BOTSWANA POWER CORPORATION

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY FOR THE MORUPULE B POWER STATION PROJECT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

14th November 2007

Volume 1: Environmental and Social Impact Assessment and the Environmental and Social Management Plan

Prepared in association by Ecosurv Environmental Consultants and GIBB Botswana
# Environmental and Social Impact Assessment Study

## Volume 1: ESIA & ESMP

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Ecosurv in association with GIBB Botswana for Botswana Power Corporation

November 2007
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List of Abbreviations

AIA  Archaeological Impact Assessment
BID  Background Information Document
BOS  Botswana Bureau of Standards
BPC  Botswana Power Corporation
CFBC Coal-Fired Circulating Fluidised Bed Combustion
CSO  Central Statistics Office
DEA  Department of Environmental Affairs
DLA  Department of Land Affairs
DWA  Department of Water Affairs
DWM&PC  Department of Waste Management and Pollution Control
EC  European Community
EIA  Environmental Impact Assessment
EIAA  Environmental Impact Assessment Act
EIS  Environmental Impact Statement
ELO  Environmental Liaison Officer
EMP  Environmental Management Programme
ESR  Environmental Scoping Report
ESP  Electrostatic precipitator
FGD  Flue Gas Desulphurisation
FSR  Final Scoping Report
Ha  Hectare
I&APs  Interested and Affected Parties
IGCC  Integrated Gasification Combined Cycle
ISO  International Standards Organisation
kl  Kilolitres (e.g. 1 000 litres)
Km  Kilometre
m  Metre
mm  Millimetre
m²
Square metre

m³
Cubic metre

mamsl
Metres above mean sea-level

mg/l
Milligrams per litre

µg/m³
Micrograms per cubic metre

mg/Nm³
Milligrams per normal cubic metre

MW
Megawatts

MWe
Megawatts electric

NDP9
National Development Plan 9

NCSA
National Conservation Strategy Co-ordinating Agency

NMAG
National Museum and Art Gallery

NO₂
Nitrogen dioxide

NOₓ
Nitrogen oxides

PC
Pulverised coal

PPP
Public Participation Process

PM10
Particulate matter with an aerodynamic diameter of less than 10µ

SANS
South African National Standards

SCR
Selective Catalytic Reduction

SNCR
Selective Non-Catalytic Reduction

SO₂
Sulphur dioxide

SEP
Stakeholder Engagement Process

ToR
Terms of Reference

WBG
World Bank Group

WHO
World Health Organisation
Foreword

The structure of this document has been prepared in accordance with the requirements of the Department of Environmental Affairs and the Environmental Impact Assessment Act, 2005 (Act No. 6 of 2005). It is recognised that the World Bank Group preferred structure for an Environmental and Social Impact Assessment Report, as provided in The World Bank Operational Policy 4.01 differs from the structure of this report.

The table below is provided to assist international financing organisations in the review of this document.

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Executive Summary

Introduction

The Botswana Power Corporation (BPC), through a 20% equity contribution to a Special Purpose Company (SPC) that is being established, intends to construct a new coal-fired power station (Morupule B Power Station) adjacent to the existing Morupule Power Station. 80% of the contribution to the SPC will be through debt finance from local and international project financiers.

The proposed 600 MW Morupule B Power Station will be wholly-owned by the SPC and is scheduled to be ready for commercial operation by 2010.

To reduce dependency on imported power, BPC initiated the Morupule B Power Station Project, a feasibility study for which was commissioned in 2003. The study consisted of a number of components including a scoping-level environmental investigation, a coal resource determination study and a water resource assessment. The feasibility study was completed in 2004 and it confirmed that the construction of the proposed Morupule B power station would be feasible.

The Environmental Impact Assessment Act, 2005 (Act 6 of 2005, the EIAA) requires the environmental impact of all activities identified in terms of Section 3 (Screening) of the EIAA to be fully considered and authorisation for the activity obtained prior to the commencement of the activity. The proposed development requires an Environmental and Social Impact Assessment (ESIA) to be undertaken in line with the provisions of the EIAA as well as taking due cognisance of the World Bank Group requirements and the Equator Principles.

An ESIA typically comprises two phases, namely a preliminary assessment or Scoping Phase and a detailed Impact Assessment Phase. The Scoping Phase identifies issues and concerns related to the project. The Scoping Phase for the proposed Morupule B Power Station development was completed in 2004.

The detailed Impact Assessment Phase comprises specialist studies to assess specific issues and concerns. Ecosurv (Pty) Ltd (Ecosurv) in association with GIBB Botswana (Pty) Ltd (GIBB Botswana) have been appointed by BPC to undertake the ESIA required for the project. This document constitutes the EIS\(^1\) for the project. The EIS has been compiled in compliance with section 10 of the EIAA.

Project location

The proposed Morupule B Power Station is to be situated adjacent to the existing Morupule Power Station, which lies approximately 280 km north of Gaborone. Palapye is the nearest village, situated approximately 5 km to the east of the power station. The main road between Palapye and Serowe (A14) lies south of the proposed site. Serowe is situated approximately 30 km west of the site and is the administrative centre of the Central District.

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\(^1\) The EIS is referred to throughout this report as the Environmental and Social Impact Assessment (ESIA)
Both the existing Morupule Power Station site and the proposed site for the Morupule B Power Station are within the ownership of the Bamangwato Tribal Authority which is leased to BPC with the future demarcated land portion for the proposed Morupule B Power Station. The proposed site is 476 ha in extent according to the survey record. A railway servitude of 18 ha is registered across the site.

Planning and legislative context

A list of the relevant acts, policies and plans relevant to the proposed project is provided hereunder:

- Central District Development Plan 6;
- Palapye Planning Area Development Plan;
- National Development Plan;
- National Water Master Plan;
- National Energy Policy;
- Botswana Strategy for Waste Management;
- International Commitments Influencing Local Planning;
- International Finance Corporation/World Bank Group Requirements;
- Botswana Biodiversity Strategy and Action Plan;
- The Tribal Land Act of 1970 (As amended in 1993 and 1999);
- The Acquisition of Property Act of 1955;
- The Factories Act of
- The Water Act of 1968;
- The Atmosphere Pollution (Prevention) Act of 1971;
- The Public Health Act of 1981;
- The Monument and Relics Act of 2001;
- The Waste Management Act of 1998;
- The Town and Country Planning Act of 1980;
- The Agricultural Resources Conservation Act of 1974;
- The Forest Act of 1968;
- The Herbage Preservation (Prevention of Fires) Act of 1978;
- The Mines and Minerals Act (As amended in 1999);
- The Mines, Quarries, Works Machinery Act of 1978;
• The Environmental Impact Assessment Act of 2005; and
• The Land Control Act of 1975.

Development plan description

Existing Morupule Power Station

The existing Morupule Power Station is a thermal power plant which combusts coal to produce heat energy, which is used to convert water into steam. The steam is used to drive the steam turbines, which then generate the electricity.

Coal is supplied to the plant via a conveyor belt from the Morupule Colliery. Coal is delivered directly to the boiler bunkers and on to a temporary (live) stockpile for reclamation at a later stage. The coal from the temporary stockpile is collected by a loader and delivered to a reclaim hopper, for forwarding to the boiler bunkers.

This temporary stockpile provides the buffer in case of variation in supply from the mine and boiler consumption requirements.

The Morupule Power Station consumes in the order of 560 000 – 630 000 tons of coal per annum depending on the availability of the plant. Each boiler, when operating at full capacity, consumes approximately 20 tons of coal per hour. The furnaces at this station are of a balanced pressure type. The steam is delivered at the turbine stop valve at 86 bar and approximately 510 °C.

The steam drives the turbine blades that are connected to the turbine shaft, which in turn is connected to an alternator rotor. The alternator rotor acts as a large electro-magnet which generates a magnetic field that in turn induces electricity. The electricity is then supplied to the national electricity grid. The facility employs approximately 375 staff.

The electricity grid in Botswana consists of a network of power lines ranging from 11 kV to 400 kV. At present, power from the existing Morupule Power Station is transmitted via 33 kV and 220 kV power lines. A single 400 kV power line from the Matimba Power Station in South Africa feeds into the Botswana electricity network at the Phokoje Substation. 66 kV and 33 kV power lines are used to distribute power to individual homes. A 102 km 400 kV transmission power line for the Morupule B Power Station will be constructed as a separate project. An EIA for this power line is currently being undertaken.

Project need and desirability

The primary motivation for the proposed Morupule B Power Station is the need for Botswana to reduce its dependency on imported power from neighbouring countries. The importance of this need is reflected in the BPC financial results for the year ending March 2006\(^2\), in which the utility reported a loss as opposed to the forecasted profit which it intended to achieve. BPC’s annual report for 2006 identifies the increased cost of imported power as one of the main reasons for not achieving the forecasted profitability targets for the year. Imported power accounts for 30 % of BPC’s annual expenditure.

\(^2\) This is the latest annual report available
The shortage of generation capacity in the Southern African region as a whole is expected to result in a significant increase in electricity costs throughout the region. Capital expenditure on a new power generation facility within Botswana has been identified as a more cost-effective option for Botswana than the continued reliance on imported power.

The strategic importance of a secure, reliable electricity supply to the economic growth of a country is a further critical factor motivating the need for the Morupule B Power Station. Countries throughout the world recognise the importance of a level of self-sufficiency especially when it comes to electricity supply so that political and social instability in one country does not result in a disruption to an electricity supply in another country. Equally important is the need for sufficient electricity supply to be vested in the interests of the state. Special Purpose Companies (SPC) are an important vehicle in the development of the electricity generation mix within a country but it is agreed internationally that sufficient supply capacity must remain in the ownership of the state.

Proposed Morupule B Power Station

The proposed Morupule B Power Station will make use of different technology but the manner in which electricity will be generated (thermal generation) is essentially the same as for the existing Morupule Power Station. The Morupule B Power Station is proposed to be constructed in two phases. Phase I involves the proposed construction of a 600 MW power plant consisting of 4x150 MW units. Phase II seeks to double the installed generating capacity to 1200 MW. This ESIA is only based on the proposed Phase I development.

The Morupule B Power Station will be an independent power station with no shared facilities with the existing power station. Detail design of the plant has not been completed and it will be influenced in part by the findings of this EIA. The general technical specifications of the plant are however envisaged to consist of the following main components and equipment:

- Boiler plant;
- Turbine-generator;
- Condenser and feedwater system;
- Closed circuit cooling water system;
- Water supply and treatment system;
- Wastewater treatment system;
- Coal handling system;
- Limestone handling system;
- Ash handling system;
- General mechanical systems;
- Electrical equipment;
- Control and instrumentation system;
- Service installations; and
- Civil works.
BPC has recommended either a Coal-Fired Circulating Fluidised Bed Combustion (CFBC) boiler or a Pulverised Coal (PC) boiler but taking due regard of the World Bank Group environmental guidelines. Raw or process water will be sourced from the wellfield currently under investigation in proximity to the Paje Wellfield.

It is estimated that approximately 2 million m$^3$ of raw water will be required for the existing Morupule Power Station and the proposed Morupule B Power Station. The raw water will be supplied to the power plant via a pipeline, which will be designed and constructed as a separate project.

The proposed coal handling system consists of two conveyor belts which will transport the coal approximately 2.5 km from the Morupule Colliery to the Morupule B Power Station. The coal will be crushed, screened and placed in hoppers at the Morupule Colliery, ready for transfer via the conveyor system. Coal received at the power plant will be screened and if necessary crushed prior to storage in coal bunkers. Screening and crushing of coal to the required <6 mm size will be undertaken. The current agreements in place with the Morupule Colliery indicate that coal must be <31 mm in size. Excess coal will be transported via belt conveyor to a stockpile area, which will serve as an emergency coal supply when the supply from the Morupule Colliery is problematic.

Limestone injection into the CFBC boiler is proposed in order to reduce SO$_x$ emissions. Limestone will be delivered to site via rail, after which it will be unloaded into hoppers from where it will be fed into screens for separating limestone into the required size.

Ash is produced from the CFBC boiler during the combustion process and is removed as bed or bottom ash and fly ash. Once the coal has been combusted, the bottom ash/coarse ash from the boiler will be collected and then cooled in the ash cooler. A positive pressure conveying system will then transport the dry bed ash to a bed ash silo. The fly ash from the bagfilters will be pneumatically collected in fly ash hoppers prior to delivery to a fly ash silo.

Dry fly ash will be unloaded from the silos into trucks through paddle/rotary type feeders. On an annual basis, approximately 35 000 tons of ash is provided to the cement industry in this way from the existing Morupule Power Station. Water will be used to condition the ash prior to unloading into open trucks in order to suppress the dust emissions during this process.

Fly ash, which cannot be disposed of in a dry form through use in other industries will be mixed with the neutralised/raw water from the ash water tank and pumped to a new ash pond via two new pipelines. Bed ash is likely to be transported by truck to the new ash pond.

The ash pond will be based on a compartmentalised design. In the much-larger first compartment (settling pond), coarse ash will settle. The water with fine ash will flow into the smaller second compartment (stilling pond) where the fine ash will settle. Water from the stilling pond is proposed to be collected in a collecting well from where it will flow by gravity to a recovery water sump situated in close proximity to the ash pond. Treatment of the water through chemical dosing will take place at the recovery water sump prior to delivery of the water to a clarifloculator for the removal of suspended particulates. The water from this process will flow via gravity into an underground clear water tank from where it will be pumped to the ash water tank for reuse. The ash pond will be lined with a Low Density Poly Ethylene (LDPE) liner.

Construction of the Morupule B Power Station is scheduled to commence in 2008. A period of commissioning of the power station will precede the operational phase, which is scheduled for October 2010.
Biophysical environmental setting

Geology and soils

The geology of the area where the proposed Morupule B Power Station is to be constructed consists of shales and mudstones of the Lotsane Formation overlain by relatively thin (10 m - 20 m) Kalahari Beds. Beneath the Lotsane Formation are the fractured quartzites of the Tswapong Formation, which outcrop as the western escarpment of the Tswapong Hills some 20 km to the southeast of the site. The soils of the study area are characterised by their orange colour and fine grain size, and their sandy silt loam texture. Soils from this area are aeolian (wind-blown), and have been derived from the weathering of the Ntane Sandstone Formation, which outcrops along the Serowe escarpment.

Topography and landform

The proposed development site is at an elevation of approximately 950 metres above mean sea-level (mamsl). The land to the northwest of the site (e.g. the rocky country around Serowe) rises to an elevation of 1100 mamsl. In general there is a gentle gradient falling away to the southeast of the site. The site lies within the Lotsane River Catchment. This is a major ephemeral river in the area. This catchment is slightly hilly, but predominantly undulating. There are a few topographical features in the area that attain elevations of approximately 100 m above the surrounding countryside. These features include the Tswapong hills, which lie about 10 km to the southeast and the two small “koppies”, to the north of the site. The rocky outcrops are situated on the Morupule Colliery property.

Surface water environment

The Lotsane River is the closest river to the proposed power station, situated approximately 3.7 km to the south east while the Morupule River is about 5 km west. The Lotsane River forms part of the Limpopo River basin and flows into the Limpopo River on the Botswana and South African border.

Groundwater environment

Underlying the majority of the site and the surrounding area is unsaturated Kalahari Beds (> 15 m of aeolian sand, sandstone, duricrusts and gravel), located above the Lotsane Formation (shale and mudstones). Below this formation is the Palapye fractured quartzitic aquifer. From a hydrogeological viewpoint, the Kalahari Beds immediately below the proposed development site can be considered to be a very minor aquifer.

The hydrogeological report indicated that a groundwater mound has developed beneath the present ash lagoon site due to seepage from the lagoon. This seepage has caused a rise in groundwater contours immediately below the site of around 3.5 m over the last ten years. This has the potential to cause the movement of contaminants away from the ash lagoon towards the southeast. The mound of water however does not appear to have moved significantly off site and the relatively small degree of rise (average 35 cm a year) shows that movement of groundwater is slow in both the saturated and unsaturated aquifer zones.


The results of this comparison indicate that the highest average concentration of sulphate, ammonia and iron in the water currently exceeds the BOS 32:2000 maximum limits for acceptable water for these parameters.
The existing power plant does not appear to have significantly impacted on the water resources in the area albeit for a rise in sulphate concentrations. The hydrogeological specialist study indicated that the proposed site, based on soil types, strata and depth to unsaturated zone, has a moderate aquifer vulnerability setting.

Ecology

Two vegetation types have been identified in the study area namely Burkea/Ochna Savannah and Acacia erioloba Savannah. Burkea/Ochna Savannah is associated with deep well-drained ferralic sandy soils, and is characterised by Colophospermum mopane species. Acacia erioloba Savannah is characterised by Acacia erioloba, Terminalia sericea, and Lonchocarpus nelsii species. Both these vegetation types are savannah type systems and occur in the areas south of the Makgadikgadi.

Although the site of the proposed power station and slurry dams has low plant species diversity, the Tswapong hills area, which is located to the east outside of the study area, has been highlighted as being host to important species.

The Tswapong hills are host to large breeding populations of Palaearctic migrants and are thus given the status of being an Important Bird Area (IBA)\(^3\). Of the species occurring in the Tswapong hills, the Cape Vulture, *Gyps coprotheres*, is a species of global conservation concern.

Climate

Semi-arid conditions with cool dry winters and warm, wetter summers characterise the climate of the study area. Rainfall data from the power station from 1989-2006 indicates a mean annual precipitation of 371 mm with the majority of rainfall received between November and March. The dominant winds occur from a north easterly direction with an average wind speed of 3 m/s. Strong winds exceeding 5 m/s occur at a frequency of 41%. Temperature maximums in the study area generally occur during the October-March months, with June and July months experiencing the lowest temperatures. Only small inter-annual variations in temperature ranges occur. The average annual maximum temperature is between 28 °C and 30 °C and the average minimum temperature is between 14 °C and 16 °C. Potential evapotranspiration is in the order of 900-1500 mm/year, which is three to four times the average annual rainfall.

Air quality

The baseline ambient air quality of the local airshed was simulated through dispersion modelling because there is insufficient on-site data available for the criteria pollutants of concern. The main sources contributing to the ambient air quality within the vicinity of the proposed Morupule B Power Station are the current Morupule Power Station and the Morupule Coal Mine. The other main sources, i.e. Matimba and Matimba B Power Stations are considered to be too far away to have a significant influence on the background concentrations at the Morupule Power Plant. The predicted baseline SO\(_2\), NO\(_2\) and PM10 baseline concentrations due to the existing Morupule Power Plant is summarised in Table 8.

\(^3\) Important Bird Areas have no national legal status
Table 8: Predicted SO$_2$, NO$_2$ and PM10 baseline concentrations due to the Morupule Power Plant (exceedances of air quality guidelines are highlighted)

<table>
<thead>
<tr>
<th>Averaging Period</th>
<th>Standard/ Guideline ($\mu$g/m$^3$)</th>
<th>MAX GLC</th>
<th>PALAPYE</th>
<th>SEROWE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max Conc ($\mu$g/m$^3$)</td>
<td>Fraction of GL</td>
<td>Max Conc ($\mu$g/m$^3$)</td>
<td>Fraction of GL</td>
</tr>
<tr>
<td>Sulphur Dioxide (SO$_2$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest hourly</td>
<td>350(d)</td>
<td>4683.6</td>
<td>13.4</td>
<td>690.0</td>
</tr>
<tr>
<td>Highest 24-hour average</td>
<td>300(a)</td>
<td>557.9</td>
<td>1.9</td>
<td>70.0</td>
</tr>
<tr>
<td></td>
<td>150(b)</td>
<td>11.2</td>
<td>0.5</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>50(c)</td>
<td>12</td>
<td>0.05</td>
<td>0.15</td>
</tr>
<tr>
<td>Annual average</td>
<td>80(a)(b)</td>
<td>155.2</td>
<td>1.9</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>30(c)</td>
<td>5.2</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO$_2$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest hourly</td>
<td>400(a)</td>
<td>164.0</td>
<td>0.4</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>200(c)</td>
<td>8</td>
<td>0.1</td>
<td>0.01</td>
</tr>
<tr>
<td>Highest 24-hour average</td>
<td>150(b)</td>
<td>19.6</td>
<td>0.1</td>
<td>2.6</td>
</tr>
<tr>
<td>Annual average</td>
<td>100(a)(b)</td>
<td>5.5</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>40(c)</td>
<td>0.1</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td>Particulates (PM10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest 24-hour average</td>
<td>150(b)</td>
<td>366.6</td>
<td>2.4</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>100(c)</td>
<td>3.7</td>
<td>0.03</td>
<td>0.012</td>
</tr>
<tr>
<td>Annual average</td>
<td>200(a)</td>
<td>189.2</td>
<td>0.9</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>50(b)(c)</td>
<td>3.8</td>
<td>0.004</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Notes:

(a) Botswana guideline (90% of observed to be less than 300 $\mu$g/m$^3$)

(b) World Bank (WBG) Thermal Power Guidelines

(c) World Health Organisation (WHO) Interim Target-2 (IT-2)

(d) European Community (EC) hourly standard

Abbreviations:

GLC – ground level concentration (this is the maximum concentration)

GL – Guideline

Max Conc – Maximum Concentration
Sulphur dioxide

The maximum predicted ground level concentrations are predicted to occur approximately 800 m west of the existing Morupule Power Station. These concentrations currently exceed the relevant Botswana and World Bank Group (WBG) limits for highest hourly, daily average and annual average intervals (Appendix 4.4).

The guidelines for highest daily averages as provided by Botswana and the WBG were not exceeded at Palapye. Annual average concentrations at Palapye and Serowe do not exceed any of the guidelines. Highest hourly predicted SO\(_2\) concentrations exceeded the European Community (EC) standard at Palapye and the WHO Interim Target (IT)-2 guideline over a 24-hour average.

The allowable frequency of exceedance according to the EC hourly standard of 350 µg/m\(^3\) is 24 hours per calendar year. Based on the predicted hourly concentrations at Palapye, the 350 µg/m\(^3\) limit will be exceeded for 7 hours in the calendar year, thus within the EC limit in this regard.

At Serowe, none of the ambient air quality guidelines or standards was exceeded for any of the averaging periods.

Nitrogen dioxide

The maximum ground level concentration was predicted to occur approximately 769 m to the west of the power station (Appendix 4.4). The maximum ground level concentration for highest hourly averages was predicted to comply with the Botswana, WBG and WHO guidelines. Highest daily and annual average predictions were also well within the respective guidelines. All predicted NO\(_2\) ground level concentrations were low and well within the respective guidelines at Palapye and Serowe.

Particulate matter (10 micron)

The maximum ground level concentration for highest hourly averages was predicted to occur within a 500 m radius of the power station (Appendix 4.4). Predicted ground level concentrations of PM10 considered all the sources at the Morupule Power Station including stacks, vehicle entrainment on roads, wind blown dust from the coal storage piles and the ash lagoon and materials handling operations.

Maximum ground level concentrations were predicted to exceed the daily and annual guidelines as reflected by the WBG and WHO (Appendix 4.4). Predicted emissions are at the limit of the Botswana annual average guideline.

At Palapye and Serowe, the predicted PM10 concentrations were low and well within the respective guidelines for highest daily and annual averages.

The quantitative assessment of ambient air quality indicated above is conservative in that the hourly and daily averaging periods contain only the maximum predicted ground level concentrations, for those averaging periods, over the entire period for which simulations were undertaken (Appendix 4.4). It is therefore possible that even though a high hourly or daily average concentration is predicted to occur at certain locations, that this may only be true for one hour or one day during the year.
Greenhouse gas production

The Morupule Power Station greenhouse gas contribution may be placed within the context of national greenhouse gas emissions by making reference to the greenhouse gas emissions inventory included in the National Communication to the United Nations Framework Convention on Climate Change (UNFCCC, 2002).

The Air Quality Impact Report compiled by Airshed Planning Professionals in 2004 indicated that the current Morupule Power Station contributed approximately 32.6%, 0.3% and 0.01% of the country’s total CO₂, NO₂ and CH₄ emissions respectively.

Botswana’s current CO₂ emissions have been calculated at approximately two tons of CO₂ emissions per person per year (Appendix 4.3). This figure excludes the carbon cost of imported electrical power but includes present coal production and use, all fuels, gas and firewood. The average figure for CO₂ emissions per person per year for middle-income countries is 3.8 tons.

Noise

The general procedure used to determine the noise impact was guided by the requirements of the Code of Practice SANS 10328:2003: Methods for Environmental Noise Impact Assessments. The noise impact criteria used specifically take into account those as specified in SANS 10103:2004, The Measurement and Rating of Environmental Noise with Respect to Land Use, Health, Annoyance and Speech Communication.

Measurements and auditory observations were taken at nine monitoring sites during the noise impact investigation in order to establish the ambient noise conditions of the study area (Table 9). These were taken at appropriate sites at varying distances from the power station site.

Table 9: Current noise levels in the Morupule Power Station study area.

<table>
<thead>
<tr>
<th>Noise Sensitive Site*</th>
<th>Period</th>
<th>Maximum Allowable Noise Level (dBA)</th>
<th>Measured Noise Level (Year 2007) (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1: Colliery Village (Suburban Residential)</td>
<td>Day</td>
<td>WHO &amp; WB 55</td>
<td>SANS 10103 50</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>Site 2: Colliery Village (Suburban Residential)</td>
<td>Day</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>Site 3: Kgaswe School (Educational)</td>
<td>Day</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Site 4: Settlement (Rural Residential)</td>
<td>Day</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>35</td>
</tr>
<tr>
<td>Site 5: Palapye (Urban Residential)</td>
<td>Day</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Site 6: Palapye (Urban Residential)</td>
<td>Day</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>45</td>
</tr>
</tbody>
</table>

* Sites 4a, 7 and 8 are omitted as no night-time measurements were taken at these locations.
The background noise levels in the study area indicate the following (Appendix 4.7):

- Noise levels in Palapye Village are high and are typical of an urban complex;
- The existing noise climate alongside the main roads in Palapye is degraded with regard to the SANS urban residential living standards, that is noise exceeds the SANS standards particularly at night. In general the daytime conditions are within the SANS noise standards;
- The areas outside Palapye and remote from the main roads and the power station/collery are very quiet and reflect a rural character;
- The existing noise climate alongside Road A14 outside Palapye Village is degraded with regard to the SANS rural residential living standards;
- The impact of the power station on noise sensitive sites in the surrounding area is minor. Noise levels from the existing power station exceed 35dBA (the SANS maximum allowable night-time level for rural residential use) up to a distance of about 2500 metres from the facility. The Colliery Village and the settlement (“Molapo wa Dipitse”) lie outside this zone and are thus not impacted by the power station noise. These residential areas are also not adversely impacted by traffic noise from Road A14. The old housing that was used during the construction of the existing power station, adjacent to the Kgase Primary School, lies within this zone but noise levels at this site are more severely affected by the Road A14 traffic noise. The power station will be heard late at night when traffic volumes are low;
- Noise levels from traffic on Road A14 at the Kgase Primary School are slightly higher than desirable for an educational environment. The maximum daytime noise level measured in the vicinity of the school was 76.6dBA whilst the average daytime noise level was 57.9dBA. Noise from vehicles passing over the speed control humps on the power station access road just to the west of the school is a significant noise nuisance factor. Noise from the power station does not have a significant impact on the activities at the Kgase Primary School; and
- The overall impact of the noise from the coal trains on noise sensitive sites in the area is not significant. There is a minor nuisance effect at the school from the warning horn sounding when the train approaches the level crossing with the power station access road.

**Socio-economic environmental setting**

**Land use**

Within the surrounding area there are a number of land use practices. These include:

- Arable agriculture;
- Livestock production;
- Urban development (mainly housing); and
- Land developed for mining and power production.
The most viable and commonly practised land use in the area is communal grazing livestock. According to the Central District Planning Study Document (1992), over 65% of land is used for livestock grazing. Within the 10 km radius of the proposed development about 68% of the land is available for traditional livestock production (made up of agricultural lands, Department of Agriculture artificial insemination camps and free range) with an additional 8% fenced for commercial livestock production.

Two Artificial Insemination (AI) camps belonging to the Ministry of Agriculture (MOA), called Leupala and Moupule are located within 10 km of the site. Livestock carrying capacities are presently 7 ha/Large Stock Unit (LSU).

Dry land farming is seen to be a common land use practice in the area with this practice accounting for approximately 11% of the total area within the district (Central District Planning Study, 1992).

The main crops grown in the Palapye area are sorghum, maize, cowpeas, millet, and melons. Arable agricultural production is low but it remains an important part of the rural economy.

**Heritage aspects**

Surveys of the eastern parts of Botswana have identified sites ranging from the early Stone Age through to the Late Stone Age, to the Iron Age and the historic period. In other words, there are signs of human activity in the eastern parts of Botswana from as early as two million years ago until historic times. Stone Age research in this area has been limited and this is evident from the National Museum site register whereby very few sites have been recorded. A review of the relevant records pertaining to the general study area at the Botswana National Museum indicated that 17 sites have been recorded in the 27-C1-map sheet. These were mostly sites of Stone Age, Iron Age and historic period with the Toutswe culture mostly represented in the Iron Age. The archaeological survey undertaken confirmed that none of these sites are located on the proposed development site.

**Population**

Central District has a population of about 501,381. The majority of the population (153,035) are concentrated in the Serowe–Palapye sub district. The sub district covers an area of 30,925 km² with a population density of 5 persons/km².

**Employment**

Employment opportunities in the area are linked to variety of economic activities, which include agriculture (arable and pastoral), mining, industrial and commercial, manufacturing, and construction. The location of the Morupule coal mine and the BPC Power Station has boosted employment opportunities in the Palapye area where unemployment has been known to be high.

**Health**

Health data (HIV/AIDS and Sexually Transmitted Infections) prevalence in Palapye is high and at present increasing.
Services

Education

The literacy rate for Central District was in the region of 62% during the 2001 census. There are nine government-owned primary schools and one privately owned school in Palapye. Preschools are also available throughout the village. There are three junior secondary and one senior secondary school in the village. There is also a vocational training centre, and informal education centre.

Health

The delivery of health services in Palapye is provided through a primary hospital and four clinics. The primary hospital falls under the Ministry of Health while clinics are coordinated by the Ministry of Local Government. There are also specialised centres such as anti-retroviral drugs distribution centres to address the high HIV/AIDS rate in Botswana. There are also a number of private medical practitioners in the village.

Housing

Housing structures in Palapye as well as most villages in Central District are predominantly modern structures with tin roofing. However, there are still traditional housing structures made from mud and grass thatch scattered throughout the village.

Social amenities

Palapye is serviced by one police station and there are plans to build a bigger one due to the rapid growth of the village. Water supply is from the national supply, community standpipes and private connections. There are three cemeteries, but only one of these is in use.

Transport and communication

The A1 trunk road (Francistown–Gaborone) links the south and the north parts of the country. There is also the B14 road, which links Central and Ngamiland Districts. The village is also serviced by an airstrip for small aircraft. Telecommunications in the area are served by Botswana Telecommunications Corporation (BTC) and cellular phone service providers. Botswana Post provides postal services.

Electricity supply

Palapye benefits from the location being close to Morupule Power Station. The village is connected to the national supply grid through one substation. However, there is another under construction as residents have been complaining about frequent power surges and outages. Main consumers of electricity are the commercial industrial establishments.

Stakeholder engagement process

The SEP for the Impact Assessment Phase commenced in August 2007 with the publication of an advertisement in English and Setswana announcing the project. The first advertisement was placed on 3 August 2007 and the second advertisement was placed on 30 August 2007 (Appendix 5.3). An opportunity to attend the scheduled public meeting regarding the project was included in the advertisements. A Background Information Document (BID), and comments sheet was made available to all I&APs (Appendix 5.4 and Appendix 5.5). It was presented in both Setswana and English.
A public meeting was held at Palapye main Kgotla on 4 September 2007. The meeting was announced through the advertisements placed in local newspapers. The public meeting was conducted in Setswana as all the participants could speak and understand the language. The meeting was attended by 31 people including the consultations team and representatives from BPC.

A meeting with key local and central government officers was convened in Palapye on 4 September 2007. The meeting was arranged through the assistance of the Central District Assistant Council Secretary responsible for the Serowe-Palapye Sub-District.

The consultations team undertook consultations in the following lands areas within 10 km of the proposed power station site:

- Morupule;
- Mantshadidi;
- Mmalenakana;
- Dikabeana; and
- Molapowadipitse.

Meetings were held with focus groups that comprised of local farmers. A summary of the comments received during the Impact Assessment Phase consultation process were as follows:

**Public, farmers and livestock owners meetings**

The town leadership and the community generally welcomed the project; Preference should be given to local people for non-skilled and semi-skilled labour requirements and the hiring should be done in a transparent manner such use of the Kgotla;

Some of the residents mentioned that increased power generation may lead to lower power costs and this will encourage the nation to divert from the use of other natural resources. This was pointed out as a worthwhile venture as it would reduce pressure on other natural resources especially firewood; Residents also pointed out that there were frequent power outages in their area, and hoped that increased power generation would help ease the problem; and Increased probability of illegal occupiers of land who will come in as job seekers.

**Business community**

Short-term increase in population in the area may lead to increase in sales and revenue; and The contractor should source some of the materials and services locally.

**Key government officers**

Construction phase might exert pressure on existing social amenities such as schools and clinics available in the town.

The proposed project was generally welcomed and viewed as a good investment for the country. All the consulted stakeholders concurred with the results of the Scoping Phase that was undertaken in 2004. Consequent to this, no new issues were identified during consultations.

**Specialist studies key findings**

**Social impact assessment**
• All of the key interest groups interviewed, namely the local authorities, farmers and businesses all indicated that they did not experience any major problems with the operations of the existing power station and mine. In addition they all indicated that the proposed power station would benefit both Botswana and the town of Palapye. The benefits to Botswana were linked to improved power generation reliability and energy security. The benefits to the town of Palapye were linked to the creation of local employment and business opportunities during both the construction and operational phase;

• Concerns were raised by the representatives from local government regarding the potential pressure that the increased number of employees and job seekers would have on existing services, such as housing and medical facilities. However, the social specialist felt that these issues could be effectively managed through the implementation of mitigation measures;

• A number of potential negative impacts during the construction phase were also identified, specifically the influx of construction workers and job seekers, impact of heavy vehicles (noise, dust and safety impacts), stock theft and increased risk of veld fires. However, each of these issues can be effectively mitigated by the implementation of an Environmental Management Plan during the construction phase;

• The findings of the study also indicate that the project will create a number of opportunities for local businesses during both the construction and operational phase of the project. These represent positive impacts;

• Based on the findings of the Social Impact Assessment it is recommended that Phase 1 of the Morupule B Power Station proceed. In order to enhance the local employment and business opportunities the mitigation measures listed in the report should be implemented; and

• The mitigation measures listed in the report to address the potential negative impacts during the construction phase, specifically the impact of heavy vehicles (noise, dust and safety impacts), stock theft and increased risk of veld fires, should also be implemented.

Noise impact assessment

A summary of the predicted noise levels compared with relevant noise limits is provided in Table 16. The assessment of the predicted noise impact during the construction phase indicated the following:

• Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over short periods during any day working period;

• Working on a worst-case scenario basis, it was estimated that the ambient noise level from general construction should not exceed 35dBA at the nearest noise sensitive receptor (namely the Kgaswe Primary School that is offset by about 1350 metres from the construction). This level is within the noise limits prescribed by the World Bank Group;

• As the daily volume of construction generated traffic will be relatively small in comparison with the existing daily traffic on the external main road system, the noise impact from this additional traffic on the surrounding areas was assessed to be insignificant; and
• For all construction work, the construction workers working with or in close proximity to equipment will be exposed to high levels of noise.

With respect to the operational phase, the noise specialist indicated the following:

• The noise from the individual power stations at any point within the area of influence of both power stations will be enhanced as a result of the cumulative noise impact from both power stations. The maximum increase will be 3dBA. This noise enhancement will be experienced mainly in the area between the power stations;

• Noise levels near to the main roads will remain high and will continue to increase as traffic volumes increase;

• The residences on the western edge of Palapye (urban residential) lie well outside the power station’s 45dBA+ impact zone and thus will not be negatively affected;

• The Colliery Village (suburban residential) lies well outside the power station’s 40dBA+ zone and thus will not be negatively affected;

• The “Molapu Wapitsi” settlement (rural residential) lies well outside the power station’s 35dBA+ zone and thus will not be negatively affected. No other settlements are potentially affected;

• Night-time noise levels in the “contractor’s” village are already degraded from road traffic noise and the anticipated increase from the planned power station will be minor;

• The noise assessment indicates that the current ambient noise levels at the school are between 41dBA and 46dBA. With the Morupule B Power Station, noise levels at the school are conservatively predicted to increase to between 45dBA and 50dBA. The WBG limit for educational land use is 55dBA. The specialist concluded that the noise from the proposed power station will not significantly worsen the noise climate at the Kgase Primary School;

• Noise impact from ancillary works and equipment (such as the conveyor belts) will in general be low and localised. The drive houses for the conveyor belt system, however, will be sites of high noise levels; and

• The volume of traffic generated by the operations at the proposed power station will only marginally increase the ambient noise levels along the road corridor between the power stations and Palapye.

The impact of noise as a result of the proposed development was assessed to be of low significance both before and after the implementation of suggested mitigation measures.
Table 16: Comparison of predicted noise levels against the World Bank Group limits

<table>
<thead>
<tr>
<th>Noise Sensitive Site</th>
<th>Period</th>
<th>Maximum Allowable Noise Level (dBA)</th>
<th>Measured Noise Level (Year 2007) (dBA)</th>
<th>Calculated Noise Level from Noise Source Component Indicated (Year 2012) (dBA)</th>
<th>Cumulative Noise Level (Σ) with and without New Power Station (NPS) (dBA)</th>
<th>Increase in Noise Level (Δ) due to New Power Station (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>WHO &amp; WB</td>
<td>SANS 10103</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site 1: Colliery Village (Suburban Residential)</td>
<td>Day</td>
<td>55 50</td>
<td>47.5</td>
<td>33.2 39.6 35.0</td>
<td>40.5 41.6</td>
<td>+1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Night</td>
<td>45 40</td>
<td>39.2                                                  33.2 33.5 35.0</td>
<td>36.4 38.7</td>
<td>+2.3</td>
</tr>
<tr>
<td>Site 2: Colliery Village (Suburban Residential)</td>
<td>Day</td>
<td>55 50</td>
<td>39.8</td>
<td>33.4 39.8 35.0</td>
<td>40.7 41.7</td>
<td>+1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Night</td>
<td>45 40</td>
<td>28.8                                                  33.4 33.8 35.0</td>
<td>36.6 38.9</td>
<td>+2.3</td>
</tr>
<tr>
<td>Site 3: Kgaswe School (Educational)</td>
<td>Day</td>
<td>55 50</td>
<td>57.9</td>
<td>44.5 55.6 46.7</td>
<td>55.9 56.4</td>
<td>+0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Night</td>
<td>na na</td>
<td>49.3                                                  44.5 49.6 46.7</td>
<td>50.8 52.2</td>
<td>+1.4</td>
</tr>
<tr>
<td>Site 4: Settlement (Rural Residential)</td>
<td>Day</td>
<td>55 45</td>
<td>45.5</td>
<td>26.0 40.3 30.5</td>
<td>40.5 40.9</td>
<td>+0.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Night</td>
<td>45 35</td>
<td>30.8                                                  26.0 34.2 30.5</td>
<td>34.8 36.2</td>
<td>+1.4</td>
</tr>
<tr>
<td>Site 5: Palapye (Urban Residential)</td>
<td>Day</td>
<td>55 55</td>
<td>62.4</td>
<td>24.1 61.6 32.8</td>
<td>61.6 61.6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Night</td>
<td>45 45</td>
<td>46.2                                                  24.1 55.5 32.8</td>
<td>55.5 55.5</td>
<td>0</td>
</tr>
<tr>
<td>Site 6: Palapye (Urban Residential)</td>
<td>Day</td>
<td>55 55</td>
<td>56.8</td>
<td>23.0 54.2 31.1</td>
<td>54.2 54.2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Night</td>
<td>45 45</td>
<td>51.0                                                  23.0 48.2 31.1</td>
<td>48.2 48.3</td>
<td>+0.1</td>
</tr>
</tbody>
</table>

Note: The Cumulative Noise Level (Σ) is obtained by summing the relevant component noise levels logarithmically.
Ecology and land use

The ecological and land use study noted that there are few ecological issues relating to the proposed development of the power station. No post-mitigation impacts of high or medium significance were noted for the construction phase of the development. The following operational phase post-mitigation impacts were assessed to be of high significance:

- Groundwater depletion and drawdown; and
- Botswana’s per capita contribution to global warming.

In terms of the latter, it has been calculated that with Phase I of the Morupule B Power Station, Botswana’s per capita CO\textsubscript{2} emissions will increase to 8.7 tons, which is slightly above the world average (Appendix 4.3). If the proposed Mmamabula Power Station and Phase II of the Morupule B Power Station proceed, this would result in a per capita CO\textsubscript{2} emission level for Botswana of nearly 17 tons. On a per capita basis, this would make Botswana the highest CO\textsubscript{2} producing country in Africa and one of the highest in the world.

The following post-mitigation impacts were assessed to be of medium significance:

- Loss of Cape Vultures due to electrocution if additional power lines are required. This impact should be considered during the transmission power line EIA;
- Human health impacts as a result of predicted daily average SO\textsubscript{2} emissions at a concentration which exceeds relevant local and international emission limits; and
- Night-time noise impact to 16 households within 2.2 km of the power station.

The latter impact is based on the findings of the noise impact specialist (Appendix 4.7). These households are currently exposed to an ambient noise level of between 35.2 dBA (2500 m from the site) and 38.2 dBA (2000 m from the site). With the Morupule B Power Station, the predicted noise profile at this distance is expected to increase to between 39.1 dBA (2500 m from the site) – 41.9 dBA (2000 m from the site). This is an approximate increase in noise of between 3.7 dBA and 3.9 dBA. Appendix A of the noise impact assessment indicates that an increase in noise of 3 dBA is just detectable. The suburban residential standard for the night-time period is 40 dBA.

Air quality

Table 17 summarises the predicted emissions concentrations of the Morupule B Power Station.
### Table 17: Predicted SO$_2$, NO$_2$ and PM10 Future Concentrations due to the Morupule and Morupule B Power Plants (Exceedances of Air Quality Guidelines are Highlighted)

<table>
<thead>
<tr>
<th>Averaging Period</th>
<th>Stack Height</th>
<th>Standard d/ Guideline (µg/m$^3$)</th>
<th>Max Conc (µg/m$^3$)</th>
<th>Fraction of GL</th>
<th>Max Conc (µg/m$^3$)</th>
<th>Fraction of GL</th>
<th>Max Conc (µg/m$^3$)</th>
<th>Fraction of GL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest hourly</td>
<td>150 m</td>
<td>4,707.03</td>
<td>13.45</td>
<td>950.00</td>
<td>2.71</td>
<td>98.00</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 m</td>
<td>4,706.55</td>
<td>13.45</td>
<td>940.00</td>
<td>2.69</td>
<td>91.00</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 m</td>
<td>4,683.60</td>
<td>13.38</td>
<td>937.00</td>
<td>2.68</td>
<td>76.00</td>
<td>0.22</td>
<td></td>
</tr>
</tbody>
</table>

#### Sulphur Dioxide (SO$_2$)

|                  | 300(d)       | 581.36                           | 1.94                | 95.00          | 0.32                 | 16.50          | 0.06                 |
|                  | 150(b)       | 3.88                             | 0.63                | 0.13          | 1.90                 | 0.33          |                      |
|                  | 50(c)        | 11.63                           | 0.30                | 0.05          |                      |               |                      |
|                  | 150(b)       | 3.85                             | 0.59                | 0.10          |                      |               |                      |
|                  | 50(c)        | 11.56                           | 0.78                | 0.29          |                      |               |                      |
| Highest 24-hour average | 300(a)   | 3.66                             | 0.27                | 0.04          |                      |               |                      |
|                  | 150(b)       | 3.75                             | 0.55                | 0.08          |                      |               |                      |
|                  | 50(c)        | 11.19                           | 0.16                | 0.25          |                      |               |                      |

#### Nitrogen Dioxide (NO$_2$)

|                  | 400(a)       | 164.90                          | 0.41                 | 34.00         | 0.09                 | 3.90           | 0.01                 |
|                  | 200(b)(c)    | 0.82                            | 0.17                 |              |                      |               |                      |
| Highest 24-hour average | 150(b)   | 20.59                           | 0.14                 | 3.50          | 0.02                 | 0.72           | 0.005                |
| Annual average   | 100(a)       | 6.74                            | 0.07                 | 0.23          | 0.002                | 0.10           | 0.001                |
|                  | 40(b)(c)     | 0.17                            | 0.01                 |              |                      |               |                      |

#### Particulates (PM10)

|                  | 150(b)       | 2,377.30                         | 15.85               | 23.00         | 0.33                 | 7.80           | 0.05                 |
|                  | 100(c)       | 23.77                            | 0.23                 |              |                      |               | 0.08                 |
| Highest 24-hour average | 200(a)   | 6.16                             | 0.29                 | 0.62          | 0.003                |               |                      |
|                  | 50(b)(c)     | 24.64                            | 0.04                 |              |                      |               | 0.01                 |
| Annual average   | 1,232.13     |                                 |                      |              |                      |               |                      |

**Notes:**
(a) Botswana guideline (90% of observed to be less than 300 µg/m$^3$)
(b) World Bank (WBG) Thermal Power Guidelines
(c) World Health Organisation (WHO) Interim Target-2 (IT-2)
(a) European Community (EC) hourly standard

**Abbreviations:**
GLC – ground level concentration (this is the maximum concentration)
GL – Guideline
Max Conc – Maximum Concentration

**Sulphur dioxide**
- The highest predicted ground level concentrations exceeded all the relevant guidelines and standards for hourly, daily and annual averaging periods. This was based on a design stack height of 150 m. The maximum ground level concentration predicted was very close to the existing Morupule Power Station impacting approximately 800 m to the west;
The zone of exceedance for highest hourly predictions (EC standard) covered a radius of approximately 10 km around the power plant site. The number of hours exceeding the EC hourly standard of 350 µg/m³ at Palapye was 13 based on the 150 m stack but reduced to 10 with the 200 m stack and with the 300 m stack down to 6. The EC allows 24 hours of exceedance;

The Botswana and WBG guideline for highest daily average and annual average at Palapye and Serowe were not predicted to be exceeded. The hourly average EC standard and highest daily WHO IT-2 guideline was exceeded at Palapye;

The zone of exceedance for highest hourly predictions (EC standard) covered a radius of approximately 10 km around the power plant site;

Over an annual average, only the maximum ground level concentrations exceeded the relevant guidelines. This was predicted to be right at the plant, less than 1 km from the source. With an increase in stack height to 200 m a reduction of 6 % would be achieved at Palapye and at 300 m the overall improvement will be 16 %;

Highest daily averaged SO$_2$ concentrations exceeded the critical level for agricultural crops, forest trees and natural vegetation (79 µg/m³) both on-site and at Palapye and surrounding areas. No reports regarding the impact of SO$_2$ emissions on agricultural crops or natural vegetation were noted during stakeholder consultation or within the social impact assessment report;

Predicted annual averaged SO$_2$ concentrations were well within the EC and United Kingdom limit value (20 µg/m³) for the protection of ecosystems;

The Morupule B Power Station has a relatively small contribution to the high SO$_2$ concentrations (Table 18);

With the increase in stack heights to 200 m and 300 m, very little difference was noted in the cumulative (i.e. including the existing Morupule Power Station) maximum predicted ground level concentrations. The predicted ground level concentrations at Palapye reduced by 1% between the 150 m stack and the 200 m stack and by a further 0.4% when increased to 300 m. The incremental impacts from the three stack heights did however indicate a significant reduction between 200 m and 300 m. The predicted maximum concentrations from the proposed Morupule B Power Station in isolation were 1315 µg/m³ at 150 m, 978 µg/m³ at 200 m and 740 µg/m³ at 300 m. Thus a reduction in ground level concentrations of 26% will be achieved by increasing the stack height from 150 m to 200 m and a further 24% reduction by increasing it to 300 m. With the background concentrations included (i.e. Morupule Power Station) the reduction is less noticeable.
### Table 18: Comparison of predicted baseline air quality with predicted air quality after the development of the Morupule B Power Station

<table>
<thead>
<tr>
<th>Averaging period</th>
<th>Max GLC* (µg/m³) Without Morupule B (baseline)</th>
<th>Max GLC* (µg/m³) With Morupule B</th>
<th>Percentage difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sulphur dioxide</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest hourly</td>
<td>4,683.6</td>
<td>4,707.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Highest daily</td>
<td>557.9</td>
<td>581.4</td>
<td>4.2</td>
</tr>
<tr>
<td>Annual average</td>
<td>155.2</td>
<td>189.2</td>
<td>21.9</td>
</tr>
<tr>
<td><strong>Nitrogen dioxide</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest hourly</td>
<td>164.0</td>
<td>164.90</td>
<td>0.6</td>
</tr>
<tr>
<td>Highest daily</td>
<td>19.6</td>
<td>20.6</td>
<td>5.1</td>
</tr>
<tr>
<td>Annual average</td>
<td>5.5</td>
<td>6.7</td>
<td>21.8</td>
</tr>
<tr>
<td><strong>Particulate matter (PM10)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest daily</td>
<td>366.6</td>
<td>2,377.30</td>
<td>548.5</td>
</tr>
<tr>
<td>Annual average</td>
<td>189.2</td>
<td>1,232.13</td>
<td>551.2</td>
</tr>
</tbody>
</table>

*Ground-level concentration

**Nitrogen dioxide**

- A maximum hourly ground level concentration of 165 µg/m³ was predicted for operations from the Morupule B Power Plant and Morupule Power Plant. This concentration did not exceed the WBG, WHO or Botswana limits;

- Highest daily averaged and annual averaged NO₂ concentrations complied with WBG, WHO and Botswana limits;

- The predicted ground level NO₂ concentrations were well below the European Union (EU) vegetation protection limits and thus no negative impacts on vegetation is expected; and

- The predicted increase in NO₂ emissions as a result of the Morupule B Power Station is relatively small (Table 18).
Particulate matter (PM10)

Predicted ground level concentrations of PM10 included all sources at Morupule, i.e. stacks, vehicle entrainment on roads, wind blown dust from the storage piles and ash dumps and materials handling operations. The findings were as follows:

- PM10 concentrations exceeded the referenced daily and annual guidelines (i.e. Botswana, WBG and WHO) for the maximum ground level concentration. Due to the low level of release of the main particulates sources (i.e. materials handling, wind blown dust and vehicle entrainment), the maximum predicted impact was expected to be within close proximity of the plant;

- The area exceeding the WBG limits for highest daily PM10 concentrations extended for approximately 2.5 km from the site. The exceedance of the annual average Botswana guidelines is within an area of a few hundred meters from the source and a radius of approximately 1 km when compared to the WBG and WHO annual guidelines;

- Predicted highest daily averaged and annual averaged PM10 concentrations at Palapye and Serowe complied with all the emission limits; and

- Current on-site concentration of particulate emissions was predicted to increase by more than 500% as a result of the Morupule B Power Station project. This predicted increase is predominantly as a result of an assumption used in the air quality assessment that road infrastructure for the new power station will be unpaved, which will not be the case (Table 18).

It is important to note that the input data used in the air quality impact assessment was based on the proposed design specification requiring that the emissions limits from the proposed plant would be at the emission limits of the World Bank Group. Actual emissions are likely to however be well below these limits and the findings of the air quality impact assessment can thus be considered to be conservative.

Hydrogeology

- The study revealed that the soils and aquifer immediately around the existing and proposed power station location are considered to be of moderate vulnerability;

- The existing power plant does not appear to have significantly impacted on the water resources in the area albeit for a rise in sulphate concentrations;

- The increased amount of coal storage, chemical storage and the amount of burnt coal ash to be disposed of are the activities which are likely to have the most potential for consequent impact;

- The possibility of the spread of contaminants by rainfall from the smoke produced by coal burning was reviewed by a desktop study of other power stations worldwide. It seems unlikely that the new development will have a significant effect on the water environment;

- The residual impact to groundwater and surface water resources were assessed to be of low significance; and

- The specialist concluded that the proposed new power station is unlikely to pose a significant pollutant risk to groundwater.
Archaeology

A team of four people surveyed the proposed Morupule B Power Plant site on foot with the aid of maps, aerial photographs and a GPS to mark and record anything that could bear archaeological significance. Surface surveying was done in transects covering a total width of 150 meters. Interviews from previous research conducted in the same area were also utilised.

The specialist concluded that there was nothing of archaeological importance in the proposed development area. The absence of archaeological material on the surface of the area however does not rule-out the probability of encountering materials during the course of project activities as the sands may cover some artifacts. Archaeological monitoring will need to be instituted during site clearance to ensure that any archaeologically significant materials are reported to the Botswana National Museum. This is especially important for the area currently covered in rubble, which due to the rubble, has not been surveyed by the archaeological specialist.

Impact assessment results

The significant environmental impacts identified in the Scoping Phase as well as newly identified possible impacts have been assessed through the various specialist studies. Table 19 summarises the results of the impact assessment. The significance of the residual impact (impact after mitigation) for most impacts was assessed to be of low significance.
Table 19: Summary of potential environmental impacts

<table>
<thead>
<tr>
<th>POTENTIAL CONSTRUCTION/PHASE IMPACTS</th>
<th>RESIDUAL IMPACT SIGNIFICANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biophysical impacts</strong></td>
<td></td>
</tr>
<tr>
<td>Impact of emissions to air on human health, fauna and flora</td>
<td>Low</td>
</tr>
<tr>
<td>Loss of vegetation and habitat</td>
<td>Low</td>
</tr>
<tr>
<td>Loss of grazing due to man-made fires</td>
<td>Low</td>
</tr>
<tr>
<td>Disturbance of wildlife</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of spillages of chemicals, petrochemicals and hydrocarbons on water resources</td>
<td>Low</td>
</tr>
<tr>
<td>Erosion and sedimentation</td>
<td>Low</td>
</tr>
<tr>
<td>Litter</td>
<td>Low</td>
</tr>
<tr>
<td>Security</td>
<td>Low</td>
</tr>
<tr>
<td>Traffic</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Socio-cultural/ socio-economic impacts</strong></td>
<td></td>
</tr>
<tr>
<td>Loss of arable lands and grazing during site establishment</td>
<td>Low</td>
</tr>
<tr>
<td>Social behaviour and human health</td>
<td>Low</td>
</tr>
<tr>
<td>Aesthetics/Visual</td>
<td>Low</td>
</tr>
<tr>
<td>Safety</td>
<td>Low</td>
</tr>
<tr>
<td>Impact on social fabric of town</td>
<td>Medium / Medium (+)</td>
</tr>
<tr>
<td>Impact on employment / temporary employment opportunities</td>
<td>High (+)</td>
</tr>
<tr>
<td>Archaeological impacts</td>
<td>Low</td>
</tr>
<tr>
<td>Noise impact during construction</td>
<td>Low</td>
</tr>
<tr>
<td>Impact on business opportunities</td>
<td>High (+)</td>
</tr>
<tr>
<td>Impact on Serowe Landfill</td>
<td>Low</td>
</tr>
</tbody>
</table>
### POTENTIAL OPERATIONAL PHASE IMPACTS

<table>
<thead>
<tr>
<th>Impact</th>
<th>Residual Impact Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biophysical impacts</strong></td>
<td></td>
</tr>
<tr>
<td>Groundwater depletion and drawdown</td>
<td>High</td>
</tr>
<tr>
<td>Habitat loss from coal dust dispersal</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of high SO$_2$ levels on agriculture</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of high SO$_2$ levels on sensitive habitats</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of NO$_2$ emissions on human health</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of PM10 emissions on human health</td>
<td>Low</td>
</tr>
<tr>
<td>Human health impacts from SO$_2$ emissions</td>
<td>High</td>
</tr>
<tr>
<td>Impact of ash waste stream on soil and groundwater</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of water reuse</td>
<td>Medium (+)</td>
</tr>
<tr>
<td>Impact of coal storage on soil and groundwater</td>
<td>Low</td>
</tr>
<tr>
<td>Global warming</td>
<td>High</td>
</tr>
<tr>
<td><strong>Socio-cultural/ socio-economic impacts</strong></td>
<td></td>
</tr>
<tr>
<td>Impact on visual “sense of place”</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of increased emissions on surrounding land use and planning</td>
<td>Medium</td>
</tr>
<tr>
<td>Impact on Botswana’s energy supply</td>
<td>High (+)</td>
</tr>
<tr>
<td>Manpower needs/ job creation</td>
<td>Medium (+)</td>
</tr>
<tr>
<td>Impact on business opportunities</td>
<td>High (+)</td>
</tr>
<tr>
<td>Impact of Morupule B on power tariffs</td>
<td>Medium</td>
</tr>
<tr>
<td>Noise impact on surrounding communities</td>
<td>Low</td>
</tr>
</tbody>
</table>
Assessment of alternatives

Alternatives within the EIA process are regarded as different means of meeting the general purpose and requirements of the originally proposed activity. To ensure that the assessment of alternatives is meaningful, the alternatives proposed must be feasible and have the same principle purpose as the originally proposed activity.

The following broad categories of alternatives were considered:

**Site alternatives**

The main factors influencing the location of a coal-fired power plant is proximity to a coal resource of suitable quality and an appropriate water supply. Other important factors that influence location include availability of land, environmental suitability, proximity to the market and availability of infrastructure such as roads, railways and telecommunications.

Establishment of the power station at any other location in Botswana would require significant additional infrastructure to be constructed such as roads, rail and the establishment of a new coalmine. Notwithstanding the financial cost associated with this additional infrastructure, the impact to the environment would be significantly greater than the proposed expansion of an existing footprint.

<table>
<thead>
<tr>
<th>POTENTIAL DECOMMISSIONING PHASE IMPACTS</th>
<th>RESIDUAL IMPACT SIGNIFICANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biophysical impacts</strong></td>
<td></td>
</tr>
<tr>
<td>Ash dam and material storage areas</td>
<td>Low</td>
</tr>
<tr>
<td>Waste disposal</td>
<td>Low</td>
</tr>
<tr>
<td>Traffic</td>
<td>Low</td>
</tr>
<tr>
<td>Air quality</td>
<td>Medium (+)</td>
</tr>
<tr>
<td>Use of water resources</td>
<td>Medium (+)</td>
</tr>
<tr>
<td>Fauna and flora</td>
<td>Low (+)</td>
</tr>
<tr>
<td><strong>Socio-cultural/ socio-economic impacts</strong></td>
<td></td>
</tr>
<tr>
<td>Land use</td>
<td>Low (+)</td>
</tr>
<tr>
<td>Noise impacts</td>
<td>Low /Low (+)</td>
</tr>
<tr>
<td>Impact on local economy</td>
<td>Low</td>
</tr>
<tr>
<td>Social behaviour and human health</td>
<td>Low</td>
</tr>
<tr>
<td>Safety</td>
<td>Low</td>
</tr>
</tbody>
</table>
Technology alternatives
The various technologies available differ markedly in their generation costs, performance and utilisation characteristics, suitability for the national context and state of commercial development.

The choice of electricity generation technology is multi-faceted and complex and must be conducted within the context of relevant national and international policies, legal requirements and the specific daily, weekly and seasonal variation in demand for electricity.

Both renewable and non-renewable technologies fall into one of the following categories:

- Base-load electricity generation technology; or
- Peaking electricity generation technology.

Base-load electricity generation technologies refer to power stations which are designed specifically to generate electricity continuously over all hours of the day.

In contrast, peaking electricity generation technologies are designed to only generate electricity during periods of high demand for electricity, normally on weekdays from 07:00 to 09:00 and 18:00 to 20:00.

The electricity demand pattern in Botswana requires that a base-load generation technology be considered because a peaking electricity generation technology will only limit the extent to which imported power will be needed at certain times of the day. Although this will assist in reducing reliance on imported power, it will not enable BPC to replace the current 70% reliance on imported power with local generation capability, which is a key strategic objective of this project. Renewable energy technologies such as solar thermal generation and wind energy are peaking generation technologies as they rely on natural conditions which do not exist on a 24-hour basis. This factor reduces the number of possible generation technology alternatives to the following base-load generation options:

- Bio-energy technologies;
- Hydro-electric technologies;
- Gas turbine technologies;
- Nuclear technologies; and
- Coal-fired technologies.

Of these, the only feasible option for a base-load technology is a coal-fired plant. A number of alternatives exist for the specific design technology of the coal-fired plant.

Operational alternatives
Peaking electricity generation technologies are only operated at a certain time of the day, typically when electricity demand is the highest. Given Botswana's need for base-load electricity generation capacity, the Morupule B Power Station must be able to generate electricity throughout the day. No feasible operational alternatives to that proposed are thus identified.
Design alternatives

The proposed Morupule B Power Station intends to make use of either the CFBC boiler design or the Pulverised Coal (PC) boiler design. The CFBC design is an advanced coal-utilisation technology which has the following benefits over conventional thermal power plants:

- Wide range of fuel adaptability which allows for the use of low grade coal, biomass and waste tyres;
- Decreased emissions of NO\textsubscript{x} and SO\textsubscript{x};
- High combustion efficiency; and
- Space saving and improved maintenance ability.

A summary of PC technology with Selective Catalytic Reduction (SCR) for removal of NO\textsubscript{x} and Flue Gas Desulphurisation (FGD) for removal of SO\textsubscript{x} compared with CFBC technology is provided in Table 21.

<table>
<thead>
<tr>
<th>Design technology</th>
<th>SO\textsubscript{2} capture mg/Nm\textsuperscript{3}</th>
<th>Ca/S</th>
<th>NO\textsubscript{x} emissions mg/Nm\textsuperscript{3}</th>
<th>Operation and Maintenance Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFBC</td>
<td>&gt; 95%</td>
<td>1,0 – 2,5</td>
<td>150-250</td>
<td>Medium</td>
</tr>
<tr>
<td>PC with SCR and FGD</td>
<td>&gt; 95%</td>
<td>1,0</td>
<td>50-100</td>
<td>High</td>
</tr>
</tbody>
</table>

Selecting between PC and CFBC boiler designs is a complex decision and environmental performance is only one criterion which should influence this decision. The results in the table above suggest that the CFBC boiler design is able to achieve a similar environmental performance with respect to gaseous emissions to PC technology with SCR and FGD at a lower operating cost.

The no-project alternative

The no-project alternative implies that BPC continues to import power from neighbouring countries. The benefits of this alternative are that most of the negative impacts associated with the proposed development option will be prevented. Notwithstanding the significant job creation potential and positive opportunities for local business, the largest cost of not proceeding with the project is that the positive impacts of the development option on Botswana’s energy supply will not be realised.

\[^{4}\text{New Energy and Industrial Technology Development Organisation (2006)}\]
Conclusions

This ESIA has been compiled in accordance with Section 10 of the EIA Act and with due consideration of international best practice including the requirements of the World Bank Group. The biophysical, socio-economic and socio-cultural impacts of the development have been assessed and mitigation measures for all identified impacts have been proposed. The main conclusions from the ESIA are summarised below:

1. The specialist studies in hydrogeology, social impact, archaeology and noise did not identify any negative impacts of high or medium significance which could not be satisfactorily mitigated through the implementation of the ESMP;

2. The stakeholder engagement process indicated that the proposed project was generally welcomed by stakeholders and viewed as a good investment for the country;

3. The per capita carbon emission rate for Botswana, based on findings within the ecological and land use specialist study, was identified as an impact of high significance. The findings indicate that with Phase I of the Morupule B Power Station, Botswana’s per capita CO$_2$ emissions will increase to 8.7 tons per year, which is slightly above the world average. This impact must however be considered with due regard to Botswana’s status as a developing nation as well as its relatively low population density. The impact is identified within this report because of the importance of global warming and its agreed contribution to global climate change. The impact is a socio-political impact, rather than a social or ecological impact;

4. The impact of SO$_2$ concentrations on human health was considered to be of high significance. SO$_2$ concentrations which exceed the Botswana and World Bank Group ambient air quality limits are predicted to occur with the highest ground level concentration predicted to be at approximately 800 m west of the existing Morupule Power Station. The Botswana and WBG guidelines for ambient SO$_2$ concentrations at Palapye and Serowe were not predicted to be exceeded;

5. Given the three stack height scenarios modelled (i.e. 150 m, 200 m and 300 m) it can be concluded that an increase in stack height will not result in significant changes to predicted SO$_2$ ground level concentrations. This is due to the elevated background SO$_2$ concentrations. For this reason, increasing the proposed Morupule B Power Station stack height beyond 150 m is considered to have an insignificant impact on emission reduction at ground level. However, in isolation from the existing Morupule Power Station emissions, a 200 m stack height is predicted to result in a 26 % decrease in maximum ground level SO$_2$ concentrations. It is concluded that both the 200 m and 300 m stack height options for the Morupule B Power Station will have a significant positive impact on ambient emission concentrations but only once the existing Morupule Power Station has been decommissioned or if emissions are reduced from the latter;

6. Predicted NO$_2$ concentrations complied with all relevant emission limits;

7. PM10 emissions are predicted to increase significantly as a result of the Morupule B Power Station, predominantly as a result of the assumption that road infrastructure will be unpaved which is not to be the case. These emissions are considered to be near-field to the source and can be effectively mitigated through the implementation of the ESMP and through paving of the road infrastructure;
8. The assessment of alternatives to the proposed development option concluded that the development of the proposed Morupule B Power Station, with the recommended mitigation measures, is considered to be the preferred alternative. It is recognised that the Morupule B Power Station will have an impact on the environment, however the impact of not proceeding with the development is considered to be of greater significance.

Recommendations

Recommendations by various parties including stakeholders, the EIA project team and the various specialists have been summarised in the text below. Where possible, all recommendations have been incorporated into specific mitigation measures within the ESMP.

1. The proposed Morupule B Power Plant should be designed to be in compliance with the World Bank Group emission limits for new thermal power plants; 5

2. Rehabilitation and mitigation of fugitive dust emissions must be continuous throughout the life of the project in order to result in the minimal effort to apply final rehabilitation strategies. The following mitigation measures are recommended for PM10 control:

   2.1 Chemical suppressants should be applied to unpaved roads and access roads to control emissions from vehicle entrainment on unpaved roads. For unpaved haul roads on the plant site it is recommended that dustfall in the immediate vicinity of the road perimeter be less than 1,200 mg/m²/day;

   2.2 The vegetation cover on the walls of the ash dump should be such to ensure at least 80% control efficiency for the walls. The surface areas should be kept wet. Dustfall immediately downwind of the site must be limited to <1 200 mg/m²/day;

   2.3 Topsoil piles and the storage pile for overburden materials should be vegetated completely to ensure as little as wind disturbance of these areas as possible; and

   2.4 Based on the increase in particulate emissions due to the proposed operations, it is recommended that a dust fallout network be designed for the site in accordance with the specifications in the ESMP.

3. Flue Gas Desulphurisation (FGD) as a control option for SO₂ emissions should be considered for the new power plant if the PC boiler design is selected;

4. Given that the existing power plant contributes up to 74% to the predicted SO₂ concentrations, it is recommended that additional studies be commissioned by BPC to investigate the feasibility of installing pollution abatement equipment for SO₂ emissions at the existing Morupule Power Station;

5. The impact of SO₂ emissions on vegetation indigenous to Botswana is unknown. Monitoring of vegetation downwind of the power plant is recommended so that any impacts can be identified and mitigated;

6. Although a stack height of 150 m would meet the relevant air quality emission limits, it is recommended that the stack height of the Morupule B Power Station be at least

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5 Note: The World Bank emissions limits fully comply to the national limits.
200 m high to take into consideration future developments such as more stringent air quality limits and the possible development of Phase II of the Morupule B Power Station;

7. An online stack monitor must be implemented at the boiler stack to measure SO\(_2\) and NO\(_x\) emissions;

8. Isokinetic stack sampling should be conducted at all the remaining point sources at least once a year. This is to ensure that the dust collectors are working according to design specifications;

9. A new ambient air quality monitoring station inclusive of a meteorological station must be installed at the Morupule B Power Station. It is recommended that this ambient station is calibrated at least once every six months to ensure accurate and continuous data capturing;

10. Archaeological monitoring must be undertaken during site clearance especially in the area of the rubble dumps and the developer must immediately inform the Botswana National Museum should they encounter anything of archaeological significance;

11. As part of the monitoring programme, a brief survey for rare and endangered plants in the area exposed to SO\(_2\) levels in excess of the national air quality objectives should be undertaken after the rainy season;

12. The Land Board and land use planners must be made aware of the power station impact zones in terms of air quality. This will allow for suitable land allocation and planning;

13. The ash dam and all coal storage areas should have an enclosed drainage system to facilitate the reuse of the water;

14. The drainage of surface water off site in the case of high intensity rainfall should be addressed in the design of the new power plant. It is recommended that all surface water and roof and car park run off be collected for reuse on the site. The retention of stormwater on site will remove the pathway for contaminants off site and the stored water can be reused back in the plant;

15. Storage of hydrocarbons and chemicals will require proper spillage and leakage protection. Bunds and the use of leakage detectors are considered vital for such storage areas (tanks, etc);

16. Additional monitoring boreholes to the four boreholes currently on site may need to be drilled to monitor any potential deterioration in groundwater quality. These should encircle the site both upstream and downstream of the site;

17. Once the final design details of the planned power station are known, the parameters, which directly affect the calculations made in the noise impact study, should be checked and validated. If necessary, the calculations should be redone and the noise impact checked;

18. Various measures to reduce the potential noise impact from the planned power station are possible and should be incorporated into the design of the plant. The noise mitigating measures will need to be designed and/or checked by an acoustical engineer in order to optimise the design parameters and ensure that the cost/benefit of the measure is optimised;
19. At commissioning, the noise footprint of the planned power station should be established by measurement in accordance with the relevant standards, namely SANS ISO 8297:1994 and SANS 10103. The character of the noise (qualitative aspect) should also be checked to ascertain whether there is any nuisance factor associated with the operation;

20. A closure plan and social development programme must be developed from mid-life of the Morupule B Power Station and annually updated by the Morupule B Power Station plant owner;

21. A database of local firms that qualify as potential service providers for post EPC tender award services (construction companies, catering companies, waste collection companies etc) should be developed. These companies should be notified of and invited to bid for project related work;

22. Where necessary, firms should be assisted and or capacitated to enable them to fill in and submit the required tender forms and fulfil contracts for post EPC tender award services;

23. The local chamber of business and hospitality industry should identify strategies aimed at maximizing the potential benefits associated with the Project;

24. Where necessary an induction programme for construction workers should be initiated prior to the commencement of the construction phase;

25. A formal structure (e.g. liaison committee) should be set up between contractors and the local authorities and adjacent landowners to ensure cordial relations and to address conflicts that may arise;

26. Farmers must be compensated in full for any stock losses and or damage to farm infrastructure that can be positively linked to construction workers. If the formal structure referred to above deems it necessary, this should be contained in an agreement of good conduct to be signed between BPC and all adjacent landowners;

27. Appropriate and adequate social amenities must be provided for the construction workers at the camp;

28. An HIV and AIDS awareness programme for construction workers must be implemented;

29. Where local skills and expertise are not available BPC should, where possible, employ Botswana nationals as opposed to expatriates. Local labour must be utilised as far as possible during the construction, operational and decommissioning phases of the development; and

30. The impacts associated with the groundwater investigations, transmission power line, coalmine expansion and water supply pipeline will have a cumulative impact, the significance of which is unknown at this stage. Authorities and stakeholders must be provided with an indication of the significance of these cumulative impacts within each of the individual EIAs.
Section 1
Introduction

1.1 Project background

The Botswana Power Corporation (BPC) is responsible for the generation, transmission and distribution of electricity in Botswana.

In recognition of their mandate, the BPC, through a 20% equity contribution to a Special Purpose Company (SPC) that is being established, intends to construct a new coal-fired power station (Morupule B Power Station) adjacent to the existing Morupule Power Station. 80% of the contribution to the SPC will be through debt finance from local and international project financiers. The proposed 600 MW Morupule B Power Station is scheduled to be ready for commercial operation by 2010.

Figure 1: Existing Morupule Power Station

The Morupule Power Station currently supplies approximately 30% of Botswana’s electricity demand. The bulk of the country’s electricity demand is satisfied by imported power from neighbouring countries, particularly South Africa.
Until relatively recently, importation of power into Botswana was a cost-effective means of providing for the electricity demands of the nation. Cost-effective importation of power has largely been possible as a result of an aggressive power generation expansion program in South Africa initiated in the late 1970’s and carried over into the early 1980’s. The main driver of this expansion programme was the anticipated rapid growth in the demand for power within South Africa.

This demand did not materialise as planned and there was thus regional excess capacity with very little capital expenditure over the last 15-20 years. Eskom's most recent Integrated Strategic Electricity Plan (ISEP) indicates that additional peaking electricity generating capacity will be needed for South Africa by 2007 and that additional base-load electricity generating capacity will be needed for South Africa by 2010. The excess capacity which once existed is thus no longer available. The implication of this is that Botswana is becoming increasingly vulnerable to increases in electricity prices and supply uncertainty.

To reduce dependency on imported power, BPC initiated the Morupule B Power Station Project, a feasibility study for which was commissioned in 2003. The study consisted of a number of components including a scoping-level environmental investigation, a coal resource determination study and a water resource assessment. The feasibility study was completed in 2004 and it confirmed that the construction of the proposed Morupule B power station would be feasible.

The Environmental Impact Assessment Act, 2005 (Act 6 of 2005, the EIAA) requires the environmental impact of all activities identified in terms of Section 3 (Screening) of the EIAA to be fully considered and authorisation for the activity obtained prior to the commencement of the activity. The proposed development requires an Environmental and Social Impact Assessment (ESIA) to be undertaken in line with the provisions of the EIAA as well as taking due cognisance of the World Bank Group requirements and the Equator Principles.

Ecosurv (Pty) Ltd (Ecosurv) in association with GIBB Botswana (Pty) Ltd (GIBB Botswana) have been appointed by BPC to undertake the required Environmental and Social Impact Assessment for the project.

1.2 Environmental Impact Assessment

1.2.1 Summary of the ESIA process

The proposed Morupule B Power Station falls into the category of developments that require an ESIA.

An ESIA typically comprises two phases, namely a preliminary assessment or Scoping Phase and a detailed Impact Assessment Phase. The Scoping Phase identifies issues and concerns related to the project. The detailed Impact Assessment Phase comprises specialist studies to assess specific issues and concerns.

Each of these phases culminates in the submission of a report for consideration by the relevant authority, the Department of Environmental Affairs (DEA), after which permission is granted for the project to be implemented or an indication given on the way forward. A schematic diagram of the EIA process in terms of the EIAA is provided on the following page of this report (Figure 2).
It is important to note that there are four other related projects being undertaken for various components of the proposed Morupule B Power Station Project. These are as follows:

- Transmission power line development;
- Expansion of the Morupule Colliery;
- Groundwater resources investigation and wellfield design, and;
- Pipeline required to transport the water from the wellfields to the proposed site of the new power station.

The above EIAs are in various stages of completion. The information from the aforementioned EIAs has been considered in this EIA where this has been possible.

1.2.2 Scoping Phase

The Scoping Phase for the proposed Morupule B Power Station development was completed in 2004.

The specific objectives of the Scoping Phase were as follows:

- Inform a broad range of I&APs about the proposed project and the EIA process to be followed;
- Provide ample opportunity to all parties to exchange information and express their views, concerns and suggestions;
- Obtain contributions of I&APs and ensure that key issues, concerns, queries and suggestions raised are fully documented and carried forward in the EIA process;
- Identify the significant environmental issues that are to be addressed in the ESIA; and
- Focus the remaining phases of the EIA on the viable project alternatives and relevant issues.

A summary of the most important recommendations made at the completion of the Scoping Phase is provided below:

- Detailed environmental assessments will need to be conducted for the proposed water supply as well as the expansion of the colliery;
- An EIA of the proposed Morupule B Power Station Project be undertaken if it is decided to proceed with the project;
- Detailed specialist studies are undertaken as part of the EIA; and
- Submit the Final Environmental Impact Statement to the DEA.
Figure 2: Schematic diagram of the EIA process in terms of the EIA Act
1.2.3 Impact Assessment Phase

The report produced at the culmination of the detailed Impact Assessment Phase is referred to as an Environmental Impact Statement (EIS). Prior to compilation of the EIS, the EIA Act requires DEA approval of a Terms of Reference (ToR) for the EIS. The ToR explains what studies will be done in the impact assessment phase and provides a brief outline of the EIS (Refer to Appendix 1.1 and Appendix 1.2 for the ToR and DEA approval letter respectively).

This document constitutes the EIS\(^1\) for the project. The EIS has been compiled in compliance with section 10 of the EIAA. The main objectives of the EIS are summarised as follows:

- To undertake specialist studies in archaeology, ecology, land-use, social impact, noise impact, air quality and hydrogeology to ensure an informed understanding of the existing biophysical and socio-economic environment;

- To provide an objective, unbiased assessment of the significance of possible impacts of the development on the environment so as to allow for informed participation and decision-making by Interested and Affected Parties (I&APs);

- To identify appropriate and practical mitigation measures which will prevent and/or reduce the significance of identified impacts to acceptable levels; and

- To provide a document which is understandable to the general public and which addresses the requirements of the EIAA and international financial institutions, such as the World Bank Group (WBG).

The approach adopted for this EIA is consistent with international best practice and the draft guidelines issued by the DEA.

\(^{1}\) The EIS is referred to throughout this report as the Environmental and Social Impact Assessment (ESIA)
Section 2

Legal status of project site and applicant, consultant details

2.1 Legal status of project site

Both the existing Morupule Power Station site and the proposed site for the Morupule B Power Station are within the ownership of the Bamangwato Tribal Authority which is leased to BPC with the future demarcated land portion for the proposed Morupule B Power Station. This ownership has legal status in the Tribal Land Act of 1970 (as amended). According to the survey record, the land is called Tribal Grant No. 4 MQ (Appendix 2). The latter Grant is held by BPC for the production of power.

The proposed site is 476 ha in extent according to the survey record. A railway servitude of 18 ha is registered across the site.

The current use of the area that falls within the potential impact zone is described in the Appendix on Ecology and Land Use.

Figure 3: The Tribal Grant No. 4 MQ held by BPC indicating the existing and proposed power stations
2.2 Applicant details

The details of the project applicant are provided hereunder.

<table>
<thead>
<tr>
<th>Project Applicant</th>
<th>Botswana Power Corporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Person</td>
<td>Mr. M. Badirwang</td>
</tr>
<tr>
<td>Postal Address (Head Office)</td>
<td>PO Box 48, Gaborone</td>
</tr>
<tr>
<td>Physical Address (Head Office)</td>
<td>Motlakase House, Macheng Way, Gaborone</td>
</tr>
<tr>
<td>Telephone Number</td>
<td>(267) 360 3000</td>
</tr>
<tr>
<td>Fax Number</td>
<td>(267) 390 8674</td>
</tr>
<tr>
<td>E-mail Address</td>
<td><a href="mailto:Badirwangm@bpc.bw">Badirwangm@bpc.bw</a></td>
</tr>
</tbody>
</table>

BPC is Botswana’s national electricity utility established in terms of the Botswana Power Corporation Act of 1974. The utility is wholly-owned by the Government of the Republic of Botswana and its operations fall within the mandate of the Ministry of Minerals, Energy and Water Resources.

2.3 Consultant details

Details of the lead consultants are provided hereunder.

<table>
<thead>
<tr>
<th>ESIA Consultant (Project Management)</th>
<th>Ecosurv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Person</td>
<td>Mr. D. Parry</td>
</tr>
<tr>
<td>Postal Address</td>
<td>PO Box 201306, Gaborone</td>
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<td>Telephone Number</td>
<td>(267) 316 1533</td>
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<tr>
<td>Fax Number</td>
<td>(267) 316 1878</td>
</tr>
<tr>
<td>E-mail Address</td>
<td><a href="mailto:david@ecosurv.com">david@ecosurv.com</a></td>
</tr>
</tbody>
</table>
Details of the specialists appointed to undertake the various specialist studies to inform the ESIA are provided in the respective specialist study reports attached as appendices to the Report.
Section 3
Planning and legislative context

3.1 Introduction

The planning and legislative context in which the proposed project is positioned was described in the Environmental Scoping Report (2004). This section of the ESIA provides additional information with respect to the planning and legislative framework that is relevant to the proposed development of the Morupule B Power Station. Additional references to legal requirements, thresholds and policies are contained within the appendices of the specialist reports prepared under this ESIA.

3.2 Planning context

3.2.1 Introduction

The majority of land use planning in Botswana is governed by the regulations promulgated under the Town and Country Planning Act of 1980 and the Land Control Act of 1975. A summary of these Acts and other relevant policies and plans is provided hereunder.

3.2.2 The Tribal Land Act of 1970 (as amended)

BPC currently lease their property from the Bamangwato Tribal Authority. The proposed development of the Morupule B Power Station should take place within this lease area. However other secondary infrastructure associated with this development such as transmission line and water pipelines could impact on tribal land and this should be considered in the respective EIAs for these components of the development.

3.2.3 The Town and Country Planning Act

The Town and Country Planning Act of 1980 establishes a framework for the orderly and progressive development of land in urban and rural areas. The Palapye Planning Area was established in terms of this Act in April 1995.

3.2.4 The Land Control Act

The Land Control Act of 1975 regulates the transactions, which involves the sale and purchase of agricultural land. BPC will have to conform to these regulations if it wishes to purchase any land from farmers for servitude purposes or buffer zones.
3.2.5 Central District Development Plan 6

The study area falls under the Central District Development Plan 6: 2003-2009. The plan supports the proposed Morupule B Power Station by indicating a need for the use of coal, the need for a Rural Village Electrification Programme, and increased pressure to use alternative energy sources.

3.2.6 Palapye Planning Area Development Plan

The Palapye Planning Area Development Plan (1996) was developed to provide for a framework upon which future development of the Palapye village would be based. The plan provides a broad strategy for a 20-year planning period (1995-2015) and covers a surface area of approximately 25,000 hectares. The Morupule Colliery and existing Morupule Power Station are included within the Palapye Planning Area. The Plan succeeds a 1976 Land Use Plan and a 1986 development plan for Palapye. As these previous plans were not statutory, development was largely based on the National Development Plan and the Central District Development Plan.

The plan provides for a number of goals and objectives within the following categories:

- Growth and development;
- Housing;
- Infrastructure;
- Land use;
- Traffic and transportation;
- Industrial;
- Commerce;
- Community and recreation facilities;
- Environment;
- Integration; and
- Phasing.

The proposed development is regarded as an industrial development. According to the plan, the goal for industrial planning is to provide suitable land for industrial purposes. The following objectives are recognised in the plan in this regard:

- Zone industrial areas close to sources of labour;
- Allot specific use zones for different types of industry; and
- When economically feasible, service industrial plots with water, sewerage, electricity and telecommunications.
In accordance with the above, the plan earmarks the area west of the existing Engen commercial centre and north of the Morupule railway line as suitable for industrial use. The proposed development area is located within the identified industrial area. It is noted that the Palapye Planning Area Development Plan (1996) is currently under review with a draft report expected to be available by December 2007 and a final report by March 2008.

### 3.2.7 National Development Plan

The development process in Botswana is guided by six-year National Development Plans (NDPs). All NDP’s published after 1997 are themselves guided by “Botswana’s Long Term Vision for Botswana: Towards Prosperity for All”. This vision is also popularly referred to as Vision 2016 and articulates Botswana’s long-term development aspirations and provides a broad framework for development within the country.

Vision 2016 is driven by the national principles of Democracy, Development, Self-reliance, Unity and Botho. In addition to these principles, one of Botswana’s long-term aspirations for the year 2016 is to be a prosperous, productive and innovative nation.

The NDPs of the Government of Botswana are based on a six-year planning cycle, with a mid-term review every three years. These development plans are guided by the planning objectives of sustainable development, rapid economic growth, economic independence, and social justice.

Currently Botswana’s Ninth National Development Plan (NDP9) promotes both environmental responsibility and environmental sustainability together with economic diversification and growth. The NDP9 makes recommendations for the appropriate use of natural resources together with responsible development.

Economic growth is reliant upon a stable, reliable electrical energy supply. The proposed development will assist in improving the security of supply within Botswana and reduce the country’s reliance on neighbouring countries. The political and economic security that this will create is significant. For these reasons and the fact that BPC is considering environmentally acceptable coal-fired technology, it can be concluded that the proposed development is consistent with NDP9.

### 3.2.8 National Water Master Plan

The National Water Master Plan Review (NWMPR 2005) documents, contained in 13 volumes, drives the administration of the water sector in Botswana. These review documents are a follow up to the National Water Master Plan (NWMP) of 1991 which proposed policy changes, institutional arrangements and legislative reform to address the shortcomings of the water sector, particularly relating to the utilisation and protection of water resources. Few of the 1991 Reports’ recommendations had been implemented at the time of the review and thus the review documents amended some of the 1991 Report recommendations and reinforced others.

The National Water Master Plan Review documents provide an overarching strategic planning framework for water resources within the country. Planning considerations within the sector range from the sociological and demographical profile of the country, to a review of all surface and ground water resources, water demand management and national resource accounting to water development modeling and the consideration of the economics of urban water.
The 2005 NWMPR made key policy, institutional and legislative recommendations that had wide implications on the water sector in terms of suggested law reform, improvement on the effectiveness of waste management, environmental conservation and sustainable development.

It is envisaged that the proposed Morupule B Power Station will obtain its process water requirements from the wellfields currently under investigation in proximity to the Paje Wellfield.

A groundwater resources investigation project is currently underway to determine the manner in which the existing 10 production boreholes can be augmented by additional groundwater resources in and around the Paje Wellfield. Earlier groundwater modeling studies undertaken between 1981 and 2005 confirmed that if correctly managed, sufficient water resources are available for the proposed new power station.

A separate EIA has been commissioned to further address the impacts of the use of the water from this aquifer. A further EIA is envisaged for the pipeline which will be needed to transport the raw water from the wellfield to the power station. Both of these EIAs will need to consider the NWMPR documents as part of the EIA process.

### 3.2.9 National Energy Policy

The policy aims at providing a least cost mix of energy supply, which reflects total life cycle costs and externalities, such as environmental damage. The energy policy objectives are mainly that:

- Energy users should have access to appropriate and affordable energy services;
- Energy should be used efficiently;
- The energy supply industry should be economically sustainable and efficient;
- All users should have security in their access to energy;
- Energy extraction, production, transport and use should not damage the environment or people’s health and safety; and
- In the long term sustainable energy usage needs to be implemented.

Special emphasis will also be put on developing new and renewable sources of energy as alternatives or complementary supplies of affordable and sustainable sources of energy. Given the concept of diversification of the fuel mix to increase security of supply, all existing sources of energy will be developed in their own right so as to achieve the optimal global energy needs for all.

To efficiently and effectively meet the national energy policy objectives, EAD carries out its functions through five sections namely: coal, new and renewable sources of energy, planning and documentation, electricity and administration.

In terms of the Rural Electrification Programme the government policy is to electrify 14 villages per annum and to date some 238 villages have been electrified.

### 3.2.8 Botswana Strategy for Waste Management, 1978

The strategy states that waste management will be carried out in a manner that protects human health and the environment, and that ensures prudent use of natural resources. It captures the principles of pollution prevention, the polluter pays and the principle of cooperation.
3.2.10 International Commitments Influencing Local Planning

In 1992, the Rio Earth Summit was held and an international programme of action was agreed to for the approaching century.

This programme of action materialised into Agenda 21, which called for sustainable and environmentally sound development in all countries in order to:

- Preserve, protect and improve the quality of the environment;
- Contribute towards protecting public health; and
- Ensure prudent and rational utilisation of natural resources.

The government of Botswana recognised and affirmed Agenda 21 and realised that national master planning, policies and strategies and processes are a crucial part of achieving the objectives of Agenda 21. Botswana has signed a number of treaties and conventions that bear testimony to its commitment towards sustainable development including the following:

- Convention on Biological Diversity (CBD) which was ratified in 1995;
- Convention on Wetlands of International Importance especially as water fowl habitats (Ramsar Convention, 1997);
- UN Convention to Combat Desertification (CCD) 1996;
- UN Framework Convention on Climate Change (UNFCCC) 1994;
- Kyoto Protocol 2005;
- Convention on International Trade in Endangered Species (CITES) 1997;
- Montreal Protocol on Substances that Deplete the Ozone Layer in 1992; and
- Basel Convention.

The UNFCCC and its associated Kyoto Protocol are of particular relevance to this project. The UNFCCC sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises shared climate resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The objective of the Kyoto Protocol is the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.” Although developing countries such as Botswana are not required to reduce carbon emissions in terms of the protocol, there is still a common responsibility that all countries have to reduce emissions where possible.

Botswana is also an active member of the Southern African Development Community (SADC) and is involved in the New Partnership for African Development (NEPAD) initiative.

In September 2000, 146 Heads of State and Government and 186 Nations in total adopted the Millennium Declaration.

The Millennium Declaration is the outcome of the United Nations (UN) global conferences of the 1990s, which drew up a number of key global development goals and targets, which subsequently became known as the International Development Targets. The latter covered a spectrum of issues relating to security, peace and development concerns, including environment, human rights and governance. The Millennium Declaration mainstreams a set of interconnected and mutually reinforcing development goals – the Millennium Development Goals (MDGs).
The MDGs are a synthesis of the goals and targets that need to be achieved to effectively combat poverty, namely:

- Eradication of extreme poverty and hunger;
- Achieve universal primary education;
- Promote gender equality and empowerment;
- Reduce child mortality;
- Improve maternal health;
- Combat HIV/AIDS, malaria and other diseases;
- Ensure environmental sustainability; and
- Develop a global partnership for development.

Botswana ratified the Millennium Declaration and adopted the adage of “think global and act local.” The implications of the MDG on the local planning framework and context are significant. A key requirement of the MDG is that local policies, programmes and plans are in alignment with this global mandate while not forsaking local development needs and pressures.

3.2.8 International Finance Corporation/World Bank Group Requirements

The General Environmental, Health and Safety Guidelines for the international funding institutions contain information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors. The guidelines require that where possible, facilities and projects should avoid, minimize, and control adverse impacts to human health, safety, and the environment from emissions to air. Where this is not possible, the generation and release of emissions of any type should be managed through a combination of the following measures:

- Energy use efficiency;
- Process modification;
- Selection of fuels or other materials, the processing of which may result in less polluting emissions; and
- Application of emissions control techniques.

The World Bank Group limits for emissions, ambient air quality, effluent and noise from new thermal power plants are summarised in the tables below.

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Table 1: World Bank Group flue gas emission limits

<table>
<thead>
<tr>
<th>Load / concentration</th>
<th>World Bank Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO₂</td>
<td>NOₓ (as NO₂)</td>
</tr>
<tr>
<td>Load (metric tons per day)</td>
<td>0.2 tons per day per MWe up to 500 MWe plus 0.1 ton per day for each additional MWe over 500 MWe with a maximum emissions level of 500 tons per day</td>
</tr>
<tr>
<td>Concentration in flue gas (milligrams per normal cubic meter)</td>
<td>2000 mg/Nm³</td>
</tr>
</tbody>
</table>

Table 2: World Bank Group ambient air quality limits

<table>
<thead>
<tr>
<th>Averaging period</th>
<th>World Bank Limit (micrograms per cubic meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SO₂</td>
</tr>
<tr>
<td>1hr Average</td>
<td>No Limit</td>
</tr>
<tr>
<td>24 hrs Average</td>
<td>150 µg/m³</td>
</tr>
<tr>
<td>Annual Average</td>
<td>80 µg/m³</td>
</tr>
</tbody>
</table>
Table 3: World Bank Group effluent limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum value (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6-9</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>50</td>
</tr>
<tr>
<td>Oil and grease</td>
<td>10</td>
</tr>
<tr>
<td>Total residual chlorine</td>
<td>0.2</td>
</tr>
<tr>
<td>Chromium (total)</td>
<td>0.5</td>
</tr>
<tr>
<td>Copper</td>
<td>0.5</td>
</tr>
<tr>
<td>Iron</td>
<td>1.0</td>
</tr>
<tr>
<td>Zinc</td>
<td>1.0</td>
</tr>
<tr>
<td>Temperature increase at the edge of the mixing zone</td>
<td>less than or equal to 3°C</td>
</tr>
</tbody>
</table>

Table 4: World Bank Group noise limits

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Maximum Allowable Level dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day Time (7:00 – 22:00)</td>
</tr>
<tr>
<td>Residential, institutional, educational</td>
<td>55</td>
</tr>
<tr>
<td>Industrial, commercial</td>
<td>70</td>
</tr>
</tbody>
</table>


The Botswana Biodiversity Strategy and Action Plan (BSAP) was compiled in compliance with the Convention on Biological Diversity, to which Botswana is a signatory.

The BSAP consists of eleven objectives which are aimed at achieving the BSAP guiding vision. These eleven objectives are as follows:

- Better understanding of biodiversity and ecological processes;
- Long-term conservation and management of Botswana’s biodiversity and genetic resources;
- Efficient and sustainable utilisation of all components of biodiversity in Botswana through appropriate land and resource use and management;
- Coping with environmental change and threats to biodiversity;
- Appropriate valuation/appreciation of biodiversity and raised public awareness on the role of biodiversity in sustainable development and public participation in biodiversity related activities and decision making;
- Fair access to biological resources and equitable sharing of benefits arising from the use of these resources;
- Safe industrial and technological development and other services based on national biodiversity resources for future prosperity;
- Improved availability and access to biodiversity data and information, and promotion of information exchange;
- Recognition of Botswana’s and the Southern African Region’s roles with regards to biodiversity; and
The ESIA for the proposed Morupule B Power Station development addresses many of the objectives summarised above in that it seeks to understand the biodiversity of the study area prior to the development taking place and to communicate this information to communities within the area.

Based on the specialist studies undertaken, the proposed development site is not considered to be an area of high biodiversity value and, provided that the recommended management measures are implemented, it can be concluded that the project is in compliance with the BSAP.

3.3 Legislative context

3.3.1 Key legislation relevant to the project

The following legislation is relevant to the project as a whole:

- The Tribal Land Act of 1970 (As amended in 1993 and 1999);
- The Acquisition of Property Act of 1955;
- The Factories Act of 1979
- The Water Act of 1968;
- The Atmosphere Pollution (Prevention) Act of 1971;
- The Public Health Act of 1981;
- The Monument and Relics Act of 2001;
- The Waste Management Act of 1998;
- The Town and Country Planning Act of 1980;
- The Agricultural Resources Conservation Act of 1974;
- The Forest Act of 1968;
- The Herbage Preservation (Prevention of Fires) Act of 1978;
- The Mines and Minerals Act (As amended in 1999);
- The Mines, Quarries, Works Machinery Act of 1978;
- The Environmental Impact Assessment Act of 2005; and
- The Land Control Act of 1975.

The project-specific relevance of the most important legislation for this project is summarised for each Act below.
3.3.2 The Tribal Land Act of 1970 (as amended)

BPC currently lease their property from the Bamangwato Tribal Authority. The proposed Morupule B Station should take place within this lease area. However other secondary infrastructure associated with this development such as transmission line and water pipelines could impact on tribal land and this should be considered in the respective EIAs for these components of the development.

3.3.3 The Acquisition of Property Act of 1955

The Act could come into effect if the existing lease area is extended or BPC has to acquire additional property for secondary infrastructure and services such as the transmission power line and water pipeline.

3.3.4 The Factories Act

This act regulates conditions of employment in factories as regards to the safety, health and welfare of employees and for the safety and inspection of certain plant and machinery and for all related purposes. The proposed development is regulated under this act as interpreted in section 5 and 6 of the act.

The act requires registration with the chief inspector (as appointed by the minister), of existing and new factories before any person occupies or uses such a factory.

The act protects the health and safety of employed persons by ensuring that inhalation of dust and fumes are taken care and that protective clothing and appliances are used. The act also requires that transmission machineries be securely fenced and well maintained and shall be provided with an efficient starting and stopping appliance and be conveniently operated. The act also provide guidelines of use of cranes and lifting machines, use of explosives and inflammable substances, steam boilers, steam receivers and steam containers, air receivers and prevention of fire.

The act gives appointed inspectors powers to enter, inspect and examine every part of the factory to ascertain compliance to this act.

3.3.5 The Water Act of 1968

Sections 4, 7, 9, 20, 25, 26 and 36 of the Act are relevant to the proposed project. Section 4 relates to the use of public water resources. Section 7 relates to the use of underground water. Section 9 regulates diverting, damming, storing and discharge of effluent into public water. Sections 20 and 25 relate to the suspension of an existing water right which may occur during drought.

Section 26 relates to the creation of servitudes and section 36 is relevant as it mentions altering the flow or polluting public water, which is an offence.

The existing Morupule Power Station lies approximately 5 km from the Palapye Wellfield. In terms of the Department of Water Affairs (DWA) 1994, Protection Zone Guidelines the power plant occurs within Protection Zone 3.

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3 "any premises in which persons are regularly employed in or in connection with the generation of electrical energy for supply by way of trade..."
Within Protection Zone 3 disposal of industrial and sewage effluent and storage of hazardous chemicals and fuels is acceptable provided that (Water Surveys Botswana, 2000-2001):

- A site investigation is implemented;
- Site specific construction and operation constraints are in place;
- There is no waste disposal below the water table;
- The discharge is in accordance with the guidelines; and
- The operator has a discharge permit.

These aspects have been incorporated into the Environmental and Social Management Plan (ESMP) for the development.

3.3.6 Draft Water Act, 2005 and Draft Water Regulations, 2005

A new Draft Water Act has been prepared to bring about the main institutional and legislative recommendations that have arisen from the recent revision of the 1991 Water Master Plan. The Draft Water Act is aimed at the overall management of water resources in the country, including policy, planning and protection measures.

It will be administered by the DWA and will replace the 1969 Water Act. The new Act seeks to address the deficiencies of the existing legislation and will provide an effective institutional and regulatory framework for the utilisation and protection of the country’s scarce water resources. The principal elements of the proposed Act seek to:

- Establish the Water Resources Council (WRC);
- Establish a framework for the licensing of hydraulic structures;
- Establish a framework for obtaining water rights;
- Establish a framework for obtaining wastewater discharge permits;
- Provide for the enforcement of the conditions of water rights and wastewater discharge permits or for their revocation or cancellation; and
- Establish penalties for the pollution of water resources.

The WRC will be responsible for all regulatory, policy formulation, and management functions for the country’s water resources. This Act is likely to have future influence on the proposed project in terms of the institutional arrangements with respect to governance of water use and wastewater discharge.

3.3.7 The Atmospheric Pollution (Prevention) Act of 1971

The key requirements of this Act with respect to the proposed development are as follows:

- Section 8 (1) (a): The applicant will have to first consult the Air Pollution Control (APC) officer before the existing industrial process is altered or extended; and
- Section 9 (4): No registration certificate will be granted until such time as the air pollution control officer is satisfied with the industrial process in question.

An applicant for a registration certificate required in terms of this Act must use best practicable means to prevent the escape of objectionable matter, which includes smoke, into
the atmosphere. The Act defines best practicable means as the ability to operate and maintain the machinery used for air pollution abatement.

The Act also requires that operations, which generate noxious gases, be efficient.

Methods must be adopted that consider local conditions and circumstances and most practically available knowledge.

3.3.8 The Public Health Act of 1981

This Act has a bearing on the health implications and public safety aspects related to the proposed project, and the BPC’s responsibility to ensure a safe environment.

3.3.9 The Monument and Relics Act of 2001

Section 19 (1) of the Act requires a pre-development archaeological impact assessment (AIA) to be undertaken by an archaeologist. The latter is tasked with determining the likelihood of the development impacting negatively on heritage resources. A specialist study in this regard has been undertaken for the proposed development, the findings of which have been incorporated into this ESIA.

3.3.10 The Waste Management Act of 1998

This Act makes provision for the planning, facilitation and implementation of advanced systems for the regulation and management of waste. Section 9 refers to the compilation of a national waste management plan, which will be developed from local waste management plans prepared by the local authority.

The other applicable sections of the Act are Section 10 and 11 where BPC should conform to principles of local recycling and litter plans.

3.3.11 The Town and Country Planning Act of 1980

The application of this Act has been explained in section 3.2.2 above.

3.3.12 The Agricultural Resources Conservation Act of 1974

This Act makes provision for the conservation and improvement of agricultural resources. The proposed development area is not identified for agricultural purposes in terms of the Palapye Planning Area Development Plan (1996).

3.3.13 The Forest Act of 1968

This Act provides for better regulation of forests and forest produce. The impact of the loss of the woodland vegetation as a result of the proposed development has been assessed in the ecological and social impact specialist studies respectively.

3.3.14 The Herbage Preservation (Prevention of Fires) Act of 1978

This Act provides a framework in which bush and other fires can be prevented and controlled.
The nature of the proposed development requires that BPC consider the construction of new firebreaks after the proposed Morupule B Power Station has been designed. This aspect has been included within the ESMP.

3.3.15 The Mines and Minerals Act of 1999

This Act regulates mining and minerals and the granting/renewal and termination of mineral concessions. The Act is of particular application to the required expansion of the Morupule Colliery.

3.3.16 The Mines, Quarries, Works and Machinery Act of 1978

Refers to health, safety and welfare of mine workers. The regulations in this Act are of more relevance to the Morupule Colliery, but aspects thereof are relevant to the Morupule Power Station. These aspects include the regulation of noise and vibration, dump classification and conveyor belts.

3.3.17 EIA Act of 2005

The intention of this Act is to ensure that the implications of policies, programmes and development projects are fully evaluated prior to implementation thereof.

EIA are required to be undertaken where policies, programmes and/or projects are likely to have a significant effect on the environment. The Act is administered by the Department of Environmental Affairs, through the Environmental Affairs Council, which was established under the Act.

Under Section 3 of the Act, the Minister will prescribe a list of activities that will require an EIA. Any licensing authority for activities for subject to an EIA may not issue a license or permit for the activity until due authorisation of the activity has been granted under the EIA Act. The ESIA for the proposed development has been undertaken in accordance with this Act and the Draft Guidelines (2006) issued in respect thereof.

3.3.18 Land Control Act of 1975

The application of this Act to the proposed development has been described in section 3.2.3 above.
Section 4
Development plan description

4.1 Background to project description

4.1.1 Introduction

The existing Morupule Power Station is a thermal power plant which combusts coal to produce heat energy, which is used to convert water into steam. The steam is used to drive the steam turbines, which then generate the electricity. The proposed Morupule B Power Station will make use of different technology but the manner in which electricity will be generated (thermal generation) is essentially the same as for the existing Morupule Power Station.

4.1.2 National electricity grid of Botswana

The electricity grid in Botswana consists of a network of power lines ranging from 11 kV to 400 kV (Figure 4). At present, power from the existing Morupule Power Station is transmitted via 33 kV and 220 kV power lines. A single 400 kV power line from the Matimba Power Station in South Africa feeds into the Botswana electricity network at the Phokoje Substation. 66 kV and 33 kV power lines are used to distribute power to individual homes. A 102 km 400 kV transmission power line for the Morupule B Power Station will be constructed as a separate project. An EIA for this power line is currently being undertaken.

The existing Morupule Power Station is the only power station currently in operation in Botswana. The power station has an installed supply capacity of 132 MW of power. There are four turbo-generators each of which has an output of 33 MW. Scheduled and unplanned maintenance activities may result in a plant availability of less than 80 %.

Imported power from the Southern African Power Pool (SAPP) currently makes up the largest power supply source for the national electricity grid.

Possible future power generation facilities (other than the Morupule B Power Station), which could supply power into the national electricity grid, are the 5 400 MW Mmamabula Energy Project (MEP) and the 200 MW Solar Thermal Power Generation Project. The MEP is a development proposed by the CIC Energy Corp, an independent power producer. The project is described as a two-phased coal-fired power station consisting of three units of 900 MW each in the first phase with the same configuration repeated in the second phase (Mmamabula Environmental Impact Statement, 2007). The power station will make use of the coal reserves in the Mmamabula coalfields. Commercial operation of the plant is scheduled for 2012.
Figure 4: Botswana electricity transmission network
The 200 MW Solar Thermal Power Generation Project is being investigated by the Government of Botswana in response to the high number of annual sunshine hours available in Botswana. This project is still at the pre-feasibility stage and if it proves feasible, will constitute Botswana’s first base-load renewable power generation technology.

4.1.3 Existing Morupule Power Station

The Morupule Power Station is a coal fired, steam turbine driven thermal plant with air-cooled condensers. The plant consists of four turbo-generators, each with a rating of 33 MW output. The plant’s current operation is base load with a sent out capacity of approximately 118 MW. Construction on the existing station was started in 1982 and completed in 1989. The facility has a design life of 40 years.

The four (4) steam turbines are two-stage, non-reheat, condensing type turbines, with an installed capability of 33 MW. The steam turbines all discharge into air-cooled condensers. The remainder of each turbine system consists of two HP heaters, a de-aerator, one LP heater, drain cooler, two boiler feed-water pumps and a condensate tank.

Figure 5: Condensers at the Morupule Power Station

Coal is supplied to the plant via a conveyor belt from the Morupule Colliery. Coal is delivered directly to the boiler bunkers and on to a temporary (live) stockpile for reclamation at a later stage. The coal from the temporary stockpile is collected by a loader and delivered to a reclaim hopper, for forwarding to the boiler bunkers.

This temporary stockpile provides the buffer in case of variation in supply from the mine and boiler consumption requirements.

The Morupule Power Station consumes in the order of 560 000 – 630 000 tons of coal per annum depending on the availability of the plant. Each boiler, when operating at full capacity, consumes approximately 20 tons of coal per hour. The furnaces at this station are of a balanced pressure type. The steam is delivered at the turbine stop valve at 86 bar and approximately 510 °C.
The steam drives the turbine blades that are connected to the turbine shaft, which in turn is connected to an alternator rotor. The alternator rotor acts as a large electro-magnet which generates a magnetic field that in turn induces electricity. The electricity is then supplied to the national electricity grid. The facility employs approximately 375 staff.

4.1.4.1 Water supply and processing

The Morupule Power Station is supplied with water through a pipeline from 10 dedicated production boreholes located approximately 50 km from Morupule. The water is transported to Morupule Power Station under the effects of gravity, via a 60 cubic metres (m³) collector station at the well site. Annual water consumption at the plant is between 600 and 700 million litres of water.

The raw water pipeline terminates in the raw water reservoir, that consists of 2 ponds set into the ground, with the combined basin volume being 12 500 m³. Raw water is pumped from the ponds to the fire service system and the water treatment plant.

The first stage of the water treatment plant consists of five (5) vertical pressure filters, which supply filtered water for the demineralisation, potable water and cooling water systems and for backwash of the filters. The demineralisation plant comprises an ion exchange/ mixed bed; consisting of two (2) streams, each stream is capable of producing 700 m³ per service run.

Wastewater from the demineralisation plant is collected in the neutralisation sump for pH adjustment. Once neutralised, the waste is transferred to the external storage basins and dirty water sump, from where the water is pumped to the ash plant for mixing with ash. The ash slurry is then pumped to the ash dams.

4.1.4.2 Coal supply and processing

Coal is supplied to the power station via a single conveyor belt from the adjacent mine. The coal received has a high percentage of fines.

A rising conveyor belt from the coal yard feeds the traversing belt for units 1, 2 and 3, which fills the boiler bunkers. Boiler 4 has its own direct feed. Each boiler bunker has a capacity of 1080 tons.

Once the coal has been combusted, the bottom ash/coarse ash from the boiler is collected and then watered for cooling the hot bottom ash and for the suppression of dust.

The fly ash from the electrostatic precipitators is pneumatically fed to the two ash silos in the ash plant. Some 35 000 tons/year is trucked off site for use in concrete production, whilst the rest is mixed with the neutralised/raw water from the water treatment plant and pumped to the ash pond.
4.1.4.3 Waste management

The current waste management practices at the existing power station do not comply with the Waste Management Act of 1998, as the disposal site for the fly ash, solid waste storage site and vehicles transporting the waste are not registered and licensed as required. BPC is currently in the process of registering these facilities. The following shows the different types of waste generated at the current power station (records obtained from the power station).

Fly ash

The amount of fly ash produced during the burning of coal is proportional to the amount of coal burnt with approximately 5 tons of coal resulting in the production of 1 tonne of fly ash. The fly ash is either pumped to the ash dam or sold to the cement industry.

General waste

It is estimated that the current power station produces approximately 261 tons of general waste per annum. Previously BPC operated a disposal site behind the ash lagoon. The site is not registered or licensed as per the requirements of Section 14 and 16 of the Waste Management Act (1998).

BPC has recently stopped using this site and all the waste is transported to the constructed regional landfill in Serowe. A five tonne tipper truck is used to transport the waste to the landfill, once a week. These vehicles are however not registered or licensed to transport waste.

The Serowe landfill is well engineered and started operating in 2005 with a design life of 20 years. The landfill has four cells and to date, only half of Cell 1 has been used.
Recyclables

Recyclables such as cardboard boxes and white paper are stored on site before being sold to a recycling company. Old conveyors, tyres and metal scraps are also sold.

Used oil

Used oil is kept on site and collected by Environmental Systems (Pty) Ltd for reuse/disposal.

Hazardous waste

Hazardous waste such as used and expired chemicals are stored within the plant and transported to South Africa for disposal via a licensed waste management company. Chemical containers are also stored on site before they are safely disposed of. Fluorescent tubes are crushed and disposed with other hazardous waste. The Serowe/Palapye Sub-District Council collects waste from the clinic on site once every two months. This waste is incinerated at the Serowe Landfill.

4.1.4 Power supply and demand

4.1.5.1 Supply

The existing Morupule Power Station has four turbo-generators, each rated at 33 MW output. The power station has the capacity to send 118 MW of power into the network. In Botswana the power demand exceeds the supply from Morupule. The balance of requirements (approximately 70%) is imported from Eskom in South Africa and other Southern African countries. The Eskom contract provides for a maximum of 410 MW of electrical power to be imported. This contract expires on 31 December 2007. A new contract has been entered into with Eskom but this contract provides for less power at a higher unit price.

The cost at which Eskom was supplying Botswana with electricity was relatively low compared to international electricity prices. This was possible as a result of an aggressive power generation expansion program initiated in the late 1970’s and carried over into the early 1980’s. The main driver of this expansion programme was the anticipated rapid demand growth for power within South Africa. This demand did not materialise at the time. As a result, Eskom had excess capacity with very little capital expenditure over the last 15-20 years.

With the excess capacity now depleted, Eskom has recently embarked on a plan to develop 40 000 MW of base-load generation capacity in South Africa over the next twenty years (Eskom, 2007). New capacity is required throughout Southern Africa at a cost. As a result of the capital-intensive projects needed to address the energy supply shortage, electricity costs are expected to increase significantly in the region.

4.1.5.2 Demand

The annual average demand for electricity in Botswana is expected to exceed 450 MW in the near future with figures of daily maximum demand exceeding 450 MW already registered during the winter months\(^1\). The mining sector accounts for the bulk of electricity demand in Botswana, followed by the commercial sector, domestic sector and government (Figure 7).

\(^1\) BPC Annual Report (2006)
4.1.5 Project need and desirability

The primary motivation for the proposed Morupule B Power Station is the need for Botswana to reduce its dependency on imported power from neighbouring countries.

The importance of this need is reflected in the BPC financial results for the year ending March 2006\(^2\), in which the utility reported a loss as opposed to the forecasted profit which it intended to achieve. BPC’s annual report for 2006 identifies the increased cost of imported power as one of the main reasons for not achieving the forecasted profitability targets for the year. Imported power accounts for 30% of BPC’s annual expenditure.

The shortage of generation capacity in the Southern African region as a whole is expected to result in a significant increase in electricity costs throughout the region. Capital expenditure on a new power generation facility within Botswana has been identified as a more cost-effective option for Botswana than the continued reliance on imported power.

The strategic importance of a secure, reliable electricity supply to the economic growth of a country is a further critical factor motivating the need for the Morupule B Power Station. Countries throughout the world recognise the importance of a level of self-sufficiency especially when it comes to electricity supply so that political and social instability in one country does not result in a disruption to an electricity supply in another country. Equally important is the need for sufficient electricity supply to be vested in the interests of the state. Special Purpose Companies (SPC) are an important vehicle in the development of the electricity generation mix within a country but it is agreed internationally that sufficient supply capacity must remain in the ownership of the state.

\(^2\) This is the latest annual report available
4.2 Project description

4.2.1 Regional location

The proposed Morupule B Power Station is to be situated adjacent to the existing Morupule Power Station, which lies approximately 280 km north of Gaborone. Palapye is the nearest village, situated approximately 5 km to the east of the power station (Figure 8 and Figure 9). The main road between Palapye and Serowe (A14) lies south of the proposed site. Serowe is situated approximately 30 km west of the site and is the administrative centre of the Central District.

A railway spur links both the power plant and Morupule Colliery to the main north-south railway line from Gaborone to Francistown.

The road network providing access to the site consists of the A14 between Palapye and Serowe and the A1 between Francistown and Gaborone.

A site plan of the existing power station and colliery together with the perceived new area for Morupule B is presented in Figure 10.

4.2.2 Morupule B Power Station

The Morupule B Power Station is proposed to be constructed in two phases. Phase I involves the proposed construction of a 600 MW power plant consisting of 4x150 MW units. Phase II seeks to double the installed generating capacity to 1200 MW. This EIA is only based on the proposed Phase I development.
Figure 9: Project study area. (The circle represents a 10 km radius from the centre of the site).
Figure 10: Preliminary site layout plan for the Morupule B Power Station
The Morupule B Power Station will be an independent power station with no shared facilities with the existing power station. Detail design of the plant has not been completed and it will be influenced in part by the findings of this EIA. The general technical specifications of the plant are however envisaged to consist of the following main components and equipment:

- Boiler plant;
- Turbine-generator;
- Condenser and feedwater system;
- Closed circuit cooling water system;
- Water supply and treatment system;
- Wastewater treatment system;
- Coal handling system;
- Limestone handling system;
- Ash handling system;
- General mechanical systems;
- Electrical equipment;
- Control and instrumentation system;
- Service installations; and
- Civil works.

A summary of the main process and the components involved is provided hereunder. Appendix 3 contains relevant flow diagrams for each of the processes described.

4.2.1.1 Boiler plant

The boiler plant generates the heat which converts the feed water into steam (Appendix 3.1).

BPC has recommended either a Coal-Fired Circulating Fluidised Bed Combustion (CFBC) boiler or a Pulverised Coal (PC) boiler but taking due regard of the World Bank Group environmental guidelines. A comparison of these two technologies based on key environmental performance criteria is provided in section 10 of this ESIA.

4.2.1.2 Turbine-generator

The turbine-generator consists of four (4) 150 MW single reheat condensing units and associated auxiliary equipment.
4.2.1.3 Water supply and industrial wastewater management

Raw or process water will be sourced from the wellfields currently under investigation in proximity to the Paje Wellfield. It is estimated that approximately 2 million m$^3$ of raw water will be required for the existing Morupule Power Station and the proposed Morupule B Power Station. The raw water will be supplied to the power plant via a pipeline, which will be designed and constructed as a separate project. Two reservoirs with a volume of 45 000 m$^3$ each will be constructed to store the raw water. The raw water will then be processed in the pre-treatment plant using four (4) pressure sand filters before being transferred to the demineralisation plant (Appendix 3.2).

The cations and anions within the water are removed within the demineralisation plant through a chemical ion exchange process. One bulk caustic storage tank for sodium hydroxide storage and one bulk acid storage tank for sulphuric acid will be required for regeneration of the ion exchange reagents used to remove the cations and anions. Two storage tanks for the demineralised water will ensure that sufficient water is available in storage to meet the water demand from the plant is met.

All wastewater from the demineralisation plant will be fed to the ash water tank including any chemical spillage or leakage from the raw water treatment process (Appendix 3.3). Chemical waste will first be treated in a neutralising pit prior to release into the ash water tank.

The following sources of wastewater will flow into the ash water tank:

- Demineraliser neutralisation tank effluent;
- Effluent from the oil/water separators including stormwater;
- Sand filters backwash; and
- Quench water.

Oil/water separators are envisaged for the following areas of the plant:

- Oil unloading and fuel oil area;
- Field transformer area;
- Turbine hall floor wash drains; and
- Car park area.

The recovered wastewater in the ash water tank will then be used in the ash handling system. Excess wastewater in the ash water tank will be directed to a solar evaporation pond.

The ash water tank will be an aboveground steel or concrete design. The capacity of the tank will be sized to provide 24 hours of working storage based on 50 % of the design flow from the ash recirculation system.
The following design controls are envisaged to prevent the release of effluent or wastewater:

- All tanks will be within a bunded area constructed to hold 1.25 times the maximum volume of spillage possible;
- Each oil/water separator will be sized to treat maximum expected volume, flow rate and degree of contamination of wastes;
- Piping and valves shall be designed to manage flows and pressures at full-capacity operation;
- Double-walled design of each oil/water separator with an interstitial space for leak detection; and
- Scheduled collection of oily solid waste from oil separators by a licensed contractor.

The design of the industrial wastewater management system is aimed at achieving the effluent quality in Table 5. These quality parameters are consistent with the World Bank Group (1998) maximum levels.

**Table 5. Proposed ash water tank effluent quality parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Proposed Limit</th>
<th>World Bank Maximum Limit(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended solids</td>
<td>50 mg/l</td>
<td>50 mg/l</td>
</tr>
<tr>
<td>Oil and grease</td>
<td>10 mg/l</td>
<td>10 mg/l</td>
</tr>
<tr>
<td>Residual chlorine</td>
<td>0.2 mg/l</td>
<td>0.2 mg/l</td>
</tr>
<tr>
<td>PH</td>
<td>6-9</td>
<td>6-9</td>
</tr>
</tbody>
</table>

4.2.1.4 General wastewater management

The existing Morupule Power Station is not connected to a wastewater system and all general wastewater such as sewerage is currently disposed of in evaporation ponds located to the south of the existing coal storage area. Contamination from this area is, according to the hydrogeological study, not of concern.

The Morupule B Power Station will be connected to the Palapye sewerage system.
4.2.1.5 Coal handling system

The proposed coal handling system consists of two conveyor belts which will transport the coal approximately 2.5 km from the Morupule Colliery to the Morupule B Power Station (Appendix 3.4). The coal will be crushed, screened and placed in hoppers at the Morupule Colliery, ready for transfer via the conveyor system. Coal received at the power plant will be screened and if necessary crushed prior to storage in coal bunkers. Screening and crushing of coal to the required <6 mm size will be undertaken. The current agreements in place with the Morupule Colliery indicate that coal must be <31 mm in size. Excess coal will be transported via belt conveyor to a stockpile area, which will serve as an emergency coal supply when the supply from the Morupule Colliery is problematic.

Current design requirements suggest that the emergency stockpile must be sufficient to allow for 3 days coal demand from the power plant with a maximum stockpile height of 2.5 m. The number and size of coal storage bunkers required will be based on a design requirement allowing for 16 hours plant demand.

Runoff from the coal stockpile will be captured via cut-off trenches designed around the stockpile. These trenches will channel water to a collection pond designed to allow for settling of solids with clear water overflow into an adjacent concrete-lined sump. The collection pond will be designed to hold 10 hours of maximum rainfall.

4.2.1.6 Limestone handling system

Limestone injection into the CFBC boiler is proposed in order to reduce $\text{SO}_x$ emissions. Limestone will be delivered to site via rail, after which it will be unloaded into hoppers from where it will be fed into screens for separating limestone into the required size (Appendix 3.5).

Large size limestone will be crushed and fed pneumatically into tube mills together with the medium size limestone. From the tube mill, the limestone will be delivered to the storage bunkers by pneumatic system. When the bunkers are full, limestone will be delivered via conveyor to a covered emergency stockpile. This stockpile will assist in buffering variations in supply of boiler requirements.

The limestone stockpile is to be designed to allow for ten (10) days limestone demand with a maximum height of 2.5 m. The number and size of limestone storage bunkers required will be based on a design requirement allowing for 16 hours plant demand.

4.2.1.7 Emission control from coal and limestone handling systems

A dust extraction system will be provided in the crusher house to remove all emissions generated during the crushing process (Appendix 3.6). The extraction system will consist of a dry cyclone and bag filter designed to meet maximum particulate emission levels of $50 \text{ mg/Nm}^3$ and a removal efficiency of 99% for particulates with a size fraction of 10 microns. This emission level is the maximum particulate matter limit recommended by the World Bank Group (1998).

Each bunker will be equipped with a ventilation system comprising of a fabric filter and a suction fan to reduce fugitive emissions during the product transportation process.

The ventilation system will be designed to achieve a maximum dust emission level of $100 \text{ mg/Nm}^3$. An occupational exposure limit of $5 \text{ mg/m}^3$ on a six (6) hour basis also applies with respect to the design of the ventilation system.
In addition, it is envisaged that the conveyor belts will be enclosed so as to reduce emissions during the conveyance process.

Dust suppression on the emergency coal stockpile via a sprinkler system has been incorporated within the current design requirements.

### 4.2.1.8 Fuel oil system

Heavy Fuel Oil (HFO) and Light Fuel Oil (LFO) will be required primarily for start-up of the boiler plant. The HFO and LFO have a higher calorific value than the coal thus enabling the plant to achieve its optimal performance parameters quicker than if the boiler was started with only coal. HFO will be delivered to site either by road tanker or by rail whilst LFO will only be delivered by road tanker. Two (2) HFO tanks of 6 500 m$^3$ capacity each and two (2) LFO tanks of 200 m$^3$ capacity each will be required for storage of the fuel oil. The storage tanks will be vertical, cylindrical and self-supporting. Offloading and forwarding of the oil will be done via pumps and pipes designed and constructed in accordance with applicable international standards (Appendix 3.7).

### 4.2.1.9 Ash handling system

Ash is produced from the CFBC during the combustion process and is removed as bed or bottom ash and fly ash. Once the coal has been combusted, the bottom ash/coarse ash from the boiler will be collected and then cooled in the ash cooler (Appendix 3.8). A positive pressure conveying system will then transport the dry bed ash to a bed ash silo. The fly ash from the bagfilters will be pneumatically collected in fly ash hoppers prior to delivery to a fly ash silo. Each of the silos will be designed for a storage capacity of 14 hours of ash generation.

Dry fly ash will be unloaded from the silos into trucks through paddle/rotary type feeders. On an annual basis, approximately 35 000 tons of ash is provided to the cement industry in this way from the existing Morupule Power Station. Water will be used to condition the ash prior to unloading into open trucks in order to suppress the dust emissions during this process.

Fly ash, which cannot be disposed of in a dry form through use in other industries will be mixed with the neutralised/raw water from the ash water tank and pumped to a new ash pond via two new pipelines. Bed ash is likely to be transported by truck to the new ash pond.

The ash pond will be based on a compartmentalised design. In the much-larger first compartment (settling pond), coarse ash will settle. The water with fine ash will flow into the smaller second compartment (stilling pond) where the fine ash will settle. Water from the stilling pond is proposed to be collected in a collecting well from where it will flow by gravity to a recovery water sump situated in close proximity to the ash pond. Treatment of the water through chemical dosing will take place at the recovery water sump prior to delivery of the water to a clarifloculator for the removal of suspended particulates. The water from this process will flow via gravity into an underground clear water tank from where it will be pumped to the ash water tank for reuse.

The ash pond will be lined with a Low Density Poly Ethylene (LDPE) liner.
4.2.1.10 Fire fighting system
The proposed fire fighting system consists of the following elements (Appendix 3.9):

- Hydrant system for the entire plant area;
- Automatic water spray deluge system for the transformer area, boiler area and coal conveyor area;
- Manually operated water spray system for the boiler burner front, fuel oil storage tanks and steam turbine area;
- Automatic sprinkler system for the turbine area, lube oil storage room, coal transfer building, diesel generator building, compressor building and fire water pump house;
- Automatic fire foam system for the fuel oil storage tanks;
- Automatic inert gas flooding fire extinguishing system for the control rooms;
- Portable fire extinguishers for the entire plant area; and
- Fire detection and alarm system for the MCC room, switchgear rooms and main control room as well as all administration and ancillary buildings.

4.2.1.11 Ancillary infrastructure
Some of the more significant ancillary infrastructure that will be constructed as part of the proposed project is as follows:

- Modification to the Palapye-Serowe Road and construction of a new 7 m wide road from this road to the new power plant;
- Internal secondary roads of 4 m width;
- Construction of a new railway siding including signalling and control. This railway will branch off the existing railway to the plant;
- Construction of a 2.5 m high security fence around the plant area;
- Generator house;
- Heating Ventilation and Air Conditioning (HVAC) plant;
- Workshop and stores;
- Air compressor house;
- Fire station complex;
- Administration building;
- Canteen;
- Gate/security house/time office; and
- Parking sheds/area.
A generic CFBC boiler process flow diagram as well as a schematic diagram of the plant is provided in Figure 11 and Figure 12 respectively.

### 4.2.3 Project time schedule

Construction of the Morupule B Power Station is scheduled to commence in 2008. A period of commissioning of the power station will precede the operational phase, which is scheduled for October 2010.
5.1 Introduction

Section 5.5 of the Scoping Report described the biophysical and socio-economic environment of the proposed development. This section of the ESIA provides a summary of the biophysical environmental setting of the proposed development. The information presented herein comprises of a summary of the information from the Scoping Report augmented by the information obtained from the additional specialist studies in geotechnical conditions, hydrogeology, air quality and fauna and flora. The individual specialist reports are provided in Appendix 4.

Throughout this report the term “site” refers to the proposed site of the development. The term “study area” refers to an area within 10 kilometres of the site.

5.2 Geology and soils

5.2.1 Geology

The geology of the area where the proposed Morupule B Power Station is to be constructed consists of shales and mudstones of the Lotsane Formation overlain by relatively thin (10 m - 20 m) Kalahari Beds (Appendix 4.1). Beneath the Lotsane Formation are the fractured quartzites of the Tswapong Formation, which outcrop as the western escarpment of the Tswapong Hills some 20 km to the southeast of the site. To the west of the site, black shales with mudstones and siltstones of the Karoo Supergroup sediments unconformably overlie the Lotsane Mudstones. These rocks form the eastern edge of the South East Central Kalahari Karoo Sub Basin (Smith 1984), where a succession of conglomerates, shales and sandstones occur to around 300 m in thickness. Within these sequences lie the coal seams that provide the fuel for the power station.

5.2.2 Soils

The soils of the study area are characterised by their orange colour and fine grain size, and their sandy silt loam texture.

Soils from this area are aeolian (wind-blown), and have been derived from the weathering of the Ntane Sandstone Formation, which outcrops along the Serowe escarpment. The geotechnical investigation by Schwartz, Tromp and Associates (2007) recorded that the aeolian soil depth varies between 2 m and 10 m.
According to Dames and Moore (1982), the soil type that dominates the area of the power station is Ferralic Arenosols (< 3% clay), whereas southwards along the axis of the Lotsane River, Calcaric Cambisols and Orthic Luvisols predominate.

The soils that are suitable for cultivation are located along the banks of the Lotsane and Morupule Rivers. Large areas of cultivated lands exist to the south east of the Power Station.

The soils are developed on coarse-grained Sedimentary rocks (ie. generally sandstones) and generally attain a maximum depth of around 150 - 200 cm. Soil texture is loamy fine to coarse sand. Clay often occurs lower in the profile but these soils are well to excessively drained.

The soils are classified as S type soils designated as Class 1 high vulnerability soils i.e. soils with little or no ability to attenuate diffuse pollutants.

5.2.3 Geotechnical conditions

The final geotechnical report for the site has not been completed at this stage. None of the literature nor the specialist studies commissioned as part of the Environmental Scoping Study raised any concerns about seismicity. The coal reserve determination study undertaken as part of the feasibility study in 2004 indicated that the Serowe/Palapye road and the Morupule River have been undermined in some areas. To date, no surface subsidence has been experienced in these areas.

5.3 Topography and landform

The proposed development site is at an elevation of approximately 950 metres above mean sea-level (mamsl). The land to the northwest of the site (e.g. the rocky country around Serowe) rises to an elevation of 1100 mamsl. In general there is a gentle gradient falling away to the southeast of the site (Appendix 4.1).

The site lies within the Lotsane River Catchment. This is a major ephemeral river in the area. This catchment is slightly hilly, but predominantly undulating. There are a few topographical features in the area that attain elevations of approximately 100 m above the surrounding countryside (Figure 13). These features include the Tswapong hills, which lie about 10 km to the southeast and the two small “koppies”, to the north of the site. The rocky outcrops are situated on the Morupule Colliery property.

The area is drained by a series of seasonal rivers that form the Lotsane River. The regional drainage direction is to the east and southeast (Colquhoun, O’Donnell and Partners, 1979).

The Morupule River, a tributary of the Lotsane River, drains from north to south and is located some three kilometres west of the power plant site. The deeply incised nature of the Lotsane also suggests little contribution to flow from the surrounding area. The main flow is a result of drainage from the Serowe escarpment.
5.4 Surface and groundwater environment

5.4.1 Surface water environment

The Morupule and the Lotsane Rivers are ephemeral in nature (i.e. they only flow at certain times of the year). Each of these rivers is located within 10 km of the project site. The Morupule River runs from north to south and flows into the Lotsane River. The Lotsane River flows towards Palapye in an easterly direction.

The Lotsane River is the closest river to the proposed power station, situated approximately 3.7 km to the south east while the Morupule River is about 5 km west. The Lotsane River forms part of the Limpopo River basin and flows into the Limpopo River on the Botswana and South African border.

5.4.2 Groundwater environment

5.4.2.1 Physical description

Underlying the majority of the site and the surrounding area is unsaturated Kalahari Beds (> 15 m of aeolian sand, sandstone, duricrusts and gravel), located above the Lotsane Formation (shale and mudstones). Below this formation is the Palapye fractured quartzitic aquifer. From a hydrogeological viewpoint, the Kalahari Beds immediately below the proposed development site can be considered to be a very minor aquifer.

The mudstones and shales of the Lotsane Formation beneath, unless significantly fractured (which does not seem likely in the area according to the results of the Geotechnical Report), do not contain usable amounts of groundwater and are almost certainly a barrier to the downward migration of water.
Likewise to the west of the site, the mudstones and shales of the Karoo sequence cannot be considered a significant aquifer.

Only the fractures within the quartzitic Tswapong Formation are capable of providing significant quantities of groundwater, and it is these rocks that have been tapped historically for the supply of Palapye via the Palapye Wellfield, which is located some 15 km to the southeast of the power station site.

Groundwater flow, what little there is, will mirror the topography away from the power station site to the southeast towards Palapye. There is thus potential for any surface contaminants that might percolate down to the shallow surface aquifer to thus be able to migrate off site towards Palapye within the Kalahari Beds. There seems little possibility that groundwater will penetrate any significant depth into the mudstones of the Lotsane Formation.

Groundwater depth at the proposed site appears to be consistent with the groundwater depth at the existing site and ranges between 10 m and 17 m.

The hydrogeological report indicated that a groundwater mound has developed beneath the present ash lagoon site due to seepage from the lagoon. This seepage has caused a rise in groundwater contours immediately below the site of around 3.5 m over the last ten years. This has the potential to cause the movement of contaminants away from the ash lagoon towards the southeast. The mound of water however does not appear to have moved significantly off site and the relatively small degree of rise (average 35 cm a year) shows that movement of groundwater is slow in both the saturated and unsaturated aquifer zones (Appendix 4.1).

5.4.2.2 Groundwater quality


The results of this comparison indicate that the highest average concentration of sulphate, ammonia and iron in the water currently exceeds the BOS 32:2000 maximum limits for acceptable water for these parameters. A summary of the comparison is provided in Table 6.

The figures in Table 6 represent the highest concentrations obtained during monitoring to date. These values are thus a conservative representation of the baseline groundwater quality. Increases in these concentrations would thus represent deterioration in the water quality and a decrease in these concentrations would constitute an improvement in the water quality at the site.

The results in the table above must also be considered in the context of broader groundwater quality in Botswana. The hydrogeological report suggests that compliance with BOS 32:2000 by naturally occurring shallow groundwater in the Kalahari Beds would seldom be achieved even where no contamination source was present. The comparison with BOS 32:2000 is thus extremely conservative.

The existing power plant does not appear to have significantly impacted on the water resources in the area albeit for a rise in sulphate concentrations.
Table 6: Groundwater quality at the site

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Highest groundwater concentration at the site (mg/l)</th>
<th>Meets maximum limit concentration in terms of BOS 32:2000 (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride</td>
<td>350</td>
<td>Yes (600)</td>
</tr>
<tr>
<td>Sulphate</td>
<td>800</td>
<td>No (400)</td>
</tr>
<tr>
<td>Carbonate</td>
<td>350</td>
<td>Yes (NA)</td>
</tr>
<tr>
<td>Nitrate</td>
<td>15</td>
<td>Yes (45)</td>
</tr>
<tr>
<td>Sodium</td>
<td>150</td>
<td>Yes (400)</td>
</tr>
<tr>
<td>Potassium</td>
<td>10</td>
<td>Yes (100)</td>
</tr>
<tr>
<td>Calcium</td>
<td>200</td>
<td>Yes (200)</td>
</tr>
<tr>
<td>Ammonia</td>
<td>5</td>
<td>No (NA)</td>
</tr>
<tr>
<td>Iron</td>
<td>5</td>
<td>No (2)</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>1500</td>
<td>Yes (2000)</td>
</tr>
<tr>
<td>Trace Elements in Total (Pb, Cr, As, V and Co)</td>
<td>0.02</td>
<td>Not in BOS 32:2000</td>
</tr>
</tbody>
</table>

NA = not available

5.4.2.3 Aquifer vulnerability

Aquifer vulnerability is assessed on the basis of physical, biological and chemical characteristics of geological and soil layers above the aquifer and can be presented as zones of differing vulnerability on maps.

The hydrogeological specialist study indicated that the proposed site, based on soil types, strata and depth to unsaturated zone, has a moderate aquifer vulnerability setting.

5.5 Ecology

5.5.1 Flora

Two vegetation types have been identified in the study area namely Burkea/Ochna Savannah and Acacia erioloba Savannah (Appendix 4.2).

Burkea/Ochna Savannah is associated with deep well-drained ferralic sandy soils, and is characterised by Colophospermum mopane species. Acacia erioloba Savannah is characterised by Acacia erioloba, Terminalia sericea, and Lonchocarpus nelsii species. Both these vegetation types are savannah type systems and occur in the areas south of the Makgadikgadi.

The most commonly occurring plant species on the ash dam is Nicotiana sp, an exotic small blue-green bush, found throughout the ash dam in the coarse ash, which is used to make the dam walls.

Sandveld and Riverine habitats (drainage with bush, riverine woodlands and river floodplains) are predominant within a 10 km radius of the site (Table 7).
Table 7: Habitats within a 10 km radius of the site

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Area (ha)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disturbed</td>
<td>3073</td>
<td>9.80</td>
</tr>
<tr>
<td>Drainages with bush</td>
<td>3660</td>
<td>11.67</td>
</tr>
<tr>
<td>Mopane woodland</td>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td>Outcrop</td>
<td>745</td>
<td>2.38</td>
</tr>
<tr>
<td>River floodplain</td>
<td>1473</td>
<td>4.70</td>
</tr>
<tr>
<td>Riverine Woodland</td>
<td>873</td>
<td>2.78</td>
</tr>
<tr>
<td>Rock outcrop</td>
<td>4</td>
<td>0.01</td>
</tr>
<tr>
<td>Sandveld</td>
<td>20628</td>
<td>65.78</td>
</tr>
<tr>
<td>Sandveld &amp; pan soils</td>
<td>32</td>
<td>0.10</td>
</tr>
<tr>
<td>Sandveld with emergent Acacia</td>
<td>588</td>
<td>1.87</td>
</tr>
<tr>
<td>Sandveld with emergent trees</td>
<td>284</td>
<td>0.91</td>
</tr>
<tr>
<td><strong>Total Area (ha)</strong></td>
<td><strong>31361</strong></td>
<td></td>
</tr>
</tbody>
</table>

Although the site of the proposed power station and slurry dams has low plant species diversity, the Tswapong hills area, which is located to the east outside of the study area, has been highlighted as being host to important species.

No species on the national Red Data list are known to occur at the proposed site. A list of rare or endangered plants and those that have some (low) potential to occur on or near the proposed development is contained in Annexure 2 of the Ecological and Land Use Report (Appendix 4.2).

5.5.2 Fauna

5.5.2.1 Avifauna

Approximately 460–500 bird species have been recorded in the project area (Birdlife Botswana Important Bird Areas and national database). The Tswapong hills are host to large breeding populations of Palearctic migrants and are thus given the status of being an Important Bird Area (IBA)\(^1\). Of the species occurring in the Tswapong hills, the Cape Vulture, *Gyps coprotheres*, is a species of global conservation concern.

5.5.2.2 Invertebrates

Little is known about the invertebrate populations throughout Botswana and the study area is no exception. Two subspecies of butterflies have however been identified as being endemic to the Tswapong hills.

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\(^1\) Important Bird Areas have no national legal status
5.5.2.3 Reptiles, amphibians and mammals
A list of reptiles, amphibians and mammals known to exist in the area is provided in of the Ecological and Land Use Report (Appendix 4.2).

5.5.3 Biodiversity

The surrounding area (outside the study area) is regarded as being high in species richness, and plant diversity (BSAP Stocktaking Report, Final Draft, 2003). The closest area of high diversity lies to the north in the Morupule Colliery concession area (at the Colliery housing site). The proposed development area itself has a low biodiversity priority.

5.6 Climate and air quality

5.6.1 Climate

5.6.1.1 Rainfall
Semi-arid conditions with cool dry winters and warm, wetter summers characterise the climate of the study area.

Rainfall data from the power station from 1989-2006 indicates a mean annual precipitation of 371 mm with the majority of rainfall received between November and March (Appendix 4.2).

Rainfall intensity is a measure of how much rain falls over a specified time period. The more intense the rainfall the more likely it is to create surface run-off thus potentially filling pans or depressions and thereby creating conditions conducive to groundwater recharge. The rainfall intensity/duration curves for Palapye indicate the maximum 100-year return value as being 132 mm/hr. When compared to other stations in the area (Serowe and Orapa for example) it appears that there is a trend of higher rainfall intensity to the north where Orapa has a maximum of 172 mm/hr and Serowe a maximum of 146 mm/hr.

5.6.1.2 Wind
Regional continental high pressure and tropical easterly systems influence the wind patterns during much of the year (Appendix 4.2). The dominant winds occur from a north easterly direction with an average wind speed of 3 m/s. Strong winds exceeding 5 m/s occur at a frequency of 41%.

5.6.1.3 Ambient temperature
Ambient temperature has important implications for the buoyancy of plumes; the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise. Temperatures also provide an indication of the extent of insolation, and therefore of the rate of development and dissipation of the mixing layer (Airshed Planning Professionals, 2004).

Temperature maximums in the study area generally occur during the October-March months, with June and July months experiencing the lowest temperatures. Only small inter-annual variations in temperature ranges occur. The average annual maximum temperature is between 28 °C and 30 °C and the average minimum temperature is between 14 °C and 16 °C.
5.6.1.4 Evapotranspiration

Potential evapotranspiration is in the order of 900-1500 mm/year (Lubczynski 2000), which is three to four times the average annual rainfall (Appendix 4.2). Generally, monthly rainfall totals are consistently exceeded by potential evapotranspiration. This would indicate that groundwater recharge is seldom ever really possible. However due to extreme rainfall conditions that occur in short duration and high intensity, groundwater recharge can occur particularly through transport via preferential flow paths.

5.6.2 Air quality

5.6.2.1 Local emission sources

General pollutant sources that may influence local air quality are as follows (Appendix 4.3):

- Industrial operations (stack, vent and fugitive emissions);
- Fugitive emissions from mining operations; and
- Vehicle tailpipe emissions from national and main roads.

Emission sources of less importance and of a more sporadic nature are as follows:

- Household fuel combustion (particularly coal and wood used by smaller communities);
- Biomass burning (veld fires in agricultural areas within the region); and
- Various miscellaneous fugitive dust sources (agricultural activities, wind erosion of open areas, vehicle-entrainment of dust along paved and unpaved roads).

5.6.2.2 Significant regional emission sources

The existing Morupule Power Station is currently the only operational power plant in the area. The 3990 MW Matimba Power Plant located near Lephalale in South Africa is the only other power plant in the larger region, located approximately 139 km to the south-southeast of the Morupule Power Station.

The proposed 4800 MW Matimba B Power Plant has been approved for construction by the South African authorities. In addition, a new 5400 MW power plant at Mmamabula (approximately 111 km south-southwest) of Morupule is proposed for development. A Nickel Smelter is operational at Selebi-Phikwe, approximately 101 km to the north east of Morupule.

Dust emissions arising from the expansion of the Morupule Colliery may impact on regional ambient particulate matter concentrations. Emissions from the agricultural activities in the area have not been quantified but are expected to occur during land tilling.

5.6.2.3 Ambient air quality

The baseline ambient air quality of the local airshed has been simulated through dispersion modelling because there is insufficient on-site data available for the criteria pollutants of concern (Appendix 4.3). The main sources contributing to the ambient air quality within the vicinity of the proposed Morupule B Power Station are the current Morupule Power Station and the Morupule Coal Mine. The other main sources, i.e. Matimba and Matimba B Power Stations are considered to be too far away to have a significant influence on the background concentrations at the Morupule Power Plant (Appendix 4.3).
Sulphur dioxide

The maximum predicted ground level concentrations are predicted to occur approximately 800 m west of the existing Morupule Power Station. These concentrations currently exceed the relevant Botswana and World Bank Group (WBG) limits for highest hourly, daily average and annual average intervals (Appendix 4.3).

The guidelines for highest daily averages as provided by Botswana and the WBG were not exceeded at Palapye. Annual average concentrations at Palapye and Serowe do not exceed any of the guidelines. Highest hourly predicted SO$_2$ concentrations exceeded the European Community (EC) standard at Palapye and the WHO Interim Target (IT)-2 guideline over a 24-hour average.

The allowable frequency of exceedance according to the EC hourly standard of 350 µg/m$^3$ is 24 hours per calendar year. Based on the predicted hourly concentrations at Palapye, the 350 µg/m$^3$ limit will be exceeded for 7 hours in the calendar year, thus within the EC limit in this regard.

At Serowe, none of the ambient air quality guidelines or standards was exceeded for any of the averaging periods.

Nitrogen dioxide

The maximum ground level concentration was predicted to occur approximately 769 m to the west of the power station (Appendix 4.3). The maximum ground level concentration for highest hourly averages was predicted to comply with the Botswana, WBG and WHO guidelines. Highest daily and annual average predictions were also well within the respective guidelines. All predicted NO$_2$ ground level concentrations were low and well within the respective guidelines at Palapye and Serowe.

Particulate matter (10 micron)

The maximum ground level concentration for highest hourly averages was predicted to occur within a 500 m radius of the power station (Appendix 4.3). Predicted ground level concentrations of PM10 considered all the sources at the Morupule Power Station including stacks, vehicle entrainment on roads, wind blown dust from the coal storage piles and the ash lagoon and materials handling operations.

Maximum ground level concentrations were predicted to exceed the daily and annual guidelines as reflected by the WBG and WHO (Appendix 4.3). Predicted emissions are at the limit of the Botswana annual average guideline.

At Palapye and Serowe, the predicted PM10 concentrations were low and well within the respective guidelines for highest daily and annual averages.

The quantitative assessment of ambient air quality indicated above is conservative in that the hourly and daily averaging periods contain only the maximum predicted ground level concentrations, for those averaging periods, over the entire period for which simulations were undertaken (Appendix 4.3). It is therefore possible that even though a high hourly or daily average concentration is predicted to occur at certain locations, that this may only be true for one hour or one day during the year.

Table 8 summarises the predicted current baseline ambient concentrations of SO$_2$, PM10 and NO$_2$. 
Table 8: Predicted SO$_2$, NO$_2$ and PM10 baseline concentrations due to the Morupule Power Plant (exceedances of air quality guidelines are highlighted)

<table>
<thead>
<tr>
<th>Averaging Period</th>
<th>Standard/Guideline (µg/m$^3$)</th>
<th>MAX GLC</th>
<th>PALAPYE</th>
<th>SEROWE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max Conc (µg/m$^3$)</td>
<td>Fraction of GL</td>
<td>Max Conc (µg/m$^3$)</td>
<td>Fraction of GL</td>
</tr>
<tr>
<td>Highest hourly</td>
<td>350(d)</td>
<td>4683.6</td>
<td>13.4</td>
<td>690.0</td>
</tr>
<tr>
<td>Highest 24-hour average</td>
<td>300(a)</td>
<td>557.9</td>
<td>1.9</td>
<td>70.0</td>
</tr>
<tr>
<td></td>
<td>150(b)</td>
<td>11.2</td>
<td>3.7</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>50(c)</td>
<td>11.2</td>
<td>3.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Annual average</td>
<td>80(a)(b)</td>
<td>155.2</td>
<td>1.9</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>30(c)</td>
<td>5.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

**Sulphur Dioxide (SO$_2$)**

<table>
<thead>
<tr>
<th>Averaging Period</th>
<th>Standard/Guideline (µg/m$^3$)</th>
<th>MAX GLC</th>
<th>PALAPYE</th>
<th>SEROWE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest hourly</td>
<td>400(a)</td>
<td>164.0</td>
<td>0.4</td>
<td>25.0</td>
</tr>
<tr>
<td>Highest 24-hour average</td>
<td>200(c)</td>
<td>0.8</td>
<td>0.1</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>150(b)</td>
<td>19.6</td>
<td>0.1</td>
<td>2.6</td>
</tr>
<tr>
<td>Annual average</td>
<td>100(a)(b)</td>
<td>5.5</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>40(c)</td>
<td>0.1</td>
<td>0.003</td>
<td>0.001</td>
</tr>
</tbody>
</table>

**Nitrogen Dioxide (NO$_2$)**

<table>
<thead>
<tr>
<th>Averaging Period</th>
<th>Standard/Guideline (µg/m$^3$)</th>
<th>MAX GLC</th>
<th>PALAPYE</th>
<th>SEROWE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest 24-hour average</td>
<td>150(b)</td>
<td>366.6</td>
<td>2.4</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>100(c)</td>
<td>3.7</td>
<td>0.03</td>
<td>0.012</td>
</tr>
<tr>
<td>Annual average</td>
<td>200(a)</td>
<td>189.2</td>
<td>0.9</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>50(b)(c)</td>
<td>3.8</td>
<td>0.004</td>
<td>0.002</td>
</tr>
</tbody>
</table>

**Particulates (PM10)**

**Notes:**

(a) Botswana guideline (90% of observed to be less than 300 µg/m$^3$)

(b) World Bank (WBG) Thermal Power Guidelines

(c) World Health Organisation (WHO) Interim Target-2 (IT-2)

(d) European Community (EC) hourly standard

**Abbreviations:**

GLC – ground level concentration (this is the maximum concentration)

GL – Guideline

Max Conc – Maximum Concentration
5.6.2.4 Greenhouse gas production

The Morupule Power Station greenhouse gas contribution may be placed within the context of national greenhouse gas emissions by making reference to the greenhouse gas emissions inventory included in the National Communication to the United Nations Framework Convention on Climate Change (UNFCCC, 2002).

The Air Quality Impact Report compiled by Airshed Planning Professionals in 2004 indicated that the current Morupule Power Station contributed approximately 32.6%, 0.3% and 0.01% of the country’s total CO$_2$, NO$_2$ and CH$_4$ emissions respectively.

Botswana’s current CO$_2$ emissions have been calculated at approximately two tons of CO$_2$ emissions per person per year (Appendix 4.3). This figure excludes the carbon cost of imported electrical power but includes present coal production and use, all fuels, gas and firewood. The average figure for CO$_2$ emissions per person per year for middle-income countries is 3.8 tons.

5.7 Noise

Botswana in general applies the World Health Organisation (WHO) and World Bank (WB) environmental standards and procedures. There are South African National Standards (SANS) codes of practice and procedures for noise which have been developed based on the requirements of the WHO and WB as well as those of the International Standards Organisation (ISO). As the South African documents are more detailed, more prescriptive and often apply more stringent standards it was recommended that the South African as well as the international standards be applied on this project. The general procedure used to determine the noise impact was guided by the requirements of the Code of Practice SANS 10328:2003: Methods for Environmental Noise Impact Assessments. The noise impact criteria used specifically take into account those as specified in SANS 10103:2004, The Measurement and Rating of Environmental Noise with Respect to Land Use, Health, Annoyance and Speech Communication.

Measurements and auditory observations were taken at nine monitoring sites during the noise impact investigation in order to establish the ambient noise conditions of the study area. These were taken at appropriate sites at varying distances from the power station site. For a description of all of the measurement sites and for more technical details of the measurement survey, refer to Appendix 4.6. Briefly the main sites at which measurements were taken were as follows (Figure 14):

- Site 1: In Morupule Mine Village in Mokowe Crescent.
- Site 2: At entrance gate to Morupule Mine Village on eastern side of access road.
- Site 3: On the western boundary of Kgaswe Primary School.
- Site 4: At remote settlement (“Molapu Wapitsi”) just north of the Lotsane River.
- Site 4a: On road to settlement (Site 4) at approximately 1000m south of Road A14.
- Site 5: On the south side of the road to Serowe (Road A14) just west of Palapye.
- Site 6: In residential area of Palapye to the east of Road A1 and just north of the Desert Sands Motel.
- Site 7: At the entrance gate to the Morupule Golf Course.
• Site 8: At the southeast corner of the Morupule Colliery Game Park.

![Figure 14: Location of noise measurement sites. Source: Jongens, Keet Associates (2007) (Appendix 4.7)](image)

The main sources of existing noise in the area are from the following (Appendix 4.6):

- Traffic on Road A North, Road A1 South and Road A14;
- Existing Morupule Power Station;
- Morupule Colliery; and
- The colliery bound trains.

The main noise sensitive areas/sites/receivers in the study area are as follows:

- Palapye Village;
- Morupule Colliery Village (residential);
- Settlement (“Molapu Wapitsi”) just north of the Lotsane River. This is the only isolated settlement in the study area;
- Contractor village adjacent to the Kgaswe Primary School; and
- Kgaswe Primary School.
The terrain across the study area is flat falling gently to the south east towards the Lotsane River. There are few natural features that will assist in the attenuation of noise. The main meteorological aspect that will affect the transmission (propagation) of the noise is the wind. The wind can result in periodic enhancement downwind or reduction upwind of noise levels. Analysis of the wind records for the area indicates that overall (day and night average) the main prevailing winds blow from a north and a north easterly direction, but the area does experience winds from the south east, a condition which is associated with thunderstorms in summer months and cold fronts during winter months.

Attenuation of noise levels is expected to occur from the thick vegetation in the area and where there are houses, other buildings and terrain restraints in the intervening ground between the source and the receiver point.

Table 9 summarises the ambient noise levels compared with the WHO, WB and SANS noise standards.

Table 9: Current noise levels in the Morupule Power Station study area.

<table>
<thead>
<tr>
<th>Noise Sensitive Site*</th>
<th>Period</th>
<th>Maximum Allowable Noise Level (dBA)</th>
<th>Measured Noise Level (Year 2007) (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>WHO &amp; WB</td>
<td>SANS 10103</td>
</tr>
<tr>
<td>Site 1: Colliery Village (Suburban Residential)</td>
<td>Day</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>Site 2: Colliery Village (Suburban Residential)</td>
<td>Day</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>Site 3: Kgaswe School (Educational)</td>
<td>Day</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Site 4: Settlement (Rural Residential)</td>
<td>Day</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>35</td>
</tr>
<tr>
<td>Site 5: Palapye (Urban Residential)</td>
<td>Day</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Site 6: Palapye (Urban Residential)</td>
<td>Day</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>45</td>
</tr>
</tbody>
</table>

* Sites 4a, 7 and 8 are omitted as no night-time measurements were taken at these locations

The background noise levels in the study area indicate the following (Appendix 4.6):

- Noise levels in Palapye Village are high and are typical of an urban complex;
- The existing noise climate alongside the main roads in Palapye is degraded with regard to the SANS urban residential living standards, that is noise exceeds the SANS standards particularly at night. In general the daytime conditions are within the SANS noise standards;
- The areas outside Palapye and remote from the main roads and the power station/collery are very quiet and reflect a rural character;
- The existing noise climate alongside Road A14 outside Palapye Village is degraded with regard to the SANS rural residential living standards;
• The impact of the power station on noise sensitive sites in the surrounding area is minor. Noise levels from the existing power station exceed 35dBA (the SANS maximum allowable night-time level for rural residential use) up to a distance of about 2500 metres from the facility. The Colliery Village and the settlement (“Molapo wa Dipitse”) lie outside this zone and are thus not impacted by the power station noise. These residential areas are also not adversely impacted by traffic noise from Road A14. The old housing that was used during the construction of the existing power station, adjacent to the Kgase Primary School, lies within this zone but noise levels at this site are more severely affected by the Road A14 traffic noise. The power station will be heard late at night when traffic volumes are low;

• Noise levels from traffic on Road A14 at the Kgase Primary School are slightly higher than desirable for an educational environment. The maximum daytime noise level measured in the vicinity of the school was 76.6dBA whilst the average daytime noise level was 57.9dBA. Noise from vehicles passing over the speed control humps on the power station access road just to the west of the school is a significant noise nuisance factor. Noise from the power station does not have a significant impact on the activities at the Kgase Primary School; and

• The overall impact of the noise from the coal trains on noise sensitive sites in the area is not significant. There is a minor nuisance effect at the school from the warning horn sounding when the train approaches the level crossing with the power station access road.
6.1 Introduction

This section of the ESIA provides a summary of the socio-economic environmental setting of the proposed development. The information presented herein comprises of a summary of the information from the Scoping Report augmented by the information obtained from the additional specialist studies in social impact, land-use and noise impact. The individual specialist reports are provided in Appendix 4.

6.2 Land use

6.2.1 Introduction

The Palapye Village is the closest village to the Morupule Power Station, and is considered one of the three primary centres of the Central District. A number of thriving commercial investments continue to attract people to the area. Both the land upon which the existing power station is built as well as the land for the proposed expansion of the power plant belongs to the Bamangwato Tribal Authority.

6.2.2 Land Use

Within the surrounding area there are a number of land use practices. These include:

- Arable agriculture;
- Livestock production;
- Urban development (mainly housing); and
- Land developed for mining and power production.

The most viable and commonly practised land use in the area is communal grazing livestock.

According to the Central District Planning Study Document (1992), over 65% of land is used for livestock grazing. The types of livestock found in these communal grazing areas include: cattle, goats and sheep (Appendix 4.3).
Table 10: Land use within a 10 km radius of the site

<table>
<thead>
<tr>
<th>Type</th>
<th>Areas (ha)</th>
<th>% Developed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Developed Land</td>
<td>8,160</td>
<td>na</td>
</tr>
<tr>
<td>Cultivated (%)</td>
<td>2,661</td>
<td>32.6</td>
</tr>
<tr>
<td>Disturbed (%)</td>
<td>96</td>
<td>1.2</td>
</tr>
<tr>
<td>Urban (%)</td>
<td>2,860</td>
<td>35.1</td>
</tr>
<tr>
<td>Mine &amp; Power (%)</td>
<td>106</td>
<td>1.5</td>
</tr>
<tr>
<td>Morupule AI Camp (%)</td>
<td>2,424</td>
<td>29.7</td>
</tr>
<tr>
<td>Wildlife (Morupule) (%)</td>
<td>1,689</td>
<td>na</td>
</tr>
<tr>
<td>Communal Grazing (%)</td>
<td>21,579</td>
<td>na</td>
</tr>
<tr>
<td>Total Area within 10 km (ha)</td>
<td>31,416</td>
<td>26</td>
</tr>
</tbody>
</table>

Note: na – Not Applicable

6.2.2.1 Urban and residential

There are three main types of residential areas within the study area, these are as follows:

- Homesteads linked to lands areas and cattle post (approximately 163 homesteads);
- Formal housing for Morupule Colliery staff (11.2 ha with about 30 households); and
- Urban Palapye which has both traditional and modern housing (2,860 ha of urban area fall within the 10 km radius).

6.2.2.2 Mining

Morupule Colliery is owned and operated by Debswana, a partnership between the government of Botswana and De Beers. The coalfield is immense and contains good quality coal, with overall reserves of over 9 billion tons. Production has increased steadily over the years from 145,000 tons per annum in 1973. A total of 984,838 tons of coal were mined and 964,555 tons were sold during the year 2005. A number of key industries in Botswana depend on coal supply from Morupule. More than half of the mine's current annual production is supplied directly by overland conveyor to the adjacent Morupule Power Station, while the BCL Mine at Selebi-Phikwe and the Botswana Ash plant at Sua Pan remain major customers.

6.2.2.3 Livestock

Within the 10 km radius of the proposed development about 68% of the land is available for traditional livestock production (made up of agricultural lands, Department of Agriculture artificial insemination camps and free range) with an additional 8% fenced for commercial livestock production. Two Artificial Insemination (AI) camps belonging to the Ministry of Agriculture (MOA), called Leupala and Moupule are located within 10 km of the site. Livestock carrying capacities are presently 7 ha/Large Stock Unit (LSU).

Based on the assessment of aerial photography (2002-2003 aerial photographs), there are at least 163 homesteads within the area all of which will have livestock as an important component of their livelihoods.
6.2.2.4 Game Ranching
Morupule Colliery has game fenced its lease area and is developing the wildlife population through protection and stocking.

6.2.2.5 Arable agriculture
Dry land farming is seen to be a common land use practice in the area with this practice accounting for approximately 11% of the total area within the district (Central District Planning Study, 1992).

Soil fertility and water resources are the determining factors with regards to the distribution of this land use practice. The majority of the lands areas are situated in close proximity to the Morupule River. Fields are near the national upper average size, being just larger than 6 ha. The total number of lands areas identified from the aerial photography analysis was 435.

The main crops grown in the Palapye area are sorghum, maize, cowpeas, millet, and melons. Arable agricultural production is low but it remains an important part of the rural economy.

6.3 Socio-cultural environment

6.3.1 Heritage aspects

Archaeological sites are the main source of information about Botswana’s past and the only tangible evidence of that past. The protection of such sites is therefore essential to safeguard the national heritage (Appendix 4.5).

Surveys of the eastern parts of Botswana have identified sites ranging from the early Stone Age through to the Late Stone Age, to the Iron Age and the historic period. In other words, there are signs of human activity in the eastern parts of Botswana from as early as two million years ago until historic times.

Stone Age research in this area has been limited and this is evident from the National Museum site register whereby very few sites have been recorded.

The Stone Age in terms of early human activity has been divided into three phases, these being; Early Stone Age (ESA), Middle Stone Age (MSA), and Late Stone Age (LSA).

The Early Stone Age dates from around two million years ago, to about 120,000 years ago. Sites, which fall within this time frame, are very rare in this area, and according to the National Museum site register-listing records, two sites belonging to this period have been recorded within the Morupule area.

The Stone Age period is preceded by the Iron Age, which represents some of Botswana’s most researched phenomena, especially in Eastern Botswana. This period is far better known in comparison to the Stone Age. The major contribution to the study of archaeology of this area has been the work of Denbow [1979, 1982, and 1983]. Denbow identified more than 400 archaeological sites in Eastern Botswana. The vast majority of these sites were defined or classified as being part of the Toutswe Tradition, which were identified from aerial photographs.

---

1 The commercial production of wild animal species
It is evident from the national site register that many Toutswe type-sites have been identified in and around the mining lease area, including other Iron Age cultures, which are not classified as Toutswe.

A review of the relevant records pertaining to the general study area at the Botswana National Museum indicated that 17 sites have been recorded in the 27-C1-map sheet.

These were mostly sites of Stone Age, Iron Age and historic period with the Toutswe culture mostly represented in the Iron Age. The archaeological survey undertaken confirmed that none of these sites are located on the proposed development site.

Abandoned kraals (Figure 15) and housing structures have been identified on the proposed development site, however, these are not considered to be of any archaeological significance.

![Figure 15: Abandoned kraal on the site](image)

### 6.4 Socio-economic environment

Data on the socio-economic environment was sourced from the Central District Development Plan 6, Central District Council Land Use Plan, Palapye Planning area Development Plan 1995 – 2015 (currently under review), Botswana National Settlement Policy, Central Statistics Office Documents, and the internet (Appendix 4.6).

#### 6.4.1 National context

Botswana is a land locked country located in Southern Africa with a population of approximately 1.7 million persons and an annual growth rate of 3.6% (2001 Population census). The country has enjoyed a stable democracy since independence in 1966. Botswana is also one of the fastest growing economies in Africa. This growth has been boosted by natural resources such as diamonds and soda ash and beef processing. Tourism is also an important economic sector, contributing in the region of 12% to the GDP in the 2003–2004 period (www.state.gov/r/pa/ei/bgn/1830). In terms of administration, the country is divided into four planning regions namely the Eastern, South Eastern, Western, and Northern regions. In addition the country is divided into nine district and five town councils.
Land use in Botswana has been divided into four categories namely settlement, agriculture and wildlife and forest reserves. On the other hand, land tenure has been divided into three categories which are tribal, state and freehold. Tribal land accounts for about 71% of the land whilst state land and freehold are 23% and 6% respectively.

Transport and communications infrastructure in Botswana is well developed and most parts of the country are connected by well maintained tarred roads. Telephone communications are also available in most parts with services rendered by Botswana Telecommunications Corporation as well as two cellular phone providers. These factors, combined with the country’s political stability, have contributed to Botswana’s economic development and growth.

In terms of basic services the government of Botswana provides basic health and education services to all citizens. Primary school education is provided for free. As a result the adult literacy rate for the Republic of Botswana currently stands at 81%. However, there is a small cost recovery fee charged for provision of other services such as refuse collection, and tertiary education.

### 6.4.2 Regional and local context

The proposed project site falls within the Palapye Planning Area which in turn is located within the Central District. In terms of location, Palapye is strategically located at the junction of major roads linking Gaborone and Francistown to the south and north respectively and Serowe to the west. This gives the village an advantage as a social, administrative and commercial centre. In terms of the settlement hierarchy Palapye is classified as a Primary III centre in the Central District and falls within the eastern planning region. Planning regions were done in order to harmonise the planning, provision and maintenance of infrastructure and services. The Central District is divided in traditional settlement patterns of village, lands and cattle posts. In Palapye, the older residential areas are mostly of a nucleated pattern while the newer areas have a linear pattern. Most businesses are located along the A1 trunk road and also along the tarred roads within the village. In terms of land tenure most of the land within the Central District is tribal with just two areas of state owned land.

### 6.4.3 Population

Central District has a population of about 501,381. The majority of the population (153,035) are concentrated in the Serowe–Palapye sub district. The sub district covers an area of 30925 km² with a population density of 5 persons/km². Palapye is the third largest town in the Central District and had an estimated population of 26,293 in 2001 (2001 Population Census). Palapye has experienced phenomenal population growth over the years (20.4% between 1991 and 2001) partly due to a number of factors which include the designation of the village as the Serowe–Palapye Sub District headquarters, and the opening of the Morupule Coal Mine (CSO 2001). According to the 1991-2021 Population Projections, Palapye population is set to grow by an estimated 2% between 2006 and 2011. Females have consistently accounted for a greater proportion of the total population. Table 11 provides information on the population of Palapye.
Table 11: Population figures for Palapye (1981 – 2001)

<table>
<thead>
<tr>
<th>Population and Housing Census Year</th>
<th>Total population</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>9,593</td>
<td>Data not available</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>17,362</td>
<td>8,098</td>
<td>9,264</td>
</tr>
<tr>
<td>2001</td>
<td>26,293</td>
<td>12,087</td>
<td>14,206</td>
</tr>
</tbody>
</table>

6.4.4 Employment

Employment opportunities in the area are linked to a variety of economic activities, which include agriculture (arable and pastoral), mining, industrial and commercial, manufacturing, and construction. The location of the Morupule coal mine and the BPC Power Station has boosted employment opportunities in the Palapye area. Unemployment rates are high as indicated in (Table 12).

Table 12: Employment statistics: Population 12 years and older by type of economic activity in the Serowe-Palapye sub-district 2004 (Source CSO, Page 69 of the Botswana AIDS Impact Survey 11)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Number of People</th>
<th>% of Sub-District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paid employee</td>
<td>33670</td>
<td>50.05 %</td>
</tr>
<tr>
<td>Self employed</td>
<td>6245</td>
<td>9.28 %</td>
</tr>
<tr>
<td>Working family business</td>
<td>421</td>
<td>0.63 %</td>
</tr>
<tr>
<td>Working in lands/cattlepost (unpaid)</td>
<td>13146</td>
<td>19.54 %</td>
</tr>
<tr>
<td>Other economically active</td>
<td>213</td>
<td>0.32 %</td>
</tr>
<tr>
<td>Actively seeking employment</td>
<td>13582</td>
<td>20.19 %</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td></td>
<td>20.20 %</td>
</tr>
</tbody>
</table>

It is clear from the statistics that unemployment is high and that self-employed initiatives are few. Tourism in the Central District is still largely wildlife based, with most of the operations located outside the village of Palapye. However, there are a number of hotels and lodges in Palapye, which offer employment opportunities for local residents.

6.4.5 Health

Health data (HIV/AIDS and Sexually Transmitted Infections) prevalence in Palapye is high and at present increasing (Figure 16).
6.4.6 Services

6.4.6.1 Education

The literacy rate for Central District was in the region of 62% during the 2001 census. There are nine government-owned primary schools and one privately owned school in Palapye. Preschools are also available throughout the village. There are three junior secondary and one senior secondary school in the village. There is also a vocational training centre, and informal education centre.

6.4.6.2 Health

The delivery of health services in Palapye is provided through a primary hospital and four clinics. The primary hospital falls under the Ministry of Health while clinics are coordinated by the Ministry of Local Government. There are also specialised centres such as anti-retroviral drugs distribution centres to address the high HIV/AIDS rate in Botswana. There are also a number of private medical practitioners in the village.

6.4.6.3 Housing

Housing structures in Palapye as well as most villages in Central District are predominantly modern structures with tin roofing. However, there are still traditional housing structures made from mud and grass thatch scattered throughout the village.

6.4.6.4 Social amenities

Palapye is serviced by one police station and there are plans to build a bigger one due to the rapid growth of the village. Water supply is from the national supply, community standpipes and private connections. There are three cemeteries, but only one of these is in use.
6.4.6.5 Transport and communication
The A1 trunk road (Francistown–Gaborone) links the south and the north parts of the country. There is also the B14 road, which links Central and Ngamiland Districts. The village is also serviced by an airstrip for small aircraft. Telecommunications in the area are served by Botswana Telecommunications Corporation (BTC) and cellular phone service providers. Botswana Post provides postal services.

6.4.6.6 Electricity supply
Palapye benefits from the location being close to Morupule Power Station. The village is connected to the national supply grid through one substation. However, there is another under construction as residents have been complaining about frequent power surges and outages. Main consumers of electricity are the commercial industrial establishments.
Section 7
Stakeholder engagement process

7.1 Introduction

Stakeholder consultations are an important element of an ESIA since it ensures that all the Interested and Affected Parties (I&APs) are involved in the project. It also enhances collaboration between the developers and I&APs throughout all the phases of a project.

This section provides a detailed description of the Stakeholder Engagement Process (SEP) conducted for the ESIA for the proposed project. The SEP process was conducted in accordance with the Environmental Impact Assessment Act, 2005 (Act 6 of 2005, the EIAA). Both the EIAA and World Bank Guidelines for Thermal Power Plants (1998) emphasise the need for stakeholder involvement in the development process. These two documents therefore informed the consultation programme designed for this ESIA. Best practice principles, such as the core values held by the International Association for Public Participation, were also applied. Stakeholder consultation during the Impact Assessment Phase was undertaken by Ecosurv, with assistance from GIBB Botswana.

The Stakeholder Engagement Process involved the following steps:

1) EIA Scoping Phase

• Distribution of a questionnaire to key stakeholders;
• Meetings with District officials at the sub and main District Land Use Planning Unit (DLUPU);
• Public consultation meetings held in Palapye;
• Preparation of a Public Consultations Report.

2) ESIA Phase

• Preparation and distribution of a Background Information Document (BID);
• Advertising of a public meeting to be held in Palapye;
• Distribution of structured questionnaires to key stakeholders;
• Focus group discussions with affected parties;
• Incorporation of the consultation results into the Social Impact Assessment Report; and
• A follow-up (advertised) public meeting will be held during the public review stage after submission of the Draft ESIA to the DEA.

The following standards guided the SEP for this project:

• Inclusive consultation that has taken place with all sectors of society and that has afforded a broad range of stakeholders the opportunity to become involved (bearing in mind that it is not practically possible to personally consult with every individual in the project area);
• Wide announcement of the project in a variety of ways and over an extended period of time;
• The provision of sufficient and easily accessible information in non-technical language to enable meaningful contributions by members of the public through the assessment process;
• Providing information to members of the public in a variety of forms, viz. by way of discussion documents, presentations at meetings and workshops, visual displays, and the print media;
• Allowing sufficient time for members of the public to examine material and to provide inputs;
• Enabling stakeholders to provide inputs by various methods, for example, written submissions, comment sheets, e-mails, faxes, public meetings and personal contact with members of the ESIA team; and
• Providing stakeholders with ongoing feedback and acknowledgement, and the opportunity to verify that their issues have been considered (and if not, to receive an explanation for this).

The SEP had the objectives of:

• Identifying the relevant stakeholders and targeting all relevant government departments;
• Introducing the proposed project and communicate its objectives to the stakeholders;
• Soliciting views, concerns, issues and comments from stakeholders with regard to the project in their respective localities;
• Providing the opportunity for all parties to exchange information;
• Compiling a report from all the feedback from the stakeholders and other relevant documents; and
• Creating a database of key stakeholders.

The SEP for the proposed project has been structured into the following phases: Scoping, Impact Assessment, authority notification of EIS and announcement of the authorisation.

The first two phases (scoping and impact assessment) can be reported on to date.

7.2 Scoping Phase

7.2.1 Outline of process followed

The consultation process was undertaken in early 2004. The detailed public consultation report in this regard was provided in Appendix 5E of the Scoping Report (2004). A summary of the findings of this process is provided hereunder.

7.2.1.1 Stakeholder identification

The public participation specialist was familiar with the area and the various stakeholders. In addition to this local knowledge, the identification of stakeholders throughout the study area took place by way of networking and referral. A Background Information Document (BID) was prepared in English (Appendix 5.1). This document was distributed to key stakeholders to notify them of the project.
7.2.1.2 Consultation

- Stakeholders were consulted through interviews, meetings and questionnaires. The following meetings were held:
  - Serowe/Palapye Sub-District Land Use Planning Unit Meeting – 26th January 2004, Venue: Rural Administration Centre, Palapye;
  - Main District Land Use Planning Unit Meeting – 4th February 2004, Venue: Rural Administration Centre, Serowe;
  - Interviewees of Green Camp Trainees – 28th January 2004;
  - Interviewees of Morupule Colliery Community – 28th January 2004; and

The representation and comments recorded at these meetings is captured in Appendix 5E of the Scoping Report (2004).

Different questionnaires were prepared for BPC stakeholders, the district officials covering the Palapye sub-district, Department of Water Affairs in Serowe, Palapye and Gaborone, the Colliery Management in Morupule, the Morupule community and the neighbouring farming community.

The issues and comments obtained from this process were responded to in a table (Appendix 5.2). The main issues identified through the Scoping Phase were summarised as follows:

- Ecological and environmental impacts;
- Potential implications for land use planning in the area;
- Potential social impacts;
- Quality and quantity of the emissions from the Morupule Power Station;
- Access to water resources (surface and groundwater);
- Potential health impacts;
- Waste management;
- Potential pollution impacts on the environment, and
- Potential impacts of relocation/resettlement.

These issues have been taken into the Impact Assessment Phase for more detailed assessment.

7.3 Impact Assessment Phase

7.3.1 Introduction

The Scoping Report (2004) recommended that the project proceed into the Impact Assessment Phase. The Impact Assessment Phase typically incorporates the use of specialists to undertake detailed investigations into the various impacts associated with the proposed project. The aim of the Impact Assessment Phase is to:

- Assess the potential significant impacts imposed by the proposed project and raised in the Scoping Phase;
- Suggest mitigation measures to minimize potential impacts; and
- Document findings into an Environmental Impact Statement (EIS) in order to inform the DEA with regard to issuing a final decision.
Consultation in the Impact Assessment Phase was undertaken by Ecosurv through a variety of means that included the following:

- Open meetings held at the traditional administrative centre (Kgotla) for Palapye;
- Focus group discussions with farmers in lands and cattle posts areas;
- Structured questionnaire sent to key government officers whose respective mandate relate to the project’s objectives;
- Placement of a BID at the Palapye Kgotla; and
- Availability of a Comment Sheet to be filled in by I&APs.

7.3.2 Outline of process followed

7.3.2.1 Project advertising

The SEP for the Impact Assessment Phase commenced in August 2007 with the publication of an advertisement in English and Setswana announcing the project.

The first advertisement was placed on 3 August 2007 and the second advertisement was placed on 30 August 2007 (Appendix 5.3). An opportunity to attend the scheduled public meeting regarding the project was included in the advertisements.

7.3.2.2 Background Information Document and comments sheet

A Background Information Document (BID), and comments sheet was made available to all I&APs (Appendix 5.4 and Appendix 5.5). It was presented in both Setswana and English.

For convenient access by the Palapye community and any other interested parties, copies of the BID were placed at the Palapye Kgotla through generous assistance of the traditional authorities. Traditional authorities were asked to hand out the BID to any interested persons that came to the Kgotla as well as to those that may have seen the public meeting advertisement.

A comment sheet was attached to the BID and I&APs were requested to fill it out and return it to the consultations team either by fax, post or e-mail by 7 September 2007. No completed comment sheets were returned despite confirmation from traditional authorities that all copies availed at the Kgotla had been taken by I&APs.

7.3.2.3 Public meeting

A public meeting was held at Palapye main Kgotla on 4 September 2007. The meeting was announced through the advertisements placed in local newspapers.

The public meeting was conducted in Setswana as all the participants could speak and understand the language. The meeting was attended by 31 people including the consultations team and representatives from BPC.

7.3.2.4 Key persons meeting

A meeting with key local and central government officers was convened in Palapye on 4 September 2007. The meeting was arranged through the assistance of the Central District Assistant Council Secretary responsible for the Serowe-Palapye Sub-District.
7.3.2.5 Focus group meetings
The consultations team undertook consultations in the following lands areas within 10 km of the proposed power station site:

- Morupule;
- Mantshadidi;
- Mmalenakana;
- Dikabeana; and
- Molapowadipits.

Meetings were held with focus groups that comprised of local farmers.

7.3.2.6 Interaction through the Public Participation Office
The newspaper advertisements, comment sheets and BID contained the contact details (telephone, facsimile, postal address and e-mail address) of the Public Participation Office in order for any Interested and Affected Party (I&AP) to interact directly with the Public Participation team, either with queries or to submit comments.

7.3.2.7 Results of the Stakeholder Engagement Process
A summary of the comments received during the Impact Assessment Phase consultation process were as follows:

Public, farmers and livestock owners meetings

- The town leadership and the community generally welcomed the project;
- Preference should be given to local people for non-skilled and semi-skilled labour requirements and the hiring should be done in a transparent manner such use of the Kgotla;
- Some of the residents mentioned that increased power generation may lead to lower power costs and this will encourage the nation to divert from the use of other natural resources. This was pointed out as a worthwhile venture as it would reduce pressure on other natural resources especially firewood;
- Residents also pointed out that there were frequent power outages in their area, and hoped that increased power generation would help ease the problem; and
- Increased probability of illegal occupiers of land who will come in as job seekers.

Business community

- Short-term increase in population in the area may lead to increase in sales and revenue; and
- The contractor should source some of the materials and services locally.

Key government officers

- Construction phase might exert pressure on existing social amenities such as schools and clinics available in the town.

The proposed project was generally welcomed and viewed as a good investment for the country. All the consulted stakeholders concurred with the results of the Scoping Phase that was undertaken in 2004. Consequent to this, no new issues were identified during consultations.
7.4 Way Forward

This report constitutes the Environmental Impact Statement (EIS) for the project.

A second round of consultation in the Impact Assessment Phase will communicate the findings contained in the EIS through a feedback meeting in Palapye.

Public Review Process: Upon review of the EIS, the DEA will place a notification in the Gazette and a newspaper inviting comments or objections to the proposed development. This notification will run each week for a period of four consecutive weeks. Appropriate comments or objections received during this time will be considered by the DEA in its decision-making. During the public review the ESIA documents will be made available for viewing at DEA, Palapye Council and Botswana Power Corporation head office.
8.1 Introduction

The methodology employed in assessing the significance of the possible impacts associated with the project is described in this section. There is no universally applicable methodology for assessing impacts within an EIA process. The methodology used for this EIA is however based on international best practice and the requirements of the DEA. To ensure consistency in the assessment of impacts, all specialists were required to make use of the impact assessment methodology described hereunder.

Ideally, an impact assessment should comprise of a detailed assessment of one or two feasible development alternatives in order to determine the most appropriate alternative. As discussed in section 4 of this report, no feasible alternatives have been identified for the project. The methodology described below has thus been used to determine the significance of the impacts of the proposed development of the Morupule B Power Station. The no-project alternative is used in the final analysis as the baseline against which the proposed development is compared.

8.2 Methodology

The objective of the assessment of impacts is to identify and assess the significance of impacts that may arise as a result of the proposed project. The process of assessing the impacts of the project encompasses the following four activities:

- Identification and assessment of potential impacts;
- Prediction of the nature, magnitude, extent and duration of potentially significant impacts;
- Identification of mitigation measures that could be implemented to reduce the severity or significance of the impacts of the activity; and
- Evaluation of the significance of the impact after the mitigation measures have been implemented i.e. the significance of the residual impact.

8.2.1.1. Identification of impacts

The possible impacts associated with the Morupule B Power Station were primarily identified in the Scoping Phase through stakeholder consultation and the specialist studies in air quality, geohydrology, ecology and archaeology. These impacts were derived from the issues that were identified in respect of all phases of the development of the power station including construction, operation and decommissioning of the proposed power plant. In the Impact Assessment Phase, additional impacts were identified through the further specialist studies in air quality, ecology and land use, social impact, noise impact and geohydrology as well as through the ongoing consultation process with interested and affected parties.
8.2.1.2. Impact prediction

Impact prediction involved assessing each of the impacts identified according to the criteria and rating scales outlined in Table 13.

Table 13: Impact assessment criteria and rating scales

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Rating Scales</th>
</tr>
</thead>
</table>
| Nature                               | • Positive  
• Negative  
• Neutral                                                                                                                                                                                                   |
| Extent (the spatial limit of the impact) | • Local (site-specific and/or immediate surrounding areas)  
• Regional (Palapye)  
• National (greater than the region, may include international spatial extent)                                                                                                     |
| Intensity (the severity of the impact) | • Low - where the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected  
• Medium - where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; and valued, important, sensitive or vulnerable systems or communities are negatively affected  
• High - where natural, cultural or social functions and processes are altered to the extent that it will temporarily or permanently cease; and valued, important, sensitive or vulnerable systems or communities are substantially affected |
| Duration (the predicted lifetime of the impact) | • Short-term (0 to 5 years)  
• Medium term (6 to 15 years)  
• Long term (16 to 30 years) - where the impact will cease after the operational life of the activity either because of natural processes or by human intervention |
| Probability (the likelihood of the impact occurring) | • Improbable – where the possibility of the impact occurring is very low  
• Probable – where there is a good possibility (<50% chance) that the impact will occur  
• Highly probable – where it is most likely (50-90% chance) that the impact will occur  
• Definite – where the impact will occur regardless of any prevention measures (>90% chance of occurring) |
| Confidence level (the specialist's degree of confidence in the predictions and/or the information on which it is based) | • Low  
• Medium  
• High |

The intensity criterion was informed by the collective consideration of cumulative impacts, non-reversibility and irreplaceable resources.

Cumulative impacts were regarded in terms of the capacity of the environmental resources within the geographic area to respond to change and withstand further stress. Non-Reversibility was considered to be the ability of the impacted environment to return to its pre-impacted state once the cause of the impact has been removed. Irreplaceable resources were defined as a resource for which no reasonable substitute exists, such as Red Date species and their habitat requirements.

In all cases, the assignment of a rating was done based on past experience and the professional judgement of the specialists as well as through desktop research.
8.2.1.3. Impact assessment

Once the impacts were assessed in terms of the criteria in Table 13, a consequence rating was applied as per the convention in Table 14. The consequence of the potential impacts was determined according to the main criteria for determining the consequence of impacts, namely the extent, duration and intensity of the impacts.

This assessment was done initially for the scenario where no mitigation measures are implemented. Mitigation measures were then identified and considered for each impact and the assessment repeated in order to determine the significance of the residual impacts (the impact remaining after the mitigation measure has been implemented).

The professional experience of the specialists determined the allocation of the pre-and post mitigation impact consequence rating.

The overall significance of the impacts was then defined based on the result of a combination of the consequence rating and the probability rating, as set out in Table 15.

The results of the assessment of the significance of the residual impacts is then linked to decision-making by authorities in the following manner:

- **Low** – should not have an influence on the decision to proceed with the proposed project, provided that recommended mitigation measures to mitigate impacts are implemented;

- **Medium** – should influence the decision to proceed with the proposed project, provided that recommended measures to mitigate impacts are implemented; and

- **High** – should strongly influence the decision to proceed with the proposed project regardless of mitigation measures.

The results of the impact assessment process as described above are provided in section 9 of the ESIA.
Table 14: Convention for assigning a consequence rating

<table>
<thead>
<tr>
<th>Consequence Rating</th>
<th>Intensity, Extent and Duration Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH Consequence</td>
<td>• High intensity at a regional level and endure in the long term</td>
</tr>
<tr>
<td></td>
<td>• High intensity at a national level and endure in the medium term</td>
</tr>
<tr>
<td></td>
<td>• Medium intensity at a national level and endure in the long term</td>
</tr>
<tr>
<td></td>
<td>• High intensity at a regional level and endure in the medium term</td>
</tr>
<tr>
<td></td>
<td>• High intensity at a national level and endure in the short term</td>
</tr>
<tr>
<td></td>
<td>• Medium intensity at a national level and endure in the medium term</td>
</tr>
<tr>
<td></td>
<td>• Low intensity at a national level and endure in the long term</td>
</tr>
<tr>
<td></td>
<td>• High intensity at a local level and endure in the long term</td>
</tr>
<tr>
<td></td>
<td>• Medium intensity at a regional level and endure in the long term</td>
</tr>
<tr>
<td>MEDIUM Consequence</td>
<td>• High intensity at a local level and endure in the medium term</td>
</tr>
<tr>
<td></td>
<td>• Medium intensity at a regional level and endure in the medium term</td>
</tr>
<tr>
<td></td>
<td>• High intensity at a regional level and endure in the short term</td>
</tr>
<tr>
<td></td>
<td>• Medium intensity at a national level and endure in the short term</td>
</tr>
<tr>
<td></td>
<td>• Medium intensity at a local level and endure in the long term</td>
</tr>
<tr>
<td></td>
<td>• Low intensity at a national level and endure in the medium term</td>
</tr>
<tr>
<td></td>
<td>• Low intensity at a regional level and endure in the long term</td>
</tr>
<tr>
<td>LOW Consequence</td>
<td>• Low intensity at a regional level and endure in the medium term</td>
</tr>
<tr>
<td></td>
<td>• Low intensity at a national level and endure in the short term</td>
</tr>
<tr>
<td></td>
<td>• High intensity at a local level and endure in the short term</td>
</tr>
<tr>
<td></td>
<td>• Medium intensity at a regional level and endure in the short term</td>
</tr>
<tr>
<td></td>
<td>• Low intensity at a local level and endure in the long term</td>
</tr>
<tr>
<td></td>
<td>• Low intensity at a regional level and endure in the short term</td>
</tr>
<tr>
<td></td>
<td>• Low to medium intensity at a local level and endure in the short term</td>
</tr>
</tbody>
</table>

Table 15: Convention for assigning a significance rating

<table>
<thead>
<tr>
<th>Consequence Rating</th>
<th>Consequence x Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH Significance</td>
<td>• High x Definite</td>
</tr>
<tr>
<td></td>
<td>• High x Highly Probable</td>
</tr>
<tr>
<td></td>
<td>• High x Probable</td>
</tr>
<tr>
<td></td>
<td>• High x Improbable</td>
</tr>
<tr>
<td></td>
<td>• Medium x Definite</td>
</tr>
<tr>
<td>MEDIUM Significance</td>
<td>• Medium x Highly Probable</td>
</tr>
<tr>
<td></td>
<td>• Medium x Probable</td>
</tr>
<tr>
<td>LOW Significance</td>
<td>• Medium x Improbable</td>
</tr>
<tr>
<td></td>
<td>• Low x Definite</td>
</tr>
<tr>
<td></td>
<td>• Low x Highly Probable</td>
</tr>
<tr>
<td></td>
<td>• Low x Probable</td>
</tr>
<tr>
<td></td>
<td>• Low x Improbable</td>
</tr>
</tbody>
</table>
Section 9

Assessment of impacts

9.1 Introduction

Potential impacts of the project during the construction and operational phases of the development were identified and discussed within section 5 of the Scoping Report (2004). These impacts were categorised into the following main impact categories:

- Groundwater usage;
- Surface water utilisation;
- Coal reserve utilisation;
- Impact on fauna;
- Impact on flora;
- Impact on soils;
- Impact on the atmosphere;
- Water resources;
- Current access to water;
- Impacts on heritage resources;
- Impacts of resettlement;
- Health impacts of gaseous emissions;
- Impacts on human health;
- Impacts on waste management practices;
- Impacts on institutional capacity;
- Impacts on traffic and safety;
- Current and future planning impacts;
- Noise impacts;
- Health and safety impacts; and
- Good practice.

After a preliminary assessment of the impacts within the above categories, the Scoping Report (2004) concluded that the majority of the project-related impacts could be mitigated satisfactorily through the implementation of an Environmental and Social Management Plan (ESMP) and Environmental Management System (EMS).
The following four significant environmental impact categories were identified in the Scoping Report (2004) for further assessment in the Impact Assessment Phase:

- Air emissions;
- Health impacts relating to air pollution;
- Water resource pollution; and
- Health impacts relating to pollution of the surrounding surface and groundwater.

These impacts were identified as significant in the Scoping Phase as they were assessed to involve non-compliance or to have health implications if left unchecked or to have significant financial implications. The specialist studies undertaken in the Impact Assessment Phase investigated these impacts in more detail.

### 9.2 Summary of specialist studies

A summary of the findings of the specialist studies in social impact, noise impact, ecology and land use, air quality, hydrogeology and archaeology is presented hereunder.

#### 9.2.1 Social impact assessment

**9.2.1.1. Introduction**

The social impact assessment was conducted by Mr. T. Barbour, an independent social impact specialist with assistance from Mr. T. Phuthego from Ecosurv. The specialist report is provided in Appendix 4.5.

**9.2.1.2. Findings**

- All of the key interest groups interviewed, namely the local authorities, farmers and businesses all indicated that they did not experience any major problems with the operations of the existing power station and mine. In addition they all indicated that the proposed power station would benefit both Botswana and the town of Palapye. The benefits to Botswana were linked to improved power generation reliability and energy security. The benefits to the town of Palapye were linked to the creation of local employment and business opportunities during both the construction and operational phase;

- Concerns were raised by the representatives from local government regarding the potential pressure that the increased number of employees and job seekers would have on existing services, such as housing and medical facilities. However, the social specialist felt that these issues could be effectively managed through the implementation of mitigation measures;

- A number of potential negative impacts during the construction phase were also identified, specifically the influx of construction workers and job seekers, impact of heavy vehicles (noise, dust and safety impacts), stock theft and increased risk of veld fires. However, each of these issues can be effectively mitigated by the implementation of an Environmental Management Plan during the construction phase;
The findings of the study also indicate that the project will create a number of opportunities for local businesses during both the construction and operational phase of the project. These represent positive impacts;

Based on the findings of the Social Impact Assessment it is recommended that Phase 1 of the Morupule B Power Station proceed. In order to enhance the local employment and business opportunities the mitigation measures listed in the report should be implemented; and

The mitigation measures listed in the report to address the potential negative impacts during the construction phase, specifically the impact of heavy vehicles (noise, dust and safety impacts), stock theft and increased risk of veld fires, should also be implemented.

9.2.2 Noise impact assessment

9.2.2.1. Introduction

The Noise Impact Assessment was undertaken by Mr. D. Cosijn of Jongens, Keet Associates. The specialist report is provided in Appendix 4.6.

9.2.2.2. Findings

The assessment of the predicted noise impact during the construction phase indicated the following:

- Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over short periods during any day working period;
- Working on a worst-case scenario basis, it was estimated that the ambient noise level from general construction should not exceed 35dBA at the nearest noise sensitive receptor (namely the Kgaswe Primary School that is offset by about 1350 metres from the construction). This level is within the noise limits prescribed by the World Bank Group;
- As the daily volume of construction generated traffic will be relatively small in comparison with the existing daily traffic on the external main road system, the noise impact from this additional traffic on the surrounding areas was assessed to be insignificant; and
- For all construction work, the construction workers working with or in close proximity to equipment will be exposed to high levels of noise.

With respect to the operational phase, the noise specialist indicated the following:

- The noise from the individual power stations at any point within the area of influence of both power stations will be enhanced as a result of the cumulative noise impact from both power stations. The maximum increase will be 3dBA. This noise enhancement will be experienced mainly in the area between the power stations;
- Noise levels near to the main roads will remain high and will continue to increase as traffic volumes increase;
- The residences on the western edge of Palapye (urban residential) lie well outside the power station’s 45dBA+ impact zone and thus will not be negatively affected;
• The Colliery Village (suburban residential) lies well outside the power station’s 40dBA+ zone and thus will not be negatively affected;

• The “Molapu Wapitsi” settlement (rural residential) lies well outside the power station’s 35dBA+ zone and thus will not be negatively affected. No other settlements are potentially affected;

• Night-time noise levels in the “contractor’s” village are already degraded from road traffic noise and the anticipated increase from the planned power station will be minor;

• The noise assessment indicates that the current ambient noise levels at the school are between 41dBA and 46dBA. With the Morupule B Power Station, noise levels at the school are conservatively predicted to increase to between 45dBA and 50dBA. The WBG limit for educational land use is 55dBA. The specialist concluded that the noise from the proposed power station will not significantly worsen the noise climate at the Kgaswe Primary School;

• Noise impact from ancillary works and equipment (such as the conveyor belts) will in general be low and localised. The drive houses for the conveyor belt system, however, will be sites of high noise levels; and

• The volume of traffic generated by the operations at the proposed power station will only marginally increase the ambient noise levels along the road corridor between the power stations and Palapye.

The impact of noise as a result of the proposed development was assessed to be of low significance both before and after the implementation of suggested mitigation measures. Table 16 provides a summary of the noise levels compared against the World Bank limits.

9.2.3 Ecology and land use

9.2.3.1. Introduction

The ecological and land use specialist study was undertaken by Mr. D. Parry and Ms. M. Konopo of Ecosurv. The specialist report is provided in Appendix 4.2.

9.2.3.2. Findings

The ecological and land use study noted that there are few ecological issues relating to the proposed development of the power station.

No post-mitigation impacts of high or medium significance were noted for the construction phase of the development. The following operational phase post-mitigation impacts were assessed to be of high significance:

• Groundwater depletion and drawdown; and

• Botswana’s per capita contribution to global warming.

In terms of the latter, it has been calculated that with Phase I of the Morupule B Power Station, Botswana’s per capita CO₂ emissions will increase to 8.7 tons, which is slightly above the world average (Appendix 4.2). If the proposed Mmamabula Power Station and Phase II of the Morupule B Power Station proceed, this would result in a per capita CO₂ emission level for Botswana of nearly 17 tons. On a per capita basis, this would make Botswana the highest CO₂ producing country in Africa and one of the highest in the world.
## Table 16: Comparison of predicted noise levels against the World Bank Group limits

<table>
<thead>
<tr>
<th>Noise Sensitive Site</th>
<th>Period</th>
<th>Maximum Allowable Noise Level (dBA)</th>
<th>Measured Noise Level (Year 2007) (dBA)</th>
<th>Calculated Noise Level from Noise Source Component Indicated (Year 2012) (dBA)</th>
<th>Cumulative Noise Level (∑) with and without New Power Station (NPS) (dBA)</th>
<th>Increase in Noise Level (Δ) due to New Power Station (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1: Colliery Village (Suburban Residential)</td>
<td>Day</td>
<td>55</td>
<td>50</td>
<td>47.5</td>
<td>33.2</td>
<td>39.6</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>40</td>
<td>39.2</td>
<td>33.2</td>
<td>33.5</td>
</tr>
<tr>
<td>Site 2: Colliery Village (Suburban Residential)</td>
<td>Day</td>
<td>55</td>
<td>50</td>
<td>39.8</td>
<td>33.4</td>
<td>39.8</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>40</td>
<td>28.8</td>
<td>33.4</td>
<td>33.8</td>
</tr>
<tr>
<td>Site 3: Kgaswe School (Educational)</td>
<td>Day</td>
<td>55</td>
<td>50</td>
<td>57.9</td>
<td>44.5</td>
<td>55.6</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>na</td>
<td>na</td>
<td>49.3</td>
<td>44.5</td>
<td>49.6</td>
</tr>
<tr>
<td>Site 4: Settlement (Rural Residential)</td>
<td>Day</td>
<td>55</td>
<td>45</td>
<td>45.5</td>
<td>26.0</td>
<td>40.3</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>35</td>
<td>30.8</td>
<td>26.0</td>
<td>34.2</td>
</tr>
<tr>
<td>Site 5: Palapye (Urban Residential)</td>
<td>Day</td>
<td>55</td>
<td>55</td>
<td>62.4</td>
<td>24.1</td>
<td>61.6</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>45</td>
<td>46.2</td>
<td>24.1</td>
<td>55.5</td>
</tr>
<tr>
<td>Site 6: Palapye (Urban Residential)</td>
<td>Day</td>
<td>55</td>
<td>55</td>
<td>56.8</td>
<td>23.0</td>
<td>54.2</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>45</td>
<td>45</td>
<td>51.0</td>
<td>23.0</td>
<td>48.2</td>
</tr>
</tbody>
</table>

Note: The Cumulative Noise Level (∑) is obtained by summing the relevant component noise levels logarithmically.
The following post-mitigation impacts were assessed to be of medium significance:

- Loss of Cape Vultures due to electrocution if additional power lines are required. This impact should be considered during the transmission power line EIA;

- Human health impacts as a result of predicted daily average SO\textsubscript{2} emissions at a concentration which exceeds relevant local and international emission limits; and

- Dave: Night-time noise impact to 16 households within 2.2 km of the power station. The latter impact is based on the findings of the noise impact specialist (Appendix 4.6). These households are currently exposed to an ambient noise level of between 35.2 dBA (2500 m from the site) and 38.2 dBA (2000 m from the site). With the Morupule B Power Station, the predicted noise profile at this distance is expected to increase to between 39.1 dBA (2500 m from the site) – 41.9 dBA (2000 m from the site). This is an approximate increase in noise of between 3.7 dBA and 3.9 dBA. Appendix A of the noise impact assessment indicates that an increase in noise of 3 dBA is just detectable. The suburban residential standard for the night-time period is 40 dBA.

9.2.4 Air quality

9.2.4.1. Introduction

Ms. H. Liebenberg-Enslin of Airshed Planning Professionals undertook the air quality impact assessment. The specialist report is provided in Appendix 4.3.

9.2.4.2. Findings

The air quality impact assessment considered the criteria pollutants of SO\textsubscript{2}, NO\textsubscript{2}, and particulate matter (PM10). Information on other pollutants from coal-fired power stations such as heavy metals and carbon monoxide was not available for inclusion in the assessment. The findings of the predicted impact of the Morupule B Power Station on the existing ambient air quality are summarised below (Table 17):

**Sulfur dioxide**

- The highest predicted ground level concentrations exceeded all the relevant guidelines and standards for hourly, daily and annual averaging periods. This was based on a design stack height of 150 m. The maximum ground level concentration predicted was very close to the existing Morupule Power Station impacting approximately 800 m to the west;

- The zone of exceedance for highest hourly predictions (EC standard) covered a radius of approximately 10 km around the power plant site. The number of hours exceeding the EC hourly standard of 350 \(\mu g/m^3\) at Palapye was 13 based on the 150 m stack but reduced to 10 with the 200 m stack and with the 300 m stack down to 6. The EC allows 24 hours of exceedance;

- The Botswana and WBG guideline for highest daily average and annual average at Palapye and Serowe were not predicted to be exceeded. The hourly average EC standard and highest daily WHO IT-2 guideline was exceeded at Palapye.

- The zone of exceedance for highest hourly predictions (EC standard) covered a radius of approximately 10 km around the power plant site;
Table 17: Predicted SO2, NO2 and PM10 future concentrations due to the Morupule and Morupule B Power Plants (exceedances of air quality guidelines are highlighted)

<table>
<thead>
<tr>
<th>Averaging Period</th>
<th>Stack Height</th>
<th>Standard Guideline (µg/m³)</th>
<th>MAX GLC Max Conc (µg/m³)</th>
<th>Fraction of GL</th>
<th>PALAPYE Max Conc (µg/m³)</th>
<th>Fraction of GL</th>
<th>SEROWE Max Conc (µg/m³)</th>
<th>Fraction of GL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest hourly</td>
<td>150 m</td>
<td>350(d)</td>
<td>4,707.03</td>
<td>13.45</td>
<td>950.00</td>
<td>2.71</td>
<td>98.00</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>200 m</td>
<td></td>
<td>4,706.55</td>
<td>13.45</td>
<td>940.00</td>
<td>2.69</td>
<td>91.00</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>300 m</td>
<td></td>
<td>4,683.60</td>
<td>13.38</td>
<td>937.00</td>
<td>2.68</td>
<td>76.00</td>
<td>0.22</td>
</tr>
<tr>
<td>Highest 24-hour average</td>
<td>150 m</td>
<td>300(a)</td>
<td>581.36</td>
<td>1.94</td>
<td>95.00</td>
<td>0.32</td>
<td>16.50</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150(b)</td>
<td>3.88</td>
<td>9.50</td>
<td>0.63</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>50(c)</td>
<td>11.63</td>
<td>1.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 m</td>
<td>300(a)</td>
<td>577.88</td>
<td>1.93</td>
<td>89.00</td>
<td>0.59</td>
<td>14.70</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150(b)</td>
<td>3.85</td>
<td>8.40</td>
<td>0.59</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>50(c)</td>
<td>11.56</td>
<td>1.78</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 m</td>
<td>300(a)</td>
<td>559.26</td>
<td>1.86</td>
<td>82.00</td>
<td>0.55</td>
<td>12.50</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150(b)</td>
<td>3.75</td>
<td>7.50</td>
<td>0.55</td>
<td>0.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>50(c)</td>
<td>11.19</td>
<td>1.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual average</td>
<td>150 m</td>
<td>80(a)(b)</td>
<td>189.16</td>
<td>2.36</td>
<td>6.30</td>
<td>0.08</td>
<td>2.40</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30(c)</td>
<td>6.31</td>
<td>1.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 m</td>
<td>80(a)(b)</td>
<td>181.68</td>
<td>2.27</td>
<td>5.90</td>
<td>0.07</td>
<td>2.30</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30(c)</td>
<td>6.06</td>
<td>1.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 m</td>
<td>80(a)(b)</td>
<td>169.06</td>
<td>2.11</td>
<td>5.30</td>
<td>0.07</td>
<td>2.20</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30(c)</td>
<td>5.64</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Sulphur Dioxide (SO2)

### Nitrogen Dioxide (NO2)

### Particulates (PM10)

Notes:
(a) Botswana guideline (90% of observed to be less than 300 µg/m³)
(b) World Bank (WBG) Thermal Power Guidelines
(c) World Health Organisation (WHO) Interim Target-2 (IT-2)
(a) European Community (EC) hourly standard

Abbreviations:
GLC – ground level concentration (this is the maximum concentration)
GL – Guideline
Max Conc – Maximum Concentration
Over an annual average, only the maximum ground level concentrations exceeded the relevant guidelines. This was predicted to be right at the plant, less than 1 km from the source. With an increase in stack height to 200m a reduction of 16% would be achieved at Palapye and at 300m the overall improvement will be 40% Check this;

Highest daily averaged SO\textsubscript{2} concentrations exceeded the critical level for agricultural crops, forest trees and natural vegetation (79 µg/m\textsuperscript{3}) both on-site and at Palapye and surrounding areas. No reports regarding the impact of SO\textsubscript{2} emissions on agricultural crops or natural vegetation were noted during stakeholder consultation or within the social impact assessment report;

Predicted annual averaged SO\textsubscript{2} concentrations were well within the EC and United Kingdom limit value (20 µg/m\textsuperscript{3}) for the protection of ecosystems;

The Morupule B Power Station has a relatively small contribution to the high SO\textsubscript{2} concentrations (Table 18);

With the increase in stack heights to 200 m and 300 m, very little difference was noted in the cumulative (i.e. including the existing Morupule Power Station) maximum predicted ground level concentrations. The predicted ground level concentrations at Palapye reduced by 1% between the 150 m stack and the 200 m stack and by a further 0.4% when increased to 300 m. The incremental impacts from the three stack heights did however indicate a significant reduction between 200 m and 300 m. The predicted maximum concentrations from the proposed Morupule B Power Station in isolation were 1315 µg/m\textsuperscript{3} at 150 m, 978 µg/m\textsuperscript{3} at 200 m and 740 µg/m\textsuperscript{3} at 300 m. Thus a reduction in ground level concentrations of 26% will be achieved by increasing the stack height from 150 m to 200 m and a further 24% reduction by increasing it to 300 m. With the background concentrations included (i.e. Morupule Power Station) the reduction is less noticeable. This is due to the background concentrations contributing between 37% and 98% of the cumulative ground level concentrations.

Nitrogen dioxide

A maximum hourly ground level concentration of 165 µg/m\textsuperscript{3} was predicted for operations from the Morupule B Power Plant and Morupule Power Plant. This concentration did not exceed the WBG, WHO or Botswana limits;

Highest daily averaged and annual averaged NO\textsubscript{2} concentrations complied with WBG, WHO and Botswana limits;

The predicted ground level NO\textsubscript{2} concentrations were well below the European Union (EU) vegetation protection limits and thus no negative impacts on vegetation is expected; and

The predicted increase in NO\textsubscript{2} emissions as a result of the Morupule B Power Station is relatively small (Table 18).
Table 18: Comparison of predicted baseline air quality with predicted air quality after the development of the Morupule B Power Station

<table>
<thead>
<tr>
<th>Averaging period</th>
<th>Max GLC* (µg/m³) Without Morupule B (baseline)</th>
<th>Max GLC* (µg/m³) With Morupule B</th>
<th>Percentage difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur dioxide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest hourly</td>
<td>4,683.6</td>
<td>4,707.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Highest daily</td>
<td>557.9</td>
<td>581.4</td>
<td>4.2</td>
</tr>
<tr>
<td>Annual average</td>
<td>155.2</td>
<td>189.2</td>
<td>21.9</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest hourly</td>
<td>164.0</td>
<td>164.90</td>
<td>0.6</td>
</tr>
<tr>
<td>Highest daily</td>
<td>19.6</td>
<td>20.6</td>
<td>5.1</td>
</tr>
<tr>
<td>Annual average</td>
<td>5.5</td>
<td>6.7</td>
<td>21.8</td>
</tr>
<tr>
<td>Particulate matter (PM10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest daily</td>
<td>366.6</td>
<td>2,377.30</td>
<td>548.5</td>
</tr>
<tr>
<td>Annual average</td>
<td>189.2</td>
<td>1,232.13</td>
<td>551.2</td>
</tr>
</tbody>
</table>

* Ground-level concentration

**Particulate matter (PM10)**

Predicted ground level concentrations of PM10 included all sources at Morupule, i.e. stacks, vehicle entrainment on roads, wind blown dust from the storage piles and ash dumps and materials handling operations. The findings were as follows:

- PM10 concentrations exceeded the referenced daily and annual guidelines (i.e. Botswana, WBG and WHO) for the maximum ground level concentration. Due to the low level of release of the main particulates sources (i.e. materials handling, wind blown dust and vehicle entrainment), the maximum predicted impact was expected to be within close proximity of the plant;

- The area exceeding the WBG limits for highest daily PM10 concentrations extended for approximately 2.5 km from the site. The exceedance of the annual average Botswana guidelines is within an area of a few hundred meters from the source and a radius of approximately 1 km when compared to the WBG and WHO annual guidelines;

- Predicted highest daily averaged and annual averaged PM10 concentrations at Palapye and Serowe complied with all the emission limits; and

- Current on-site concentration of particulate emissions was predicted to increase by more than 500% as a result of the Morupule B Power Station project. This predicted increase is predominantly as a result of an assumption used in the air quality assessment that road infrastructure for the new power station will be unpaved, which is unlikely to be the case (Table 18).
It is important to note that the input data used in the air quality impact assessment was based on the proposed design specification requiring that the emissions limits from the proposed plant would be at the emission limits of the World Bank Group.

Actual emissions are likely to however be well below these limits and the findings of the air quality impact assessment can thus be considered to be conservative.

9.2.5 Hydrogeology

9.2.5.1. Introduction
This study was undertaken by Mr. J. Hiley of Water Surveys Botswana. The specialist report is provided in Appendix 4.1.

9.2.5.2. Findings
The study considered the hydrological and hydrogeological environment at the site. The main findings of the study are as follows:

- The study revealed that the soils and aquifer immediately around the existing and proposed power station location are considered to be of moderate vulnerability;
- The existing power plant does not appear to have significantly impacted on the water resources in the area albeit for a rise in sulphate concentrations;
- The increased amount of coal storage, chemical storage and the amount of burnt coal ash to be disposed of are the activities which are likely to have the most potential for consequent impact;
- The possibility of the spread of contaminants by rainfall from the smoke produced by coal burning was reviewed by a desktop study of other power stations worldwide. It seems unlikely that the new development will have a significant effect on the water environment;
- The residual impact to groundwater and surface water resources were assessed to be of low significance.

The specialist concluded that the proposed new power station is unlikely to pose a significant pollutant risk to groundwater.

9.2.6 Archaeology

9.2.6.1. Introduction
Ms. P. Sekgarometso-Modikwa, of Archaeological Resources Management Services, undertook this study. The specialist report is provided in Appendix 4.4.

9.2.6.2. Findings
A team of four people surveyed the proposed Morupule B Power Plant site on foot with the aid of maps, aerial photographs and a GPS to mark and record anything that could bear archaeological significance. Surface surveying was done in transects covering a total width of 150 meters. Interviews from previous research conducted in the same area were also utilised.
The specialist concluded that there was nothing of archaeological importance in the proposed development area.

The absence of archaeological material on the surface of the area however does not rule-out the probability of encountering materials during the course of project activities as the sands may cover some artifacts. Archaeological monitoring will need to be instituted during site clearance to ensure that any archaeologically significant materials are reported to the Botswana National Museum. This is especially important for the area currently covered in rubble, which due to the rubble, has not been surveyed by the archaeological specialist.

### 9.3 Impact assessment results

The significant environmental impacts identified in the Scoping Phase as well as newly identified possible impacts have been assessed through the various specialist studies. The findings of the impact assessment have been consolidated into Table 19 and Table 20 below. For simplicity, the impacts have been classified within these tables as impacts on the biophysical environment and impacts on the socio-economic environment. The impacts are further classified in terms of the phase of the development in which they are likely to occur namely construction phase, operational phase or decommissioning phase.

The significance of residual (post-mitigation) impacts are marked according to the following colour code:

```
<table>
<thead>
<tr>
<th>Impact of high significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact of medium significance</td>
</tr>
<tr>
<td>Impact of low significance</td>
</tr>
</tbody>
</table>
```

Table 19 summarises the results of the impact assessment. The significance of the residual impact (impact after mitigation) for most impacts was assessed to be of low significance.

Cumulative impacts were identified for impacts to air, noise, groundwater quality and groundwater use. These impacts were accordingly assigned a higher intensity. Only one irreplaceable resource, namely the Cape Vulture, was identified in the impact assessment (Appendix 4.3).

#### 9.3.1 Construction phase impacts

Only one negative impact of medium significance was assessed for the construction phase namely the impact on the social fabric of the town. This impact is however also a positive impact of medium significance as the influx of workers into the area is likely to have a positive socio-economic impact. The following positive impacts were assessed to be of high significance:

- Impact on employment/temporary employment opportunities; and
- Impact on business opportunities.
9.3.2 Operational phase impacts

Two negative impacts of medium significance and which should therefore be carefully considered before making a decision on the proposed project were as follows:

- Impact of increased emissions on surrounding land use and planning; and
- Impact of Morupule B on power tariffs.

The following positive impacts during the operational phase of medium significance were identified:

- Impact of water reuse; and
- Manpower needs/job creation.

Negative impacts of high significance, which should influence decision-making regardless of the mitigation proposed, were as follows:

- Groundwater depletion and drawdown;
- Human health impacts from SO$_2$ emissions; and
- Global warming

The following operational phase positive impacts of high significance should also influence decision-making:

- Impact on Botswana’s energy supply; and
- Impact on business opportunities.

9.3.3 Decommissioning phase impacts

No impacts of high significance were identified for the decommissioning phase. The following two positive impacts of medium significance were identified:

- Air quality; and
- Use of water resources.

The detailed assessment of impacts is indicated in Table 20. Suggested mitigation measures for identified impacts are provided in the Environmental and Social Management Plan (Appendix 6).
### Table 19: Summary of potential environmental impacts

<table>
<thead>
<tr>
<th>POTENTIAL CONSTRUCTION PHASE IMPACTS</th>
<th>RESIDUAL IMPACT SIGNIFICANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biophysical impacts</strong></td>
<td></td>
</tr>
<tr>
<td>Impact of emissions to air on human health, fauna and flora</td>
<td>Low</td>
</tr>
<tr>
<td>Loss of vegetation and habitat</td>
<td>Low</td>
</tr>
<tr>
<td>Loss of grazing due to man-made fires</td>
<td>Low</td>
</tr>
<tr>
<td>Disturbance of wildlife</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of spillages of chemicals, petrochemicals and hydrocarbons on water resources</td>
<td>Low</td>
</tr>
<tr>
<td>Erosion and sedimentation</td>
<td>Low</td>
</tr>
<tr>
<td>Litter</td>
<td>Low</td>
</tr>
<tr>
<td>Security</td>
<td>Low</td>
</tr>
<tr>
<td>Traffic</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Socio-cultural/ socio-economic impacts</strong></td>
<td></td>
</tr>
<tr>
<td>Loss of arable lands and grazing during site establishment</td>
<td>Low</td>
</tr>
<tr>
<td>Social behaviour and human health</td>
<td>Low</td>
</tr>
<tr>
<td>Aesthetics/Visual</td>
<td>Low</td>
</tr>
<tr>
<td>Safety</td>
<td>Low</td>
</tr>
<tr>
<td>Impact on social fabric of town</td>
<td>Medium / Medium (+)</td>
</tr>
<tr>
<td>Impact on employment / temporary employment opportunities</td>
<td>High (+)</td>
</tr>
<tr>
<td>Archaeological impacts</td>
<td>Low</td>
</tr>
<tr>
<td>Noise impact during construction</td>
<td>Low</td>
</tr>
<tr>
<td>Impact on business opportunities</td>
<td>High (+)</td>
</tr>
<tr>
<td>Impact on Serowe Landfill</td>
<td>Low</td>
</tr>
</tbody>
</table>
### POTENTIAL OPERATIONAL PHASE IMPACTS

<table>
<thead>
<tr>
<th>Biophysical impacts</th>
<th>RESIDUAL IMPACT SIGNIFICANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater depletion and drawdown</td>
<td>High</td>
</tr>
<tr>
<td>Habitat loss from coal dust dispersal</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of high SO(_2) levels on agriculture</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of high SO(_2) levels on sensitive habitats</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of NO(_2) emissions on human health</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of PM10 emissions on human health</td>
<td>Low</td>
</tr>
<tr>
<td>Human health impacts from SO(_2) emissions</td>
<td>High</td>
</tr>
<tr>
<td>Impact of ash waste stream on soil and groundwater</td>
<td>Low</td>
</tr>
<tr>
<td>Impact of water reuse</td>
<td>Medium (+)</td>
</tr>
<tr>
<td>Impact of coal storage on soil and groundwater</td>
<td>Low</td>
</tr>
<tr>
<td>Global warming</td>
<td>High</td>
</tr>
</tbody>
</table>

### Socio-cultural/ socio-economic impacts

<p>| Impact on visual “sense of place”                        | Low                          |
| Impact of increased emissions on surrounding land use and planning | Medium                  |
| Impact on Botswana’s energy supply                        | High (+)                    |
| Manpower needs/ job creation                              | Medium (+)                  |
| Impact on business opportunities                           | High (+)                    |
| Impact of Morupule B on power tariffs                     | Medium                      |
| Noise impact on surrounding communities                   | Low                         |</p>
<table>
<thead>
<tr>
<th>POTENTIAL DECOMMISSIONING PHASE IMPACTS</th>
<th>RESIDUAL IMPACT SIGNIFICANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biophysical impacts</td>
<td></td>
</tr>
<tr>
<td>Ash dam and material storage areas</td>
<td>Low</td>
</tr>
<tr>
<td>Waste disposal</td>
<td>Low</td>
</tr>
<tr>
<td>Traffic</td>
<td>Low</td>
</tr>
<tr>
<td>Air quality</td>
<td>Medium (+)</td>
</tr>
<tr>
<td>Use of water resources</td>
<td>Medium (+)</td>
</tr>
<tr>
<td>Fauna and flora</td>
<td>Low (+)</td>
</tr>
<tr>
<td>Socio-cultural/ socio-economic impacts</td>
<td></td>
</tr>
<tr>
<td>Land use</td>
<td>Low (+)</td>
</tr>
<tr>
<td>Noise impacts</td>
<td>Low /Low (+)</td>
</tr>
<tr>
<td>Impact on local economy</td>
<td>Low</td>
</tr>
<tr>
<td>Social behaviour and human health</td>
<td>Low</td>
</tr>
<tr>
<td>Safety</td>
<td>Low</td>
</tr>
</tbody>
</table>
## Table 20: Detailed assessment of identified impacts

<table>
<thead>
<tr>
<th>Potential construction phase impacts</th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>Without Mitigation</td>
<td>With Mitigation</td>
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</tbody>
</table>

### Biophysical impacts

(a) Impact of emissions to air on human health, fauna and flora

Construction activities are likely to result in an increase in particulate matter emissions. This impact is however limited to the construction phase and can be successfully mitigated through the implementation of the Environmental and Social Management Plan (ESMP).

(b) Loss of vegetation and habitat

Establishment of the site will result in the removal of vegetation and the permanent loss of habitat in some areas. The significance of this impact is however reduced because the sandveld habitat is not a conservation priority, and there is the ability to mitigate the impact by ensuring that development takes place in low impact areas and by limiting the size of the development footprint.
## Potential construction phase impacts

<table>
<thead>
<tr>
<th>Potential construction phase impacts</th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
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<tbody>
<tr>
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<td></td>
<td>Without Mitigation</td>
<td>With Mitigation</td>
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</tr>
<tr>
<td>(c) Loss of grazing due to man-made fires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Communal grazing areas may be lost to man-made fires especially during the construction phase when construction workers are likely to use fires for energy. This impact can however be mitigated through measures such as the restriction of fires to the construction camp area, creation of a firebreak around the construction camp and training of workers during induction.</td>
<td>Local</td>
<td>Short-term</td>
<td>Low</td>
<td>Probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>(d) Disturbance of wildlife</td>
<td></td>
<td></td>
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<td></td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Construction activity could potentially affect the movements of domestic and wild animals. Due to high mobility of fauna and the fact that there are no known faunal species of high conservation priority in the area, this impact is of low significance.</td>
<td>Local</td>
<td>Short-term</td>
<td>Medium</td>
<td>Highly Probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
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</table>
### Potential construction phase impacts

<table>
<thead>
<tr>
<th>Potential construction phase impacts</th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
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</thead>
<tbody>
<tr>
<td>(e) Impact of spillages of chemicals, petrochemicals and hydrocarbons on water resources</td>
<td>Local</td>
<td>Short-term</td>
<td>Low</td>
<td>Probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Refuelling on site and the use of fuel driven machinery could potentially increase the risk of hydrocarbon spillage on site. Spillages of oils and other liquid pollutants including cement may leach through soils into the groundwater. Given that this impact is short-term in duration and that it could be easily mitigated by the implementation of a construction phase ESMP, this impact is considered to be of low significance.</td>
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<tr>
<td>(f) Erosion and sedimentation</td>
<td>Local</td>
<td>Short-term</td>
<td>Low</td>
<td>Probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Removal of vegetation during clearing operations could potentially render the ground surface susceptible to erosion by wind and water. Erosion of soil would be of concern around stockpile areas and on steep slopes and sedimentation of adjacent watercourses (during the rainy season) could occur. Given the low rainfall in the area and the distance to watercourses, this impact is of low concern.</td>
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<tr>
<td>Potential construction phase impacts</td>
<td>EXTENT</td>
<td>DURATION</td>
<td>INTENSITY</td>
<td>PROBABILITY</td>
<td>SIGNIFICANCE</td>
<td>STATUS</td>
<td>CONFIDENCE</td>
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<tr>
<td>(g) Litter</td>
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<td></td>
<td>Without Mitigation</td>
<td>With Mitigation</td>
<td></td>
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<tr>
<td></td>
<td>Local</td>
<td>Short-term</td>
<td>Low</td>
<td>Probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
</tbody>
</table>

The potential effects of litter on the biophysical environment would be minimal. It would however represent more of an impact on the aesthetics of the area than a pollution threat. Given that this impact could be easily mitigated by the implementation of a construction phase ESMP and “good housekeeping” practice, and owing to its temporary nature, this impact is considered to be of low significance.
<table>
<thead>
<tr>
<th>Potential construction phase impacts</th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(h) Traffic</td>
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</tr>
<tr>
<td>Construction vehicles would have to make use of the public roads, to access the site. This could potentially cause temporary inconvenience to users as well as wear and tear on dirt roads used. The presence of large vehicles, as well as movements onto and off of public roads could impact negatively on traffic flow in the area. This impact is of a temporary nature, and given that proper planning could ensure the erection of adequate warning signage and the use of construction vehicles on public roads outside of peak traffic flow, this impact is considered to be of low significance.</td>
<td>Local</td>
<td>Short-term</td>
<td>Low</td>
<td>Improbable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
</tbody>
</table>
### Socio-economic impacts

#### (a) Loss of arable lands and grazing during site establishment

The proposed development area which belongs to BPC is currently used by surrounding communities for grazing of their livestock. This grazing land will no longer be available once site establishment begins. Limiting the development footprint and ensuring communication with local communities will mitigate this impact.

<table>
<thead>
<tr>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Probability</th>
<th>Significance</th>
<th>Status</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Highly Probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
</tbody>
</table>

#### (b) Social behaviour and human health

Construction activities can disrupt social patterns within communities. Human health impacts from diseases like HIV/AIDS can also occur as a result of a change in social dynamics. Sourcing labour from local communities and limiting the degree to which normal social patterns are disrupted can reduce the significance of the impact. Ongoing education during the construction process can also assist in limiting the probability of this impact.

<table>
<thead>
<tr>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Probability</th>
<th>Significance</th>
<th>Status</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Short-term</td>
<td>Medium</td>
<td>Probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
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</table>

#### (c) Security

The presence of labourers in the area could potentially pose a security risk. Furthermore, criminals may capitalise on the increased movement and anonymity created by the

<table>
<thead>
<tr>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Probability</th>
<th>Significance</th>
<th>Status</th>
<th>Confidence</th>
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</thead>
<tbody>
<tr>
<td>Local</td>
<td>Short-term</td>
<td>Low</td>
<td>Improbable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
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</tbody>
</table>
### Potential construction phase impacts

<table>
<thead>
<tr>
<th></th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
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<td></td>
<td>W/O Mitigation</td>
<td>With Mitigation</td>
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<tr>
<td>construction activities to carry out criminal activities in the area. This impact is of a temporary nature and improbable, and accordingly is considered to be of low significance.</td>
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<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>(d) Aesthetics/ Visual</td>
<td></td>
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<tr>
<td>The presence of earthmoving equipment and machinery as well as construction operations (trenches, stockpiles, labourers and general construction activities) could detract from the rural aesthetics of the area. This impact is of a temporary nature, and accordingly is considered to be of low significance.</td>
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<td>Low</td>
<td>Low</td>
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<tr>
<td>(e) Safety</td>
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<tr>
<td>The presence of open excavations during construction would pose a safety hazard to people and animals, as there is a risk of falling into the open trenches. Large vehicles and earthmoving equipment operating on site and using public roads could also pose a risk. Through good site management and barricading of excavations, and considering its temporary nature, this impact is considered to be of low significance.</td>
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<td>Low</td>
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</table>
### Potential *construction* phase impacts

<table>
<thead>
<tr>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Probability</th>
<th>Significance</th>
<th>Status</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional</td>
<td>Long-term</td>
<td>Low</td>
<td>Highly probable</td>
<td>Medium</td>
<td>Mitigation</td>
<td>High</td>
</tr>
<tr>
<td>(f) Impact on social fabric of town</td>
<td></td>
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</tbody>
</table>

The project is likely to result in an influx of workers (estimated 1000-1500 during construction) and job seekers to the area during both the construction and operational phase. The majority of workers are likely to be males and this can create a number of negative social impacts in the host community. If mitigation measures are effectively implemented, the potential impacts associated with the influx of construction workers from outside the area can be mitigated to some extent. However, this will not stop the in-migration of job seekers to the area. The influx of workers and job seekers will also result in additional spending in the local economy and will thus have a positive socio-economic impact.

### Impact on employment / temporary employment opportunities

During construction there would be a need for labour, which should preferably be sourced from the local community. Any opportunity to create additional employment, even if it is temporary employment, is regarded as a significant positive impact. This was confirmed by the feedback from all of the interest groups interviewed (local government departments, farmers and businesses).
### Potential construction phase impacts

<table>
<thead>
<tr>
<th>Potential construction phase impacts</th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
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</thead>
<tbody>
<tr>
<td>(h) Archaeological impacts</td>
<td></td>
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</tr>
<tr>
<td>No archaeological sites were identified within the proposed development area. It is however possible that archaeological remains will be unearthed during construction activities. Implementation of archaeological monitoring during construction will mitigate this impact.</td>
<td>Local</td>
<td>Permanent</td>
<td>Medium</td>
<td>Highly probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>(i) Noise impact during construction</td>
<td></td>
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<tr>
<td>A number of additional noise sources are likely during the construction phase. The duration of this impact is however short-term and is likely to only occur during daytime when higher noise levels are considered to be acceptable. Worst-case prediction of noise levels during the construction phase by the noise specialist indicated an acceptable noise level in terms of international noise standards. The monitoring of noise levels during construction will be necessary.</td>
<td>Local</td>
<td>Short-term</td>
<td>Low</td>
<td>Probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
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<tr>
<td>(j) Impact on business opportunities</td>
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</tr>
<tr>
<td>A percentage of the total wage bill will be spent in the local economy and this will create additional opportunities for local businesses. The local economy will benefit from the injection of capital associated with the construction phase of the Project.</td>
<td>Regional</td>
<td>Short-term</td>
<td>Medium</td>
<td>Highly probable</td>
<td>High</td>
<td>High (+)</td>
<td>Positive</td>
</tr>
<tr>
<td>Potential <em>construction</em> phase impacts</td>
<td>EXTENT</td>
<td>DURATION</td>
<td>INTENSITY</td>
<td>PROBABILITY</td>
<td>SIGNIFICANCE</td>
<td>STATUS</td>
<td>CONFIDENCE</td>
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<td></td>
<td>W/O Mitigation</td>
<td>With Mitigation</td>
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<tr>
<td>(k) Impact on Serowe Landfill</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
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</table>

The construction phase is likely to produce construction waste which will need to be disposed at the nearest registered landfill site, which is the Serowe Landfill. Although the amount of waste to be disposed cannot be quantified at this time, the disposal of waste at this landfill will reduce the airspace of the landfill. This impact is considered to be of low significance because of the ability to segregate and recycle waste as part of a waste management plan. In addition, the Serowe Landfill has significant airspace available.
### Potential operational phase impacts

<table>
<thead>
<tr>
<th>Potential operational phase impacts</th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biophysical impacts</strong></td>
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<td></td>
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</tr>
<tr>
<td>(a) Groundwater depletion and drawdown</td>
<td>Regional</td>
<td>Long-term</td>
<td>High</td>
<td>Highly probable</td>
<td>High</td>
<td>High</td>
<td>Negative</td>
</tr>
<tr>
<td>Large quantities of water are needed for the proposed development. Investigations on the availability of a sustainable supply of this water and the impact this will have on existing water users are still ongoing. The uncertainty in this regard requires that this impact be assigned a high significance pending the outcome of the EIA for the groundwater investigation.</td>
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<tr>
<td>(b) Habitat loss from coal dust dispersal</td>
<td>Local</td>
<td>Medium-term</td>
<td>Low</td>
<td>Improbable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Windblown coal dust from the coal storage areas and general operations may impact on vegetation growth downwind of the power plant. The proposed measures for suppressing the coal dust will however mitigate this impact.</td>
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<tr>
<td>(c) Impact of high SO(_2) levels on agriculture</td>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Improbable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>High SO(_2) levels may impact upon grass and crop productivity (<a href="#">Appendix 4.2</a>). The air quality impact assessment indicated that the current highest daily averaged SO(_2) ground level concentrations in the region exceed the international limits for agricultural crops. The Morupule B Power Station will further increase</td>
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<tr>
<td>Potential operational phase impacts</td>
<td>EXTENT</td>
<td>DURATION</td>
<td>INTENSITY</td>
<td>PROBABILITY</td>
<td>SIGNIFICANCE</td>
<td>STATUS</td>
<td>CONFIDENCE</td>
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<tr>
<td>SO₂ concentrations albeit marginally in comparison with the existing SO₂ concentrations. The installation of additional SO₂ pollution abatement equipment to the existing Morupule Power Station such that the limits are complied with will effectively mitigate this impact but this has not been considered in this significance assessment. A low confidence level is assigned to this impact because of the lack of research on the impact of SO₂ emissions on the site-specific agricultural activities.</td>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Improbable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>(d) Impact of high SO₂ levels on sensitive habitats</td>
<td>A loss of species diversity on outcrops in the Colliery lease area and the Palapye ridge may occur due to elevated SO₂ emissions. This impact may be mitigated through the installation of SO₂ pollution abatement equipment to the existing Morupule Power Station. A low confidence level is assigned to this impact because of the lack of research on the impact of SO₂ emissions on vegetation indigenous to Botswana.</td>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Improbable</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>(e) Impact of NO₂ emissions on human health</td>
<td>Human respiratory tract irritation represents a direct effect of exposure to NO₂ (<a href="#">Appendix 4.3</a>). The predicted average hourly, daily and annual concentrations complied with the</td>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Probable</td>
<td>Medium</td>
<td>Low</td>
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<tr>
<td>Potential operational phase impacts</td>
<td>EXTENT</td>
<td>DURATION</td>
<td>INTENSITY</td>
<td>PROBABILITY</td>
<td>SIGNIFICANCE</td>
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<td>CONFIDENCE</td>
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<tr>
<td>Botswana ambient air quality guidelines.</td>
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<tr>
<td>The average hourly WB limit was predicted to be exceeded but only on-site with all sensitive receptor areas in compliance with all limits.</td>
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<tr>
<td>(f) Impact of NO\textsubscript{x} emissions on vegetation</td>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Probable</td>
<td>Medium</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Direct exposure to NO\textsubscript{x} may cause growth inhibitions in some plants (Appendix 4.3). The predicted ground level NO\textsubscript{2} concentrations were well below the European Union (EU) guideline for protection of vegetation and this impact is thus considered to be of low significance after mitigation.</td>
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<tr>
<td>(g) Impact of PM10 emissions on human health</td>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Probable</td>
<td>Medium</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Fine suspended particles are able to be deposited in, and cause damage to the lower airways and gas-exchange portions of the lungs (Appendix 4.3). PM10 concentrations were predicted to exceed the daily average and annual average Botswana and World Bank Group limits. The impact has been assessed to be of low significance after mitigation because of the near-field extent of the impact and the ability to mitigate the contribution of fugitive dust sources through the ESMP.</td>
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</table>
### Potential operational phase impacts

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<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
<th>W/O Mitigation</th>
<th>With Mitigation</th>
</tr>
</thead>
</table>

#### (h) Human health impacts from SO\(_2\) emissions

SO\(_2\) is an irritant. Exposure to excessive concentrations of this gas has side effects that include coughing, chest discomfort and bronchitis. Highest hourly SO\(_2\) concentrations as predicted in the air quality impact assessment are exceeded both on-site and at Palapye (approximately 5 km away). The majority of these high emissions are as a result of the existing Morupule Power Station. This impact may however be mitigated through the installation of SO\(_2\) pollution abatement equipment to the existing Morupule Power Station but this has not been considered in the significance assessment.

| Regional | Long-term | Medium | Highly probable | Medium | High | Negative | Medium |

#### (i) Impact of ash waste stream on soil and groundwater

The fly ash waste stream has high sulphate and calcium loadings in the leachate as well as other potential trace elements. This leachate can impact on the soil and groundwater. The waste product also remains on site after the lifetime of the plant and the impact is thus long-term in duration. The lining of the ash dam and the reuse of the slurry water will mitigate this impact.

<p>| Regional | Long-term | High | Highly probable | Medium | Low | Negative | High |</p>
<table>
<thead>
<tr>
<th>Potential operational phase impacts</th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
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<tr>
<td>(j) Impact of water reuse</td>
<td>Regional</td>
<td>Long-term</td>
<td>Medium</td>
<td>Highly probable</td>
<td>Low</td>
<td>Medium (+)</td>
<td>Positive</td>
</tr>
<tr>
<td>Reuse of treated water from the evaporation ponds will be a substantial resource for the power station and save resources being drawn from the Paje Wellfield. The reuse of the slurry water will also reduce raw water usage.</td>
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<tr>
<td>(k) Impact of coal storage on soil and groundwater</td>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Probable</td>
<td>Medium</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Contaminated stormwater runoff from the coal storage areas may have a high sulphate and hardness (CaCO$_3$) leachate potential. This impact is of long-term duration. The proposed stormwater system to be designed to collect runoff from the coal storage area will mitigate this impact.</td>
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<tr>
<td>(l) Global warming</td>
<td>National</td>
<td>Long-term</td>
<td>High</td>
<td>Highly probable</td>
<td>High</td>
<td>High</td>
<td>Negative</td>
</tr>
<tr>
<td>Botswana’s per capita contribution to global warming is set to increase substantially should the proposed project proceed. This may have socio-political implications in the future in terms of the UNFCCC.</td>
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<tr>
<td>Potential operational phase impacts</td>
<td>EXTENT</td>
<td>DURATION</td>
<td>INTENSITY</td>
<td>PROBABILITY</td>
<td>SIGNIFICANCE</td>
<td>STATUS</td>
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<tr>
<td>Socio-economic</td>
<td></td>
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<td></td>
<td>W/O Mitigation</td>
<td>With Mitigation</td>
<td></td>
</tr>
<tr>
<td>(a) Impact on visual “sense of place”</td>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Highly probable</td>
<td>Medium</td>
<td>Low</td>
<td>Negative</td>
</tr>
</tbody>
</table>

The Morupule B Power Station will not affect the “sense of place” as the proposed infrastructure is similar to the infrastructure already in place at the site.

(b) Impact of increased emissions on surrounding land use and planning

The air quality impact assessment indicated that the existing airshed is polluted to the point where local and international air quality limits for some parameters have been exceeded. The Morupule B Power Station is predicted to increase concentrations of these pollutants. The degraded airshed may have the impact of land use restriction around the power station and thus prevention of the establishment of other industries and job creation potential from these industries. This impact is considered to be of high significance unless mitigation of emissions from the current Morupule Power Station is implemented.
### Potential **operational** phase impacts

<table>
<thead>
<tr>
<th>Impact Description</th>
<th>Potential Impact</th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(c) Impact on Botswana’s energy supply</td>
<td>The increased supply security will have an important positive impact on the country’s economy, especially the mining industry which is currently the greatest energy user in Botswana. Individual power users in the country may also be impacted upon positively if the cost of power provision can be achieved through this project at a lower cost than power importation.</td>
<td>National</td>
<td>Long-term</td>
<td>High</td>
<td>Definite</td>
<td>High</td>
<td>Positive</td>
<td>Medium</td>
</tr>
<tr>
<td>(d) Impact of Morupule B on power tariffs</td>
<td>The capital cost incurred in constructing the Morupule B Power Station is likely to result in an increase in electricity costs.</td>
<td>National</td>
<td>Short-term</td>
<td>Low</td>
<td>Probable</td>
<td>Medium</td>
<td>Negative</td>
<td>Medium</td>
</tr>
<tr>
<td>(e) Manpower needs/job creation</td>
<td>The Morupule B Power Station will have a positive impact on job creation, as additional employees will be needed. However, the potential local employment opportunities associated with the proposed development may be somewhat reduced by the shortage of appropriate skills levels in the area. This impact is considered of medium significance given the relatively low number of skilled jobs likely to be filled by local residents during the operational phase.</td>
<td>Local</td>
<td>Long-term</td>
<td>Medium</td>
<td>Highly probable</td>
<td>Medium</td>
<td>Positive</td>
<td>High</td>
</tr>
</tbody>
</table>
### Potential operational phase impacts

<table>
<thead>
<tr>
<th>Impact Description</th>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Probability</th>
<th>Significance</th>
<th>Status</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>(f) Impact on business opportunities</td>
<td>Regional</td>
<td>Long-term</td>
<td>Medium</td>
<td>Highly probable</td>
<td>High</td>
<td>Positive</td>
<td>High</td>
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<tr>
<td>The operational phase of the power station will create opportunities for local</td>
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<tr>
<td>business in Palapye. The majority of these opportunities are likely to be linked to</td>
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<td>the retail and service industry, such as cleaning, security, catering etc.</td>
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<tr>
<td>The local hospitality industry is also likely to benefit during the operational</td>
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<td>phase.</td>
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<tr>
<td>(g) Noise impact on surrounding communities</td>
<td>Local</td>
<td>Long-term</td>
<td>Medium</td>
<td>Highly probable</td>
<td>Medium</td>
<td>Low</td>
<td>Negative</td>
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<tr>
<td>The land-use study indicated that there were 16 homesteads within the</td>
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<td>predicted 40dBA noise contour area (<a href="#">Appendix 4.2</a>). These households are</td>
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<td>currently exposed to an ambient noise level of between 35.2dBA (2500 m from the</td>
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<td>site) and 38.2dBA (2000 m from the site). With the Morupule B Power Station, the</td>
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<td>predicted noise profile at this distance is expected to increase to between</td>
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<tr>
<td>39.1dBA (2500 m from the site) – 41.9dBA (2000 m from the site). This is an</td>
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<td>approximate increase in noise of between 3.7dBA and 3.9dBA. Appendix A of the</td>
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<td>noise impact assessment indicates that an increase in noise of 3dBA is just</td>
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<td>detectable. The introduction of mitigation measures to reduce noise from the</td>
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<td>power station is, according to the noise impact assessment, expected to mitigate</td>
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<td>this impact to an impact of low significance.</td>
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</tbody>
</table>
**Note:** A closure plan for the Morupule B Power Station has not been compiled at this time and it is therefore not possible to assess the decommissioning phase impacts against this plan. The impacts that have been assessed below are generic for coal-fired power stations and provide a reasonable indication of the likely significance of the impacts associated with this phase of the development.

<table>
<thead>
<tr>
<th>Potential decommissioning phase impacts</th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
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<tbody>
<tr>
<td><strong>Biophysical impacts</strong></td>
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<tr>
<td>(a) Ash dam and material storage areas</td>
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<tr>
<td>The ash dam will remain on site after the lifetime of the plant. With appropriate design of the ash dam and rehabilitation, post-closure pollution can be avoided. The visual impact of the ash dam is, as a result of the gentle topography of the area, likely to persist in the long-term. Material storage areas, such as the coal storage area, will be rehabilitated through the removal of as much material as possible and appropriately re-vegetated.</td>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Highly probable</td>
<td>Medium</td>
<td>Low</td>
<td>Negative</td>
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<tr>
<td>Potential <em>decommissioning</em> phase impacts</td>
<td>EXTENT</td>
<td>DURATION</td>
<td>INTENSITY</td>
<td>PROBABILITY</td>
<td>SIGNIFICANCE</td>
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<tr>
<td>(b) Waste disposal</td>
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<tr>
<td></td>
<td>Regional</td>
<td>Medium-term</td>
<td>Medium</td>
<td>Highly probable</td>
<td>Medium</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Although a closure plan has not been compiled as yet, it is expected that all infrastructure will be removed or buried if appropriate. Large amounts of waste material are likely to be generated at this time and disposal of this waste will have an impact on regional landfill airspace and may have a pollution impact if landfill airspace is not available. A waste management plan within the closure plan that considers the segregation and recycling of materials will mitigate this impact.</td>
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<tr>
<td>(c) Traffic</td>
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<td></td>
<td>Local</td>
<td>Short-term</td>
<td>Low</td>
<td>Highly probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Traffic will increase significantly during the decommissioning phase as a result of the construction vehicles and machinery needed for the decommissioning activities. Vehicles transporting waste, materials and heavy equipment will impact on other road users. This impact can be mitigated through planning of transportation activities and through the erection of appropriate warning signage.</td>
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<tr>
<td>Potential <strong>decommissioning</strong> phase impacts</td>
<td>EXTENT</td>
<td>DURATION</td>
<td>INTENSITY</td>
<td>PROBABILITY</td>
<td>SIGNIFICANCE Without Mitigation</td>
<td>STATUS</td>
<td>CONFIDENCE</td>
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<tr>
<td>(d) Air quality</td>
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<tr>
<td>Decommissioning of the power station will improve the local air quality. The extent to which this will improve the airshed will depend on the ambient air quality at the time of decommissioning.</td>
<td>Regional</td>
<td>Long-term</td>
<td>Medium</td>
<td>Probable</td>
<td>Medium</td>
<td>Positive</td>
<td>Medium</td>
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<tr>
<td>(e) Use of water resources</td>
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<tr>
<td>The possible rehabilitation of the Paje wellfield after decommissioning will be a positive impact on the availability of groundwater resources in the region.</td>
<td>Regional</td>
<td>Long-term</td>
<td>Medium</td>
<td>Probable</td>
<td>Medium</td>
<td>Positive</td>
<td>Medium</td>
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<tr>
<td>(f) Fauna and flora</td>
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<tr>
<td>A positive impact on fauna and flora is expected after decommissioning has been completed as it is likely that the land will be returned to grazing or wilderness use. Although it will take time for natural populations to move into the area, the long-term impact is positive.</td>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Highly probable</td>
<td>Low (+)</td>
<td>Positive</td>
<td>Medium</td>
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</tbody>
</table>
### Potential impacts decommissioning phase

<table>
<thead>
<tr>
<th></th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
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<tbody>
<tr>
<td>Without Mitigation</td>
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<tr>
<td>With Mitigation</td>
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</tbody>
</table>

### Socio-economic impacts

**(a) Land use**

It is expected that the land will be returned to grazing or wilderness during decommissioning. This will have a positive impact for the tribal authority once the land has been reinstated, as it will provide for additional grazing area.

<table>
<thead>
<tr>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Probability</th>
<th>Significance</th>
<th>Status</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Long-term</td>
<td>Low</td>
<td>Highly probable</td>
<td>Low</td>
<td>Positive</td>
<td>Medium</td>
</tr>
</tbody>
</table>

**(b) Noise impacts**

Noise levels can be expected to increase during the decommissioning phase as dismantling and removal of infrastructure intensifies. Similar to the construction phase, this impact will be limited to daytime and will be short-term in duration. After decommissioning has been completed, noise levels will be significantly lower in the area, hence a combined negative / positive impact.

<table>
<thead>
<tr>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Probability</th>
<th>Significance</th>
<th>Status</th>
<th>Confidence</th>
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</thead>
<tbody>
<tr>
<td>Local</td>
<td>Short-term</td>
<td>Low</td>
<td>Definite</td>
<td>Low</td>
<td>Low / Low (+)</td>
<td>Negative / Positive</td>
</tr>
</tbody>
</table>
### Potential impacts: Decommissioning phase

<table>
<thead>
<tr>
<th>Potential impacts</th>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(c) Impact on local economy</td>
<td>Local</td>
<td>Medium-term</td>
<td>Medium</td>
<td>Probable</td>
<td>Medium</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>In the absence of a social development programme implemented as part of the closure plan, impacts to the local economy may be significant and result in an increase in crime, violence and poverty. The diversification of the local economy and skills development for power station employees through the social development programme will mitigate this impact. In addition, it is likely that by the time closure is considered, Palapye will have a more diversified economy than is currently the case.</td>
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</tr>
<tr>
<td>(d) Social behaviour and human health</td>
<td>Local</td>
<td>Short-term</td>
<td>Medium</td>
<td>Probable</td>
<td>Low</td>
<td>Low</td>
<td>Negative</td>
</tr>
<tr>
<td>Decommissioning activities can disrupt social patterns within communities. Human health impacts from diseases like HIV/AIDS can also occur as a result of a change in social dynamics. Sourcing labour from local communities and limiting the degree to which normal social patterns are disrupted can reduce the significance of the impact. Ongoing education during the decommissioning process can also assist in limiting the probability of this impact.</td>
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</tbody>
</table>
Potential decommissioning phase impacts

<table>
<thead>
<tr>
<th>EXTENT</th>
<th>DURATION</th>
<th>INTENSITY</th>
<th>PROBABILITY</th>
<th>SIGNIFICANCE</th>
<th>STATUS</th>
<th>CONFIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without Mitigation</td>
<td>With Mitigation</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e) Safety</td>
<td></td>
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</table>

Various decommissioning activities would pose a safety hazard to people and animals. Large vehicles and earthmoving equipment operating on site and using public roads could also pose a risk. Through good site management and barricading of excavations and dangerous areas and considering its temporary nature, this impact is considered to be of low significance.
Section 10
Assessment of alternatives

10.1 Project alternatives

Alternatives within the EIA process are regarded as different means of meeting the general purpose and requirements of the originally proposed activity. To ensure that the assessment of alternatives is meaningful, the alternatives proposed must be feasible and have the same principle purpose as the originally proposed activity.

The World Bank’s Pollution Prevention and Abatement Handbook (1998) suggests that the following alternatives be addressed within an EIA for a new thermal power plant:

- Fuels used;
- Power generation technologies;
- Heat rejection systems;
- Water supply;
- Solid waste disposal;
- Plant and sanitary waste discharge;
- Engineering and pollution control equipment; and
- Management systems.

These alternatives are incorporated into the following broad categories of alternatives, each of which is described hereafter:

- Site alternatives;
- Technology alternatives;
- Operational alternatives;
- Design alternatives; and
- The no-project alternative.
10.1.1.1 Site alternatives

The main factors influencing the location of a coal-fired power plant is proximity to a coal resource of suitable quality and an appropriate water supply. Other important factors that influence location include availability of land, environmental suitability, proximity to the market and availability of infrastructure such as roads, railways and telecommunications.

The coal reserve determination study undertaken as part of the project feasibility study (2004) confirmed that sufficient coal reserves exist at the Morupule Colliery for the supply of suitable quality coal to the Morupule B Power Station for the duration of its operational life. The Morupule Colliery is currently the only operating coal mine in Botswana.

The Morupule B Power Station will require an additional 2 million m$^3$ of water per annum (Phase I and Phase II). Groundwater investigations have confirmed that sufficient water is available within the aquifers of the Paje Wellfield and investigations are currently underway to establish the most appropriate manner in which the water resource can be abstracted and utilised.

The feasibility study undertaken in 2004 confirmed the availability of the land for the proposed power station. Although various environmental issues were identified during the Scoping Phase of the EIA, mitigation of impacts to a satisfactory level was considered to be possible.

The existing power station site is well positioned to supply power into the national electricity grid and because there are established transmission and distribution lines, only one additional transmission line is needed. Established road, rail and telecommunications infrastructure is also available on site.

The existing Morupule Power Station site was identified as the only site alternative as it was the only site that complied with the above requirements.

Establishment of the power station at any other location in Botswana would require significant additional infrastructure to be constructed such as roads, rail and the establishment of a new coalmine. Notwithstanding the financial cost associated with this additional infrastructure, the impact to the environment would be significantly greater than the proposed expansion of an existing footprint.

The homogenous characteristics of the environment within the proposed development area is such that the impact of the location of ancillary infrastructure such as roads, wastewater facilities and the ash disposal site will be similar, regardless of the location selected.

For these reasons, no alternative sites have been identified for the proposed power plant.

10.1.1.2 Technology alternatives

A range of technologies exist by which primary energy sources (uranium, water, sunlight, fossil fuels etc.) can be converted into a more convenient form of energy like electricity. These technologies are often categorised into renewable energy technologies and non-renewable energy technologies. Renewable energy technologies make use of a natural resource base which, for all practical purposes, cannot be depleted. Examples of these technologies include wind turbines, solar thermal panels and wave energy converters. Non-renewable energy technologies rely on sources of energy which can ultimately be depleted including fossil fuels and uranium. The proposed Morupule B Power Station is a non-renewable technology.
The various technologies available differ markedly in their generation costs, performance and utilisation characteristics, suitability for the national context and state of commercial development.

The choice of electricity generation technology is multi-faceted and complex and must be conducted within the context of relevant national and international policies, legal requirements and the specific daily, weekly and seasonal variation in demand for electricity.

Both renewable and non-renewable technologies fall into one of the following categories:

- Base-load electricity generation technology; or
- Peaking electricity generation technology.

Base-load electricity generation technologies refer to power stations which are designed specifically to generate electricity continuously over all hours of the day.

In contrast, peaking electricity generation technologies are designed to only generate electricity during periods of high demand for electricity, normally on weekdays from 07:00 to 09:00 and 18:00 to 20:00.

The electricity demand pattern in Botswana requires that a base-load generation technology be considered because a peaking electricity generation technology will only limit the extent to which imported power will be needed at certain times of the day. Although this will assist in reducing reliance on imported power, it will not enable BPC to replace the current 70% reliance on imported power with local generation capability, which is a key strategic objective of this project. Renewable energy technologies such as solar thermal generation and wind energy are peaking generation technologies as they rely on natural conditions which do not exist on a 24-hour basis.

This factor reduces the number of possible generation technology alternatives to the following base-load generation options:

- Bio-energy technologies;
- Hydro-electric technologies;
- Gas turbine technologies;
- Nuclear technologies; and
- Coal-fired technologies.

Other generation options, including decentralised options such as the National Photovoltaic Rural Electrification Programme, are likely to be used in conjunction with an additional base-load generation option. Bio-energy technologies use energy from wood and sugarcane for example to produce a gas in a gasifier, which is then passed through a generator.

The technology is still largely in a research phase and cannot be regarded as proven for use on a large scale, as required by BPC for this project. For this reason, as well as the absence of suitable biomass in Botswana, this alternative is considered unsuitable for further consideration.

Hydro-electric technologies use the energy from the movement of water to generate electricity. No suitable resources for this technology exist in Botswana. New generation capacity from Inga II, a site on the Congo River has been identified for hydro development for the Southern African region as a whole.
It has the potential of generating 40-45 GW. The downside of the project is the remoteness of the supply from any real potential market. Generation and transmission costs can consequently be expected to be very high. This option would also not assist in achieving the general purpose of this project which is to reduce reliance on imported power. For this reason, this alternative is rejected from further consideration.

Combined Cycle Gas Turbine (CCGT) technologies make use of natural gas resources to generate electricity. Suitable natural gas resources have been identified in the coal beds south-east of Botswana on the eastern side of the Kalahari Karoo Basin. Kalahari Energy is currently investigating these methane resources and initial indications are that the available reserves have significant potential as a gas resource for the Southern African region. The project is however considered to be in a pilot phase and will not be able to meet BPC’s timing requirements of commissioning of a power station by 2010.

Various nuclear technologies are currently in use throughout the world. Current research focus is on high-pressure reactors such as the Pebble Bed Modular Reactor (PBMR), which has promising safety features. All nuclear technologies require a source of enriched uranium and a cooling water supply.

Adequate uranium supplies are not known to be available in Botswana and the need to import these resources would again create reliance on importation. Nuclear technologies are thus excluded from further consideration.

Figure 16: Koeberg Nuclear Power Station, South Africa

The only remaining feasible option for a base-load technology is thus a coal-fired plant. A number of alternatives exist for the specific design technology of the coal-fired plant.

These alternatives are discussed in the design category of alternatives.

10.1.1.3 Operational alternatives

The difference between a base-load electricity generation technology and a peaking electricity generation technology has been described in section 4.1.7.1. Peaking electricity generation technologies are only operated at a certain time of the day, typically when electricity demand is the highest. Given Botswana’s need for base-load electricity generation capacity, the Morupule B Power Station must be able to generate electricity throughout the day. No feasible operational alternatives to that proposed are thus identified.
10.1.1.4 Design alternatives

This alternatives category provides a summary of the different technology designs with respect to the power plant, the heat rejection system and pollution control equipment.

Alternative power plant designs

The World Bank Group identifies four kinds of fossil-fuel-based thermal power plants. These are as follows:

- Conventional steam-producing thermal power plants;
- Combined-cycle units;
- Engine-driven power plants; and
- Advanced coal-utilisation technologies.

The existing Morupule Power Station is an example of a conventional steam producing thermal power plant in which the coal is burned in boilers to convert water to high-pressure steam, which is then used to drive a turbine that generates the electricity.

Combined-cycle units include a second turbine which is driven by waste gases from a combustion chamber, resulting in a more efficient system. These plants generally make use of a natural gas resource as the primary energy input from which the electricity is generated. Engine-driven power plants such as the Open-Cycle Gas Turbine (OCGT) designs use fuels such as diesel, oil and gas. These plants are generally limited to a generation capacity of 150 MWe.

Coal-fired Circulating Fluidised Bed Combustion (CFBC) boilers and Integrated Gasification Combined Cycle (IGCC) are examples of advanced coal-utilisation technologies. These technologies offer improved thermal efficiency and in many cases improved environmental performance when compared with conventional thermal power plants.

The proposed Morupule B Power Station intends to make use of either the CFBC boiler design or the Pulverised Coal (PC) boiler design. The CFBC design has the following benefits over conventional thermal power plants:

- Wide range of fuel adaptability which allows for the use of low grade coal, biomass and waste tyres;
- Decreased emissions of NO\textsubscript{x} and SO\textsubscript{x};
- High combustion efficiency; and
- Space saving and improved maintenance ability.

A summary of PC technology with Selective Catalytic Reduction (SCR) for removal of NO\textsubscript{x} and Flue Gas Desulphurisation (FGD) for removal of SO\textsubscript{x} compared with CFBC technology is provided in Table 21.

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Table 21: Comparison between PC and CFBC boiler designs. Source: Alstom (2006).

<table>
<thead>
<tr>
<th>Design technology</th>
<th>SO$_2$ capture mg/Nm$^3$</th>
<th>Ca/S</th>
<th>NO$_x$ emissions mg/Nm$^3$</th>
<th>Operation and Maintenance Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFBC</td>
<td>&gt; 95%</td>
<td>1.0 – 2.5</td>
<td>150-250</td>
<td>Medium</td>
</tr>
<tr>
<td>PC with SCR and FGD</td>
<td>&gt; 95%</td>
<td>1.0</td>
<td>50-100</td>
<td>High</td>
</tr>
</tbody>
</table>

Selecting between PC and CFBC boiler designs is a complex decision and environmental performance is only one criterion which should influence this decision. The results in the table above suggest that the CFBC boiler design is able to achieve a similar environmental performance with respect to gaseous emissions to PC technology with SCR and FGD at a lower operating cost.

**Alternative heat rejection systems**

The proposed Morupule B Power Station will make use of an Air Cooled Condenser (ACC) and Closed Circuit Cooling Water (CCCW) system. This is a so-called dry-cooling heat rejection system. Two other alternatives namely wet-cooling and once-through cooling are also used for thermal power plants. Both once-through cooling and wet-cooling require significantly more water than is the case for dry cooling and because water is scarce within the study area, these alternatives are not considered any further.

**Alternative pollution control designs**

A number of pollution control designs are available to prevent and/or reduce the environmental impact of a CFBC boiler.

These designs can be summarised as follows$^3$:

- Use of cleaner fuels;
- Abatement of particulate matter;
- Abatement of sulphur oxides;
- Abatement of nitrogen oxides;
- Fly ash handling; and
- Water use.

**Use of cleaner fuels**

Besides the use of fuel oil during start-up, the only available fuel source for the proposed power station is coal from the Morupule Colliery.

The quality of the coal can be improved through washing thereof, resulting in less ash and thus improved emissions to atmosphere.

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The washing process itself however has an environmental impact in that it requires additional water. The feasibility study undertaken in 2004 indicated that the expansion of the Morupule Colliery included the addition of a coal washing plant. The supply of coal for the Morupule B Power Station was, at that time, proposed to comprise of a mixture of raw coal, a middlings product from the washing plant and some discard material. Most of the washed coal was proposed to be exported from the colliery. The use of washed coal for the Morupule B Power Station cannot be confirmed at this time. However, the technical design criteria within the tender documents for the project indicate that the design and operation of the plant must take cognisance of the quality specifications of the worst coal (EPC Tender Document, 2006).

This implies that the design of the plant must be able to manage reasonable fluctuations in quality without the technical and environmental performance of the plant being affected. The quality of the coal supply from the colliery is understood to be subject to contractual agreement between BPC and the Morupule Colliery and sampling will be undertaken on a regular basis to ensure that the quality specifications are met. Notwithstanding the above, the washing of coal remains an alternative which should be considered by BPC throughout the operational life of the plant.

Abatement of particulate matter

The Morupule B Power Station proposes the use of cyclones for pre-cleaning followed by baghouses for the removal of particulate matter of all size fractions. Electrostatic Precipitators (ESPs) are often used as an alternative to baghouses. Both baghouses and ESPs, when correctly designed and maintained, are effective at removing up to 99.9 % of particulate matter (World Bank Group, 1998).

Although ESPs are considered to be less sensitive to variations in operational parameters such as maximum temperature and pressure drops, baghouses have an important advantage in that they enhance the removal of sulphur oxides when sorbent injection is utilised, which is the case for the Morupule B Power Station. Further assessment of these two alternatives is not considered, as their removal efficiency is the same.

Abatement of sulphur oxides

The abatement of sulphur oxides (SO\(_x\)) is proposed to be achieved in the Morupule B Power Station by adding pulverized limestone to the coal within the boiler. This process results in the removal of the sulphur for capture in the baghouse and subsequent removal to the ash pond.

Flue-Gas Desulphurisation (FGD) is an alternative consisting of dedicated SO\(_x\) absorbers that have a removal efficiency of 70-95% (World Bank Group, 1998). This removal efficiency is higher than what can be achieved with sorbent injection and removal with a baghouse. The costs of FGD are however significantly higher because of the power requirements of the units, the chemicals used and the residues to be disposed of. The current specifications for the design of the plant requires the removal of sulphur oxides to a level not exceeding the maximum emissions level of the World Bank (1998), which is 500 tons per day. FGD should only be considered if this is not possible as the introduction of FGD is likely to increase the amount of ash disposed of to the ash pond together with a possible increase in the amount of slurry water needed. This may result in a reduction in the life of the ash pond and the consequent need to construct a second ash pond with a greater footprint than originally intended.
Abatement of nitrogen oxides

Abatement of nitrogen oxides (NO\textsubscript{x}) is achieved by modifying combustion conditions, Selective Catalytic Reduction (SCR) or Selective Non-Catalytic Reduction (SNCR). As is the case with the SO\textsubscript{x} emissions, it is a design requirement that the Morupule B Power Station comply with the maximum NO\textsubscript{x} emission levels of the World Bank Group. It is proposed that this will be done through the most cost-efficient method, namely combustion modification. Should the NO\textsubscript{x} reduction not be possible with combustion modification alone, then SNCR should be investigated. SCR is not considered to be feasible as the sulphur content of the coal from the Morupule Colliery is likely to exceed 1.5 %, a level at which the catalyst elements of the SCR become impaired (World Bank Group, 1998).

Fly ash handling

Dry (10-20 % moisture) and wet (> 20% moisture) ash handling systems are recognised. The Morupule B Power Station proposes the use of a wet ash handling system together with a recovery water system to be reused as slurry water. Dry ash will however also be managed which, as with the existing power plant, will be provided to the cement industry for use in the production of clinker.

Water use

Various options exist for ensuring water reuse and water conservation. These options include the use of evaporative recirculating cooling systems, siting of intakes and outfalls, use of biocides and anticorrosion chemicals and the control of discharge temperatures. These measures are not true alternatives of one another and should be implemented concurrently where feasible. The most significant water conservation measure for the proposed Morupule B Power Station is the recovery and reuse of water from the ash ponds.

10.1.1.5 The no-project alternative

The no-project alternative implies that BPC continues to import power from neighbouring countries. The benefits of this alternative are that most of the negative impacts associated with the proposed development option will be prevented. In particular, the following negative impacts of medium and high significance will be prevented by the implementation of the no-project alternative:

- Impact on social fabric of the town;
- Impact of increased emissions on surrounding land use and planning;
- Impact of Morupule B on power tariffs;
- Human health impacts from SO\textsubscript{2} emissions;
- Groundwater depletion and drawdown; and
- Global warming.

Prevention of the above impacts will have a significant ecological, social and economic benefit.

Notwithstanding the significant job creation potential and positive opportunities for local business, the largest cost of not proceeding with the project is that the positive impacts of the development option on Botswana’s energy supply will not be realised. Some of the possible consequences associated with this cost are as follows:
• Reduced power supply quality and quantity in Botswana in the medium to long-term until the power situation in the SADC region has stabilised;

• Reliance on imported power with its associated socio-political risks and high financial cost;

• Reduced investor confidence in Botswana because of uncertainty with respect to a reliable energy supply (especially in the manufacturing and production sector);

• Loss of employment opportunities associated with the Morupule B Power Station and potential retrenchment of BPC staff in order to cover the high financial cost of imported power;

• Ecological damage as cheaper alternative energy sources (e.g. wood, coal) are used if electricity tariffs become too high or if supply quality or quantity is unsatisfactory; and

• Ongoing reliance on the power availability in other countries as a determining factor for further economic growth in Botswana.

The above simplistic cost/benefit comparison demonstrates that whichever alternative is selected, there are likely to be ecological, social and economic consequences.

The potential for mitigation of consequences may be used as a criterion for determining which of the two alternatives is the preferred alternative. By applying this principle, it is reasonable to deduce that mitigation of the development alternative impacts has greater potential than mitigation of the no-project alternative. This is based on the rationale that through the use of technologies to reduce air pollution at the existing power plant, most if not all impacts could be mitigated to an acceptable level.

The mitigation of the impacts associated with the no-project alternative is however largely reliant on multilateral negotiations and political stability within the region. For this reason, the proposed development option, with the recommended mitigation measures, is considered to be the preferred alternative.
Section 11
Conclusions and recommendations

11.1 Conclusions

This ESIA has been compiled in accordance with Section 10 of the EIA Act and with due consideration of international best practice including the requirements of the World Bank Group. The biophysical, socio-economic and socio-cultural impacts of the development have been assessed and mitigation measures for all identified impacts have been proposed. The main conclusions from the ESIA are summarised below:

1. The specialist studies in hydrogeology, social impact, archaeology and noise did not identify any negative impacts of high or medium significance which could not be satisfactorily mitigated through the implementation of the ESMP;

2. The stakeholder engagement process indicated that the proposed project was generally welcomed by stakeholders and viewed as a good investment for the country;

3. The per capita carbon emission rate for Botswana, based on findings within the ecological and land use specialist study, was identified as an impact of high significance. The findings indicate that with Phase I of the Morupule B Power Station, Botswana’s per capita CO$_2$ emissions will increase to 8.7 tons per year, which is slightly above the world average. This impact must however be considered with due regard to Botswana’s status as a developing nation as well as its relatively low population density. The impact is identified within this report because of the importance of global warming and its agreed contribution to global climate change. The impact is a socio-political impact, rather than a social or ecological impact;

4. The impact of SO$_2$ concentrations on human health was considered to be of high significance. SO$_2$ concentrations which exceed the Botswana and World Bank Group ambient air quality limits are predicted to occur with the highest ground level concentration predicted to be at approximately 800 m west of the existing Morupule Power Station. The Botswana and WBG guidelines for ambient SO$_2$ concentrations at Palapye and Serowe were not predicted to be exceeded;

5. Given the three stack height scenarios modelled (i.e. 150 m, 200 m and 300 m) it can be concluded that an increase in stack height will not result in significant changes to predicted SO$_2$ ground level concentrations. This is due to the elevated background SO$_2$ concentrations. For this reason, increasing the proposed Morupule B Power Station stack height beyond 150 m is considered to have an insignificant impact on emission reduction at ground level. However, in isolation from the existing Morupule Power Station emissions, a 200 m stack height is predicted to result in a 26 % decrease in maximum ground level SO$_2$ concentrations. It is concluded that both the 200 m and 300 m stack height options for the Morupule B Power Station will have a significant positive impact on ambient emission concentrations but only once the existing Morupule Power Station has been decommissioned or if emissions are reduced from the latter;
6. Predicted NO$_2$ concentrations complied with all relevant emission limits;

7. PM10 emissions are predicted to increase significantly as a result of the Morupule B Power Station, however these emissions are considered to be near-field to the source and can be effectively mitigated through the implementation of the ESMP;

8. The assessment of alternatives to the proposed development option concluded that the development of the proposed Morupule B Power Station, with the recommended mitigation measures, is considered to be the preferred alternative. It is recognised that the Morupule B Power Station will have an impact on the environment, however the impact of not proceeding with the development is considered to be of greater significance.

### 11.2 Recommendations

Recommendations by various parties including stakeholders, the EIA project team and the various specialists have been summarised in the text below. Where possible, all recommendations have been incorporated into specific mitigation measures within the ESMP (Appendix 6).

1. The proposed Morupule B Power Plant should be designed to be in compliance with the World Bank Group emission limits for new thermal power plants;

2. Rehabilitation and mitigation of fugitive dust emissions must be continuous throughout the life of the project in order to result in the minimal effort to apply final rehabilitation strategies. The following mitigation measures are recommended for PM10 control:
   2.1 Chemical suppressants should be applied to unpaved roads and access roads to control emissions from vehicle entrainment on unpaved roads. For unpaved haul roads on the plant site it is recommended that dustfall in the immediate vicinity of the road perimeter be less than 1,200 mg/m$^2$/day;
   2.2 The vegetation cover on the walls of the ash dump should be such to ensure at least 80% control efficiency for the walls. The surface areas should be kept wet, if feasible. Dustfall immediately downwind of the site must be limited to <1 200 mg/m$^2$/day;
   2.3 Topsoil piles and the storage pile for overburden materials should be vegetated completely to ensure as little as wind disturbance of these areas as possible; and
   2.4 Based on the increase in particulate emissions due to the proposed operations, it is recommended that a dust fallout network be designed for the site in accordance with the specifications in the ESMP.

3. Flue Gas Desulphurisation (FGD) as a control option for SO$_2$ emissions should be considered for the new power plant if the PC boiler design is selected;

4. Given that the existing power plant contributes up to 74% to the predicted SO$_2$ concentrations, it is recommended that additional studies be commissioned by BPC to investigate the feasibility of installing pollution abatement equipment for SO$_2$ emissions at the existing Morupule Power Station;

5. The impact of SO$_2$ emissions on vegetation indigenous to Botswana is unknown. Monitoring of vegetation downwind of the power plant is recommended so that any impacts can be identified and mitigated;
6. It is recommended that the stack height of the Morupule B Power Station be either 200 m or 300 m high unless the cost associated with either of these stack heights proves to be excessive;

7. An online stack monitor must be implemented at the boiler stack to measure SO2 and NOx emissions;

8. Isokinetic stack sampling should be conducted at all the remaining point sources at least once a year. This is to ensure that the dust collectors are working according to design specifications;

9. A new ambient air quality monitoring station inclusive of a meteorological station must be installed at the Morupule B Power Station. It is recommended that this ambient station is calibrated at least once every six months to ensure accurate and continuous data capturing;

10. Archaeological monitoring must be undertaken during site clearance especially in the area of the rubble dumps and the developer must immediately inform the Botswana National Museum should they encounter anything of archaeological significance;

11. As part of the monitoring programme, a brief survey for rare and endangered plants in the area exposed to SO2 levels in excess of the national air quality objectives should be undertaken after the rainy season;

12. The Land Board and land use planners must be made aware of the power station impact zones in terms of air quality. This will allow for suitable land allocation and planning;

13. The ash dam and all coal storage areas should have an enclosed drainage system to facilitate the reuse of the water;

14. The drainage of surface water off site in the case of high intensity rainfall should be addressed in the design of the new power plant. It is recommended that all surface water and roof and car park run off be collected for reuse on the site. The retention of stormwater on site will remove the pathway for contaminants off site and the stored water can be reused back in the plant;

15. Storage of hydrocarbons and chemicals will require proper spillage and leakage protection. Bunds and the use of leakage detectors are considered vital for such storage areas (tanks, etc);

16. Additional monitoring boreholes to the four boreholes currently on site may need to be drilled to monitor any potential deterioration in groundwater quality. These should encircle the site both upstream and downstream of the site;

17. Once the final design details of the planned power station are known, the parameters, which directly affect the calculations made in the noise impact study, should be checked and validated. If necessary, the calculations should be redone and the noise impact checked;

18. Various measures to reduce the potential noise impact from the planned power station are possible and should be incorporated into the design of the plant. The noise mitigating measures will need to be designed and/or checked by an acoustical engineer in order to optimise the design parameters and ensure that the cost/benefit of the measure is optimised;

19. At commissioning, the noise footprint of the planned power station should be established by measurement in accordance with the relevant standards, namely
SANS ISO 8297:1994 and SANS 10103. The character of the noise (qualitative aspect) should also be checked to ascertain whether there is any nuisance factor associated with the operation;

20. A closure plan and social development programme must be developed from mid-life of the Morupule B Power Station and annually updated by the Morupule B Power Station plant owner;

21. A database of local firms that qualify as potential service providers for post EPC tender award services (construction companies, catering companies, waste collection companies etc) should be developed. These companies should be notified of and invited to bid for project related work;

22. Where necessary, firms should be assisted and or capacitated to enable them to fill in and submit the required tender forms and fulfil contracts for post EPC tender award services;

23. The local chamber of business and hospitality industry should identify strategies aimed at maximizing the potential benefits associated with the Project;

24. Where necessary an induction programme for construction workers should be initiated prior to the commencement of the construction phase;

25. A formal structure (e.g. liaison committee) should be set up between contractors and the local authorities and adjacent landowners to ensure cordial relations and to address conflicts that may arise;

26. Farms must be compensated in full for any stock losses and or damage to farm infrastructure that can be positively linked to construction workers. If the formal structure referred to above deems it necessary, this should be contained in an agreement of good conduct to be signed between BPC and all adjacent and neighbouring landowners;

27. Appropriate and adequate social amenities must be provided for the construction workers at the camp;

28. An HIV and AIDS awareness programme for construction workers must be implemented;

29. Where local skills and expertise are not available BPC should, where possible, employ Botswana nationals as opposed to expatriates. Local labour must be utilised as far as possible during the construction, operational and decommissioning phases of the development; and

30. The impacts associated with the groundwater investigations, transmission power line, coalmine expansion and water supply pipeline will have a cumulative impact, the significance of which is unknown at this stage. Authorities and stakeholders must be provided with an indication of the significance of these cumulative impacts within each of the individual EIAs.


Republic of Botswana - The Acquisition of Property Act of 1955
Republic of Botswana - The Agricultural Resources Conservation Act of 1974
Republic of Botswana - The Atmosphere Pollution (Prevention) Act of 1971
Republic of Botswana - The Forest Act of 1968
Republic of Botswana - The Herbage Preservation (Prevention of Fires) Act of 1978
Republic of Botswana - The Mines and Minerals Act (As amended in 1999)
Republic of Botswana - The Public Health Act of 1981
Republic of Botswana - The Town and Country Planning Act of 1980
Republic of Botswana - The Water Act of 1968
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY FOR THE MORUPULE B POWER STATION PROJECT

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

14th November 2007

Prepared in association by Ecosurv Environmental Consultants and GIBB Botswana
# Environmental and Social Management Plan
## Morupule B Power Station

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ABBREVIATIONS

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<td>DEA</td>
<td>Department of Environmental Affairs</td>
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<td>EIA</td>
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<td>Environmental Management Plan</td>
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<td>Environmental and Social Management Plan</td>
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<td>EMS</td>
<td>Environmental Management System</td>
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<td>ESIA</td>
<td>Environmental and Social Impact Assessment</td>
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<td>HSE</td>
<td>Health, Safety and Environment</td>
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<td>NCSA</td>
<td>National Conservation Strategy Co-ordinating Agency</td>
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<td>Representative Engineer</td>
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GLOSSARY OF TERMS

<table>
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<tr>
<td>Contractors Camp</td>
<td>A temporary camp, located within the BPC grant housing the contractors</td>
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<td>Development Site</td>
<td>The construction site areas for power station and associated infrastructure</td>
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1 INTRODUCTION

The Botswana Power Corporation (BPC) was established by an Act of the Republic of Botswana’s Parliament, and is wholly owned by the Government of Botswana. BPC is the sole utility in the country that has a mandate of supplying Botswana with power. Thus BPC is responsible for the generation, transmission and distribution of electricity in the country.

In recognition of their mandate, BPC intends to construct a new coal-fired power station (Morupule B Power Station) adjacent to the existing Morupule Power Station. The proposed 600 MW Morupule B Power Station is scheduled to be ready for commercial operation by 2010.

The existing Morupule Power Station, which is owned and operated by BPC, is a coal-fired and dry cooled power plant with a capacity of 132 MW. It is situated near Palapye, approximately 280 km north of Gaborone. The Morupule Colliery (Ltd), located adjacent to the power station supplies the coal needed for power generation.

The Morupule Power Station currently produces 30% of Botswana’s power requirements. Eskom (South Africa) supplies Botswana with the balance of the country’s power requirements through a power purchase agreement, which expires in December 2007. A new power purchase agreement is about to be entered into. To reduce dependency on imported power, BPC initiated the Morupule B Power Station Development, a feasibility study for which was commissioned in 2003. The study consisted of a number of components including a scoping-level environmental investigation, a coal resource determination study and a water resource assessment. The feasibility study was completed in 2004 and it confirmed that the construction of the proposed Morupule B power station was feasible.

The Impact Assessment Phase of the ESIA (including specialist investigations) has been conducted and a number of possible impacts of the project on the biophysical and socio-economic environment have been identified. Recommendations for the prevention and mitigation of these impacts during the construction, operational and decommissioning phases are captured in this Environmental and Social Management Plan (ESMP).

The ESMP is included as Appendix 6 in the EIS and it should be included in the Tender and Contract documentation for Contractors working on the project.
2  OVERVIEW OF ENVIRONMENTAL MANAGEMENT PLANS

The EIAA (2005) defines an EMP as "...a document representing the administration of efforts that will be made to manage any significant environmental impact resulting from the implementation of the activity".

In addition the European Environment Agency (2006) defines an EMP as follows:

An action plan or system which addresses the how, when, who, where and what of integrating environmental mitigation and monitoring measures throughout an existing or proposed operation or activity.

Globally, most environmental assessment to date has focussed on the Environmental Impact Assessment (EIA) component of the Integrated Environmental Management (IEM) approach. ESIA however, is only one tool in the IEM toolbox and there is growing recognition of the need for the post-assessment mitigation and monitoring of impacts. Although EMPs differ according to their scale and content, the objectives of an EMP are usually the same, namely to:

- Identify the possible environmental impacts of the proposed activity and;
- Develop measures to minimise, mitigate and manage these impacts.

At the project level, EMPs are usually compiled at three stages in a project lifecycle:

- Construction;
- Operation and;
- Decommissioning.

The mitigation measures required for each stage in a project lifecycle differentiate the one EMP from another. The content of an EMP at the project level can be standard or generic where the proposed activities are implemented frequently, mitigation measures are standard and the impacts are known (DEAT 2004).

However, in the case of large complex projects, such as the proposed Morupule B Power Station, the EMP should form part of an overall Environmental Management System (EMS). Figure 1 overleaf is a schematic representation of an EMS indicating the integration of an EMP within the EMS.

The term Environmental and Social Management Plan (ESMP) is used in this document in order to emphasise the inclusion of social aspects within the plan. The document is however consistent with EMPs as described above.

1 http://glossary.eea.eu.int/EEAGlossary/E/environmental_management_plan
Figure 1: Diagram indicating the integration of an Environmental Management Plan with the Environmental Management System. Source: Adapted from DEAT (2004)
3 MORUPULE B POWER STATION ESMP ORGANISATIONAL STRUCTURE

The organisational structure identifies and defines the authority structure, and the communication structure of the various parties involved in the implementation of this ESMP. All instructions and official communications regarding environmental matters and the ESMP shall follow the organisational structure shown in Figure 2.

BPC has appointed a Consulting Engineer to administer the proposed development. The Consulting Engineer shall appoint a Representative Engineer (RE) and an Environmental Liaison Officer (ELO) on site to co-ordinate and monitor the Contractor during the construction of the Works.

The Environmental Liaison Officer (ELO) will oversee the implementation of the ESMP on site. It will be the responsibility of the ELO to consult with the Representative Engineer (RE) regarding instructions pertaining to contravention, corrective actions or working methods. Except in an emergency situation, where instructions may be given directly to the Contractor, all instructions given by the ELO shall go through the RE, who will then convey these to the Contractor.

BPC shall appoint an Environmental Manager/Officer (EM) who will undertake regular audits of the construction site.

The ESMP will be an item of site meetings, and the ELO shall attend these meetings in order to provide input with respect to compliance with the ESMP. Copies of the minutes are to be sent to BPC.

During the construction phase, the ELO and EM will be responsible for ensuring contractor compliance with the ESMP. During the operational phase the EM will be responsible for ensuring employee compliance.
4 ROLES AND RESPONSIBILITIES AS PER THE PROPOSED PROJECT

4.1 Botswana Power Corporation (BPC)

BPC will be responsible for the overall implementation, administration and enforcement of the ESMP.

BPC shall appoint an Environmental/ Engineering Consultant, who in turn shall:

- Ensure that the ESMP specifications are included in all tender documents issued for building works and activities on site, and shall monitor/enforce that the prospective Tenderers/Contractors abide by the provisions thereof;
- Appoint an ELO to monitor implementation of and compliance with the ESMP for the duration of the works. The Consultant/RE may be required to fulfill this function when the ELO is not available;
- Through the Consultant/RE issue fines or stop works orders for contravention of the ESMP and give instruction regarding corrective action.

4.2 Environmental Liaison Officer (ELO)

The ELO will be responsible for monitoring, reviewing and verifying compliance with the ESMP by the Contractor.

In particular, the ELO shall:

- Be appointed by the Environmental/ Engineering Consultant to monitor on site;
- Visit/inspect the site regularly, to ascertain the level of compliance of works, as well as attend weekly Contractor’s meetings and monthly site meetings with the project management team and report back on the environmental issues;
- Maintain inspection reports on file;
- Assist the RE in ensuring that necessary environmental authorisations and permits have been obtained;
- Monitor and verify that the ESMP 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;
- Review and approve construction Method Statements together with the Consultant/RE;
- Assist the Contractor in finding environmentally responsible solutions to problems;
- Keep records of all activities/incidents concerning the environment on site in the Site Diary;
- Keep a register of complaints in the Site Office and deal with any community comments or issues;
- Monitor the undertaking by the Contractor of environmental awareness training for all new personnel coming onto site; or undertake environmental awareness courses themselves;
- Provide material/manuals and assistance for the environmental awareness courses;
• Advise on the removal of person(s) and/or equipment not complying with the specifications (via the Consultant/RE);
• Recommend the issuing of fines for transgressions of site rules and penalties for contravention;
• Monitor activities on site for compliance with legislation of relevance to the environment;
• Complete checklists as necessary; and
• Continually, internally review the ESMP and submit a report to BPC at the end of the project.

A photographic record, before and after construction, should be kept. Such a record would assist the monitoring of the environmental damages – if any.

4.3 Representative Engineer (RE)

The Representative Engineer (RE) will be responsible for monitoring, reviewing and verifying compliance with the ESMP by the Contractor when the ELO is not available or when assigned to do this. The RE’s duties, will include the following:

• Comply with the contents of this document as well as with the ESMP specifications in the Contract Document to ensure that the requirements of the ESMP are met;
• Monitor and verify that the ESMP 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;
• Review construction Method Statements in conjunction with the ELO;
• Assist the Contractor in finding environmentally responsible solutions to problems with input from the ELO;
• 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 ESMP;
• Order the removal of, or issuing spot fines for, person(s) and/or equipment not complying with the specifications; and
• Issue penalties for contravention of the ESMP.

4.4 Contractor

The Contractor shall:

• Ensure that the environmental specifications of this 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 ESMP;
• Prepare Method Statements for submission to ELO;
• 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 with the ELO;
• Notify ELO 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 ELO;
• Notify the ELO of all incidents, accidents and transgressions on site with respect to environmental management as well as requirements of the ESMP and corrective actions/remedial action taken;
• Report and record all accidents and incidents resulting in injury or death;
• Inform the ELO of problems arising when implementing the ESMP and ways of improving the ESMP; and
• Inform the ELO of any complaints received.

4.5 Environmental Manager/ Officer (EM)

The Environmental Manager/ Officer (EM) shall be a BPC employee and shall:

• Be responsible for monitoring and verifying compliance with the ESMP by the Contractor on a weekly basis;
• Be liable/accountable, to the relevant authority (DEA), for any contravention/non-compliance by any Contractor;
• Visit/inspect the site regularly, to ascertain the level of compliance of works, as well as attend weekly Contractor’s meetings; and
• Report back on the environmental issues to the Project Steering Committee and BPC Management.
5 HEALTH, SAFETY AND ENVIRONMENT PLAN

The Contractor shall submit a Health, Safety and Environmental Plan to the Owners Engineer for approval, covering those activities which are identified (in this document and/or by the ELO), as being potentially harmful to the environment.

The HSE Plan must indicate how compliance with the Environmental Specification (see section 6 of the ESMP) will be achieved. The HSE Plan shall clearly state the following:

- Timing of activities;
- Materials to be used;
- Equipment and staffing requirements;
- The proposed construction procedure designed to implement the relevant environmental specifications;
- The system to be implemented to ensure compliance with the above; and
- Other information deemed necessary by the ELO.

The HSE Plan shall be submitted at least 4 weeks prior to projected commencement of work on an activity, to allow the ELO time to study and approve the HSE Plan. The Contractor shall not commence work on activities until such time as the HSE Plan has been approved in writing by BPC (this will be within 7 working days).

Due to changing circumstances, it may be necessary to modify the HSE Plan. In such cases, the proposed modifications must be indicated and agreed upon in writing between the ELO and RE. The ELO and RE must retain records of any amendments and ensure that the most current version of any HSE Plan is being used.

The following are typical HSE aspects, which will be called for by the ELO. Amendments to the HSE Plan may be required by the ELO during the course of works, depending on the nature of the construction works and its location.

- Location, layout and preparation of the construction camp;
- Location, layout and preparation of cement/concrete batching facilities including the methods employed for the mixing of concrete and the management of runoff water from such areas;
- Contaminated water management plan, including the containment of runoff and polluted water;
- Emergency construction Method Statements (including details of methods for fuel spills and clean up operations);
- Logistics for the environmental awareness course for all the Contractors Employees and management staff;
- Rehabilitation of disturbed areas and revegetation after construction is complete; and
- Solid waste control and removal of waste from site.

The RE and ELO respectively shall approve any deviation from the HSE Plan.
6 ENVIRONMENTAL SPECIFICATIONS

The following environmental specifications are relevant to varying degrees for all phases of the proposed development.

6.1 Environmental Legislation

The Contractor shall ensure that all relevant legislation concerning the natural environment, pollution and the built environment is strictly enforced. Applicable environmental legislation that must be complied with includes the following:

- Acquisition of Property Act of 1955;
- Agricultural Resources Conservation Act of 1974;
- Atmosphere Pollution (Prevention) Act of 1971;
- EIA Act of 2005;
- Factories Act of 1979;
- Forest Act of 1968;
- Land Control Act of 1975 (as amended);
- Monument and Relics Act 1998 (Act 12 of 2001);
- Public Health Act of 1981;
- Mines and Minerals Act (As amended in 1999); and
- Mines, Quarries, Works Machinery Act of 1978;
- Town and Country Planning Act of 1980;
- Tribal Land Act of 1970 (As amended in 1993 and 1999);
- Waste Management Act of 1998;
- Water Act of 1968 (as amended);

6.2 General Site Procedures

All works shall be undertaken in an environmentally sensitive manner. A precautionary approach shall be adopted, with any works deviating from the specification being approved by both the RE and ELO.

6.3 Contractor’s Camp/Materials Storage Area

The Contractor’s camp and materials storage area shall be located at a position approved by the ELO. No site staff other than security personnel shall be housed on the development site. The Contractor shall provide water and/or washing facilities at the Contractor’s camp for personnel. Accommodation and facilities will be provided as per the EPC tender documentation. Water quality is to meet the national standards for drinking water. The Contractor’s camp and materials storage area shall be kept neat and tidy and free of litter.
6.4 Demarcation of the Site

It is important that activities are conducted within a limited area to facilitate control and to minimise impacts on the natural environment. For this reason, the development site will be divided into working areas and ‘no-go’ areas. Working areas are defined, as those areas required by the Contractor to construct the Works.

The Contractor shall, after confirmation has been received from the ELO, demarcate the boundaries of the Contractor’s camp and fence and ensure that all plant, labour and materials remain within the boundaries of the working areas. Disturbance of vegetation shall be limited to this area. Maintenance and final removal of the fence shall remain the responsibility of the Contractor.

The Contractor is advised that certain areas within the site property are environmentally sensitive or “no-go” areas, and personnel and equipment shall not be permitted within these areas:

- Areas containing sensitive habitats or vegetation;
- The hills found in the area;
- Steep slopes that are sensitive to erosion; and
- Archaeological resources found on site.

These areas shall be suitably fenced.

6.5 Protection of Flora, Fauna, Natural Features

The Ecological and Land Use Study (Appendix 4.3) has indicated that there are few ecological issues relating to the establishment of the power plant on the present site and that the area is considered to have no known rare, endangered or endemic plant species.

The removal or picking of any protected or unprotected indigenous plants shall not be permitted and no horticultural specimens (outside the demarcated working area) shall be removed, damaged or tampered with, unless agreed to by the ELO. In the event of this happening, the Contractor shall reinstate the damaged area to the satisfaction of the ELO.

All fauna (including domestic livestock) within and around the site shall be protected. Birds and animals shall not be caught or killed by any means, including poisoning, trapping, shooting or setting of snares. Any injured animals shall be reported to the RE/ELO.

Natural features shall not be defaced, painted for benchmarks or otherwise damaged even for survey purposes, unless agreed by the ELO. Any features defaced by the Contractor shall be reinstated to the satisfaction of the ELO.
6.6 Protection of Archaeological Material

The Archaeological Impact Assessment (Appendix 4.5) did not identify archaeological material on the site. However, archaeological material may be buried beneath the surface. In addition to this, if the proposed site should extend to the area covered by the rubble dumps, it is recommended that close archaeological monitoring be adhered to as this area has not been surveyed and may have some important cultural materials. Should any area of historical importance or archaeological sensitivity be identified it shall be demarcated and considered a “no go area” until cleared by the National Museums. If any palaeontological/archaeological material (eg fossils, bones, artefacts etc) is found during construction, the Contractor shall stop work immediately and inform the ELO. The ELO shall inform the National Museum and arrange for a palaeontologist/archaeologist to inspect, and if necessary excavate, the material, subject to acquiring the requisite approval from the National Museum.

The Contractor shall not recommence working in that area until he has received written permission from the ELO.

6.7 Access to Site

The Contractor shall ensure that access to the Site and associated infrastructure and equipment is off-limits to the public at all times during construction. Additional areas restricted to the public and suggested detours shall be clearly marked on the information boards to the satisfaction of the RE.

Access to the site shall be gained via routes approved by the RE. Only demarcated roads and existing tracks shall be used.

6.8 Site Clearance

All earthworks shall be undertaken in such a manner so as to minimise the extent of any impacts caused by such activities. Clearing operations should be kept to only that which is necessary to execute the works. Traditional healers shall be allowed on site to collect any plants of medicinal value prior to clearing operations.

No equipment associated with the site clearance shall be allowed outside of the demarcated area unless expressly permitted by the RE.
6.9 Ablution Facilities

The Contractor shall provide the necessary ablution facilities for all his personnel. Chemical toilets shall be used. A minimum of one toilet per 15 persons shall be provided. Toilets shall be easily accessible and shall be transportable. The toilets shall be secured to prevent them from blowing over, and shall be provided with an external closing mechanism to prevent toilet paper from being blown out. Toilet paper shall be provided in all toilets. Toilets shall be cleaned and serviced regularly by the Contractor. Toilets shall be emptied before long weekends and builders’ holidays. Toilets shall be locked after working hours.

Abluting anywhere other than in the toilets shall not be permitted. Use of other areas within the site for ablution purposes and/or spillage of chemicals and/or waste, may result in the Contractor being penalised by the ELO. The Contractor shall also be responsible for cleaning up any waste deposited by his personnel.

6.10 Eating Areas

The Contractor shall designate eating areas, in consultation with the ELO, as approved by the RE.

6.11 Refuse and Waste Management

A procedure for refuse and waste management must be discussed with and approved by the RE and ELO prior to commencement of this activity.

Refuse and waste refers to all solid waste, including construction debris (wrapping materials, timber, cans etc), waste and surplus food, food-wrappers etc.

The Contractor shall institute an on-site waste management system to prevent the spread of refuse within and beyond the site. The Contractor shall provide sufficient bins with secure, “animal-proof” lids on site to store waste and these shall be emptied regularly. The Contractor shall also institute a daily clean up of the site.

The Contractor shall ensure that chemicals and/or waste from toilet-cleaning operations are not spilled on the ground at any time. Spilled chemicals or waste shall be cleaned up immediately, to the satisfaction of the ELO.

The Contractor shall not dispose of any waste and/or construction debris by burning or burying. The Contractor shall ensure that all waste is deposited in the waste bins for removal by the Contractor. Bins shall not be used for any purposes other than waste collection and shall be emptied on a regular basis. All waste shall be disposed of off site at approved landfill sites.

Offenders found littering will be liable for a spot fine.
6.12 Water Supply

The Contractor shall provide for all his water requirements (construction and potable water). Water is a scarce resource in Botswana and water shall be conserved wherever possible.

6.13 Contaminated Water

The ash dam shall be constructed on a Low Density Polyethylene (LDPE) liner and equipped with a self-contained drainage system for the recycling of water.

If evaporation ponds are to be used for sewage, these ponds must be lined. Treated water from the sewage system/evaporation pond should be reused as slurry water.

All drainage from the site and from coal storage areas should be collected at the evaporation ponds and hence back into the system for reuse. A completely self sealed drainage and run off collection system should be designed.

In addition, to the operational mitigation measures mentioned above, the Contractor shall prevent discharge of any pollutants, such as cements, concrete, lime, chemicals and fuels into any water sources.

Runoff from fuel depots/workshops/truck washing areas and concrete swills shall be directed into a conservancy tank and disposed off at a site approved by the RE and Local Authority.

No mechanical plant or equipment shall be washed on site.

6.14 Air Quality and Dust Control

The Contractor shall take all reasonable measures to minimise the generation of dust as a result of construction activities to the satisfaction of the RE. Dust control measures for open areas can consist of wet suppression, chemical suppressants, vegetation, wind breaks, etc. Wet suppressants and chemical suppressants are generally applied for short storage pile durations.

Removal of vegetation shall be avoided until such time as soil stripping is required and similarly exposed surfaces shall be re-vegetated or stabilised as soon as is practically possible.

Excavation, handling and transport of erodible materials shall be avoided under high wind conditions or when a visible dust plume is present.

During high wind conditions, the RE will evaluate the situation and make recommendations as to whether dust-damping measures are adequate, or whether working will cease altogether until the wind speed drops to an acceptable level.
Where possible, soil stockpiles shall be located in sheltered areas where they are not exposed to the erosive effects of the wind. Where erosion of stockpiles becomes a problem, erosion control measures shall be implemented at the discretion of the RE.

Three types of measures may be taken to reduce vehicle entrained dust from unpaved roads: measures aimed at reducing the extent of unpaved roads, e.g. paving, traffic control measures aimed at reducing the entrainment of material by restricting traffic volumes and reducing vehicle speeds, and measures aimed at binding the surface material or enhancing moisture retention, such as wet suppression and chemical stabilisation.

Vegetation cover density for the storage piles and ash dump must be 80% on the entire slope up to 1 m from the crest, and dustfall immediately downwind must be <1 200 mg/m2/day.

100% control efficiency must be ensured during the decommissioning phase through vegetation establishment or rock cladding or chemical capping of side slopes and surface.

6.15 Noise Control

The following noise mitigation measures must be implemented during the construction and decommissioning phase of the development:

- Construction site yards, concrete batching plants, asphalt batching plants, construction worker camps (accommodation) and other noisy fixed facilities should be located well away from noise sensitive areas adjacent to the development site;
- All construction vehicles and equipment is to be kept in good repair;
- Construction activities are to be contained to reasonable hours during the day and early evening;
- With regard to unavoidable very noisy construction activities in the vicinity of noise sensitive areas, the contractor should liaise with local residents on how best to minimise impact;
- In general operations should meet the noise standard requirements of the South African Occupational Health and Safety Act (Act No 85 of 1993); and
- Construction staff working in areas where the 8-hour ambient noise levels exceed 75dBA should wear ear protection equipment.

The following noise mitigation measures must be implemented during the operational phase of the development:

- The design of the proposed power station is to incorporate all the necessary acoustic design aspects required in order that the overall generated noise level from the new installation does not exceed a maximum equivalent continuous day/night rating level ($L_{Rdn}$), namely a noise level of 70dBA;
- The latest technology incorporating maximum noise mitigating measures for the power station components should be designed into the system; and
- The design process is to consider, inter alia, the following aspects:
  - The position and orientation of buildings on the site.
  - The design of the buildings is to minimise the transmission of noise from the inside to the outdoors.
  - The insulation of particularly noisy new plant and equipment.
  - The alignment of the coal conveyor system and in particular the positioning of the drive houses.
Noise levels exceeding 85dB within the development site area shall only be permitted where approved by the RE/ELO or during an emergency situation. These levels are to be monitored on a regular basis.

The noise impact assessment must be updated after commissioning of the power station.

6.16 Erosion and Sedimentation Control

The Contractor shall protect areas susceptible to erosion by installing necessary temporary and permanent drainage works as soon as possible and by taking other measures necessary to prevent the surface water from being concentrated in streams and from scouring the slopes, banks or other areas.

Any runnels or erosion channels developed during the construction period or during the vegetation establishment period shall be made good.

A Method Statement shall be developed and submitted to the ELO to deal with erosion issues prior to bulk earthworks operations commencing.

Stabilisation of cleared areas to prevent and control erosion shall be actively managed. The method of stabilisation shall be determined in consultation with the RE.

Traffic and movement over stabilised areas shall be restricted and controlled, and damage to stabilised areas shall be repaired and maintained to the satisfaction of the RE.

6.17 Effluent and Stormwater Management

Procedures for effluent and stormwater management must be discussed with and approved by the ELO prior to commencement of this activity.

The Contractor must ensure that all reasonable precautions are taken to prevent pollution of the ground and water resources as a result of site activities. Ground contamination may hinder or prevent the re-establishment of vegetation.

The Contractor shall ensure that all mechanical equipment used in construction activities is clean, and free from leaks of oil, petrol, diesel, hydraulic fluid, etc and contaminated compounds.

The Contractor shall ensure that all servicing and refuelling of vehicles and equipment takes place off-site or within the Contractor’s camp. The Contractor shall not change oil or lubricants anywhere on site except at designated locations, unless there is a breakdown or an emergency repair.

The Contractor shall keep the necessary materials and equipment on site to deal with ground spills of any of the materials used or stored on site.

The Contractor shall ensure that no oil, petrol, diesel, etc is discharged onto the ground. Pumps and other machinery requiring oil, diesel, etc that are to remain in one position for longer than two days shall have physical controls in place to prevent all lubricants and fuels
from entering the ground. Contaminated water disposed of off site at a facility capable of handling such wastewater. Drip trays shall be cleaned before any possible rain events that may result in the drip trays overflowing, and before long weekends and holidays.

The Contractor shall remove all oil-, petrol-, and diesel-soaked sand immediately and shall dispose of it as hazardous waste.

Stormwater and/or groundwater may accumulate during excavations. The Contractor shall ensure that this water does not become contaminated.

The Contractor shall take reasonable measures to control the erosive effects of stormwater runoff.

Contaminated water (eg cement washings, waste water from ablution or kitchen facilities etc) shall be collected in a conservancy tank, removed from the site and disposed of in a manner approved by the ELO.

Washing of concrete delivery trucks will be allowed only in designated areas.

6.18 Materials Use, Handling, Storage and Transport

Procedures for materials handling must be discussed with and approved by the ELO prior to commencement of this activity.

(a) Hazardous materials

The Contractor shall comply with all relevant national, regional and local legislation with regard to the transport, use and disposal of hazardous materials. If necessary, the Contractor shall obtain the advice of the manufacturer with regard to the safe handling of hazardous materials. Any claims against the Contractor shall be for his account.

The Contractor shall ensure that there is an emergency procedure to deal with accidents and incidents (eg spills) arising from hazardous substances. The Contractor shall immediately report major incidents (spills in excess of 10 litres) to the ELO.

The Contractor shall maintain a register of any spills or incidents involving hazardous materials, as well as measures taken.

The Contractor shall be responsible for training of all personnel on site who will be handling hazardous material about its proper use, handling and disposal.

(b) Use of cement/concrete

The Contractor is advised that cement and concrete are regarded as highly hazardous to the natural environment on account of the very high pH of the material, and the chemicals contained therein. Therefore the Contractor shall ensure that:

- Concrete shall not be mixed directly on the ground;
- The concrete batching activity shall be located in an area of low environmental sensitivity to be identified and approved by the RE. Furthermore, the permitted location of the batching plant (including the location of cement stores and sand
and aggregate stockpiles) shall be indicated on the Site Layout Plan and approved by the RE. A Method Statement indicating the layout and preparation of this facility is required in this regard:

- All wastewater resulting from batching of concrete shall be disposed of via the wastewater management system;
- Contaminated water storage facilities shall not be allowed to overflow and appropriate protection from rain and flooding shall be implemented;
- Mortar boards, mixing trays and impermeable sumps shall be used at all mixing and supply points. Contaminated water shall be disposed at a waste disposal site approved by the ELO;
- Unused cement bags are to be stored, in weatherproof containers, so as not to be effected by wind, rain or runoff events;
- Used bags shall be disposed of on a regular basis via the solid waste management system, and shall not be used for any other purpose;
- Concrete transportation shall not result in spillage; and
- All visible remains of excess concrete shall be physically removed on completion of the plaster or concrete pour section and disposed off. Washing the remains into the ground is not acceptable. All excess aggregate shall also be removed.

(c) **Transport of materials outside the site**

The Contractor shall comply with all the applicable local, regional and national by-laws with regard to road safety and the transport of materials, especially hazardous and/or toxic materials. Any claims against the Contractor shall be for his account.

---

**6.19 Fuel (Petrol and Diesel) and Oils**

The construction phase of the new power station will involve the influx of machinery and equipment with the consequent need for fuel and chemicals. All necessary approvals with respect to fuel storage and dispensing shall be obtained from the appropriate authorities.

The Contractor shall ensure that all liquid fuels and oils are stored in tanks with lids, which are kept firmly shut and under lock and key at all times.

Areas for storage of fuels and other flammable materials shall comply with standard fire safety regulations.

The location of the fuel storage area will be approved by the RE.

These materials should be stored on an impermeable bunded surface within a secure location. This bunded area could be a surface required within the final power plant complex or could be a temporary enclosure. Spills, leaks and fuelling operations should be contained within this location with drainage leading to a sump which can contain spillages should any occur. The floor of bund shall be smooth and impermeable, constructed of concrete or plastic sheeting with impermeable joints with a layer of sand over to prevent perishing. The bund walls shall be formed of well-packed earth with the impermeable lining extending to the crest. The floor of the bund shall be sloped towards an oil trap or sump to enable any spilled fuel and/or fuel-soaked water to be removed. The tanks and bunded areas shall be covered by a roofed structure. Any water that collects in the bund shall not be allowed to stand and shall be removed within one day and taken off site to a disposal site approved by the RE.
Only empty and clean tanks may be stored on the bare ground. All empty and dirty tanks shall be sealed and stored on an area where the ground has been protected.

If fuel is dispensed from 200 litre drums, the proper dispensing equipment shall be used. The drum shall not be tipped in order to dispense fuel. The dispensing mechanism of the fuel storage tank shall be stored in a waterproof container when not in use.

Adequate precautions shall be provided to prevent spillage during the filling of any tank and during the dispensing of the contents.

No smoking shall be allowed in the vicinity of the stores and adequate fire-fighting equipment shall be available at the fuel storage and dispensing area or areas.

6.20 Gravel and Other Borrow Material

All borrow material purchased or excavated must come from legal excavation operations which hold EIA certificates and are registered with the Department of Mines.

6.21 Emergency Procedures

6.21.1 General

The Contractor shall ensure that emergency procedures are set up prior to commencing work. Emergency procedures shall include, but are not limited to, fire, spills, contamination of the ground, or water bodies, accidents to Employees, use of hazardous substances, the event of damaging services, etc. Emergency procedures, including responsible personnel, contact details of emergency services, etc shall be made available to all the relevant personnel and shall be clearly demarcated at the relevant locations around the site.

The Contractor shall provide reasonable quantities of absorbent materials for use during spills and contamination of the ground or water.

The Contractor shall also comply with National Health and Safety Standards and any amendments and any other relevant national, regional or local regulations with regard to operations on site.

The Contractor shall advise the ELO of any emergencies on site, together with a record of action taken.

6.21.2 Fire

The Contractor shall take all the necessary precautions to ensure that fires are not started as a result of his activities on site.

Open fires shall be permitted in designated areas only. Closed fires or stoves shall only be permitted at a designated safe site to be determined by the Contractor in consultation with the ELO. Fires shall also not be permitted near any potential sources of combustion, such as near vehicles that are being serviced or refuelled, fuel storage area, vegetation etc.
The Contractor shall ensure that there is adequate fire-fighting equipment on the site, especially where ‘hot work’ is to be undertaken.

The Contractor shall be liable for any expenses incurred by any organisations called to assist with fighting fires, and for any costs relating to the rehabilitation of burnt areas and/or property and/or persons should the fire be the cause of the Contractor’s activities on the site.

6.21.3 Safety

The Contractor shall take all reasonable measures to ensure the safety of all his staff.

The Contractor shall ensure that all construction vehicles using public roads are in a roadworthy condition that they adhere to the speed limits, that their loads are secured and that any local, provincial and national regulations are adhered to. Vehicles transporting materials such as sand, rock and pipes shall be covered to prevent their contents falling/blowing off and causing a traffic hazard.

All accidents and incidents resulting in injury or death (during construction) are to be recorded by the Contractor and reported in accordance with National Health and Safety Standards. The Contractor shall, in addition, inform the ELO and RE of these incidents, together with steps taken to treat injuries and prevent repeat occurrences.

The Contractor should prevent public access to the construction site.

The Contractor shall ensure compliance with all other relevant safety standards and the ELO and RE shall inform BPC’s Senior Safety Officer of the compliance status with respect to safety.

6.21.4 Security

The Contractor shall not house his construction personnel on the site, with the exception of security personnel.

The Contractor shall supply security personnel with adequate protective clothing, cooking, heating, resting and ablution facilities, and water and refuse collection facilities.

The Contractor shall provide rest facilities as appropriate.

6.22 Environmental Awareness Training

An initial environmental and archaeological awareness training session is required prior to the contractor commencing work.

The ELO will provide the Contractor with the course content for the environmental awareness-training course, and the Contractor shall communicate this information to his Employees on the site, to any new Employees coming onto site, to his subcontractors and to his suppliers. The training session shall be delivered in the languages of the site staff.
All the Contractors employees and Sub-Contractors Employees and any suppliers Employees that spend more than 1 day a week or four days in a month on site, must attend an Environmental Awareness Training course presented by the Contractor, the first of which shall be held within one week of the commencement date. Subsequent courses shall be held as and when required. The Contractor is responsible for ensuring that personnel commencing work on site after the start of the contract (who therefore miss the initial training session) are also made aware of the environmental procedures before commencing work.

The emphasis should be on any (potential) environmental impacts relating to the construction activities to be undertaken on site and the related environmental precautions, which need to be taken to avoid or mitigate these impacts.

The Contractor shall submit a Method Statement detailing the logistics of the environmental awareness-training course.

6.23 Community Relations

The contractor/s appointed for the construction phase should use local facilities for services and BPC should ensure that this is taken on board during the tendering stage.

Where possible contractors should attempts to hire from local communities (Palapye/Serowe). However, due to the low skills levels in the area, it is recognised that the majority of skilled posts are likely to be taken by people from outside the area.

An employment office should be set up prior to the commencement of the construction phase in order to identify locals who can be employed on the project.

At the commencement of construction a complaints procedure should be established to address concerns. These complaints and the manner in which each was addressed must be available for the SHE manager and for audit purposes.

The contractor should ensure that all staff are informed of the consequences of stock theft and trespassing on adjacent farms at the outset of the construction phase.

The local authorities, community organizations and leaders should be informed of the project and the potential job opportunities for locals.

The employment selection process should seek to promote gender equality.

A database of local firms that qualify as potential service providers for post EPC tender award services (construction companies, catering companies, waste collection companies etc) should be developed. These companies should be notified of and invited to bid for project related work.

Local businesses should ensure that they identify and cater for the needs of the construction workers (to maximise spending of wages within the local economy).

It would greatly benefit BPC if the local chamber of business and hospitality industry could be assisted to identify strategies aimed at maximizing the potential benefits associated with the Project.
The Palapye Physical Planner and the Land Board are to be made aware of noise and SO₂ dispersion areas so that local planning does not conflict with the proposed development.

6.24 Site and Construction Camp Rehabilitation

All construction equipment and excess aggregate, gravel, stone, concrete, bricks, temporary fencing and the like shall be removed from the site and contractors camp within 2 months of completion of the work. No discarded materials of whatsoever nature shall be buried on the site or on any other land within the site.

Retentions will only be released after site clearing and rehabilitation activities undertaken.

6.25 Payment for Environmental Specifications

The Contractors costs incurred for compliance with this ESMP shall be included in the tender price
7 MONITORING AND AUDITING

A key component of the mitigation strategy is the use of monitoring and auditing tools. Two levels are recommended for this project namely, self-monitoring, and authority auditing.

The EIAA (2005) requires the developer to “submit an evaluation report to the relevant technical department or local authority.” The objective is to determine compliance with the agreed mitigation measures.

In addition the EIAA requires that the “competent authority shall carry out or cause to be carried out biennially at its own expense, environmental audits for approval and operational purposes.”

7.1 Self-monitoring

The majority of the monitoring will be conducted by the BPC through the ELO appointed for the project. In general, the ELO is responsible for monitoring, reviewing and verifying compliance with the ESMP by the Contractor. An audit procedure should be developed by the ELO. The audit should be done at an agreed frequency and should incorporate both planned and unannounced site inspections.

The audit outputs should be compiled into an evaluation report which should be made available to the competent authority.

7.2 Authority monitoring

To limit the extent to which site inspections are necessary, it is recommended that monthly reports generated by the ELO be made available to the authorities for their records. A specific report format could be agreed between the ELO, DEA and Department of Waste Management and Pollution Control (DWM&PC) which would allow for the rapid assessment of compliance with conditions of project approval and with the ESMP for the development.

7.3 Monitoring approach

The ESIA identified a number of areas of concern. Mitigation measures have been developed and the monitoring of the effectiveness of such mitigation measures is important. The Department of Environmental Affairs requires monitoring to address the following:

- Environmental Aspect;
- Parameter to be monitored;
- Monitoring objective;
- Responsible agent;
• Monitoring locations;
• Methods for monitoring;
• Reporting structure;
• Thresholds or existing standards; and
• Recommended actions where thresholds are exceeded.

7.4 Monitoring during construction

All monitoring during construction, apart from noise monitoring, will be carried out under the “Self Monitoring” component outlined in section 1.1 above.

Noise monitoring during the construction phase must be undertaken by a suitably qualified and experienced acoustical engineer in order to ensure the following:

• Construction site yards, concrete batching plants, asphalt batching plants, construction worker camps (accommodation) and other noisy fixed facilities are located well away from noise sensitive areas adjacent to the development site;
• All construction vehicles and equipment are kept in good repair;
• Construction activities, and particularly the noisy ones, are contained to reasonable hours during the day and early evening;
• With regard to unavoidable very noisy construction activities in the vicinity of noise sensitive areas, that the contractor liaises with local residents on how best to minimise impact;
• Compliance with the noise standard requirements of the relevant occupational health and safety legislation; and
• Construction staff working in areas where the 8-hour ambient noise levels exceed 75dBA wear ear protection equipment.

A botanical survey will be required during the construction phase to identify if any of the rare or endangered plant species identified in the Environment and Land Use report (Appendix 4.3) are present in the area affected by the predicted 80 micrograms SO$_2$/annum deposition zone (Figure 3).
7.5 Operational phase monitoring

Monitoring of the following environmental aspects is required for the operational phase of the development (Table 1):

**Table 1: Monitoring plan for the operational phase**

<table>
<thead>
<tr>
<th>Environmental Aspect</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>Staff, school and homesteads</td>
</tr>
<tr>
<td>Emissions (ambient)</td>
<td>Ground-level concentration</td>
</tr>
<tr>
<td>Emissions (in-stack)</td>
<td>Stack emission concentration</td>
</tr>
<tr>
<td>Emissions (dust)</td>
<td>Dust fallout</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Groundwater</td>
</tr>
<tr>
<td>Meteorological</td>
<td>Local Meteorology</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Plant leaves</td>
</tr>
</tbody>
</table>
### Parameter to be monitored

<table>
<thead>
<tr>
<th>Parameter to be monitored</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>dB(A)</td>
</tr>
<tr>
<td>Emissions (ambient)</td>
<td>µg/m³</td>
</tr>
<tr>
<td>Emissions (in-stack)</td>
<td>µg/Nm³</td>
</tr>
<tr>
<td>Emissions (dust)</td>
<td>mg/m²/day</td>
</tr>
<tr>
<td>Groundwater</td>
<td>TDS, Conductivity, NH₄, Ca, Cl, F, Hardness as CaCO₃, Mg, NO₃, NO₂, K, Na, SO₄, and Zn. Other trace elements as are currently carried out within BPC’s laboratory as well as Total Organic Carbon</td>
</tr>
<tr>
<td>Meteorological</td>
<td>Wind direction and speed, temperature, rainfall, evaporation</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Leaf and plant condition</td>
</tr>
</tbody>
</table>

### Monitoring objective

<table>
<thead>
<tr>
<th>Parameter to be monitored</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>Ensure that the maximum noise levels fall within the National and World Bank limits</td>
</tr>
<tr>
<td>Emissions (ambient)</td>
<td>Ensure that ambient emissions for SO₂, NOₓ, and PM10 meet the National and World Bank limits</td>
</tr>
<tr>
<td>Emissions (in-stack)</td>
<td>Identify if the emissions meet the required design specifications and World Bank limits</td>
</tr>
<tr>
<td>Emissions (dust)</td>
<td>Dust fallout of less than 1200mg/m²/day</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Monitor movement of water from the flyash dumps into groundwater and identify changes in groundwater quality.</td>
</tr>
<tr>
<td>Meteorological</td>
<td>Improve the understanding of site specific climatic conditions</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Identify whether there are impacts on local vegetation and crops within the high SO₂ deposition areas.</td>
</tr>
</tbody>
</table>

### Responsible party/agent

<table>
<thead>
<tr>
<th>Parameter to be monitored</th>
<th>Party/Agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>BPC</td>
</tr>
<tr>
<td>Emissions (ambient)</td>
<td>BPC, DWMPC</td>
</tr>
<tr>
<td>Emissions (in-stack)</td>
<td>BPC</td>
</tr>
<tr>
<td>Emissions (dust)</td>
<td>BPC</td>
</tr>
<tr>
<td>Groundwater</td>
<td>BPC with external audit</td>
</tr>
<tr>
<td>Meteorological</td>
<td>BPC – SHE</td>
</tr>
<tr>
<td>Vegetation</td>
<td>BPC – SHE Manager</td>
</tr>
</tbody>
</table>

### Monitoring locations

<table>
<thead>
<tr>
<th>Parameter to be monitored</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>As per the measurement sites in the ESIA including school, workplace and closest residences</td>
</tr>
<tr>
<td>Emissions (ambient)</td>
<td>Present site or south east corner of the BPC lease area</td>
</tr>
<tr>
<td>Emissions (in-stack)</td>
<td>In-stack</td>
</tr>
</tbody>
</table>
| Emissions (dust)          | Dust fallout buckets must be placed at the following locations:  
  - 1 directional dust fallout bucket next to the unpaved road from the plant to the ash dump;  
  - 5 directional dust fallout buckets around the existing and proposed ash dumps;  
  - 1 directional dust fallout bucket near each of the main materials transfer points; and,  
  - 1 directional dust fallout bucket down wind (i.e. to the southwest) of the coal and lime storage piles. |
| Groundwater               | 5 new monitoring boreholes should encircle the site both upstream and downstream and be linked into the existing monitoring system.  
  - Three should be drilled to the south and southeast and... |
east of the final new power plant site as these directions represent the likely flow of groundwater.
- One should be drilled to the north (to act as a background control and to try to differentiate any contaminant flow emanating from the existing power plant) and,
- one to the west to try to assess any groundwater arriving from the evaporation and oxidation ponds area.
- Siting of these boreholes will only be possible once the design and infrastructure of the new power plant has been finalised.

<table>
<thead>
<tr>
<th>Meteorological</th>
<th>Existing meteorological station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation</td>
<td>Monitoring sites to be established within the high SO\textsubscript{2} deposition areas near the SE corner of the BPC lease area and a second one to the north west outside the high deposition area. Annual observations of arable crops falling within the high deposition area should be carried out to look at leaf condition. Observations to be compared with those outside the area of concern</td>
</tr>
</tbody>
</table>

**Methods for monitoring**

**Noise**
- At commissioning, the noise footprint of the planned power station should be established by measurement in accordance with the relevant standards, namely SANS ISO 8297:1994 and SANS 10103. The character of the noise (qualitative aspect) should also be checked to ascertain whether there is any nuisance factor associated with the operation.
- Once the final design details of the planned power station are known, the parameters which directly affect the calculations made in the noise impact study are to be checked and validated. If necessary, the calculations are to be redone and the noise impact checked.

**Emissions (ambient)**
- An independent company must calibrate the existing ambient air quality monitoring station equipment at least every six months.

**Emissions (in-stack)**
- Continuous in-stack monitoring of SO\textsubscript{2} and NO\textsubscript{x} emissions.
- Isokenetic stack sampling should be conducted at all the remaining point sources at least once a year.

**Emissions (dust)**
- Dust fallout buckets

**Groundwater**
- As a result of the development there will be a need to produce a groundwater quality monitoring audit of the new site. It is thought likely that this can be incorporated as an extension of the existing yearly audit produced by BPC for the current power plant.

Boreholes to be dipped and sampled on a monthly basis. Basic analysis should consist of the major inorganic determinands within BOS32: 2000 namely:

- TDS, Conductivity, NH\textsubscript{4}, Ca, Cl, F, Hardness as CaCO\textsubscript{3}, Mg, NO\textsubscript{3}, NO\textsubscript{2}, K, Na, SO\textsubscript{4}, and Zn. Other trace elements as are currently carried out within BPC’s laboratory as well as Total Organic Carbon should also be analysed for.

**Meteorological**
- The ambient monitoring station must be calibrated at least once every six months.
Vegetation
 Fixed plot sampling to be established with assistance of University of Botswana or other botanical specialist.

<table>
<thead>
<tr>
<th>Reporting structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
</tr>
<tr>
<td>Emissions (ambient)</td>
</tr>
<tr>
<td>Emissions (in-stack)</td>
</tr>
<tr>
<td>Emissions (dust)</td>
</tr>
<tr>
<td>Groundwater</td>
</tr>
<tr>
<td>Meteorological</td>
</tr>
<tr>
<td>Vegetation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thresholds or existing standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
</tr>
<tr>
<td>Emissions (ambient)</td>
</tr>
<tr>
<td>Emissions (in-stack)</td>
</tr>
<tr>
<td>Emissions (dust)</td>
</tr>
<tr>
<td>Groundwater</td>
</tr>
<tr>
<td>Meteorological</td>
</tr>
<tr>
<td>Vegetation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recommended actions where thresholds are exceeded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
</tr>
</tbody>
</table>
| Emissions (ambient) | • Investigate reason for high emissions.  
• Notify Department of Waste Management and Pollution Control.  
• Implement additional abatement measures if necessary. |
| Emissions (in-stack) | • Investigate reason for high emissions.  
• Notify Department of Waste Management and Pollution Control.  
• Implement additional abatement measures if necessary. |
| Emissions (dust) | • Investigate reason for high emissions.  
• Notify Department of Waste Management and Pollution Control.  
• Implement additional abatement measures if necessary. |
| Groundwater | Notify Department of Geological Surveys for advice |
| Meteorological | NA |
| Vegetation | Notify Department of Crop Production |
Table 2: Environmental Management Specifications for the Construction, Operational and Decommissioning Phases of the Development

<table>
<thead>
<tr>
<th>No.</th>
<th>Issue</th>
<th>Action</th>
<th>Responsibility</th>
<th>Implementation</th>
<th>Statutory Condition (Botswana or World Bank Group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fugitive Emissions resulting from:</td>
<td>Rehabilitation and mitigation of fugitive dust emissions must be continuous throughout the life of the project in order to result in the minimal effort to apply final rehabilitation strategies;</td>
<td>ELO/BPC</td>
<td>Construction, Operational and Decommissioning Phases</td>
<td>• Recommended dust fallout limit is 1200 mg/m²/day</td>
</tr>
<tr>
<td></td>
<td>• Materials handling operations including the transportation of coal and fly ash;</td>
<td>• Wind erosion from ash dumps must be controlled through vegetation or rock cladding or chemical capping of side slopes and surfaces;</td>
<td></td>
<td></td>
<td>• Annual average PM10 ambient limit = 200 µg/m³ (Botswana)</td>
</tr>
<tr>
<td></td>
<td>• Wind blown dust from ash dams; and</td>
<td>• Chemical suppressants should be applied to unpaved roads and access roads to control emissions from vehicle entrainment on unpaved roads;</td>
<td></td>
<td></td>
<td>• 24-hour average PM10 ambient limit = 150 µg/m³ (WBG)</td>
</tr>
<tr>
<td></td>
<td>• Vehicle entrained dust from unpaved roads.</td>
<td>• For unpaved haul roads on the plant site it is recommended that dustfall in the immediate vicinity of the road perimeter be less than 1,200 mg/m²/day;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The vegetation cover should be such to ensure at least 80% control efficiency for the walls. The surface areas should be kept wet, if feasible. Dustfall immediately downwind of the site must be limited to &lt;1 200 mg/m²/day;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Topsoil piles and the storage pile for overburden materials should be vegetated completely to ensure as little as wind disturbance of these areas as possible;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Isokinetic stack sampling should be conducted at all the remaining point sources at least once a year. This is to ensure that the dust collectors are working according to design specifications; and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Vehicles used to transport sand and building materials must be fitted with tarpaulins and covers.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>High ground level concentrations of SO₂</td>
<td>The proposed Morupule B Power Plant should be designed to be in compliance with the World Bank Group SO₂ emission limits for new thermal power plants;</td>
<td>BPC</td>
<td>Operational Phase</td>
<td>• 24-hour average SO₂ ambient limit = 300 µg/m³ (Botswana)</td>
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<td>• Flue Gas Desulphurisation (FGD) as a control option for SO₂ emissions should be considered for the new power plant if the PC boiler design is selected;</td>
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<td></td>
<td>• 24-hour average SO₂ ambient limit = 150 µg/m³ (WBG)</td>
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<td></td>
<td>• World Bank Group</td>
</tr>
</tbody>
</table>

Environmental and Social Management Plan  November 2007
| 3 | NO$_2$ emissions | • The proposed Morupule B Power Plant should be designed to be in compliance with the World Bank Group NO$_x$ emission limits for new thermal power plants. | BPC | Operational Phase | • Annual average NO$_2$ ambient limit = 100 µg/m$^3$ (Botswana)  
• 24-hour average NO$_2$ ambient limit = 150 µg/m$^3$ (WBG)  
• World Bank Group stack emission limit = 750 mg/Nm$^3$ |
| 4 | Current on-site concentration of particulate emissions was predicted to increase by more than 500% as a result of the Morupule B Power Station | • The proposed Morupule B Power Plant should be designed to be in compliance with the World Bank Group particulate matter emission limits for new thermal power plants. Emissions may be reduced by:  
• Water sprays or chemical suppressants on the unpaved roads;  
• Water sprays or chemical suppressants on all material transfer points; and,  
• Vegetation cover on the ash dumps (existing and future) to reduce the potential for wind blown dust.  
• A new ambient air quality monitoring station inclusive of a meteorological station must be installed at the Morupule B Power Station. This ambient station must be calibrated at least once every six months to ensure accurate and continuous data capturing; and  
• Based on the increase in particulate emissions due to the proposed operations, it is recommended that a dust fallout network be designed for the site as per the specifications in Table 1 of this ESMP. | BPC | Operational Phase | • Annual average PM$_{10}$ ambient limit = 200 µg/m$^3$ (Botswana)  
• 24-hour average PM$_{10}$ ambient limit = 150 µg/m$^3$ (WBG)  
• World Bank Group stack emission limit = 50 mg/Nm$^3$ |
## B. Protection of Archaeological Material

|   | The findings of any paleontological or archaeological material during construction. | • Inform the National Museum if anything of archaeological significance is identified;  
• Demarcate the area as sensitive; and  
• Archaeological monitoring to be adhered to at all times. | ELO | Construction Phase | Monuments and Relics Act |
|---|---|---|---|---|---|

## C. Ecology and Land Use

|   | Loss of habitat through the excavation of large volumes of gravel. | • Abstraction sites should be located on low impact areas and must be registered with mines. | ELO | Construction Phase | Mines and Minerals Act  
EIA Act |
|---|---|---|---|---|---|
| 2 | Loss of vegetation due to:  
• Coal dust pollution;  
• Clearing of site for construction and the construction camp;  
• Expansion of ash dumps;  
• High pH from spills from fly ash dam;  
• Potential risk of fires; and  
• High levels of SO\(_2\) in the air | • Dampen or clean coal before transporting to store site;  
• Use disturbed areas for the camp and maintain as much vegetation on site via demarcation.  
• None  
• None  
• There should be no fires outside of the construction camp. A firebreak should be put into place around the camp and awareness should be raised at Induction.  
• Investigation into reduction of SO\(_2\) from the existing power station | ELO/BPC | Construction & Operational Phase | 24-hour average SO\(_2\) ambient limit = 300 µg/m\(^3\) (Botswana)  
24-hour average SO\(_2\) ambient limit = 150 µg/m\(^3\) (WBG) |
| 3 | Impact of SO\(_2\) emissions on:  
• Riverine;  
• Close Urban Habitats (Homesteads & School);  
• Arable Agriculture especially bean crops | • Investigation into reduction of SO\(_2\) from the existing power station. | BPC | Operational Phase | 24-hour average SO\(_2\) ambient limit = 300 µg/m\(^3\) (Botswana)  
24-hour average SO\(_2\) ambient limit = 150 µg/m\(^3\) (WBG) |

## D. Contaminated Water

|   | Ground works may impact the soils if spillages or accidents occur which contaminate:  
• Groundwater and  
• Surface water sources | • All storage areas should have impermeable bases.  
• A good traffic management system should be implemented to prevent any accidents from occurring.  
• Local containment drainage should be implemented to cope with spills. | ELO/BPC | Construction and Operational Phase | BOS 32:2000 Drinking Water Standards |
<table>
<thead>
<tr>
<th>No.</th>
<th>Issue Description</th>
<th>Countermeasure</th>
<th>Responsible Phase</th>
<th>Applicable Standards/Regulations</th>
</tr>
</thead>
</table>
| 2   | Leachate from the ash waste stream may infiltrate groundwater and surface water   | • The ash dam shall be constructed on a Low Density Polyethylene (LDPE) liner and equipped with a self-contained drainage system for the recycling of water.  
• A sealed internal drainage system should be constructed to prevent run-off and contamination of any surface water. | BPC Construction Phase and Operational Phase | BOS 32:2000 Drinking Water Standards |
| 3   | The storage of coal on site may pose a risk if rain occurs, thus contaminating     | • Evaporation ponds shall be used, and should be lined;  
• Once the water is treated, it shall be reused as slurry water. | BPC Construction Phase and Operational Phase | BOS 32:2000 Drinking Water Standards |
|     | groundwater and surface water.                                                   |                                                                                 |                   |                                 |
| 4   | The spillage/leakage of chemicals, hydrocarbons and fuels on site may contaminate | • Evaporation ponds shall be used, and should be lined;  
• Once the water is treated, it shall be reused as slurry water;  
• A sealed internal drainage system should be constructed to prevent run-off and contamination of any surface water. | BPC Construction and Operational Phase | BOS 32:2000 Drinking Water Standards |
| 5   | Water scarcity                                                                     | • Water shall be reused wherever possible, including run off and site drainage sources, this results in there being less water available for surface flow. | BPC Construction and Operational Phase | Not applicable |
| 6   | Monitoring and Auditing of Groundwater Quality                                     | • Additional monitoring boreholes to the four boreholes currently on site may need to be drilled to monitor any potential deterioration in groundwater quality. These should encircle the site both upstream and downstream of the site;  
• All boreholes to be dipped and sampled on a monthly basis;  
• The analysis should determine the presence of the major inorganic determinants within BOS32: 2000; namely: TDS, Conductivity, NH₄, Ca, Cl, F, Hardness as CaCO₃, Mg, NO₃, NO₂, K, Na, SO₄, and Zn. Other trace elements are currently carried out within BPC's laboratory as well as Total Organic Carbon should also be analysed for.  
• In addition effective operational and maintenance systems should be employed, these include:  
  • Documented procedures to control operations that may have an adverse impact on the environment;  
  • A defined procedure for identifying, reviewing and prioritising items of plant for which a preventative maintenance regime is appropriate;  
  • Documented procedures for monitoring emissions or impacts;  
  • A preventative maintenance programme covering all plant, whose failure could lead to impact on the environment, including regular inspection of major ‘non productive’ items such as tanks, pipework, retaining | BPC Operational Phase and Decommissioning Phase | BOS 32:2000 Drinking Water Standards |
### E. Noise Control

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<tr>
<td>1</td>
<td>Increase in noise level attributed to the potential increase of traffic on the main roads.</td>
<td>• With regard to unavoidable very noisy construction activities and operational activities in the vicinity of noise sensitive areas, the contractor should liaise with local residents on how best to minimize impacts (i.e. specific travelling times)</td>
<td>RE/BPC Construction &amp; Operational Phase Rural residential areas surrounding site: 45 dBA – day (SANS) 35 dBA – night (SANS) 55 dBA – day (WBG) 45 dBA – night (WBG)</td>
</tr>
<tr>
<td>2</td>
<td>Impact of noise generated from the construction activities on local communities.</td>
<td>• Construction site yards, concrete batching plants, asphalt batching plants, construction worker camps (accommodation) and other noisy fixed facilities should be located well away from noise sensitive areas adjacent to the development site; • All construction vehicles and equipment is to be kept in good repair; and • Construction activities are to be contained to reasonable hours during the day and early evening.</td>
<td>ELO Construction Phase Rural residential areas surrounding site: 45 dBA – day (SANS) 35 dBA – night (SANS) 55 dBA – day (WBG) 45 dBA – night (WBG)</td>
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<td>3</td>
<td>Impact of high noise level on staff during construction and operation of the proposed power plant.</td>
<td>• Staff working in areas where the 8-hour ambient noise levels exceed 75 dBA should wear ear protection equipment.</td>
<td>ELO/BPC Construction &amp; Operational Phase Rural residential areas surrounding site: 45 dBA – day (SANS) 35 dBA – night (SANS) 55 dBA – day (WBG) 45 dBA – night (WBG)</td>
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<td>4</td>
<td>Impact of noise generated once the proposed power plant is fully operational.</td>
<td>• The design of the proposed power station is to incorporate all the necessary acoustic design aspects required in order that the overall generated noise level from the new installation does not exceed a maximum equivalent continuous day/night rating level ( L_{eq} ), namely a noise level of 70dBA; • The latest technology incorporating maximum noise mitigating measures for the power station components should be designed into the system; and • The design process is to consider, inter alia, the following aspects: • The position and orientation of buildings on the site. • The design of the buildings is to minimise the transmission of noise from the inside to the outdoors. • The insulation of particularly noisy new plant and equipment.</td>
<td>RE/BPC Operational Phase Rural residential areas surrounding site: 45 dBA – day (SANS) 35 dBA – night (SANS) 55 dBA – day (WBG) 45 dBA – night (WBG)</td>
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### F. Community Relations

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<tr>
<th></th>
<th>Creation of local employment opportunities</th>
<th>Due to the low skills levels in the area, the majority of skilled posts are likely to be taken by people from outside the area. Where local skills and expertise are not available BPC and the contractor should, where possible, employ Botswana nationals as opposed to expatriates. Local labour must be utilised as far as possible during the construction, operational and decommissioning phases of the development;</th>
<th>C/ BPC</th>
<th>Construction and Operational Phase</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>• An employment office should be set up by BPC in Palapye prior to the commencement of the construction phase in order to identify locals who can be employed on the project. A skills audit should also be undertaken to assess the ability to maximise the opportunities for local residents;</td>
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<td>• The contractor should ensure that all staff are informed of the consequences of stock theft and trespassing on adjacent farms at the outset of the construction phase;</td>
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<td>• At the commencement of construction a complaints procedure should be established by the contractor to address concerns. These complaints and the manner in which each was addressed must be available for the SHE manager and for audit purposes.</td>
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<td>• The local authorities, community organizations and leaders should be informed of the project by BPC and the potential job opportunities for locals;</td>
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<td>• The employment selection process by contractors should seek to promote gender equality.</td>
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<td>2</td>
<td>Creation of local business opportunities</td>
<td>• The contractor shall make themselves aware of the availability of local firms that qualify as potential post EPC tender award service providers (construction companies, catering companies, waste collection companies etc).</td>
<td>C</td>
<td>Construction and Operational Phase</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

**Note:**

- The alignment of the coal conveyor system and in particular the positioning of the drive houses.
- Noise levels exceeding 85dB on the development site shall only be permitted where approved by the RE/ELO or during an emergency situation.
- More speed restriction signs should be installed on the approaches to the speed humps on the existing access road to the power plant or, if the safety of the school children is not jeopardized, the speed humps should be removed.
These companies should be notified of tenders and invited to bid for project related work;
- Where necessary, firms should be assisted and/or capacitated to enable them to fill in and submit the required tender forms and fulfill contracts for post EPC tender award services;
- Local businesses should ensure that they identify and cater for the needs of the construction workers (to maximise spending of wages within the local economy).

<table>
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<tr>
<th>3</th>
<th>An influx of job seekers may impact negatively on the lives of locals in one or more of the following ways:</th>
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<tbody>
<tr>
<td></td>
<td>• Transmission of sexually transmitted diseases, including HIV/AIDS;</td>
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<td>• Increase in prostitution;</td>
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<td></td>
<td>• Increase in alcohol and drug related incidents;</td>
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<td>• Increase in crime;</td>
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<td></td>
<td>• Creation of tension and conflict within the local community;</td>
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<td></td>
<td>• Pressure on existing services and amenities.</td>
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<tr>
<th>4</th>
<th>Traffic and road safety</th>
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<tr>
<td></td>
<td>• Operating hours for heavy vehicles must be instituted so as</td>
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C/BPC Constructional and Operational Phase

Not applicable
to avoid times of day when pedestrian and other use of the roads is high;
- All vehicles must be maintained according to the manufacturer’s specifications and must be in a road worthy condition at all times; and
- Vehicles drivers must be qualified and made aware of the potential safety issues.

| 5 | Veld fires | • Open fires are not to be permitted on the site;  
|   |  | • Fire fighting equipment for fighting veld fires and other fires must be provided on site; and  
|   |  | • Fire-fighting training must be provided to an appropriate number of construction staff. |

| C | Constructional and Operational Phase | Not applicable |