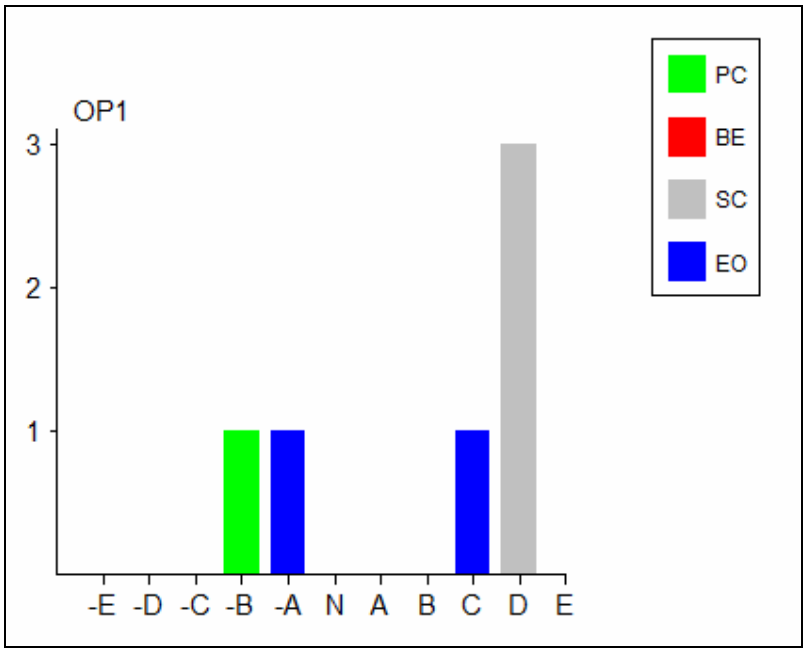


Figure 11-2: Summary of RIAM results for the operation phase

The process of analysis of the identified impacts leads to the development of the EMP which proposes mitigation measures to the impacts. The evaluation of the impacts determines how the mitigation will be carried out as well how monitoring of the EMP for individual aspects of the environment will be carried out for instance the frequency of the monitoring.

12 ENVIRONMENTAL MANAGEMENT PLAN

12.1 Introduction

An Environmental Management Plan (EMP) has been developed based on the outcome of the analysis of the potential impacts and the relevant mitigation measures. The purpose of the EMP is to outline the mitigation measures to be undertaken during the construction and operation of the proposed infrastructure development component of the BGEWDP to control the adverse environmental impacts and the actions needed to implement these mitigation measures. The EMP also stipulates the acceptable results/environmental indicators which show the level that must be reached if the mitigation measure is adequately implemented. Corrective action may also be required in the event that the suggested mitigation measures prove to be insufficient or inadequate. Monitoring throughout the life of the project implementation at the suggested frequencies will establish the effectiveness of the proposed mitigation measures as well as the Contractor's compliance with the EMP. The tables that form the EMP are the mitigation plan and monitoring plan as discussed in Section 12.3 and Section 12.4 respectively further below.

12.2 Roles and Responsibilities

For the EMP to be effectively implemented and the desired results realized, there are responsibilities to be met by different parties in the implementation of the proposed project. It is important to clearly spell out the environmental management structure in respect of the actual implementation of the EMP. This ensures among other things, clear definition of the roles and responsibilities of all key persons involved which in turn prevent and/or reduce delays and possible duplication of efforts. The important role players who will ensure proper implementation of the EMP are the Developer, Contractor, Environmentalist and the Engineer. The role players will work in close liaison to ensure that the EMP is successfully implemented.

Developer (DWA)

DWA is the developer and thus bears the main responsibility of ensuring that the construction and operation activities of the proposed project are carried out in line with the requirements of the EMP. Although the developer appoints specific role players to perform functions on his behalf, this responsibility is delegated. The developer is responsible for ensuring that sufficient resources are available to the other role players to efficiently perform their tasks in terms of the EMP.

Contractor

The Contractor shall:

- Ensure that the environmental specifications of this EMP document (including any revisions, additions or amendments) are effectively implemented. This includes the on-site implementation of steps to mitigate environmental impacts
- Ensure that all employees and co-contractors employed comply with the requirements and provisions of the EMP
- Monitor environmental performance and conformance with the specifications contained in this document during daily site inspections
- Discuss implementation of and compliance with this document with staff at routine site meetings
- Report progress towards implementation of and non-conformances with this document at site meetings
- Notify the Engineer of the anticipated programme of works and fully disclose all details of activities involved
- Ensure that suitable records are kept and that the appropriate documentation is available to the Environmentalist
- Notify the Environmentalist of all incidents, accidents and transgressions on site with respect to environmental management as well as requirements of the EMP and corrective actions/remedial action taken
- Report and record all accidents and incidents resulting in injury or death

- Inform the Environmentalist of problems arising when implementing the EMP and ways of improving the EMP
- Inform the Environmentalist of any complaints received

Environmentalist

The Environmentalist will be responsible for monitoring implementation of the EMP requirements, reviewing and verifying compliance with the EMP by the Contractor. In particular, the Environmentalist shall:

- Inspect the site regularly, to ascertain the level of compliance of works with EMP, as well as attend Contractor's meetings and site meetings with the project management team and report back on the environmental issues
- Maintain inspection reports on file
- Assist the Contractor in ensuring that necessary environmental authorisations and permits have been obtained
- Monitor and verify that the EMP is adhered to at all times and take action if the specifications are not followed
- Monitor and verify that environmental impacts are kept to a minimum
- Provide environmental input towards review and approval of method statements by the Engineer
- Assist the Contractor in finding environmentally responsible solutions to problems
- Closely work with the Engineer in identifying affected properties and how to lessen impacts
- Continue consultation of all stakeholders
- Facilitate compensation process for affected properties (if any) in conjunction with the Land Board Assessment Committee
- Salvage any archaeological finds that may be exposed during excavation and notify the DNMM

Engineer

The Engineer's duties will include the following:

- Comply with the contents of this document as well as with the EMP specifications in the Contract document to ensure that the requirements of the EMP are met
- Monitor and verify that the EMP is adhered to at all times and take action if the specifications are not followed
- Review construction Method Statements in conjunction with the Environmentalist
- Assist the Contractor in finding environmentally responsible solutions to problems with input from the Environmentalist
- Keep records of all activities/incidents on site in the site diary concerning the environment
- Inspect the site and surrounding areas regularly with regard to compliance with the EMP
- Issue penalties for contravention of the EMP

12.3 Mitigation Plan

The mitigation plan provides the recommended framework for monitoring and reporting on the implementation of mitigation measures. The mitigation and monitoring plans are working guides to facilitate the implementation of mitigation measures by the Contractor, environmental monitoring team, the project proponent and Government authorities. The Contractor will be required to comply with the mitigation and monitoring plans in all aspects. In any instances where non-compliance occurs, the Environmentalist shall issue a warning to the Contractor. Any decisions to halt work due to non-compliance shall be made by the Environmentalist. The Environmentalist shall keep records of any incidents on non-compliance with mitigation measures. Copies of the EMP will be supplied to the Contractor. Table 12-1 presents the mitigation plan.

Table 12-1: Mitigation plan

Classification	EMP Issue Environmental Aspect	Mitigation measure	Objective	Target	Performance Indicator	Estimated cost	Implementing agency
Soil	• Increased potential for soil erosion	• Stockpiled soil should be leveled after completion of the project	To prevent soil erosion in the project area	Soil in the whole area protected	• Minimal soil erosion occurs in the area	No extra costs anticipated	Contractor
	• Contamination due to oil spillages e.g. soil and groundwater	• Vehicles and machines should be adequately maintained • Use of designated fueling point/workshop • Oil catchment bunds to be designed to collect used oil • Contaminated soil to be treated biochemically on site	To prevent contamination of water and soil resources due to spillages and leakages	Maintenance of the equipment and vehicles in good working condition and fuel point leakage free	• Incidents of soil and groundwater pollution are obviated • Any spillages on the soil is treated • Risks to groundwater contamination is lessened	Standard procedure for the contractor to implement	Contractor
	• Interruption of existing infrastructure	• Map existing services e.g. BTC lines, BPC lines, DWA pipelines and sewer lines (if any) • Inform the relevant department when damage occurs on existing infrastructure • Inform the community about possible interruption • Put up signs to signal interruption	To prevent any disruptions of infrastructure services	All existing line services and infrastructure mapped Relevant service providers promptly informed Legible signage put up Community informed	Minimal interruptions in infrastructure services	Standard procedure for the contractor to implement	Contractor
Air Quality	• Generation of dust	• Visually monitor dust generation from work zones • Sprinkle work areas with grey water to suppress dust	To prevent air pollution from dust	Proper maintained working area that emit very little or no dust	• Dust levels greatly reduced or eliminated	No extra costs anticipated	Contractor

Classification	EMP Issue Environmental Aspect	Mitigation measure	Objective	Target	Performance Indicator	Estimated cost	Implementing agency
Ambient noise	• Generation of noise	• All vehicles and equipment must be monitored and maintained in good working condition • Workers must be provided with earmuffs • Limit working hours to day time (6am-6pm)	To reduce the noise impact on the neighbouring land users and workers	Noise kept at levels that wont disturb other land users and workers	Neighbouring land users and workers not affected by noise	No extra costs anticipated	Contractor
Flora	• Loss of vegetation	• Minimize vegetation removal to the design area • Trees not requiring complete removal should be lopped at the base and the rootstock left to coppice	Minimise loss of vegetation	No vegetation cut beyond the development area	Vegetation outside the development area protected	No extra costs anticipated	Contractor
Aesthetic appeal	• Loss of aesthetic appeal	• Limit activities to construction area only • Rehabilitation of all disturbed area	Improve aesthetic appeal of the project area	The area appearing visually attractive	The area remaining visually attractive	No extra costs anticipated	Contractor
Socio-economic aspects	• Creation of employment	• Manpower sourced locally as much as is possible especially in the semi-skilled and unskilled categories	Increased recruitment of locals	Recruitment done mostly among the local people	Majority of employees being locals	No extra costs expected	Contractor
	• Boost to the local economy	• Maximize sourcing of supplies from local businesses	Increase in procurement from the local businesses	Local businesses experiencing a boom	Majority of local businesses experiencing a boom	No extra costs expected	Contractor

Classification	EMP Issue Environmental Aspect	Mitigation measure	Objective	Target	Performance Indicator	Estimated cost	Implementing agency
	• Possibility of spread of HIV/AIDS	• Increase employees HIV/AIDS awareness • Distribute condoms regularly at the site • Conduct awareness campaigns	Reduce incidents of spread of diseases	No new infections of HIV/AIDS among the employees	• Improved awareness of AIDS/HIV among employees • Reduced or absence of the spread of diseases	Covered as part of environmental awareness	Contractor
	• Risk of accidents / Occupational hazards	• All open trenches should be marked and fenced • Workers should be provided with safety gear on site • Construction area should be fenced • First aid kits provided at construction sites • Fire extinguishers installed in construction vehicles and at the construction sites	Eliminate occurrence of injuries	No injuries among employees	• Greatly reduced occurrence of accidents • Effective and swift response to accidents that occur	Standard procedure for the Contractor to implement	Contractor
	• Improved water supply **(to be realized during operation phase)**	• DWA to embark on water conservation programmes e.g. water harvesting	Meeting water needs of all village demand centres	Supplying enough potable water to the villages	All demand centres with enough potable water	Standard procedure for DWA	DWA
Waste management	• Generation of waste	• Only the designated landfill should be used for solid waste disposal. • Trucks hauling waste must be covered. • Waste receptacles which can be covered must be provided at the Contractor camp site • Use of portable toilets on site	Proper waste management practice in the working area	Solid waste disposed of at the designated landfills	• All waste disposed of at a designated point • No smoke emissions from waste burning	Standard procedure for the Contractor to implement	Contractor

Classification	EMP Issue Environmental Aspect	Mitigation measure	Objective	Target	Performance Indicator	Estimated cost	Implementing agency
Cultural aspects	• Destruction of cultural artifacts	• Archaeologist on site to salvage archaeological artifacts during excavation • DNMM to be notified of any archaeological findings immediately	Adequate protection of archaeological resources in the area	No archaeological finding destroyed	• Any artefacts found treated in line with DNMM guidelines	Contractor to budget as part of the contract	Contractor Archaeologist
EMP	• Improved environmental protection and awareness on environmental issues	• Ensure that the EMP is complied with	Adequate protection of the environment in the area	Improved environmental protection in the area	Environment adequately protected	No extra costs expected	EO Contractor

12.4 Monitoring Plan

The monitoring plan is designed as a written statement for the Contractor to adhere to and to which recourse can be made in the event of perceived undesirable impacts. The plan will be continually updated and improved to cater for residual and unanticipated impacts and any measures that prove to be ineffective. This may include modifying the causal activity as necessary without changing overall project design. The Contractor shall be required to strictly adhere to the EMP failing which appropriate action will be taken to ensure that the Contractor repairs the damage at his cost. If the Environmentalist, responsible agency, or Engineer determined that non-compliance has occurred or that recommended thresholds are exceeded, a written notice shall be delivered to the Contractor describing the non-compliance and requiring compliance within a specified period of time. If non-compliance still persists at the expiration of the specified period of time, construction may be halted and the Client and other authorities may be asked to take action. The monitoring plan is presented in Table 12-2.

The nature of some environmental incidents will require specialist services for clean-up, sampling, removal or management. The need for engaging this level of support throughout an incident must be determined by the Engineer. The following basic incident responses should be followed in the event the recommended thresholds are exceeded:

Identify: Identify the environmental incident and make sure the area is safe for staff and public.
Stop: Respond immediately and take action to stop the incident from spreading or escalating
Contain: Contain any material which has or may have escaped.
Clean up: Clean up as much as possible and seek assistance where required.
Report: Report to the client and other authorities.

Table 12-2: Monitoring Plan

Environmental aspect	Location (Where)	Monitoring technique Method (How)	Frequency (When)	Threshold/Standard Acceptable results	Monitoring Agency	Recommended action if thresholds are exceeded	Reporting authority
Escalation of HIV/AIDS and other social ills	In the project area	Observation of meetings being held on HIV/AIDS and health issues awareness Observation of availability of condoms in places where workers can access them	Monthly Twice a week	Awareness meetings held Condoms availed	Environmentalist	Enhanced education	KDC Ministry of Health
Generation of noise	Construction sites	Conduct investigative noise monitoring in response to specific complaints	Weekly	Construction activities limited to 6am-6pm All vehicles and equipment in good working condition Workers provided with earmuffs	Environmentalist	Penalty system	KDC DWMPC
Generation of dust	Construction sites	Visually monitor dust generation from work zones Inspect work zones to ensure adequate dust controls are being used such as regular watering of work areas	Twice a week	Workers provided with masks Dusty work areas sprayed with water	Environmentalist	Penalty system	KDC (Environmental Health Unit) DWMPC
Generation of waste	At temporary camp sites and construction sites	Inspect construction zones to monitor for any unauthorized waste disposal activities Inspect waste receptacles to ensure that they are not overfilled and are collected on a regular basis	Twice a week	Waste disposed of at designated dumping areas Trucks hauling waste covered Waste containers with lids available at contractor camp site	Environmentalist	Penalty system	KDC DWMPC
Possibility of oil spillages	Construction site and camp sites	Inspect construction vehicles and equipment to ensure no leaks are occurring	Daily	Vehicles and machinery in good condition Designated fueling point used No traces of leakages at the fuel point	Environmentalist	Penalty system	KDC DWMPC

Environmental aspect	Location (Where)	Monitoring technique Method (How)	Frequency (When)	Threshold/Standard Acceptable results	Monitoring Agency	Recommended action if thresholds are exceeded	Reporting authority
Risk of accidents	Construction site and along haulage routes	Observation	Daily	Open trenches should be clearly marked and fenced Workers provided with safety gear Construction area fenced	Environmentalist	Penalty system	Botswana Police Service DRTS
Interruption of existing infrastructure	In the project area	Observation	Weekly	Alternative temporary paths available Contractor aware of existing services e.g. BTC lines, BPC lines, sewer lines and DWA pipelines	Environmentalist	Penalty system	KDC BTC BPC DWA DRTS
Interruption of traffic and pedestrian movement	In the project area	Observation	Every other day	Alternative temporary paths available Temporary bridges built over open trenches	Environmentalist	Penalty system	Botswana Police KDC
Loss of aesthetic appeal	Construction sites and surrounding areas	Observe the construction area and surrounding area for undesirable visual impacts and untidy areas.	Monthly	Minimal visual impact	Environmentalist	Penalty system	DEA
Loss of vegetation	Construction sites and pipeline servitudes	Observation	Weekly	Trees outside the design area retained Limited or no trampling of vegetation outside the design area	Environmentalist	Penalty system	DEA DFRR
Increased potential for soil erosion	Construction site	Observation	At the end of construction	Soil leveled	Environmentalist	Penalty system	MOA
Creation of employment	In the project area	Count of employees, check of employees register	Monthly	Most employees obtained from the project locality. Jobs should be announced and advertised at the project locality.	Environmentalist	Enhanced education	VDCs
Improved environmental protection	In the project area	Ensure adherence to the EMP	Daily	Impacts minimised or avoided	Environmentalist	Enhanced education	DEA

Environmental aspect	**Location (Where)**	**Monitoring technique Method (How)**	**Frequency (When)**	**Threshold/Standard Acceptable results**	**Monitoring Agency**	**Recommended action if thresholds are exceeded**	**Reporting authority**
Improved awareness on environmental issues	In the project area	Ensure adherence to the EMP	Daily	EMP followed	Environmentalist	Enhanced education	DEA
Boost to the local business and economy	In the project area	Observe new businesses at the construction site and camp site.	Once in two months	Increased business with purchases from contractors	Environmentalist	Enhanced education	VDCs KDC
Improved water supply **(to be realized during the operation phase)**	In the project area	Observation	Weekly	No reports of water shortage	DWA	Enhanced education	KDC DWA

12.5 Decommissioning of the contractors office and campsites

The proposed project does not require a decommissioning plan because the water reticulation infrastructure will not be decommissioned. At the end of project implementation the contractor would however have to decommission and rehabilitate the camp sites and site offices. Decommissioning refers to the dismantling, decontamination and removal of process equipment and facility structures; the removal of surface installations; and recontouring the land and planting vegetation to prevent soil erosion as appropriate. Assuming there is no other use for field facilities, all structures including production, processing, treatment, storage, power, and related infrastructure facilities should be dismantled.

Disturbed areas where temporary construction facilities existed should be returned to natural contours where possible. Compaction of the subsoil should be relieved by scarification in areas of disturbance. The topsoil stored during the clearing phase of construction should be returned to the site, evenly spread and lightly packed to prevent depressions and water pockets. In areas where topsoil was not stripped, the surface will be ripped or scarified to relieve compaction.

Each site with the potential for hydrocarbon contamination should be identified, characterized, and assessed for contamination. Contaminated soils should be removed and replaced with clean fill, or remediated in place in accordance with applicable regulations and standard industry practices in place at the time of actual decommissioning. Remediation and/or treatment methods will be selected based on proven and effective technologies that will minimize or eliminate the potential for further contamination of the environment.

13 CONCLUSIONS AND RECOMMENDATIONS

13.1 Conclusion

The detailed EIA Study of the BGEWDP comprehensively undertook a pre-development environmental baseline study of the project area using appropriate approaches and techniques. The study also identified and assessed the likely impacts of the BGEWDP on the environment, taking into account the major phases of the BGEWDP, namely the Exploration Phase (Phase 2) and the Resources Quantification Phase (Phase 3).

The EIA Study found out that there are a number of significant adverse environmental impacts that require mitigation. The most significant negative impacts the project will cause in the area include possible increase in the spread of HIV/AIDS; generation of noise, dust, waste and a possible contamination of soil and groundwater with leaking oil as well as an interruption of infrastructure facilities within the project area. The negative impacts will mostly occur during the construction phase while most of the impacts of the operation phase are positive. The positive outcome from the project will be employment opportunities during construction as well as improved water supply in the villages in the area during operation. Mitigation measures to the identified impacts were developed and their implementation is described in the EMPs. Due to the phasing of the BGEWDP, it was necessary to develop an EMP and Code of Conduct for the Exploration Phase to guide the exploration activities aimed at identifying groundwater resources in the area. Once the exploration was complete and the resources quantified, it was then also necessary to develop another EMP for the planned utilization of the identified groundwater resources (the Malwelwe Wellfield). It should be noted that the planned utilization is a separate project that still will be commissioned in the future.

The EMP is divided into 2 components: the mitigation plan and the monitoring plan. The mitigation and monitoring plans are working guides to facilitate the implementation of mitigation measures by the Contractors, environmental monitoring team, the project proponent and other authorities. The Contractors will be required to strictly adhere to the proposed mitigation and monitoring plans in all aspects of project implementation. Implementation of the proposed mitigation and monitoring plans will ensure that the project results in minimal adverse impacts. To ensure that the EMP is effectively implemented during the construction phase of the project, it is imperative that a project environmentalist be appointed to ensure that the contractor(s) adequately adhere(s) to the requirements of the EMP.

At the end of project implementation the contractor would have to decommission and rehabilitate the camp sites and site offices. Rehabilitation of the camp sites should strive to restore the area to its pre-development status in terms of indigenous vegetation. The Contractor should use locally sourced species for vegetation restoration. The decommissioning process should contribute positively to the aesthetic appeal of the area and limit long term liabilities that will be borne by future generations.

13.2 Recommendations

The following recommendations are made with regard to the implementation of the construction of the planned infrastructure development:

i Environmental monitoring services (EMP Supervision) should be engaged during implementation of infrastructure development

ii The detailed design of the proposed pipe lay out and other associated infrastructure should be cleared with DEA prior to implementation

iii The proposed water lines should follow the road reserves in order to minimise issues of relocation and damage to existing properties

iv The Contractor should consult the Department of Roads and the KDC to seek permission to use the road reserves

v The Contractor should take all precautionary measures to avoid damage to existing services on sections where these are located within the vicinity of the project works

vi Any borrow pits used by the contractor should be appropriately licenced with the relevant authorities

vii The contractor should rehabilitate any camp sites at the end of project implementation

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