ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

DRAFT EIA REPORT

PROPOSED TSHIVHASO COAL-FIRED POWER PLANT, NEAR LEPHALALE, LIMPOPO PROVINCE

14/12/16/3/3/3/211

DRAFT REPORT FOR PUBLIC REVIEW

Prepared for:

Cennergi
272 West Avenue, Block A,
Ground Floor, Lakefield Office Park,
Centurion,
0157

Prepared by:

Savannah Environmental Pty Ltd

UNIT 10, BUILDING 2
5 WOODLANDS DRIVE OFFICE PARK
WOODMEAD
JOHANNESBURG 2191
TEL: +27 (0)11 656 3237
FAX: +27 (0)86 684 0547
E-MAIL: INFO@SAVANNAHSA.COM
WWW.SAVANNAHSA.COM

Savannah
ENVIRONMENTAL (PTY) LTD

PROJECT DETAILS

DEA Reference No.	**:**	14/12/16/3/3/3/211
Title	**:**	PROPOSED TSHIVHASO COAL-FIRED POWER PLANT, NEAR LEPHALALE, LIMPOPO PROVINCE
Authors	**:**	Savannah Environmental (Pty) Ltd Jo-Anne Thomas John von Mayer
Sub-consultants	**:**	Riaan Robbeson, Dewald Kamffer, Lukas Niemand, (Bathusi Environmental Consulting) Johan Mare (Menco) Morne de Jager (EAR) Mark Zunkel (uMoya-NiLU) Jaco Jansen (Savannah Environmental) – Peer Reviewed by Garry Patterson (Agricultural Research Council) Jaco van der Walt (HCAC) John Almond (Natura Viva) Jon Marshal (Afzelia) Harmke Immink (Promethium Carbon) Elena Broughton (Urban Econ)
Client	**:**	Cennergi
Report Status	**:**	Draft Environmental Impact Assessment Report for public review 13 September 2016 – 14 October 2016

When used as a reference this report should be cited as: Savannah Environmental (2016) Draft EIA Report: Proposed Proposed Tshivhaso Coal-Fired Power Plant, near Lephalale, Limpopo Province

PUBLIC REVIEW PERIOD FOR THE DRAFT EIA REPORT

This draft EIA Report for Karreebosch Wind Farm has been made available for a 30-day public review period. The 30 day public review period is 13 September 2016 – 14 October 2016. The draft EIA_report which has been submitted to DEA is also available for download at www.savannahsa.com or on request from Savannah Environmental. The report will be distributed to relevant Organs of State and will also be made available at the libraries as below:

- Lephalale Local Municipality Public Library (Address: Cnr Joe Slovo Street and Douwater Avenue, Lephalale)
- Marapong Community Library (Address: 1456 Setlhora Street, Marapong)

TABLE OF CONTENTS

Appendices

Appendix K: Visual Assessment

Appendix L: Climate Change

Appendix M: Social Assessment

Appendix N: EMPr

Appendix O: A3 Maps

SUMMARY: ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Cennergi, an Independent Power Producer (IPP) is proposing the construction of a coal-fired power station (the "Project") on a site near Lephalale in the Limpopo Province. The proposed coal-fired power station will have a generating capacity of up to 1 200 MW which is intended to provide electricity for integration into the national grid. The purpose of the proposed Tshivhaso Power Station is to provide baseload power to the national electricity grid.

The main infrastructure that is required for the Tshivhaso coal-fired power station includes:

- Access roads.
- Coal storage areas and bunkers. Coal is to be provided to the power station from the new Thabametsi mine to be established to the south-east of the site.
- Pipeline for water supply. Water is to be supplied from the allocation to Exxaro Coal from the Mokolo-Crocodile Water Augmentation Project (MCWAP2).
- Coal loading and offloading areas, as well as conveyor belts.
- Power plant production unit/s (boilers / furnaces, turbines, generator and associated equipment, control room).
- Ash dump.
- Wastewater treatment facilities (including Raw-Water Storage Dams, wastewater treatment works, purification works and reservoirs).
- A High Voltage Yard.
- 400kV overhead power line to connect into the Eskom grid (Matimba – Medupi loop-in line).
- Office and maintenance area/s.

The environmental impact assessment (EIA) for the proposed Tshivhaso Power Station has been undertaken in accordance with the EIA Regulations of December 2014, in terms of Section 24(5) of the National Environmental Management Act (NEMA; Act No 107 of 1998). The EIA Phase aimed to achieve the following:

- Provide an overall assessment of the social and biophysical environments affected by the proposed alternatives put forward as part of the project.

» Assess potentially significant impacts (direct, indirect and cumulative, where required) associated with the proposed project.

» Comparatively assess identified alternatives put forward as part of the project.

» Identify and recommend appropriate mitigation measures for potentially significant environmental impacts.

» Undertake a fully inclusive public involvement process to ensure that I&APs are afforded the opportunity to participate, and that their issues and concerns are recorded.

The conclusions and recommendations of this EIA are the result of the assessment of identified impacts by specialists, and the parallel process of public participation. The public consultation process has been extensive and every effort has been made to include representatives of all stakeholders in the study area.

Impact sources associated with the proposed power station and associated infrastructure are expected to include:

» Biodiversity impacts associated with the construction of the power station and associated infrastructure. While most of the expected impacts associated with this development to the actual footprint will be unavoidable, the success of mitigation will be determined by the success of preventing impacts from spreading outside the footprints of the development. Aspects such as infestation of surrounding habitat by alien and invasive species, the introduction of non-endemic and invasive animals, dust, effluents, contamination, hydro-carbons spillages, human-animal conflict situations, etc. will represent the ultimate challenge of the environmental management plan as these aspects will cause the spread and exacerbation of impacts into the natural environment caused by the development. The major objective of the environmental management programme of the development should therefore be the complete prevention and containment of any impact from the development that might cause harm to areas of surrounding natural habitat.

Ultimately, the expected loss of natural resources from the site and immediate surrounds because of the development will result in significant, but localised, impacts on the natural environment. While a significant impact is expected on the protected trees that occur on the site, the conservation status and regional abundance of these species are not expected to be affected on a local or regional scale. The overall impact to pans/wetland areas for the project would be considered to be low, as mitigation measures can be adopted in order to avoid direct and indirect impacts on pans/wetland areas. Similarly, animals could potentially be affected severely, but the mobility of most species that are of conservation concern, renders the probability of this impact unlikely.

Impacts of a cumulative nature, although estimated to result in moderate and low significance, represent a continuous, low level threat to biodiversity on a local and regional scale. The increase in industrial and mining activity in the region implies constant losses of natural habitat and species. This is exacerbated by the decline in environmental quality caused by peripheral and indirect impacts such as species invasion, degradation, contamination, disruption of ecological processes, habitat fragmentation and isolation, etc.

In conclusion however, no specific impact was identified that would render the proposed development as an unacceptable threat to the biological environment or any specific aspect or species that are known to occur, or could potentially occur within the study area or required servitudes, provided that detailed, comprehensive and sensible environmental management principles are applied throughout the lifetime of the project.

» Impacts on Soils and Agricultural Potential associated with the construction phase (soil loss and erosion) and the operational phase (permanent loss of agricultural land). The development of the power station will have low negative impact on agricultural resources and productivity. The significance of all agricultural impacts is influenced by the fact that the land is suitable only as non-arable, moderate potential grazing land. Soils on the site are sandy in texture and have limited water holding capacity. Erosion potential could increase in areas disturbed on the site during construction unless appropriate mitigation is implemented. Impacts in this regard are however expected to be of low significance with the implementation of appropriate management measures.

There are no fatal flaws associated with agriculture on the site and the project can therefore be developed, with the use of good soil management measures, during all its phases.

» Impacts on Surface and Groundwater Resources related to construction and operation of the power station. Impacts on water resources are related to quality and quantity. Impacts on water quantity of local resources are not expected as water is not proposed to be abstracted from a natural resource in the area, but will rather be obtained through the MCWAP scheme being developed by the Department of Water and Sanitation . The implementation of dry cooling and dry ashing is the preferred technology for the project in order to minimise water required thereby reducing impacts on water resources. Impacts on water quality relate to sedimentation and contamination during all phases of the project life-cycle. These impacts can be successfully managed through the implementation of appropriate mitigation and management measures, such as the use of appropriate liners for the ash dump and coal stockpile areas. Impacts on water resources are expected to be of Medium to Low significance post-mitigation. A Water Use License will be required to be obtained from the DWS. On-going water quality monitoring throughout the operational phase is required to be undertaken. A borehole monitoring network should be established for the site in order to monitor groundwater quality.

No fatal flaws were identified in the water resources assessment. From this perspective, therefore, there is no reason why the development should not proceed.

» Impacts on air quality and human health associated with the construction phase (dust) and the operational phase (emissions from the power station). Impacts associated with the construction phase are expected to be of low significance. Impacts during operation relate to dust from the ash dump and coal stockpile as well as emissions (SO2, NO2 and PM10) from the power station. From the results of the modelling undertaken, air emissions are predicted to be below the national air emission standards. Impacts are expected to be of moderate significance for all emissions. Roads should be tarred or traffic control measures implemented to limit vehicle-entrained dust from unpaved roads (e.g. by limiting vehicle speeds and by restricting traffic volumes) and the sidewalls of the ash dump should be vegetated as they rise, and the vegetation cover should be maintained to reduce the exposed area and limit wind entrainment. An Air Emissions License (AEL) is required to be obtained for the power station from the AEL Authority. On-going monitoring will be required to be undertaken throughout the life of the power station.

No fatal flaws were identified in terms of air quality and health impacts. From this perspective, therefore, there is no reason why the development should not proceed.

» Noise impacts associated with the construction (short-term) and operational (long-term) phases. Impacts are expected to be more significant during the night (22:00 – 06:00) than during the daytime (i.e. 06:00 – 22:00). Impacts during both the construction and operational phases are however expected to be of low significance. No mitigation or routine noise monitoring is therefore required in the operation phase of the facility. Generic measures are however recommended for the developer to note. Mitigation measures mainly relate to the planning phase, with the recommendation that the power station be located sufficiently away from potential noise-sensitive receptors. Measurement locations, frequencies and procedures are provided as a guideline for the developer to consider should there be a noise complaint.

No fatal flaws were identified in terms of noise impacts. From this perspective, therefore, there is no reason why the development should not proceed.

» Visual impacts associated with power station and associated infrastructure. Potential visual impacts are expected to be of Medium to low significance. Location of tall elements close to the northern site boundary is likely to make the power station more obvious to routes, homesteads and game farm areas to the north. The location of main elements away from the existing industrial land uses could make the power station more obvious and increase cumulative impacts of industrial development particularly when viewed from the Upland LCA and the D'Nyala Nature Reserve. Vegetation clearance generally during construction could make the power station more visible to surrounding areas and loss of vegetation between the Stockpoort Road and the power station could make the development visible from the road.

The development should be planned to minimise visibility particularly from the Stockpoort Road and from areas to the north of the development as well as to minimise the apparent area of industrial development particularly when viewed from higher areas within the Upland LCA. Ensure that colours used particularly for larger elements within the development do not draw attention to the development particularly when viewed from a distance. Managing vegetation buffers during the operational period to ensure their effectiveness in screening the development from surrounding areas as well as consolidation of industrial-type infrastructure will aid in decreasing operational visual impacts to acceptable levels.

No fatal flaws were identified in terms of visual impacts. From this perspective, therefore, there is no reason why the development should not proceed.

» Impacts on Heritage Sites and Palaeontology during the construction phase. In terms of the built environment of the area (Section 34), no standing structures older than 60 years occur within the study area, although the remains of several dilapidated ruins of unknown age were found. From the 1: 50 000 topographic maps of the study area it is clear that no features of significance occurred in the area.

No burial sites were recorded within the development area. It should be noted that ruins such as the features that were recorded in the study area are known to be associated with unmarked graves. If any graves are located in future they should ideally be preserved in-situ or alternatively relocated according to existing legislation. A chance find procedure in this regard must be included within the EMPr for the project.

The known site – Nelson's Kop located to the east of the site - will not be impacted by the proposed development. The impacts of the power line on heritage resources are expected to be low, but it is recommended that the final alignment should be submitted to a heritage walk down prior to construction.

No fatal flaws were identified in the heritage impact assessment study for the power station site. From an archaeological point of view there is no reason why the development should not proceed.

The great majority of the study area for the proposed Tshivhaso Coal-fired Power Plant and associated ash-dumps is underlain by sedimentary rocks of the Karoo Supergroup (Eendragtpan and Clarens Formations) as well as volcanic rocks of the Lebombo Group (Letaba Formation) that are all of low palaeontological sensitivity. Significant impacts on local fossil heritage resources are not anticipated here.

» Socio-economic impacts expected during both the construction and operation phases of the proposed project. The construction and operation of the power station is expected to have both negative and positive social and economic effects. From a socio-economic perspective, the positive effects in terms of construction, operation, and decommissioning of the coal-based power plant include an increase in national electricity capacity, economic development, job creation, increase in household income, and government revenue. However, the coal-based power station will be associated with a number of other negative effects that are more challenging to quantify and to offset. These are associated with the sense of place, property values, social pathogens, standards of living, and pressure on socio-economic infrastructure. Importantly, most of the negative impacts will be limited to the local economy or surrounding area, while positive effects will accumulate to the local and national economies. Considering that many of the negative impacts will also be possible to mitigate, although not completely eliminate, the trade-offs between negative and positive effects suggest that from the socio-economic perspective the project should be approved for development. The project will contribute to achieving local and national government developmental objectives at a relatively limited cost. Nonetheless, it is imperative that the construction, operation, and decommissioning of the project should be conducted in the most sustainable way with the primary objective of minimising, and where feasible, completely eliminating the potential for deterioration of human livelihoods, reducing business turnover, and altering the environment in the proposed area. This can be achieved to some extent through the prioritisation of using local labour and service providers, as well as through obtaining materials from local sources.

No fatal flaws were identified in terms of socio-economic impacts. From this perspective, therefore, there is no reason why the development should not proceed.

» Impacts on Climate Change. From the analysis undertaken within this EIA process, it is apparent that the proposed circulating fluidised bed combustor, fuelled with 100% coal, is in fact the most intensive in terms of carbon emissions. As such, it is the option that will have the greatest impact on climate change. While pulverised fuel will produce marginally less emissions, both technologies will produce emissions intensities above the forecasted 2025 national baseline, as expected from base load generation. Once operational there will be limited potential for the plant to reduce its emissions over its lifetime. For this reason, a hybrid technology which may allow for the gradual addition of biomass or solar thermal energy into the plant is strongly suggested. The facility should be designed with this potential addition in mind. Making provisions for the future addition of carbon capture and storage systems presents another opportunity to reduce carbon emissions.

The management of coal stockpiles and maintenance of coal crushers are important areas for operational emissions management. It would be advisable to include these facilities as core areas within a Carbon Management Plan for the power plant. Such a plan could be modelled on the Plan Do Check Act (PDCA) approach within the ISO 9001 Quality Management System Requirements. Beyond the two priority areas mentioned in the specialist report (Appendix L), the plan should aim to incorporate carbon management into the everyday organisation practices of the power plant. In general a good governance structure with high level responsibility for carbon emissions and climate change assist in effectively implementing such management plans. Specifically, it is recommended that the management plan ensure that coal be stored appropriately so as to protect it from unnecessary moisture exposure. The storage and transportation of coal must also be managed in such a way that it does not crush the coal beyond its useful size. Maintaining the coal crushers will further ensure that the coal particles are optimally sized.

Monitoring is essential to tracking the effectiveness of any carbon management plan. Monitoring of the moisture content and size of the coal particles supplied to the furnace will be of particular interest for CFB combustion. This information should be supported by the monitoring of the coal storage conditions, transport systems and crusher performance. Furthermore, it will be valuable to monitor the on-site electricity demands as these form part of a plant's parasitic load requirements and effectively reduce the amount of exportable electricity per tonne of CO2 emitted. The specific monitoring of carbon emissions will become a requirement as part of the carbon tax and may even require Tier 3 direct emissions measurement in the future. Thus is may be advisable to consider the inclusion of systems for emissions monitoring via direct measurement.

The Project is being developed in line with South Africa's energy policy framework. The magnitude of the GHG emissions from the project is expected to be very high. However new coal power plants will always have High (Negative) impacts from a GHG perspective due to the nature of their emissions, and this is not considered to be a fatal flaw provided that mitigation proposed is implemented.

Cumulative impacts. Considering the findings of the specialist assessments undertaken for the project, the cumulative impacts for the proposed project will be acceptable and the majority are rated as being of low to medium significance with the implementation of appropriate mitigation. On this basis, the following can be concluded considering the Tshivhaso Power Station and associated infrastructure:

Overall Conclusion (Impact Statement)

From the above conclusions of the specialist studies undertaken, it is concluded that the impacts associated with the construction and operation of the power station and associated infrastructure are expected to be of Medium to Low significance with the implementation of appropriate mitigation measures. No environmental fatal flaws were identified to be associated with the proposed project.

The findings of the specialist studies undertaken within this EIA to assess both the benefits and potential negative impacts anticipated as a result of the proposed project conclude that:

» The impacts associated with the construction and operation of the power station and associated infrastructure are expected to be of Medium to Low significance with the implementation of appropriate mitigation measures.

» Several areas of high sensitivity were identified within the project development area - refer to Figure 9.1. These areas must be taken into consideration when Cennergi plan their detailed on-site layouts.

» The Project is being developed in line with South Africa's energy policy framework. The magnitude of the GHG emissions from the project is expected to be very high. However new coal power plants will always have High (Negative) impacts from a GHG perspective due to the nature of their emissions, and this is not considered to be a fatal flaw provided that mitigation proposed is implemented.

» No environmental fatal flaws were identified to be associated with the proposed project.

» From the assessment of the ash dump alternatives, the option to locate the ash dump on Graafwater (the same site as the power station) is preferred.

» CFB Technology is considered preferable over conventional pulverised fuel technology due to the potential to utilise lower grade coals in the area and the reduction of emissions with the implementation of this technology.

» Dry cooling and dry ashing are considered to be the preferred options as these will minimise the requirements for water.

Overall Recommendation

Based on the nature and extent of the proposed project, the local level of disturbance predicted, the benefits expected at a regional and national scale, the findings of the EIA, and the understanding of the significance level of potential environmental impacts, it is the opinion of the EIA project team that the project can proceed on condition that the mitigation measures specified in Chapter 7 and within the EMPr are observed and implemented.

Upon authorisation of the proposed project by the DEA, the following conditions must be included within the authorisation issued:

Management and compliance monitoring

» All mitigation measures detailed within this report and the specialist reports contained within Appendices C to L must be implemented.

» The Environmental Management Programme (EMPr) as contained within Appendix M of this report must be used to ensure compliance with environmental specifications and management measures. The implementation of this EMPr for all life cycle phases of the proposed project is considered to be key in achieving the appropriate environmental management standards as detailed for this project.

» An independent Environmental Control Officer (ECO) must be appointed by the project developer prior to the commencement of any authorised activities. The ECO must monitor compliance with all applicable environmental legislation and requirements throughout the construction phase.

Design

» Following the final design of the facility, a final layout indicating all relevant infrastructure and affected areas (permanent and temporary) must be submitted to DEA for review and approval prior to commencing with construction. This layout must consider all sensitive areas identified within the site and servitude corridors.

» Develop and implement a stormwater management plan for the project considering all stormwater and water pollution control facilities such as Pollution Control Dams and storm water drainage system. Pollution control infrastructure is required to be designed in accordance with Regulation 636 of August 2013 published in terms of the NEM: Waste Act (Act No 59 of 2008).

» An appropriate liner system must be installed at the ash disposal system to be designed in accordance with Regulation 636 of August 2013 published in terms of the Waste Act.

» During construction, unnecessary disturbance to habitats should be strictly controlled and the footprint of the impact should be kept to a minimum.

Biodiversity maintenance and integrity

» Conduct an ecological walk through survey for the power station and all associated infrastructure including power lines. Results of this survey must guide permitting requirements for the removal of protected trees from the selected property.

» A detailed Alien and Invasive Plant Management Plan must be developed and implemented throughout the project life-cycle up to the decommissioning phase.

» A rehabilitation programme that makes use of locally endemic or indigenous species must be developed and implemented.

» Site rehabilitation of temporary laydown and construction areas to be undertaken immediately after construction is completed in an area.

» Limit the development to the facility footprint area and avoid impacts in adjacent habitats.

» Demarcation of suitable areas for development (mainly on habitat with low sensitivity) prior to commencement of construction.

» Undertake Search and Rescue of protected species within the development footprint prior to the undertaking of construction activities. All search and rescue must be undertaken in terms of a relevant permit obtained from the relevant conservation authority.

Air quality management

» Design and implement an air quality management plan for the operational phase of the power station.

» It is important that an emission control and reduction strategy for dust is designed and implemented, ensuring that the contribution to ambient concentrations is minimised. Roads should be tarred or traffic control measures implemented to limit vehicle-entrained dust from unpaved roads. The sidewalls of the ash dump should be vegetated as they rise, and the vegetation cover should be maintained to reduce the exposed area and limit wind entrainment. Stabilise open areas with dust palliative, gravel or similar.

Surface water and wetlands

» Where wetlands are impacted by the project, a rehabilitation programme must be prepared and implemented.

» A stormwater management plan demonstrating the separation of clean and dirty stormwater flows must be prepared and implemented.

» An Integrated Water and Waste Management Plan (IWWMP) must be developed and implemented for all phases of the proposed project.

» An Integrated Water Use License must be obtained from the Department of Water and Sanitation for all relevant water uses.

Groundwater

» Update the numerical model contained within the specialist EIA study against monitored data during operations.

» Water quantity and quality data should be collected on a regular, ongoing basis during operation. These data must be used to recalibrate and update the water management model, to prepare monitoring and audit reports, to report to the regulatory authorities against the requirements of the IWUL and other authorisations and as feedback to stakeholders in the catchment, perhaps via the CMA.

» The monitoring as recommended in the specialist geohydrology report should be established prior to operation. Geochemical analyses and modelling must be conducted on the material during operations to update the transport model and refine geochemical predictions.

Management of heritage features

» Conduct a heritage walk through survey for the power station and all associated infrastructure including power lines. Any heritage sites recorded during this survey could be mitigated by micro adjustments of the layout or through the recording of the site prior to destruction.

» Include a chance finds procedure within the EMPr for the project to address the procedures to follow in the event of unearthing archaeological or palaeontological material or graves during the construction process.

Waste management

» Monitoring of waste treatment and management facilities throughout all phases of the project should be undertaken.

» Develop and implement an Integrated Water and Waste Management Plan (IWWMP) for all phases of the project.

Noise monitoring

» No mitigation or routine noise monitoring is required in the operation phase of the facility. However, if noise measurements are conducted, annual feedback should be presented to all stakeholders and other Interested and Affected parties in the area.

Climate Change

» The facility should be designed with the potential addition of biomass of solar thermal hybrid technology in mind in order to reduce carbon emissions beyond 2025. Making provisions for the future addition of carbon capture and storage systems presents another opportunity to reduce carbon emissions.

Social impacts

» During the design and construction phase the developer should meet with local communities to determine their concerns and take into consideration any mitigating proposals. An appropriate grievance mechanism and communications plan should be designed and implemented for the project.

» Increase the local procurement practices and employment of people from local communities as far as feasible to maximize the benefits to the local economies.

» Develop and implement a traffic management plan for the construction and operational phases of the power station.

Mineral consent

» A Section 53 Application should be submitted to the Department of Mineral Resources (DMR) to ensure that proposed activities do not sterilise a mineral resource that might occur on site.

Rehabilitation and operations

» Site rehabilitation of temporary laydown and construction areas are to be undertaken immediately after construction.

» The process of communication and consultation with the community representatives must be maintained after the closure of this EIA process, and, in particular, during the construction phase associated with the proposed project.

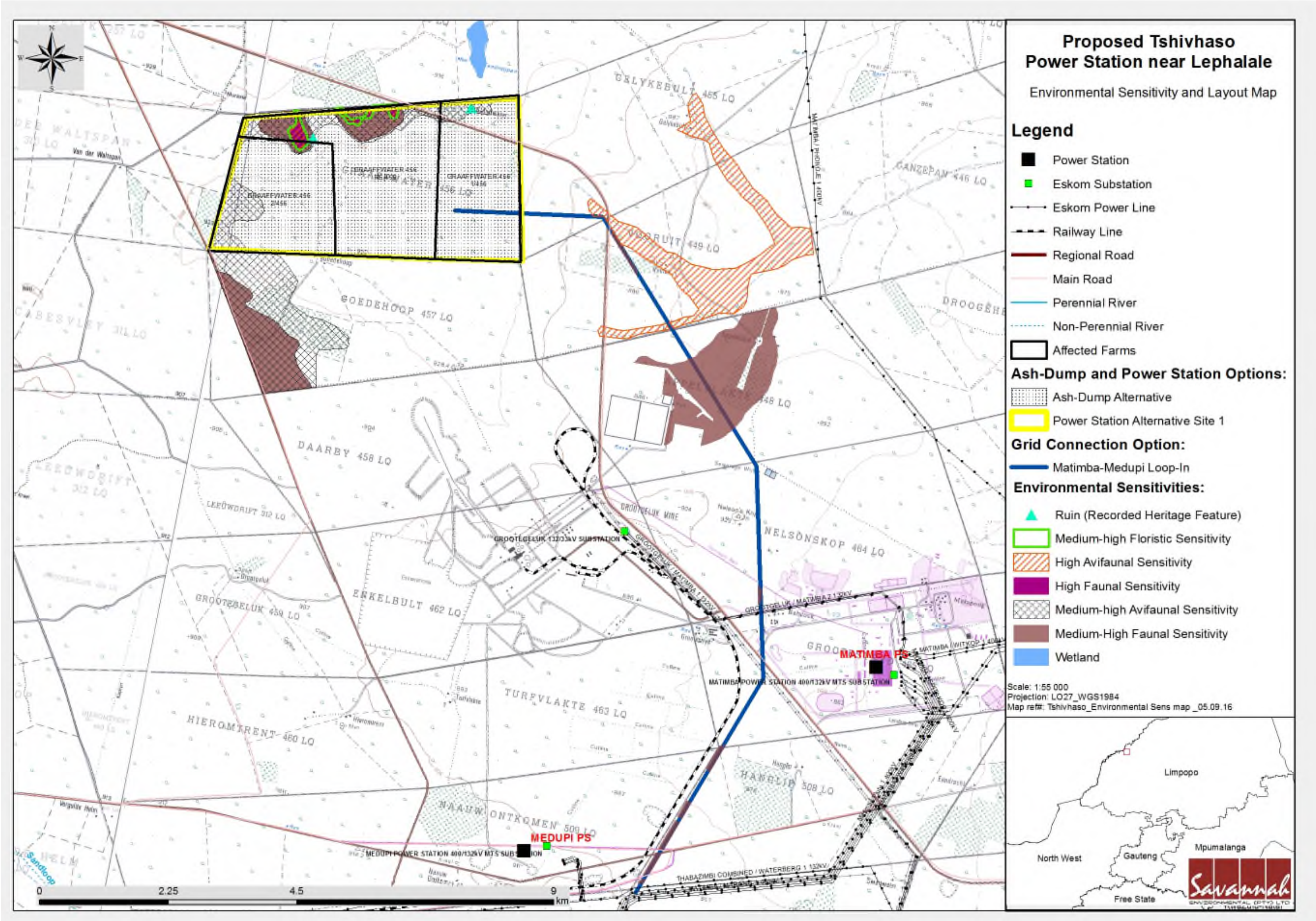


Figure 1: Environmental sensitivity map for the project study area illustrating sensitive areas ion the site **(Appendix O contains an A3 map)**

INTRODUCTION CHAPTER 1

Cennergi is proposing the construction of a coal-fired power station and associated infrastructure on a site near Lephalale in the Limpopo Province. The power station would have a capacity of up to 1200MW (to be developed in 2 phases of 600MW each). The project is to be known as the **Tshivhaso Coal-fired Power Plant**. Various options regarding siting of the power station and associated infrastructure are being investigated (refer to Figure 1.1). Coal is proposed to be sourced from Exxaro Coal's Thabametsi Coal-Mine development which is to be located in the vicinity of the sites under investigation. The electricity generated from the power station will be fed into the Eskom electricity grid.

South Africa's energy-resource base is dominated by coal. Coal provides for about 80% of South Africa's primary energy needs and according to the South Africa Yearbook 2013/14. This is unlikely to change significantly in the next 20 years due to the relative lack of suitable affordable alternatives to coal as a baseload energy source. Owing to the relatively favourable cost at which most of the deposits can be exploited, a large coal mining industry has developed in the country. About two thirds of South Africa's coal reserves and resources are in the Waterberg area, which is the driving force behind the development of Lephalale.

The Integrated Resource Plan Update report of 2013 assumes that South Africa has a total installed capacity of 48 220 MW, of which approximately 88% is generated by Eskom and specifically about three quarters is generated from Eskom owned coal-fired power stations. The IRP also recognises that electricity generation needs to increase to 80 000 MW capacity by 2030. In order to meet this required generation capacity, the IRP includes a mix of generation technologies for new generation plants, including a nuclear fleet of 9.6 GW; 6.3 GW of coal; 17.8 GW of renewables; and 8.9 GW of other generation sources.

In response to the need for additional electricity supply to the national grid, and the goal of Government to procure electricity from Independent Power Producers (IPPs), as detailed in the IRP 2010, Cennergi (the "Project Company") is proposing the construction of the Tshivhaso Coal-fired Power Plant.

As the project has the potential to impact on the environment, an Environmental Impact Assessment (EIA) process is required to be completed in support of an application for Environmental Authorisation prior to the commencement of construction of the project.

This EIA Report assesses this proposed project and consists of ten chapters, which include:

» **Chapter 1** provides background to the proposed project and the environmental impact assessment process.
» **Chapter 2** outlines the strategic legal context for the energy planning and the proposed project.
» **Chapter 3** provides a description of the proposed project.
» **Chapter 4** provides details of the alternatives considered for the proposed project.
» **Chapter 5** outlines the process which was followed during the EIA process.
» **Chapter 6** describes the existing biophysical and socio-economic environment affected by the proposed project.
» **Chapter 7** provides an assessment of the potential issues and impacts associated with the proposed project and presents recommendations for mitigation of significant impacts.
» **Chapter 8** provides an assessment of cumulative impacts.
» **Chapter 9** presents the conclusions and recommendations based on the findings of the EIA.
» **Chapter 10** provides references used to compile the EIA Report.

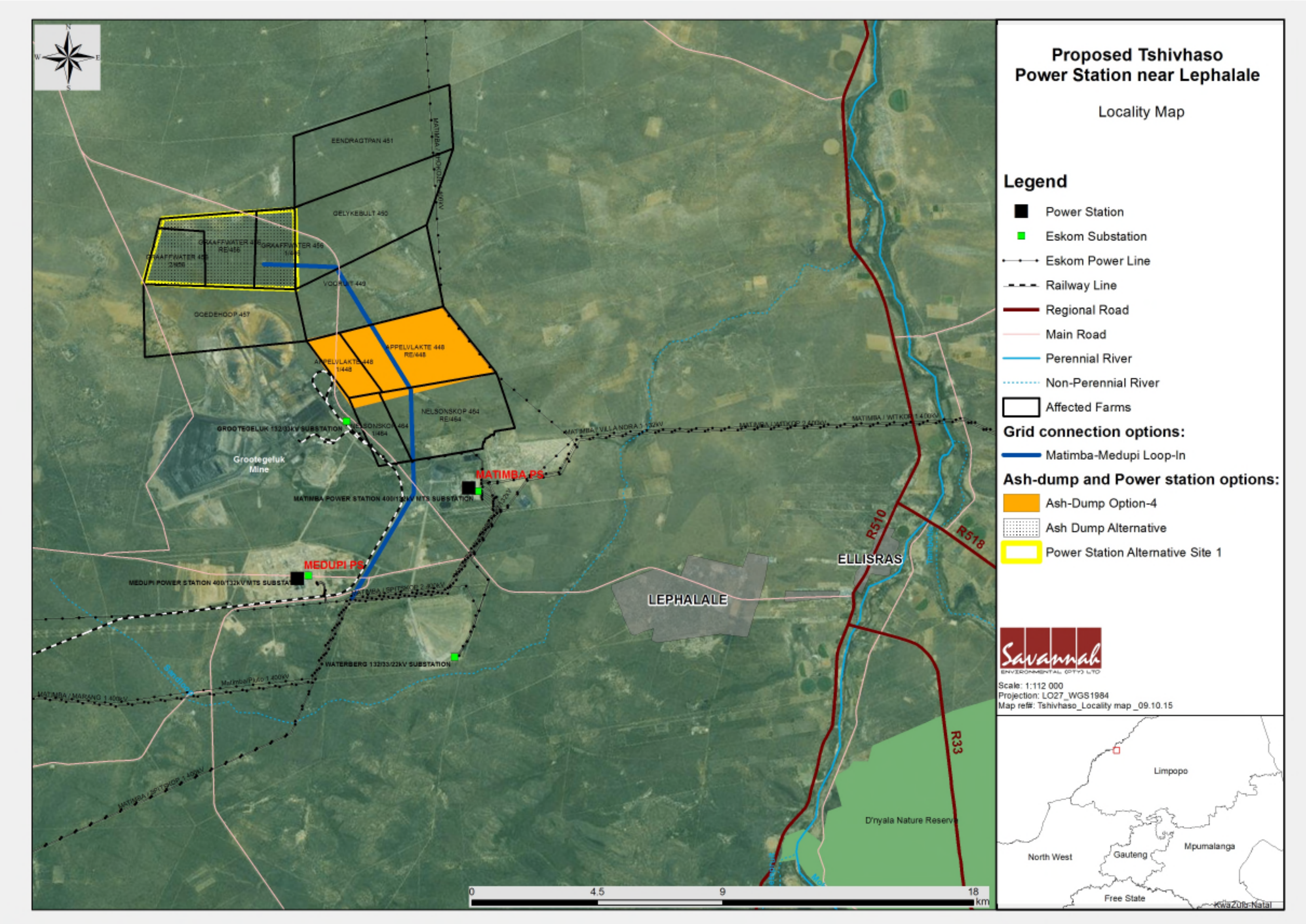


Figure 1.1: Locality map showing the proposed areas now being proposed for the establishment of the Tshivhaso coal-fired power station and associated infrastructure

1.1. Project Overview

The Tshivhaso coal-fired power plant will have a generating capacity of up to 1200 MW (to be developed in 2 phases of 600MW each). The proposed site is located approximately 26km north-west of Lephalale within the Lephalale Local Municipality, in the Waterberg District Council of the Limpopo Province. The site is located within the Waterberg Coal Fields, in close proximity to a proven coal resource. Coal is to be supplied via conveyor from the Thabametsi coal mine to be developed in close proximity to the identified alternative sites. Technologies being considered for the project include conventional pulverised coal fired or circulating fluidised bed boiler (CFB) technology. Dry cooling will be used for condensing steam exhausted from the turbines. An above-ground ash dumping (where ash is stacked in an ash dump within the power station area and the ash dump is rehabilitated (using topsoil and vegetation)) will be utilised.

The main infrastructure proposed power station includes:

» Access roads;
» Power plant production unit/s (boilers / furnaces, turbines, generators and associated equipment,);
» Raw-Water Pipeline, Treatment and Storage;
» Waste-Water Storage and Treatment;
» Storm-water and polluted-water facilities, treatment and storage;
» Coal Transfer-House, Strategic Stockpile, Working Stockyard, Silos and Conveyors;
» Limestone Rail/Road Offloading, Storage, Silos and Conveyors;
» Ash-Handling Conveyors, -Silos, -Disposal and Dump Facilities;
» Workshops, Offices, Warehouses and Control Rooms
» Hazardous and Non-Hazardous Waste, Disposal Facilities and Logistics;
» Heavy Fuel Oil (HFO), Diesel, and Liquid Petroleum Gas (LPG) Logistics and Storage;
» Rail-head extension from Grootgeluk Mine, Rail-Spur to power station, and Tippler facilities;
» High-Voltage Yards, substations and overhead power lines to connect into the Eskom grid, and
» Temporary facilities for construction, including workshop facilities, laydown areas, water-supply, electricity-supply and logistics.

More details regarding the proposed project are included within Chapters 3 and 4 of this Report.

1.1.1. Alternatives

The following site alternatives were identified for the proposed project in the Scoping Phase:

Power Plant Alternatives:

» Option 1 – GraaffwaterOption;
» Option 2 – Eendrachtpan/ Gelykebult/ Voorui Option;

Ashing Facility Alternatives

» Option 1 – Graaffwater Option;
» Option 2 – Appelvlakte Option;
» Option 3 – Jackhalsvley Option;
» Option 4 – Kalkvlakte & Elandsvley Option;
» Option 5 – Vooruit Option;

Power Evacuation Alternatives:

» Alternative 1 – Matimba – Witkop Loop-In; and
» Alternative 2 – Matimba – Medupi Loop-In.

A brief appraisal of existing data revealed that none of the sites represent a 'Fatal Flaw' or 'Red Flag' for the proposed development and that the 'No-Go' Options would not apply in any of the site alternatives. Some sites do however exhibit limitations as suitable alternatives, and should preferably not be considered as viable alternatives, especially in terms of impacts on biodiversity. From the recommendations made within the desk-top scoping study, the following was concluded:

» The **power station site alternative Option 1** (Graaffwater Option) is currently regarded the preferred option, mainly as a result of expected lower habitat sensitivities of these farms as well as the proximity to existing areas of anthropogenic transformation.

» Overall the Goedehoop Option 1 was recommended as the most suitable option for the **ashing facility**. Option 2 (Appelvlakte Option) is recommended as the second preferred alternative. However during scoping Exxaro responded that it is not desirable for them to have the ashing facility located on Farm Goedehoop from a land-use perspective. The option of placing the ashing facility on the same site as the power station (Graaffwater) was therefore considered as an alternative.

» **Power line Alternative 2** (Matimba – Medupi Loop-In), although slightly longer than Alternative 1, makes use of existing corridors of transformation, limiting the potential direct impacts to some extent. This alternative is therefore considered the preferred option and localised areas of sensitivity can be avoided through local realignment options.

Only these alternatives were assessed in the EIA-phase.

1.1.2. Need for the project

At a National level, the demand for electricity in South Africa has grown, on average, at more than 4% over the past few years, with a simultaneous reduction in the surplus generating capacity due to limited commissioning of new generation facilities and the ageing infrastructure currently owned and operated by Eskom. Although this has changed somewhat in recent years due largely to the commissioning of new generation capacity by Independent Power Producers (IPPs), there remains a need for the introduction of new baseload power generation in order to ensure reliable supply of electricity.

The Integrated Resource Plan (IRP) 2010 developed by the South African Department of Energy (DoE) projected that an additional capacity of up to 56 539MW of generation capacity will be required to support the country's economic development and ensure adequate reserves over the next twenty years. The required expansion is more than two times the size of the existing capacity of the system.

In December 2012, the Minister announced determinations regarding the expansion of electricity generation capacity by Independent Power Producers (IPPs) to contribute towards the generation of this additional required electricity. This determination includes additional base-load generation capacity of 7 761 MW, comprising of:

» 2 500 MW of energy from coal for connection to the grid between 2014 and 2024 under the Coal Baseload IPP Procurement Programme;
» 2 652 MW of gas power for connection to the grid between 2021 and 2025; and
» 2 609 MW of imported hydro power from regional projects for connection to the grid between 2022 and 2024.

1.1.3 Key Risks to Project Development

Water Availability

One of the key constraints to the development of the power station within the proposed area is the availability of water for the power generation process. A significant amount of water is required to be sourced for this purpose over the lifetime of the project. Considering the proposed locality of the project on the farm Graaffwater 456, Lephalale, it is already reported that the A42J drainage area of the Mogol River is regarded as water scarce with an over allocation on the available water sources.

Consultation with Department of Water and Sanitation has revealed that the water scarcity in the area is considered a high priority and to be addressed through the Crocodile Mogol Water Augmentation Program (MCWAP). Phase 1 of the MCWAP is already in place and needs to be further developed with the implementation of Phase 2. The DWS has appointed the Trans Caledon Tunnel Authority (TCTA) to fund and construct the required pipeline from the Hartbeespoort Dam to the Lephalale area. The pipeline forms an integral part of CMWAP Phase 2. The original planning was for the construction of a pipeline that could deliver $140Mm^3$ of raw water to Lephalale, but it was reduced to $100Mm^3$/annum when Sasol has withdrawn their development plans for the area. The latest is that the TCTA has committed for the construction of a pipeline that could deliver $75Mm^3$/annum.

The TCTA is awaiting the approval from National Treasury to obtain finance from the banking sectors to fund the MCWAP2 project. Approval in this regard is expected in due course where after the required environmental authorisations. Timeous implementation of MCWAP 2 eliminates the availability of water as a fatal flaw.

Air Quality

The rich coal reserves in the Steenbokpan Lephalale area have led to the establishment of a coal fired power station (Matimba), the largest direct dry-cooling power station in the world, and the construction of a second (Medupi) - both owned by Eskom. The combination of the existing sources of air pollution has a negative impact on air quality, and the potential exists for further impact in the light of the current development projects and proposed projects. As a result, the Minister declared the Waterberg Priority Area for Air Quality Management (Republic of South Africa, 2012a). The priority area includes the Waterberg District Municipality and Lephalale Local Municipality.

With the expansion of the power generation capacity in the Waterberg District Municipality through the Medupi and Thabametsi Powers Stations, and the associate increase in mining will result in increased ambient concentrations of SO_2, NO_X and particulates (DEA, 2015). Scenario modelling shows the potential for exceedances of the NAAQS over large parts of Lephalale Local Municipality with new and proposed power plants becoming operational.

Although unlikely to be a fatal flaw to the development of the project, air quality considerations may result in additional mitigation measures being required to be implemented for the project, which could result in additional financial requirements for the development.

1.2. Details of Environmental Assessment Practitioner and Expertise to conduct the Scoping and EIA

Savannah Environmental was contracted by Cennergi as an independent consultant to undertake the required Environmental Impact Assessment (EIA) for the proposed project, as required by the NEMA EIA Regulations of December 2014. Neither Savannah Environmental, nor any of its specialist sub-consultants on this project are subsidiaries of / or affiliated with Cennergi. Furthermore, Savannah Environmental does not have any interests in secondary developments that may arise out of the authorisation of the proposed project.

The Savannah Environmental staff and sub-consultants have acquired considerable experience in environmental assessment and environmental management over the last 10 years, and have been actively involved in undertaking environmental studies for a wide variety of projects throughout South Africa. Strong competencies have been developed in project management of environmental EIA processes, as well as strategic environmental assessment and compliance advice, and the identification of environmental management solutions and mitigation/risk minimising measures. Savannah Environmental has successfully completed various EIAs for transmission power lines, as well as EIAs for several substations, distribution power lines and power generation projects for Eskom Holdings Limited and Independent Power Producers.

Jo-Anne Thomas, is a registered Professional Natural Scientist (in the practice of environmental science) with the South African Council for Natural Scientific Professions. She has gained extensive knowledge and experience on potential environmental impacts associated with electricity generation and transmission projects through her involvement in related EIA processes over the past eighteen (18) years. She has successfully managed and undertaken EIA processes for electricity generation projects throughout South Africa. She is supported by John von Mayer, a senior environmental consultant, and Gabriele Wood, a public participation consultant, from Savannah Environmental. In order to adequately identify and assess potential environmental impacts as well as evaluate alternatives, Savannah Environmental has appointed several specialist consultants to conduct specialist studies, as required. Details of these specialist studies are included in Chapter 5.

STRATEGIC CONTEXT FOR ENERGY PLANNING CHAPTER 2

The Department of Energy (DoE) is mandated to ensure the secure and sustainable provision of energy for socio- economic development. This is achieved by developing an integrated energy plan, regulating the energy industries, and promoting investment in accordance with the integrated resource plan. The department's strategic goals are to:

» ensure that energy supply is secure and demand is well managed
» facilitate an efficient, competitive and responsive energy infrastructure network
» ensure that there is improved energy regulation and competition
» ensure that there is an efficient and diverse energy mix for universal access within a transformed energy sector
» ensure that environmental assets and natural resources are protected and continually enhanced by cleaner energy technologies
» implement policies that adapt to and mitigate the effects of climate change
» implement good corporate governance for effective and efficient service delivery.

The DoE places emphasis on broadening electricity supply technologies to include gas and imports, as well as nuclear, biomass and renewable energy resources (wind, solar and hydro), to meet the country's future electricity needs and reduce its carbon-dioxide (CO_2) emissions.

Goals beyond 2020 include contracting more than 20 000 megawatts (MW) of renewable energy, including an increasing share from regional hydro-electricity.

About 11 000 MW of Eskom's older coal-powered stations will be decommissioned, but close to 6 000 MW of new coal capacity will be contracted – part of it from other southern African countries.

South Africa has committed to attain substantial reductions in CO_2 emissions by 2025. The country supports research, technology development and special measures aimed at environmentally sustainable economic growth.

2.1 Strategic Electricity Planning in South Africa

The need to expand electricity generation capacity in South Africa is based on national policy and informed by on-going strategic planning undertaken by the Department of Energy (DoE). The hierarchy of policy and planning documentation that support the development of energy projects such as the proposed Tshivhaso Power Plant is illustrated in **Figure 2.1**.

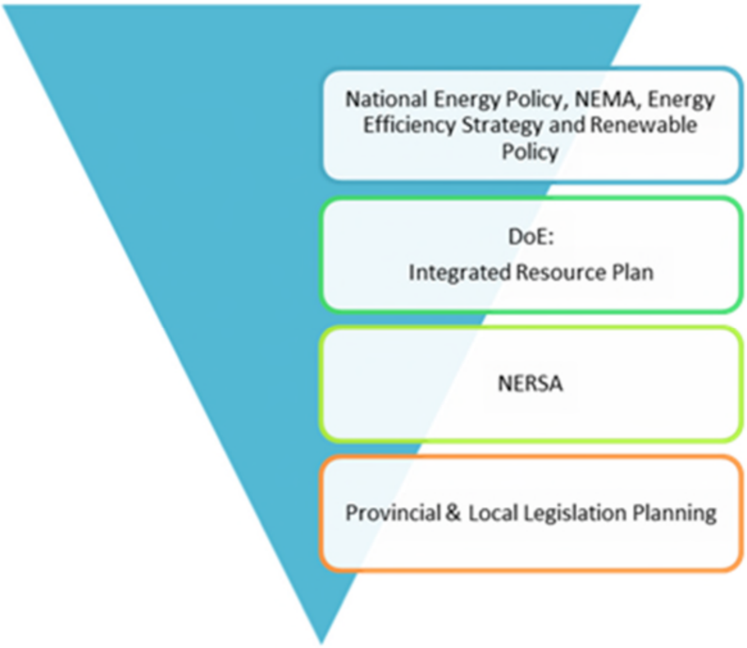


Figure 2.1: Hierarchy of electricity policy and planning documents

These policies are discussed in more detail in the following sections, along with the provincial and local policies or plans that have relevance to the proposed development.

2.2. Regulatory Hierarchy

The South African energy industry is evolving rapidly, with regular changes to legislation and industry role-players. The regulatory hierarchy for an energy generation project of this nature consists of three tiers of authority who exercise control through both statutory and non-statutory instruments – that is National, Provincial and Local levels.

At **National Level**, the main regulatory agencies are:

» *Department of Energy (DoE):* This Department is responsible for policy relating to all energy forms, including renewable energy, and are responsible for forming and approving the IRP (Integrated Resource Plan for Electricity).

» *National Energy Regulator of South Africa (NERSA):* This body is responsible for regulating all aspects of the electricity sector, and will ultimately issue licenses for projects to generate electricity.

» *Department of Environmental Affairs (DEA):* This Department is responsible for environmental policy and is the controlling authority in terms of NEMA and the EIA Regulations. The DEA is the competent authority for this project, and charged with granting the relevant environmental authorisation.

» *The South African Heritage Resources Agency (SAHRA):* The National Heritage Resources Act (Act No 25 of 1999) and the associated provincial regulations provides legislative protection for listed or proclaimed sites.
» *South African National Roads Agency (SANRAL):* This agency of the Department of Transport is responsible for all National road routes.
» *Department of Water and Sanitation (DWS):* This Department is responsible for effective and efficient water resources management to ensure sustainable economic and social development. This Department is also responsible for evaluating and issuing licenses pertaining to water use.
» *Department of Agriculture, Forestry and Fisheries (DAFF):* This Department is the custodian of South Africa's agriculture, fisheries and forestry resources and is primarily responsible for the formulation and implementation of policies governing the Agriculture, Forestry and Fisheries Sector.
» *Department of Mineral Resources:* Approval from the Department of Mineral Resources (DMR) may be required to use land surface contrary to the objects of the Act in terms of section 53 of the Mineral and Petroleum Resources Development Act, (Act No 28 of 2002): In terms of the Act approval from the Minister of Mineral Resources is required to ensure that proposed activities do not sterilise a mineral resources that might occur on site.

At **Provincial Level**, the main regulatory agencies are:
» *Provincial Government of Limpopo Province – Department of Economic Development, Environment and Tourism (LEDET):* This department is the commenting authority for this project for environmental assessments as well as development planning applications.
» *Department of Transport and Public Works (Limpopo):* This department is responsible for roads and the granting of exemption permits for the conveyance of abnormal loads on public roads.
» *Department of Agriculture:* This Department's involvement relates specifically to sustainable resource management and land care.
» *Limpopo Heritage Resources Authority (LIHRA:* LIHRA is a provincial heritage resources authority. This public entity seeks to identify, protect and conserve the rich and diverse heritage resources of the Limpopo province.
» *Department of Water and Sanitation:* This Department is responsible for evaluating and issuing licenses pertaining to water use.

At **Local Level** the local and municipal authorities are the principal regulatory authorities responsible for planning, land use and the environment. The site is located within the Lephalale Local Municipality.

» In terms of the Municipal Systems Act (Act No 32 of 2000) it is compulsory for all municipalities to go through an Integrated Development Planning (IDP) process to prepare a five-year strategic development plan for the area under their control.

- Bioregional planning involves the identification of priority areas for conservation and their placement within a planning framework of core, buffer and transition areas. These could include reference to visual and scenic resources and the identification of areas of special significance, together with visual guidelines for the area covered by these plans.
- By-laws and policies have been formulated by local authorities to protect visual and aesthetic resources relating to urban edge lines, scenic drives, special areas, signage, communication masts, etc.

There are also numerous non-statutory bodies such as and environmental lobby groups that play a role in various aspects of planning and the environment that will influence development of this nature.

2.3. National Policy

2.3.1 The National Energy Act (2008)

The National Energy Act was promulgated in 2008 (Act No 34 of 2008). One of the objectives of the Act was to promote diversity of supply of energy and its sources. The National Energy Act aims to ensure that diverse energy resources are available, in sustainable quantities and at affordable prices, to the South African economy in support of economic growth and poverty alleviation, taking into account environmental management requirements and interactions amongst economic sectors. The Act provides the legal framework which supports the development of power generation facilities.

2.3.2 White Paper on the Energy Policy of South Africa, 1998

The South African Energy Policy, published in December 1998 by the Department of Minerals and Energy (DME) identifies five key objectives, namely:

- Increasing access to affordable energy services;
- Improving energy sector governance;
- Stimulating economic development;
- Managing energy-related environmental impacts; and
- Securing supply through diversity.

In order to meet these objectives and the developmental and socio-economic objectives in South Africa, the country needs to optimally use the available energy resources. The South African Government is required to address what can be done to meet these electricity needs both in the short- and long-term. The White Paper identifies key objectives for energy supply, such as increasing access to affordable energy services, managing energy-related environmental impacts and securing energy supply through diversity.

2.3.3 Final Integrated Resource Plan, 2010 - 2030

The Integrated Resource Plan (IRP) 2010-30 was promulgated in March 2011. The primary objective of the IRP 2010 is to determine the long term electricity demand and detail how this demand should be met in terms of generating capacity, type, timing and cost. However, the IRP 2010 also serves as input to other planning functions, *inter alia* economic development, and funding, environmental and social policy formulation. The accuracy of the IRP 2010 is to be improved by regular reviews and updates, and a draft revised Plan is currently available for public comment. The IRP 2010 projected that an additional capacity of up to 56 539MW of generation capacity will be required to support the country's economic devlopment and ensure adaquate reserves over the next twenty years. The required expansion is more than two times the size of of the existing capacity of the system.

The current iteration of the Integrated Resource Plan (IRP) for South Africa, initiated by the Department of Energy (DoE) after a first round of public participation in June 2010, led to the Revised Balanced Scenario (RBS) that was published in October 2010. The document outlines the proposed generation new build fleet for South Africa for the period 2010 to 2030. This scenario was derived based on the cost-optimal solution for new build options (considering the direct costs of new build power plants), which was then "balanced" in accordance with qualitative measures such as local job creation. In addition to all existing and committed power plants, the RBS included a nuclear fleet of 9.6 GW; **6.3 GW of coal**; 17.8 GW of renewables; and 8.9 GW of other generation sources.

	New build options							
	Coal (PF, FBC, imports, own build)	Nuclear	Import hydro	Gas – CCGT	Peak – OCGT	Wind	CSP	Solar PV
	MW	MW	MW	MW	MW	MW	MW	MW
2010	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	300
2013	0	0	0	0	0	0	0	300
2014	500[1]	0	0	0	0	400	0	300
2015	500[1]	0	0	0	0	400	0	300
2016	0	0	0	0	0	400	100	300
2017	0	0	0	0	0	400	100	300
2018	0	0	0	0	0	400[4]	100[4]	300[4]
2019	250	0	0	237[3]	0	400[4]	100[4]	300[4]
2020	250	0	0	237[3]	0	400	100	300
2021	250	0	0	237[3]	0	400	100	300
2022	250	0	1 143[2]	0	805	400	100	300
2023	250	1 600	1 183[2]	0	805	400	100	300
2024	250	1 600	283[2]	0	0	800	100	300
2025	250	1 600	0	0	805	1 600	100	1 000
2026	1 000	1 600	0	0	0	400	0	500
2027	250	0	0	0	0	1 600	0	500
2028	1 000	1 600	0	474	690	0	0	500
2029	250	1 600	0	237	805	0	0	1 000
2030	1 000	0	0	948	0	0	0	1 000
Total	6 250	9 600	2 609	2 370	3 910	8 400	1 000	8 400

Firm commitment necessary now

Final commitment in IRP 2012

1. Built, owned & operated by IPPs 2. Commitment necessary due to required high-voltage infrastructure, which has long lead time 3. Commitment necessary due to required gas infrastructure, which has long lead time 4. Possibly required grid upgrade has long lead time and thus makes commitment to power capacity necessary

Figure 2.2: National Energy Development Commitments detailed in the IRP 2010

Figure 2.2 above indicates the new capacities of the Policy commitment. The dates shown indicate the latest that the capacity is required in order to avoid security of supply concerns. The IRP notes that projects could be concluded earlier than indicated if feasible.

When promulgated in March 2011, it was indicated that the IRP should be a "living plan" which would be revised by the Department of Energy (DoE) every two years. Since the promulgation of the IRP 2010 there have been a number of developments in the energy sector in South and Southern Africa. In addition the electricity demand outlook has changed markedly from that expected in 2010. The DoE completed an IRP 2010 Update (which was available for comments until 7 February 2014). This update was not been promulgated. The IRP 2010 is therefore considered to be the basis for energy planning in the country at this stage.

2.3.4 Electricity Regulation Act, 2006

Under the National Energy Regulator Act, 2004 (Act No 40 of 2004), the Electricity Regulation Act, 2006 (Act No 4 of 2006) and all subsequent relevant Acts of Amendment, NERSA has the mandate to determine the prices at and conditions under which electricity may be supplied by licence to Independent Power Producers

(IPPs). NERSA has recently awarded electricity generation licences for new generation capacity projects to energy generation projects under the Renewable Energy IPP procurement (REIPPP) programme. Generation licenses will be issued in the same manner to IPPs who are successful through the Coal Baseload IPP Procurement Programme.

In terms of Regulation 34 of the Act, the Minister may, in consultation with NERSA, make determinations regarding whether new generation capacity shall be established by Eskom, any other Organ of State or an IPP. If the determination requires that the new generation capacity be established by an IPP, the Minister shall also determine the identity of the buyer or, where applicable, the procurer and the buyer. In December 2012, the Minister announced determinations regarding the expansion of electricity generation capacity by Independent Power Producers (IPPs) to contribute towards the generation of this additional required electricity. This determination including includes additional base-load generation capacity of 7 761 MW, comprising of:

» 2 500 MW of energy from coal for connection to the grid between 2014 and 2024 under the Coal Baseload IPP Procurement Programme;
» 2 652 MW of gas power for connection to the grid between 2021 and 2025; and
» 2 609 MW of imported hydro power from regional projects for connection to the grid between 2022 and 2024.

2.3.5. Integrated Energy Plan

The development of a national Integrated Energy Plan (IEP) was envisaged in the White Paper on Energy Policy of 1998 and the Minister of Energy, as entrenched in the National Energy Act of 2008, is mandated to develop and publish the IEP on an annual basis. The IEP takes existing policy into consideration and provides a roadmap of the future energy landscape for South Africa which guides future energy infrastructure investments and policy development.

The IEP takes into consideration the crucial role that energy plays in the entire economy of the country and is informed by the output of analyses founded on a solid fact base. It is a multi-faceted, long-term energy framework which has multiple aims, some of which include:

» To guide the development of energy policies and, where relevant, set the framework for regulations in the energy sector.
» To guide the selection of appropriate technologies to meet energy demand (i.e. the types and sizes of new power plants and refineries to be built and the prices that should be charged for fuels).

- » To guide investment in and the development of energy infrastructure in South Africa.
- » To propose alternative energy strategies which are informed by testing the potential impacts of various factors such as proposed policies, introduction of new technologies, and effects of exogenous macro-economic factors.

Eight key objectives for energy planning were identified:

- » Objective 1: Ensure the security of supply
- » Objective 2: Minimise the cost of energy
- » Objective 3: Increase access to energy
- » Objective 4: Diversify supply sources and primary sources of energy
- » Objective 5: Minimise emissions from the energy sector
- » Objective 6: Promote energy efficiency in the economy
- » Objective 7: Promote localisation and technology transfer and the creation of jobs
- » Objective 8: Promote the conservation of water

The DoE has released a draft Integrated Energy Planning Report (June 2013) for public comment. Once the implications of all the energy options have been explored and evaluated against each of the eight (8) key objectives, final recommendations will be made in the form of the Final IEP Report. The DoE has acknowledged the need to finalise the IEP, which will also provide the revised IRP (DoE Strategic Plan, 2015-2020). The DoE must ensure that these policies serve both the purpose of providing policy certainty as well as ensuring energy security, support development of local industries, job creation and skills transfer.

2.3.6. The Kyoto Protocol, 1997

South Africa's electricity is mainly generated from coal-based technologies. South Africa accounts for ~38 % of Africa's CO_2 (a greenhouse gas contributing to climate change) from burning of fossil fuels and industrial processes. The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. South Africa ratified the Kyoto Protocol in 2002. The Kyoto Protocol requires developing countries to reduce its greenhouse gas emissions through actively cutting down on using fossil fuels, or by utilising more renewable resources. Therefore certain guidelines and policies (discussed further in the sections below) were put in place for the Government's plans to reduce greenhouse gas emissions. The development of renewable energy projects (such as the proposed CSP energy facility) is therefore in line with South Africa's international obligations in terms of the Kyoto Protocol. A second commitment period commenced from 1 January 2013, and extends to 31 December 2020.

2.3.7. United Nations Framework Convention on Climate Change and COP21 – Paris Agreement

Climate change is one of the major global challenges of the 21st century that require global response. The adverse impacts of climate change include persistent drought and extreme weather events, rising sea levels, coastal erosion and ocean acidification, further threatening food security, water, energy and health, and more broadly efforts to eradicate poverty and achieving sustainable development. Combating climate change would require substantial and sustained reductions in greenhouse gas emissions (GHGs), which, together with adaptation, can limit climate change risks. The convention responsible for dealing with climate change is called United Nations Framework Convention on Climate Change (UNFCCC).

The UNFCCC was adopted in 1992 and entered into force in 1994. It provides the overall global policy framework for addressing the climate change issue and marks the first international political response to climate change. The UNFCCC sets out a framework for action aimed at stabilizing atmospheric concentrations of greenhouse gases to avoid dangerous anthropogenic interference with the climate system.

The Convention has established a variety of arrangements to govern, coordinate and provide for oversight of the arrangements described in this document. The oversight bodies take decisions, provide regular guidance, and keep the arrangements under regular review in order to enhance and ensure their effectiveness and efficiency. The Conference of Parties (COP), established by Article 7 of the Convention, is the supreme body and highest decision-making organ of the Convention. It reviews the implementation of the Convention and any related legal instruments, and takes decisions to promote the effective implementation of the Convention.

COP 21 was held in Paris from 30 November to 12 December 2015. From this conference, an agreement to tackle global warming was reached between 195 countries. This Agreement shall be open for signature and subject to ratification, acceptance or approval by States and regional economic integration organizations that are Parties to the Convention from 22 April 2016 to 21 April 2017. Thereafter, this Agreement shall be open for accession from the day following the date on which it is closed for signature. The agreement can only enter into force once it has been ratified by 55 countries, representing at least 55% of emissions. South Africa signed the Agreement in April 2016.

This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;
(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

In order to achieve the long-term temperature goal set out in Article 2 of the Agreement, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty.

In working towards this goal, advanced economies have already included renewables in their energy mix and have planned to increase their use in order to meet their mitigation goals: Japan aims to derive 22-24% of its electricity production from renewable sources by 2030 and the European Union plans for them to reach 27% of its final energy consumption. Developing countries are also playing their part, including South Africa which has included a goal of 17,8GW of renewables by 2030 within the IRP.

South Africa supports the adoption of the Paris Agreement and will be required to communicate a nationally determined contribution to the global response to climate change every five years from 2020.

2.3.8. Department of Energy Process for Independent Power Producers (IPPs)

The Coal Baseload IPP Procurement Programme aims to procure 2 500MW of electricity from coal fired power stations with individual bids capped at 600MW per project. The programme is designed to contribute towards socio-economic development and sustainable growth, and to start and stimulate the participation of independent power producers in the Baseload Energy generation capacity industry in South Africa.

The IPP will undergo a bidding process in which the Department of Energy will determine preferred bidders. A preferred bidder will be held to compliance with the price and economic development proposals in its bid, with regular reporting to demonstrate compliance during the life of the project.

2.4. Provincial Policy and Planning Context

2.4.1. Limpopo Development Plan 2015 - 2019

The Limpopo Employment Growth and Development Plan aims to solve the problem areas of growth, decent jobs and poverty reduction within a broad economic wide framework. This plan synthesises findings from recent analysis of different sectors and features of the Limpopo political economy. While its focus is broad, it does not try to present all the components of a comprehensive growth plan – in some areas, it points instead to issues where further investigation is called for. The main objective of this plan is to contribute to the economic debate in the province and in the country by highlighting policy imperatives that should be addressed to promote growth and employment in a complex international and domestic economic environment. The proposed project will contribute to growth and development of the study area by expanding the economic base and creating employment opportunities.

2.4.2. Limpopo Green Energy Development Plan

The Limpopo Green Energy Development plant includes Climate change response strategies for the province.

2.5. Local Policy and Planning Context

2.5.1. Waterberg District Spatial Development Framework (2009)

The overarching aim of the Waterberg District Spatial Development Framework (SDF) is to provide a spatial framework within which the sustainable development of the district and its specific resources can be carried out. The Framework is intended to be broad-scaled and centred on principles and issues significant to the district as a whole. The principle focus of the SDF is on spatial elements. The Waterberg SDF consists of 6 main objectives namely:

» restructure spatially inefficient settlements;
» promote the sustainable use of the land resources in the country;
» channel resources to area of greatest need and development potential, thereby redressing the inequitable historical treatment of marginalised areas;

- take into account the fiscal, institutional and administrative capacities of role players, the needs of communities and the environment;
- stimulate economic development opportunities in rural and urban areas; and
- support an equitable protection of rights to and in land.

The proposed project will contribute towards the stimulation of economic development opportunities, specifically within the energy sector.

2.5.2. Waterberg District Municipality Integrated Development Plan (2015/2016)

The integrated planning approach for the Waterberg District is documented in the IDP which focuses on: local economic development and spatial rational; municipal transformation and organisational development; good governance and public participation; basic service delivery and infrastructure; municipal financial viability and financial management. The vision of the Municipality is "to be the energy hub and eco-tourism destination in Southern Africa." The municipality's mission is "to invest in a constituency of talented human capital who are motivated and innovative to build a sustainable economy in the field of energy, minerals and eco-tourism for the benefit of all our communities." The proposed project will contribute in assisting the WDM in its aim for building a sustainable economy in the field of energy.

2.5.3. Waterberg District Environmental Management Framework (EMF) (2010)

The WDM, together with the Department of Environmental Affairs (DEA), developed an Environmental Management Framework (EMF) for the WDM area. The purpose of the EMF is to develop a framework that will integrate policies and frameworks, and align different government mandates in a way that will streamline decision-making to improve cooperative governance and guide future development in an environmentally responsible manner. The specific objectives of the EMF include:

- Encourage sustainable development;
- establish development priorities;
- identify strategic guidance and development management proposals;
- identify the status quo, development pressures and trends in the area;
- determine opportunities and constraints;
- identify geographical areas in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- specify additional activities within identified geographical areas that will require EIA based on the environmental attributes of such areas;
- specify currently listed activities that will be excluded from EIA within certain identified geographical areas based on the environmental attributes of such areas; and

» develop a decision support system for development in the area to ensure that environmental attributes, issues and priorities are taken into account.

The EMF defines Environmental Management Zones for the Waterberg on the basis of the status quo of the area as well as from inputs obtained through the EMF development process. The proposed project development site falls within Zone 4: Mining focus areas (refer to Figure 2.3). This zone represents areas where significant mineral resources (in this instance coal) of strategic national importance occur within largely natural environments. The proposed power station would be viewed as a preferred development within this Zone as it is directly associated with mining, and does not restrict or constrain potential mineral exploitation.

2.5.4. Lephalale Local Municipality IDP (2013 – 2016)

The proposed project site falls within Spatial Development Area 3 (mixed non-residential land-use driven by mining and energy) as defined in the Spatial Development Framework and within the mining zone (focus area 3) as defined in the IDP. The proposed project is therefore in line with the strategic planning of the municipality.

The IDP acknowledges the coal reserves and potential for establishment of additional mines and power stations in the area as part of the municipality's competitive advantage. These developments are recognised as being part of the economic development potential of Lephalale and will contribute towards benefits to the local community. Further, the creation of an enabling environment where the electricity sector can become a hub within the provincial and national economy is noted as a contributing factor towards the realisation of development opportunities within the municipality.

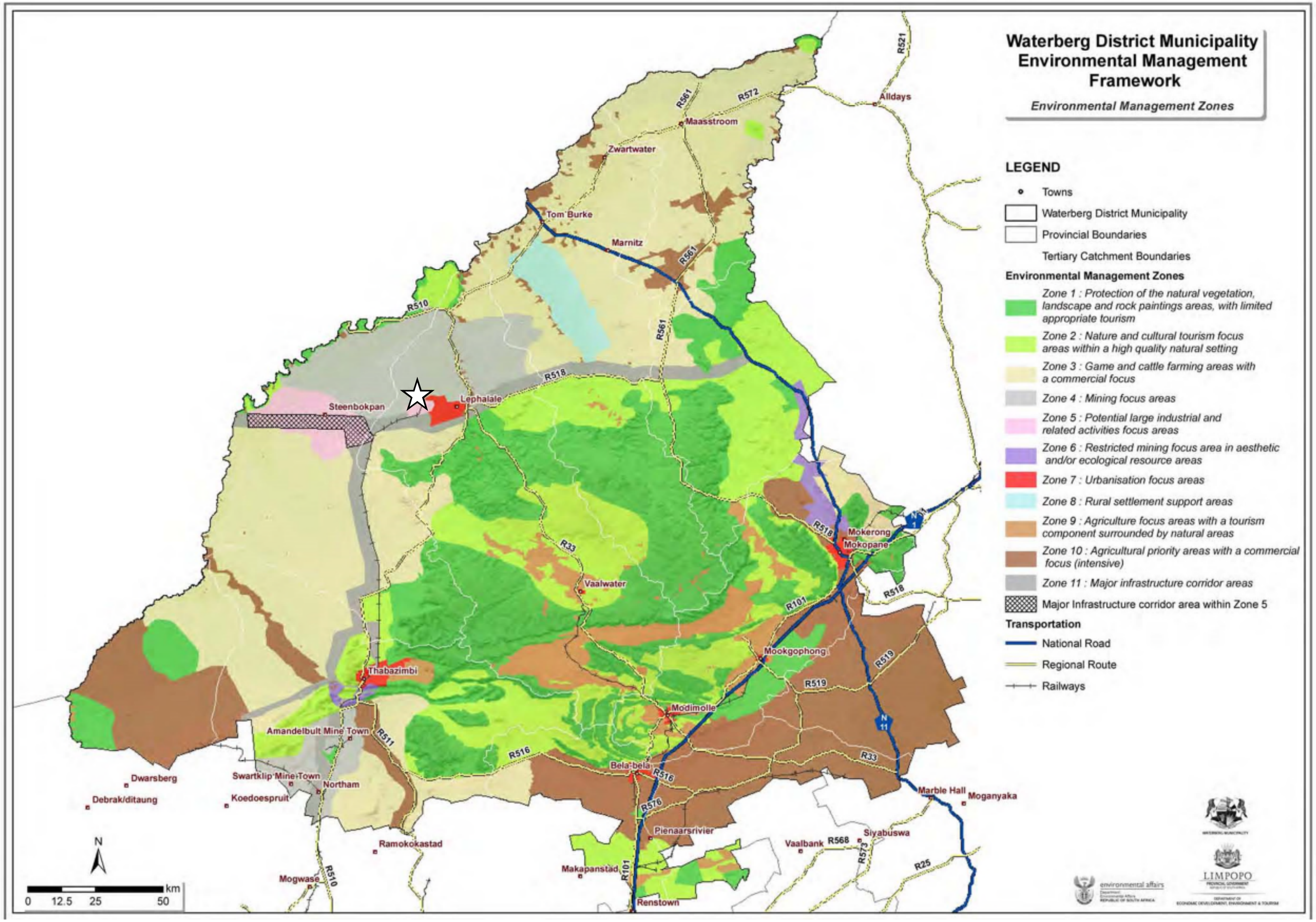


Figure 2.3: WDM EMF: Environmental Management Zones showing the location of the study area (white star)

2.4 International Standards

2.4.1 Equator Principles

The Equator Principles is a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects and is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making. The Principles include:

» Principle 1: Review and Categorisation
» Principle 2: Environmental and Social Assessment
» Principle 3: Applicable Environmental and Social Standards
» Principle 4: Environmental and Social Management System and Equator Principles Action Plan
» Principle 5: Stakeholder Engagement
» Principle 6: Grievance Mechanism
» Principle 7: Independent Review
» Principle 8: Covenants
» Principle 9: Independent Monitoring and Reporting
» Principle 10: Reporting and Transparency

Should funding for the project by Equator Principles Financial Institutions (EPFIs) be required, the EPs will need to be complied with, whereupon, the following documentation will need to be considered:

» The Equator Principles (June 2013)
» International Finance Corporations Performance Standards, 2012
» International Finance Corporations General Environment, Health and Safety

2.4.2 IFC Performance Standards

The Equator Principles' Social and Environmental Rating Framework integrally derives from the International Finance Corporation (IFC) Performance Standards which were developed to manage social and environmental risks and impacts and to enhance development opportunities. Together, they establish standards that the client is to meet throughout the life of an investment.

IFC Performance Standards (January 2012) are as follows:

» Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
» Performance Standard 2: Labour and Working Conditions

- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

The IFC published General Environmental, Health and Safety Guidelines, which contain information on environmental, health, and safety issues potentially applicable to all industry sectors. An industry specific **Environmental Health and Safety Guidelines for Thermal Power Plants** (including coal-fired power stations) was developed as a technical reference document providing industry-specific examples of Good International Industry Practice (GIIP)[1]. The guideline contains a detailed description of industry activities, impacts and risks for this sector, as well as guidance for Environmental Assessment of thermal power projects of which this EIA Report takes cognisance.

Environmental issues in thermal power plant projects during operations primarily include air emissions, Greenhouse Gas emissions, water consumption and aquatic habitat alteration, effluent discharge, solid wastes, hazardous materials and oil and noise. In addition, health and safety impacts are of particular concern during operation of thermal power plants due to risks relating to non-ionizing radiation, heat, noise, confined spaces, electrical hazards, fire and explosion hazards, chemical hazards and dust.

[1] Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

SCOPE AND DESCRIPTION OF THE PROJECT CHAPTER 3

The Tshivhaso Power Station and associated infrastructure is proposed to be developed on a site located approximately 26km north-west of Lephalale within the Lephalale Local Municipality, in the Waterberg District Council of the Limpopo Province. The site is located within the Waterberg Coal Fields, in close proximity to a proven coal resource. A potentially feasible site for the power station has been identified through a feasibility study and environmental scoping study. The location of this site is considered to be preferred by virtue of technical considerations (discussed in more detail below and in Chapter 4), as well as its location in relation to other industrial-type activities and within a Mining Focus Area (as defined in the EMF for the Waterberg District Municipality).

3.1. Need and Desirability for the Proposed Tshivhaso Coal-Fired Power Station

3.1.1. Need for the Project at a National Level

Approximately 80% of South African electricity comes from coal-fired power stations, with Eskom being the dominant electricity producing company generating 95% of all electricity in South Africa (SA Yearbook 2009/2010). Electricity demand is expected to double over the next 20 years as government implements its Programme of Action, including the Infrastructure Development Programme, to put the country's economy onto a higher growth path (http://www.gov.za/about-sa/energy). Although the electricity demand shows a slight negative trend over the recent past, the maximum demand, together with the greater need for maintenance of existing power plants, has put the available power supply under pressure. In spite of capacity coming on line in the near future (as a result of the commissioning of Medupi Power Station near Lephalale, and a number of renewable energy projects across the country), the electricity demand within the country is still higher than the available capacity.

The Integrated Resource Plan (IRP) 2010 developed by the Department of Energy projected that an additional capacity of up to 56 539MW of generation capacity will be required to support the country's economic development and ensure adequate reserves over the next twenty years. The required expansion is more than two times the size of the existing capacity of the system. In order to meet this required generation capacity, the IRP includes a mix of generation technologies, including a nuclear fleet of 9.6 GW; **6.3 GW of coal**; 17.8 GW of renewables; and 8.9 GW of other generation sources. Between 2010 and 2020, the IRP (2010) provides that 14.7% of the generation capacities of the envisioned coal-powered power stations to be developed are to be added by Independent Power Producers (IPPs).

The need to develop IPP coal-fired power stations has been identified by Cennergi in order to meet the requirements of the IRP 2010 and the determination by the Minister for 2500MW to be developed by IPPs. In addition, the proposed project is considered desirable in terms of the planning and policy aims and needs of the Limpopo Province, Waterberg District Municipality and Lephalale Local Municipality, as discussed in the previous chapter of this report.

3.1.2. Desirability of the Proposed Site for the Project

Cennergi completed a high level desktop investigation to inform the technical and bankable feasibility of the proposed power plant project. The study concluded that several key advantages exist from a locational perspective which directly inform the need and desirability of the project, the primary advantages being:

» Proximity to the coal resource for use in the firing process. As the availability of the coal resource is critical to the development of such a project, the location of the power station is constrained to a large degree by the location of this resource. Over 50% of South Africa's remaining coal reserves lie in the Waterberg coalfields, a 3 500km^2 expanse of Limpopo that stretches into Botswana and hosts almost 76 billion tonnes of in-situ inferred resources in 11 coal-bearing zones. In order to exploit this resource, a number of new coal mines are proposed in the Waterberg area. Of particular relevance to the proposed power station is the new coal mine, Thabametsi Coal Mine, to be developed by Exxaro Resources. This mine will provide the required coal resource to the power station for the operational life of the power station.
» Raw water surplus from mines and other industrial sources in the area.
» Generation would result in a substantial reduction in pressure on the Eskom grid.

The construction and operation of the Tshivhaso power-plant at the proposed site is considered to be technically feasible due to the industrial and mining land use context and the availability of coal and water resources for the operation of the power station.

From an environmental perspective, the following can be concluded when considering the Tshivhaso Power Station and associated infrastructure (as discussed and assessed within Chapter 7):

» The construction of the project will not result in the unacceptable loss of threatened or protected plant species. The proposed development is acceptable from an ecological perspective.
» Moderate risk to fauna and avifauna through loss of habitat.

» An appraisal of the potential and likely impacts on the floristic environment indicated the no immediate Red Flags were identified. However, an evaluation of impacts revealed that certain sensitive parts of the study area should be excluded from the proposed development. Furthermore, the application of detailed and site-specific mitigation measures is required to ameliorate significant impacts to an acceptable significance level.
» The construction of the project will not result in the complete or whole-scale change in sense of place and character of the area nor will the project result in unacceptable visual intrusion.
» The construction of the project will not result in unacceptable loss of or impact to heritage resources.
» The project will not significantly increase the negative impact on the social environment. However, an increase in positive impacts, specifically as a result of job creation and socio-economic benefits, can be expected.
» The project will contribute towards a reduction in greenhouse gas emissions from energy generation and will aid the country in meeting the commitments made under the COP 21 Agreement, to which the Government has committed to become a signatory.

3.1.3. Need and Desirability of the Site from a Socio-economic Perspective

The following table outlines the need and desirability of the proposed project from a locational perspective. It informs the justification of the project to be built in the proposed time and location from a socio-economic perspective.

Table 3.1: Socio-economic need and desirability assessment

Aspect	Comment
Creation of residential and employment opportunities in close proximity to or integrated with each other	The proposed development will create vital employment opportunities, particularly for those who need new work upon the completion of Medupi power station and other large-scale construction projects in the area. Being in close proximity to the town of Lephalale, the employment opportunities combined with demand for housing will create positive economic development within the area. The cumulative impact of providing further employment opportunities upon the completion of other major projects is vital to the continued socio-economic development of the area.
Complimenting other uses in the area	The area where the power station is to be developed is already utilised for mining and utilities purposes. It is therefore an ideal area to locate the power station because it suits the economic characteristics and development path of the local area. It is also in close

Aspect	Comment
	proximity to coal, which is the primary resource that will be used to generate power.
Alignment with planning for the area	The review of applicable key policy documents revealed that all spheres of government support the establishment of the proposed project at the envisaged location. No red flags could be identified that could raise a concern over the project's development from a policy perspective. Moreover, the development is aligned with policy objectives for the area, which suggest that Limpopo and more specifically Lephalale are development nodes for the mining and industry sectors.
Contribution to the correction of the historically distorted spatial patterns of settlements and to the optimum use of existing infrastructure in excess of current need	The proposed development will assist in bringing employment opportunities closer to communities who were previously disadvantaged. This assists in correcting spatial disadvantages by creating development in more rural areas of South Africa.
Generation of the highest socio-economic returns	The power station will make better economic use of the land because it will provide relatively higher socio-economic returns than the current land use. While it could withhold the mining of energy resources (gas) beneath the surface, these have not yet been proven as economically feasible to extract. As the project does not permanently remove these resources, these reserves can still be explored in the future. It is therefore considered that the proposed project is an optimal use of the land from a socio-economic perspective for the time-period of the development.
Promotion or contribution to create a more integrated settlement	The project will create employment opportunities for the local communities, which may reduce the need for some of the people to look for these in other more remote locations. It will also increase the number of middle to high and high income individuals in the area due to the demand for high skilled labour. This will contribute towards diversifying the socio-economic characteristics of the town and addressing past legacies of spatial segregation.
Impact on the sense of history, sense of place and heritage of the area and the socio-cultural and cultural-historic characteristics	The cultural sense of place in the Lephalale area is changing rapidly as the area industrialises. The conflict between tourism and industry is evident and the proposed development adds to the growing change in cultural sense of the area by further industrialising the region, which detracts from tourism. However, considering that the project is to be located in the area

Aspect	Comment
and sensitivities of the area	that is already surrounding by industrial activities, the impact on the sense of history and place by the project in question is considered to be marginal.
Encouragement of environmentally sustainable land development practices and processes	The power station is part of the coal IPP national programme and will assist in supplying baseload electricity to the region and the country while providing renewable energies the time required to develop. It therefore assists in the national and regional developmental goals of supplying sufficient electricity to meet demand.

3.2. Proposed Project Components

The project involves the construction of a captive coal-fired power station and associated infrastructure with a generating capacity of 1200MW. This capacity is constrained by the available water, as well as constraints associated with grid integration.

Table 3.2 below summarises the details/components of the proposed project, including the main infrastructure and services. Refer also to the detailed descriptions in this Chapter and the preliminary layout included in Appendix O.

Table 3.2: Description of components of the proposed Tshivhaso Power Plant

Component	Description/ Dimensions
Municipal Jurisdiction	The property is located within the Lephalale Local Municipality which falls within the Waterberg District Municipality.
Electricity Generating capacity	1200MW, to be developed in two phases of 600 MW each.
Proposed technology	Circulating Fluidised Bed (CFB) coal-fired power station (baseload power supply) Dry cooled The facility will be developed as a zero liquid effluent discharge (ZLED) plant.
Extent of the proposed development footprint (including Power plant production unit/s (boilers / furnaces, turbines, generator and associated equipment, control room), Office and	Power Plant - 50ha (25 ha for each 600MW) Ash Dump – 360 (180ha for each plant (extending over a 40-year period) Strategic Coal Stockpile –40 (20 ha for each plant) (providing for a stockpile for 30 days) A Raw-Water Dam - 2ha

Component	**Description/ Dimensions**
maintenance area/s and ash dump area	
Stack height	220m to 250m in height
Coal storage areas and bunkers, Coal loading and offloading areas, as well as conveyor belts with transfer house	Coal is to be provided to the power station from the Thabametsi coal mine which is to be established to the south-east of the site. o be supplied at a rate of 1000 t/h Coal will be transported to the coal storage area via overland conveyors.
Strategic Coal Stockyard	Sized for a ~30-days capacity of ~700 000 tonnes
Sorbent (limestone granular)	50 to 60 T/hr for 1200 MW capacity Sources on order of preference: Beester Kraal Marble Hall; Limeacres A number of sources are being considered: Beestekraal, Lime Acres and Marble hall.
Ash dumps and associated drainage channels and pollution control dams	660-t/h of ash and spent sorbent to be disposed of to the ash dump 360ha in extent (180 ha per plant) Height: up to 50m Provides storage for a volume of approximately 200 million cubic meters of ash Ash to be transported from power station to ash dump via overland conveyors Three pollution control dams to be associated with three ash dump – capacity proposed to be 75 000m^3, 54 000m^3 and 33 000 m^3
Site access	Access from existing roads in close proximity to site.
Grid connection	Two power evacuation Alternatives: Alternative 1:a Matimba – Witkop loop-in line (dropped at scoping phase); and Alternative 2: a Matimba – Medupi loop-in line 400kV line required Servitude width – 55m Height of towers – maximum height of 35m
Services required	Refuse material disposal - all refuse material generated from the proposed development will be collected by a contractor to be disposed of at a licensed waste disposal site off site. This service will be arranged with the municipality when required. Sanitation – during construction, all sewage waste will be collected by a contractor to be disposed of at a licensed waste disposal site. This service will be arranged with the

Component	Description/ Dimensions
	municipality when required. During operation, a wastewater treatment facility will be operated on the site. Water– 1.5-million m^3/a is required for 1200MW. Water is to be supplied from the Mokolo-Crocodile Water Augmentation Project (MCWAP) Phase 1 and 2.
Pipeline for water supply	A water supply pipeline of approximately 1m in diameter will be required to be constructed to the power station site from the point of supply. Peak throughput of >120 litres per second.
Raw-Water Storage Reservoir and Pump-station	Capacity: 120 000m^3 Reservoir wall height: 1-2 m (to be confirmed in final design)
Water treatment plant	Daily treatment capacity: 4800 m^3/day
Wastewater treatment plant	Daily throughput capacity: 6000 m^3/day

3.3. Process Description

This section of the report provides a description of the energy generation process from the point of material (coal and limestone supply), materials handling, workings of the power plant, water used in the process, ash management system and waste management and treatment.

Two technologies were originally considered for the project include conventional pulverised coal fired or circulating fluidised bed boiler (CFB) technology. The majority of South Africa's electricity currently comes from thermal power stations, which use coal (a natural resource / fossil fuel) as fuel for electricity production. These power stations provide baseload power to the electricity grid. A power station converts energy into a form which can be used by people, i.e. electricity.

3.3.1. Pulverised Fuel Technology

Electricity generation at a conventional coal-fired power station using pulverised fuel technology can be described as follows:

1. **Fuel**: Coal is sourced from a mine, and taken to the coal stockyard and then to the coal bunkers via conveyor belts.
2. **Pulverizer:** The coal is then ground into a fine powder to facilitate ease of burning.
3. **Boiler and Furnace:** The powdered coal is blown into the furnace by air, where it ignites. Oil is used to ignite the boiler. An array of tubes forms the boiler walls. Demineralised (pure) water enters the boiler tubes via pipes. The heat which is

released from the burning coal is absorbed by the tubes which convert the water into steam.

4. **Condensation and Cooling:** The spent steam goes into a condenser (brass tubes). The brass tubes are filled with water. The spent steam comes into contact with the cold outer surfaces of the condenser tubes and condensation of the steam to a liquid state (water) occurs. This water is then pumped back to the boiler for reheating. The water cooling method could be wet-cooling or indirect or direct dry-cooling. Wet-cooling (cooling towers) is the most efficient cooling method; however dry-cooling is designed to conserve water. In the event that wet-cooling will be used at the power station, warm water from the condensers is piped to cooling towers. The warm water releases its heat in the upward draught of cold air created by the shape of the cooling towers. The cooled water is re-circulated to the condensers.
5. **Smoke Stacks:** Gases that are released from combustion in the furnaces, are filtered and then released into the atmosphere through smoke stacks.
6. **Turbine**: The high pressure steam is piped to turbines. The steam passes through the turbine blades, causing the blades to turn. The movement of the steam through the turbines causes the thermal (heat) energy to be converted to mechanical energy.
7. **Generator:** The turbine is linked to the rotor of the generator. The rotor is an electromagnet which spins inside large coils of copper to generate electricity (alternating current (AC)), which is essentially what is produced by a power station.
8. **Transformer:** This is an electrical device by which AC current of one voltage is increased or stepped up (normally to 400 kV) and the current flow is reduced.
9. **Transmission:** The electricity is then fed into the Eskom integrated power grid for distribution and usage.

3.3.2. Fluidised bed combustion

Fluidised bed combustion (FBC) is a proven technology used for power plants with widespread application internationally but very limited application in South Africa. The technology has proven to be well suited to burning fuels that are difficult to ignite, such as petroleum coke and anthracite, low quality fuels like high ash coals and coal mine wastes, and fuels with highly variable heat content, including biomass and mixtures of fuels. The technology therefore has the ability to utilise a wide range of fuels.

Fluidised beds suspend solid fuel (such as coal / biomass) on upward-blowing jets of air during the combustion process. It results in a turbulent mixing of gas and solids. The tumbling action, much like a bubbling fluid, provides effective chemical reactions and heat transfer. The FBC has a cyclone filter to separate solid material from the hot flue gases which leave the exhaust of the furnace. The solids from the filter are re-circulated into the bed.

The technology burns fuel at temperatures of 760°C to 930°C, a range where nitrogen oxide formation is lower than in traditional pulverized coal units. FBC technology also reduces the amount of sulphur emitted in the form of sulphur dioxide emissions. Limestone can be added to capture sulphur and prevent its release to the atmosphere as sulphur dioxide.

The following is a basic description of the process flow for the generation of electricity using CFB technology (Figure 3.3):

1. **Fuel**: Coal is sourced from a coal mine and transported via conveyor to the power plant coal stockyard. When required by the boiler, a stacker reclaimer serves coal onto a conveyor system which transports the coal to the day silos next to the boiler. The coal is then drawn from the day silos directly into the furnace for combustion.
2. **CFB Boiler:** Fluidised beds consist of a bed of sand which is heated up and fluidised by passing streams of air through the sand. Solid fuel (such as coal / biomass) is introduced to the hot suspended sand on upward-blowing jets of air and the solid fuels starts to combust. The result is a turbulent mixing of gas and solids. The tumbling action provides effective chemical reactions and heat transfer. The CFB has a cyclone filter to separate the sand and coarse particles from the hot flue gases which leave the exhaust of the furnace. Due to the design of the CFB, limestone can be injected directly into the bed where it neutralises most of the sulphur which is released from the fuel during combustion leading to very low Sulphur Dioxide emissions.
3. **Condensation and Cooling:** The availability of water will have an impact on the choice of cooling technology. Firstly the turbine steam condensing system must be based on a dry system, either dry direct or dry indirect. The proposed project will be based on the dry indirect system including cooling tower as this is likely to bring a slight improvement in plant efficiency.

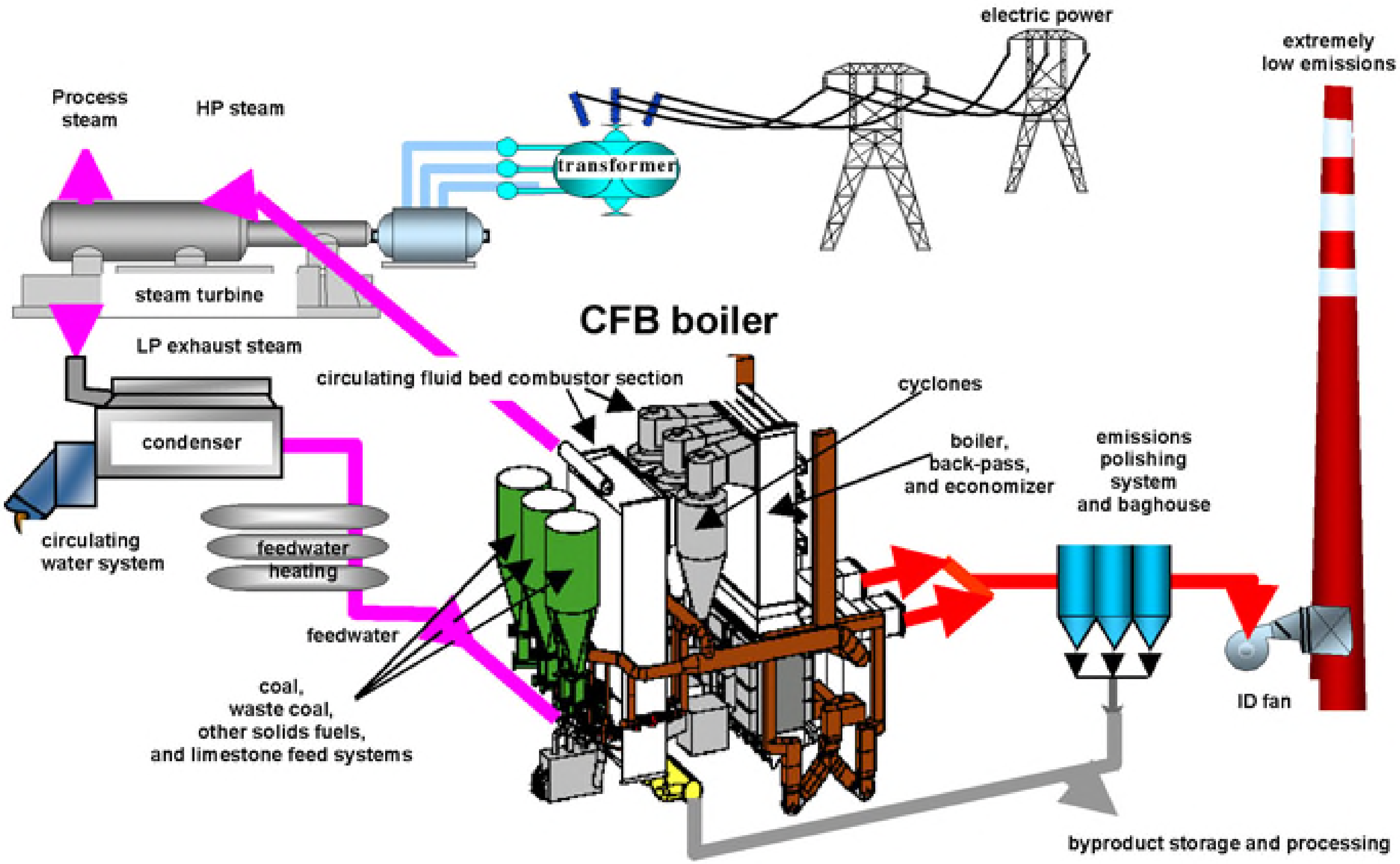


Figure 3.2: Illustration of CFB technology in the generation of electricity

4. **Flue Gas Desulphurisation:** Any system to reduce the emissions of sulphur dioxide must be a dry system. The fuel has a sulphur content of up to 2% and therefore it is possible to reduce the sulphur emissions by injecting dry limestone directly into the CFB boiler. Further reduction of emissions can be obtained by using an external secondary Flue Gas Desulphurisation system this time utilising lime as the reagent.

5. **Turbine**: The high pressure steam is piped to turbines. The steam passes through the turbine blades, causing the blades to turn. The movement of the steam through the turbines causes the thermal (heat) energy to be converted to mechanical energy.
6. **Generator:** The turbine is linked to the rotor of the generator. The rotor is an electromagnet which spins inside large coils of copper to generate electricity (alternating current (AC), which is essentially what is produced by a power station.
7. **Transformer:** This is an electrical device by which AC current of one voltage is increased or stepped up (normally to 400 kV) and the current flow is reduced.
8. **Transmission:** The electricity is then fed into the Eskom integrated power grid for distribution and usage.

3.3.3. Coal Supply and Coal Handling

Coal is proposed to be sourced from Exxaro Coal's Thabametsi Coal-Mine development which is to be located in the vicinity of the sites under investigation.

Run-of-Mine coal will be supplied from the new coal-mine development which is adjacent to the Grootgeluk Mine. Coal properties are provisional (based on Grootgeluk RoM), and confirmation of coal qualities needs to be obtained to ensure compliance with CFB Boilers requirement.

3.3.4. Water Use

Direct or indirect dry cooling technology is proposed for use in the project. During this process the steam from turbines goes into a dry-cooling element or a heat exchanger. Fans are used to blow air over a condenser which causes water vapour to change back into liquid. This liquid is then pumped back into the boiler for reuse. This system does not require a cooling tower and therefore evaporation loss is limited. Similarly, a dry ashing approach has been proposed, where the ash waste is to be stored in an above-ground ash dump.

The project will source its water from the Mokolo Crocodile Water Augmentation Project (MCWAP) Phase 2 which is scheduled for completion by 2019/20. The power plant will use water of different qualities in following specific areas or processes:

- Dry cooling will be used for condensing steam exhausted from the turbines. The cycle heat rejection will be undertaken through use of heat exchangers that transfer the heat directly to the ambient air. No water will thus be required for this purpose.
- The steam cycle will utilise demineralised water in a closed circuit. Some make-up water will be required as the result of small losses due to leakage and blow-downs. Make-up demineralised water will be produced by treating raw water using the ion exchange method.
- Service water will be required for general cleaning of the plant, fire protection, and other miscellaneous plant uses.
- Recycled water from other processes is proposed to be used for ash hydration, ash handling, and coal dust suppression.
- Treated sewage plant effluent is proposed to be used for irrigation of the ash landfill for dust suppression and for regeneration of plant life as cells are covered with soil and grass.
- Potable water for domestic purposes at the power station will be obtained by treatment of raw water.
- Plant wastewater will be treated as required for utilization in the bottom ash system, ash hydration and landfill process, and the coal dust suppression systems.

In terms of the National Water Act (Act No 36 of 1989), a water use license will be required to be obtained for the various water uses as described above. In terms of the application for water supply from MCWAP2, the date for submission of applications is to be confirmed by the DWS and TCTA. As the Water Use license application process requires that a project submits a consolidated application (i.e. for all water uses), the application for all water uses will only be submitted once the date for submission has been confirmed.

In terms of water uses which would be relevant for the project, the following is applicable:

» 21 a) taking water from a water resource
» 21 b) storing water
» 21 c) Impeding and diverting the flow of a watercourse
» 21 e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1) (i.e. using wastewater for dust suppression)
» 21 g) Disposing of waste in a manner which may detrimentally impact on a water resource
» 21 h) Disposing in any manner of water which contains waste from or which has been heated in any industrial or power generation process
» 21 i) Altering the bed, banks. course or characteristics of a watercourse

3.2.5. Waste Management and Treatment

The Tshivhaso Coal-Fired Power Plant will be a zero liquid effluent discharge plant. This means that all plant processes will be optimised for minimisation of water demand and all effluents will be collected and either re-used or evaporated on site. In case not all treated waste water can be re-used for ash wetting or irrigation within the plant area, it will be discharge to an evaporation pond to be installed at the plant site. The pond will be bottom sealed with chemically and mechanically resistant fabric for ground water protection and sufficiently sized to take up all treated waste water. All waste-water systems will be designed to meet the World Bank standard for discharge into surface waters.

A relatively small amount of steam cycle blow down water arises during operation of the plant, which is necessary to maintain the quality of the steam cycle water. This water is slightly contaminated with salts, corrosion products and residues of dosing chemicals. After neutralisation this blow-down water can be reused for ash wetting or conditioning to prevent particulate emissions from the ash storage yard.
Oil contaminated drains from the plant area will be directed to an oil / water separator system consisting of an oily water retention basin, oil skimmer, plate separator and oil holding tank. Contaminated drains and wash water will be collected and treated in a batch treatment system capable of precipitating and neutralising the waste water by adding flocculating / precipitating aids and / or caustic / acid.

Effluents from boiler acid cleaning procedures will be collected in a waste water tank and neutralised. After precipitation of the solids the clear water phase is discharged to the cooling water outfall channel. The spray water and preparatory water from coal storage yard and ash storage will be collected. The drain water will also be collected, treated and dewatered in the on-site process waste treatment system. The treated water will be used for ash wetting.

The sewage and grey water coming from toilets, showers, canteens and laundry will be discharged to a new sewage treatment plant. The sewage plant will consist of primary settlement, sludge tanks, extended aeration devices and sludge separators to provide the required acceptable effluent quality, a sterilization chamber and a chlorination contact tank. The sewage will be treated prior to re-use for irrigation or discharge into the on-site evaporation pond. The sewage sludge separated from the treatment process will be used as fertilizer in agriculture.

The on-site process waste water treatment system will include pH-adjustment, mechanical filters, mechanical clarifiers, flocculent chemical dosing, sludge thickeners, and filter presses. The clear treated effluent will be discharged to the on-site evaporation pond.

Solid wastes and sludge arising during operation will be collected and stored at site until a reasonable amount has accumulated. Chemical wastes will be collected and stored separately in a safe manner. All wastes will be transported off-site by road and disposed of according to the local standard.

Waste treatment for the power station includes the following:

- Liquid waste disposal
- Solid waste disposal
- Waste storage and separation
- Waste transport
- Solid waste disposal

Total waste handled (tonnes per day)
16,000

Table 3.3 provides an estimate of the quantities of waste produced by the IPP Thabametsi Power Station.

Table 3.3: Estimate of the quantities of waste produced by the IPP Thabametsi Power Station

Hazardous waste	Non-hazardous waste	
Ash + Sorbent		
Waste Water		6,000
Sewage		50
	Polluted Water (Rainwater Run-off)	To be determined
	Compactable General Waste	16
	Un-Compactable General Waste	4
Oil-contaminated Run-off / Water		0.2
Spent Lubricants & Chemical Fills		0.2
Spent Consumable / Fills Materials		0.2
Spent Flue-Gas Filter Bags		To be determined

The figure below provides an overview of the waste generation and treatment process at the power plant.

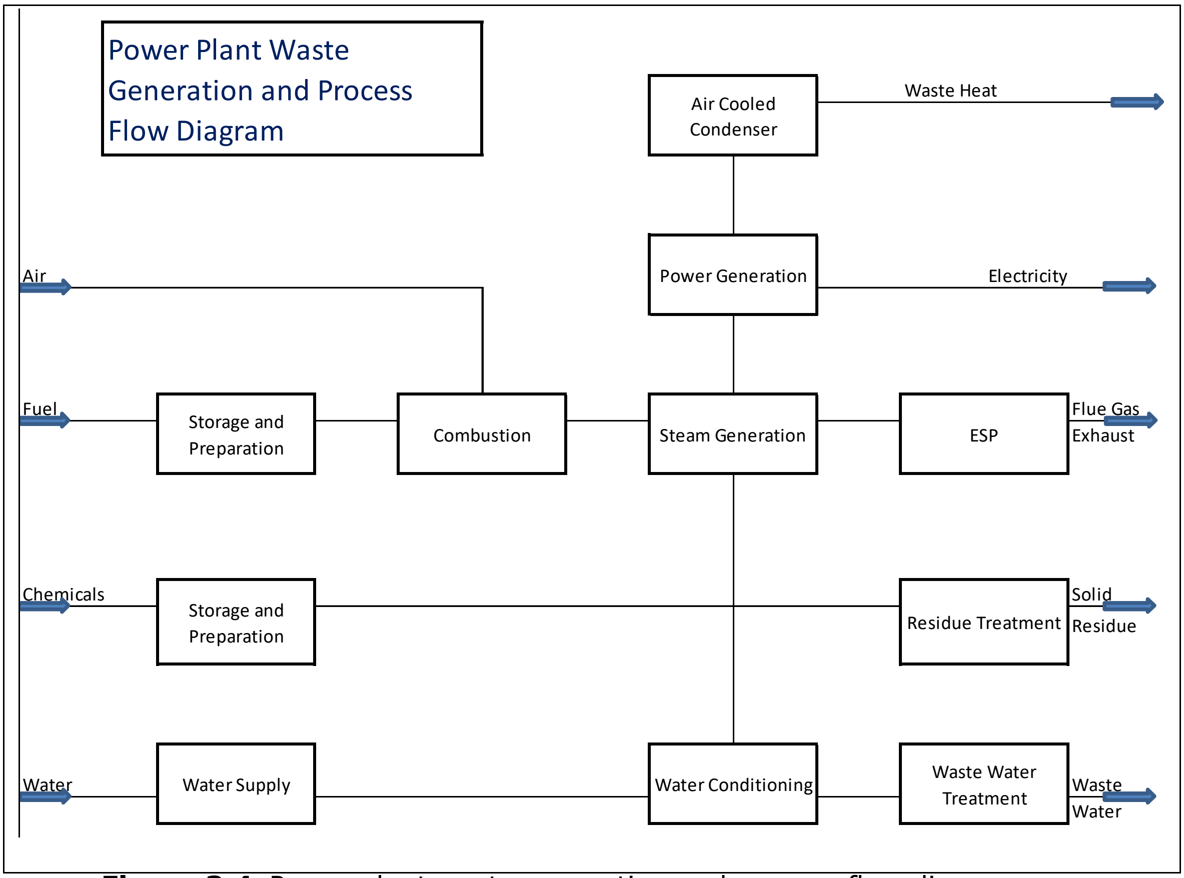


Figure 3.4: Power plant waste generation and process flow diagram

<u>Liquid Waste Treatment</u>

» ***Sewage Treatment***

All sewage will be treated in a wastewater treatment works. It is proposed that a central packaged Sewage Treatment Plant (STP) shall be provided for the control room, admin building and workshop area, and small package units will be installed at distant locations such as the ash handling plant.

The wastewater treatment system will be designed to meet national legislation requirements. The following is proposed in terms of the process (refer to Figure 3.5):

* The influent wastewater will enter the wastewater treatment plant by passing through a bar screen for gross solids removal. This step provides for the mechanical reduction of solids prior to aeration.
* A flow equalization chamber shall be sized to handle the daily design flow profile. The flow equalization chamber allows for a constant flow through the plant by equalizing flow surges that may be incurred during peak flow times.
* Once the wastewater has entered the aeration chamber, the untreated flow is mixed with an active biomass in a rolling action that takes place in the length and width of the chamber

in a slow forward progression. The aeration chamber will be of sufficient capacity to provide a minimum of 24 hours retention of the average daily flow, and/or maximum loading of BOD5 per m^3 of aeration tank volume as per international norms. This rolling mixing action is the result of air originating from air diffusers located along one side of the bottom of the tank. This ensures that adequate mixing is maintained in the tank. The chambers are filleted on each side along the bottom to assure and enhance the rolling motion of the water and to eliminate any "dead zones" in the tank. The oxygen transfer achieved with the diffused air passing through the wastewater coupled with the rolling action provides a sufficient oxygen supply allowing microorganisms to oxidize treatable wastes in to carbon dioxide, water, and stable sludge.

* After aeration, the wastewater flows to the clarifier that typically has a hopper bottom configuration. The wastewater clarifiers are sized to provide the required retention time based on an average 24 hour design flow. During the settling period, solids settle on the bottom of the clarifier. Airlift pumps with adjustable pumping capabilities are used to return these solids, as activated sludge, to the aeration chamber to maintain the maximum efficiency of the biological process. When necessary, excess sludge is wasted to an aerated sludge digestion tank for additional treatment and reduction. A skimmer airlift pump is used to return floatable solids and scum to the aeration chamber for further processing.
* The treated water flows from the clarifier to a disinfection chamber for treatment via chlorination or ultra-violet (UV) disinfection prior to discharge to complete the treatment process. Tertiary filters may also be used where a higher quality of effluent is required.

A control panel with the capability to operate the system when required as determined by the variation in the daily flow rate shall be installed. Properly sized circuit breakers and fuses will protect all electrical equipment and circuitry.

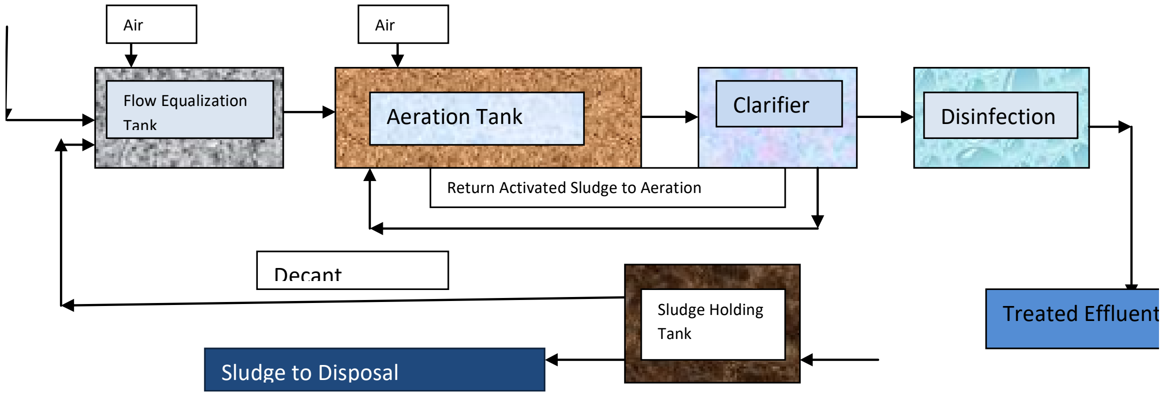


Figure 3.4: Efficient multi-step wastewater treatment process

Treated liquid effluent from wastewater treatment will be recycled within the power station precinct. If tests indicate that it is suitable to do so, waste sludge will be used as a soil conditioner. As far as possible provision will be made for the re-use of the treated effluent for dust suppression, ash quenching and soil conditioning. Waste water forwarding pumps shall circulate the water from the treatment facility to places of usage.

» ***Oily Waste Treatment***

At the power plant, waste water potentially containing lubricants, oil, grease etc. will be routed to the Oily Waste Treatment System. The Oily Waste Treatment System consists of the following:

* Oily wastewater sump(s) with sump pumps.
* Separation of oil from water using suitable process
* Removed oil is disposed of through authorised external contractors

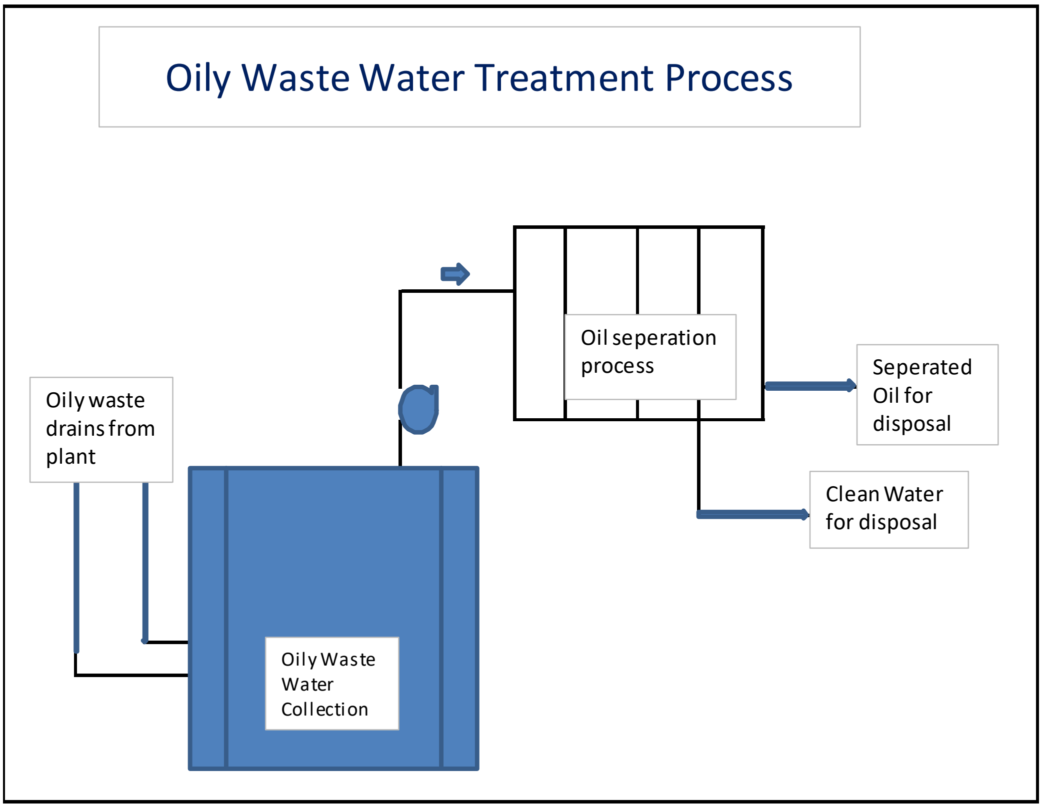


Figure 3.5: Oily wastewater treatment and disposal

» ***Chemical Waste***

At the power plant, wastes potentially containing high or low pH wastewater are routed to the Chemical Waste Treatment System. The Chemical Waste Treatment System consists of the following:

* Chemical wastewater sump(s) with sump pumps.
* One neutralisation basin with mixing systems.
* Common acid and caustic addition systems, using the demineraliser regeneration subsystems.
* Neutralized water transfer pumps.
* All interconnecting piping, valves, controls, instrumentation and accessories for a complete system.

» ***Solid waste management***

Power plant waste will include the following:

* Metallic wastes. This type of waste will be collected in bins for occasional collection from the site, to be sold to or removed by specialist contractors by road transport.
* Oils and cleaning chemicals. Waste oils and chemicals will be recycled by external contractors. Empty oil drums will be returned to suppliers for recycling or re-use.

* Miscellaneous waste. This includes paper, plastic, glass, cloth, etc., which will be collected and re-used wherever possible and once deemed waste, will be discarded as per relevant regulations.

Waste will be separated at source and contained in appropriately labelled containers. All bulk waste containers on site (skips, bins, drums etc.) shall be appropriately labelled to show what class and type of waste can be disposed of in them. Containers shall be appropriately designed to store liquid, solid, hazardous or non-hazardous waste. Solid and liquid wastes will not be mixed.

» ***Waste storage and separation during construction***

During the construction phase, hazardous and general (non-hazardous) waste will be collected at source and transported for storage at temporary or permanent storage facilities. These storage facilities will be appropriately designed with appropriate flooring / lining, covered (for protection from direct sunlight, wind and rain) if necessary, and bunded where required to contain accidental spills or leaks. Storage will be in accordance with the requirements of the National Norms and Standards for the storage of waste promulgated in Government Notice 926 in terms of the National Environmental Management: Waste Act (Act No 59 of 2008).

» ***Waste transport***

Waste will be transported from source to the temporary storage facilities in an appropriate manner:

* The nature, composition and integrity of transport packaging and containers will be appropriate to the type and class of waste being transported.
* Transport vehicles will cater for the type, class and quantity of waste being transported in terms of its composition, load capacity, covering etc.
* Transport vehicles will follow the traffic speed and safety requirements on site.
* Loading and unloading procedures to avoid waste loss will be followed.
* Employees will be trained in the correct procedure to address accidents and emergencies.
* All transport vehicles will be equipped with suitable materials or equipment to contain, manage and remove accidental spillages.
* Vehicles carrying hazardous wastes shall be labelled appropriately.

» ***Ash Disposal***

The ash dump will be sized to accommodate the estimated bottom ash and fly ash from all units for 40 years assuming a conservative availability and capacity factor. The ash dump provides storage for a volume of approximately 200 million cubic meters of ash and would have a footprint of approximately 500ha and approximately 50m high. The ash dump will be designed according to the requirements for waste disposal as contained in Regulation 636 of August 2013 published in terms of the NEM: Waste Act (Act No 59 of 2008).

A sufficiently high berm will be constructed around the landfill, and a suitable drainage channel will be constructed inside the berm for surface runoff water control. A conveyor system will be constructed from the plant site for transporting bottom ash to the ash dump. Conditioned ash will be transported to the disposal area by conveyor, and suitable ash handling equipment like stacker(s) will be used to position, spread, level and contour the ash mound as necessary. The ash dump will have a membrane liner and a run-off collection system. Run-off ponds of suitable size will be constructed around the dump.

The following mitigation measures will apply for the ash dump as it is developed through the course of the project lifespan:

* The ash dump will be developed in stages. The initial ash dump area is to be suitably lined. Thereafter, each area will be lined in accordance with legislative requirements.
* Stormwater canals are to be constructed along the entire perimeter of the ash dump.
* The perimeter stormwater canals will be designed to collect dirty water runoff from the dump surface and will discharge to pollution control dams (three planned). The canals will be sized to accommodate runoff from a 50 year 24 hour rainfall event. Canals will be appropriately lined to prevent seepage.
* Treated effluent from the wastewater treatment plant will be used at the ash dump for dust suppression.

In the CFB process the ash produced consists of two fractions. The bed ash fraction (about 15%) removed from the fluidised bed and the 85% fraction fly ash, which is collected in the electrostatic precipitators. Both will have to be disposed of either on the Ash-Dump or in the Mine-Pit, because the content of unburned carbon in the bed ash and the high $CaSO_4$ content in the fly ash make them unsuitable for further use.

The ash handling system to be implemented for the proposed new unit will be designed to evacuate the fly ash as well as furnace bottom ash from the unit. The ash will, after intermediate storage in a silo, be transported via conveyors to the ash-dumping site.

It is likely that ash and other by-products will conveyed to the dump, within the Tshivhaso Coal-Fired Power Plant precinct, where it is stacked and spread. The ash dumps would have to be able to accommodate the likely total volume of ash and other by-products that would be generated throughout the Tshivhaso Coal-Fired Power Plant’s life-spans. The ash dump would be continuously rehabilitated over time, using accepted rehabilitation methods. Rehabilitation measures shall include, reshaping, application of topsoil and re-vegetation with an acceptable grass species.

3.4. Life-cycle Phases of the proposed Power Station

3.4.1. Construction of a Coal-Fired Power Station

Construction of the proposed coal-fired power station is expected take between 48 - 54 months. The construction activity involves the following[2]:

- Prior to initiating construction, a number of surveys will be required including, but not limited to, geotechnical survey, transportation survey, site survey and confirmation of the power station footprint, survey of substation site, pipeline and survey of power line servitude;
- Access roads will need to be established to the site;
- Site preparation activities will include clearance of vegetation and excavations for foundations. These activities will require the stripping of topsoil, which will need to be stockpiled, backfilled and/or spread on site;
- Thereafter civil works will take place which involves concrete works for structures such as foundation, the production unit (which houses the turbines, generator and so forth), stacks, cooling towers (if applicable), substation and associated infrastructure;
- Mechanical and electrical work will then follow;
- Ancillary infrastructure such as office buildings, pipeline (to transfer water from the Mokolo-Crocodile Water Augmentation Project (MCWAP2)), conveyor belt, and a power line linking to the electricity transmission grid will be established; and
- As construction is completed in an area, and as all construction equipment is removed from the site, the site will be rehabilitated where practical and reasonable.

3.4.2. Operation of a Coal-Fired Power Station

Prior to the operation of the power station, testing and trails will need to be undertaken. The proposed facility will create 239 permanent employment positions that will be retained for 40 years. It is anticipated that there will be full time security, maintenance and control room staff required at the site. In order to operate a coal-fired power station, resources are required (input), and processes and outputs occur from the electricity generation process. This concept is outlined in **Figure 3.6.**

[2]http://www.eskom.co.za/live/monster.php?URL=%2Fcontent%2FCO_0003BuildCoalPSRev4.pdf&Src=Item+28).

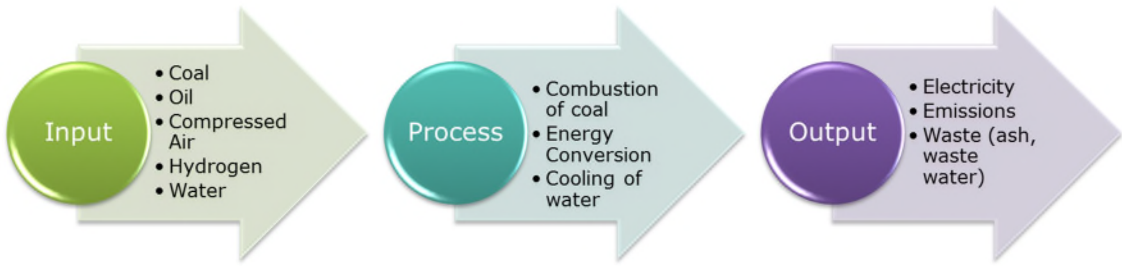


Figure 3.6: Resources (input), processes and outputs (waste) for a coal-fired power station

Figure 3.6 illustrates that in order to operate a coal-fired power station, natural resources such as coal and water will be required. For combustion coal and air are required. Water is required in the power generation process – it is converted to steam for energy conversion (from thermal energy to mechanical energy). Water is also used for cooling in a power station. The output of the process is electricity as well as waste and by-products. The power station will operate for 24 hours a day and 7 days a week.

3.4.3. Decommissioning of a Coal-Fired Power Station

The lifespan of the proposed coal-fired power station is more than 30 years. Equipment associated with this facility would only be decommissioned once it has reached the end of its economic life. It is most likely that decommissioning activities of the infrastructure of the facility discussed in this EIA would comprise the disassembly and disposal of the infrastructure. Decommissioning activities will involve disassembly of the production units and ancillary infrastructure, demolishing of buildings, removal of hazardous waste and rehabilitation of the ash dumps and site.

Decommissioning Activities: The following decommissioning activities are relevant:

» Operational access roads are expected to be in good condition and be appropriate for the transit of decommissioning equipment (heavy cranes, special trucks, etc.).
» A temporary decommissioning camp may be established with associated staff facilities.
» Laydown areas will be prepared as required. In this regard vegetation may require stripping and topsoil may be stockpiled for use in rehabilitation.
» All waste materials and chemicals will be removed for reuse in other facilities or proper management through authorised waste management service providers.
» The elimination of all lubricants and chemical products stored in the plant will be carried out. These products may be sold or turned over to an authorised waste management service provider, as they are not the plant's main components.

» Reusable elements are components that can be used again, i.e., are not waste. It is advantageous to find a use for these so-called sub-products, due to the reduced costs involved with the consequent economic and environmental benefits.
» Concrete structures and buildings (including foundations) will be demolished and the rubble will be disposed of at appropriate facilities, unless otherwise agreed for an alternative use in line with the decommissioning and closure plan.

Rehabilitation: Following decommissioning and removal of all project material from the site, the disturbed areas will be rehabilitated to a state reflective of anticipated future use. Where possible, rehabilitation will be conducted concurrently with decommissioning. The following rehabilitation activities are relevant:

» The existing profiles of the land affected will be improved and stabilised thereby leaving profiles not incompatible with the topography of the area, which is essentially flat.
» Ripping of compacted soils will be done prior to adding topsoil, which will be done by mechanical means. It is expected that there will be a sufficient amount of topsoil and/or subsoil moved and stockpiled during the construction phase to facilitate rehabilitation.
» If required, potential areas or land for extracting topsoil or subsoil will be identified. The land capability characteristics of such areas should be similar to the affected soils (same texture, colour, permeability, etc.).
» Vegetation will be re-established. The plant species used will match those naturally occurring in the area as far as possible.

Aftercare and Maintenance: Following rehabilitation, a period of maintenance and aftercare will be required to ensure that rehabilitation is successful. In this regard, the following activities are relevant:
» Fertilisation of soil depending on soil fertility test results
» Control and removal alien/invasive species
» Replacement of unhealthy plants and altering vegetation composition, if needed
» Implementation of erosion controls (if required)
» Support irrigation (if required)
» Auditing of vegetation recovery and adaption of strategies where necessary.

PROJECT ALTERNATIVES CHAPTER 4

In terms of the Environmental Impact Assessment (EIA) Regulations, reasonable and feasible alternatives are required to be considered within the Environmental Impact Assessment process. All identified, feasible alternatives are required to be assessed in terms of social, biophysical, economic and technical factors.

Most guidelines use terms such as 'reasonable', 'practicable', 'feasible' or 'viable' to define the range of alternatives that should be considered. Essentially there are two types of alternatives:

» incrementally different (modifications) alternatives to the project; and
» fundamentally (totally) different alternatives to the project.

Fundamentally different alternatives are usually assessed at a strategic level, and EIA practitioners recognise the limitations of project-specific EIAs to address them. Electricity Generating alternatives have been addressed at a strategic level as part of the National Integrated Resource Plan (IRP) by the Department of Energy. In this regard, the need for power generation from coal as part of the technology mix for power generation in the country in the next 20 years has been identified.

Incrementally different alternatives relate specifically to the project under investigation. "Alternatives", in relation to a proposed activity, means different ways of meeting the general purposes and requirements of the activity, which may include alternatives to:

» The property on which, or location where, it is proposed to undertake the activity;
» The type of activity to be undertaken;
» The design or layout of the activity;
» The technology to be used in the activity; and
» The operational aspects of the activity.

These alternatives are discussed below.

4.1. Site Alternatives

4.1.1. Selection of the Waterberg Region for the development of the proposed project

As the availability of the coal resource is critical to the development of such a project, the location of the power station is constrained to a large degree by the location of this resource. Over 50% of South Africa's remaining coal reserves lie in the Waterberg coalfields, a 3

500km^2 expanse of Limpopo that stretches into Botswana and hosts almost 76 billion tonnes of in-situ inferred resources in 11 coal-bearing zones. In order to exploit this resource, a number of new coal mines are proposed in the Waterberg area. Of particular relevance to the proposed power station is the new coal mine, Thabametsi Coal Mine, to be developed by Exxaro Resources. This mine will provide the required coal resource to the power station for the operational life of the power station. These factors dictated the selection of the Waterberg region for the development of the proposed power station.

All project alternatives are located near Lephalale town in the Limpopo Province, in close proximity to the authorised Thabametsi power station and north of the Grootgeluk coal mine. At scoping there are two possible sites currently considered for the establishment of the power station and four possible sites for the ash dump.

One of the power station site alternatives included the farm Graaffwater 456, while the other alternative includes farms Eendragtpan 451, Geylkebult 450 and Vooiruit 449.

Site alternatives for the ash dump were more scattered. Alternative 1, i.e. including farms Kalkvlakte 256 and Elandsvley 453, situated north of the location of the approved Thabametsi Coal-Fired Power Station. Alternatives 2 (farm Goedehoop) was situated between the proposed site for the power station and the mine. **Both of these alternatives were screened out at scoping.**

During scoping it was the also recommended that the possibility of locating the ashing facility on Graaffwater 456 which is the same farm as the power station site and this option was investigated as alternative 1 during the EIA phase.

Alterntaive 3 (farm Vooruit 449) and 4 (farm Appelvlakte 448) were adjacent to the farms where Grootegeluk mine is located and are to be situated between the proposed site for the power station and the mine. The last alternative (farm Jackalsvley) is located further away and is proposed to be established above the underground component of the proposed Thabametsi coal mine. Relative to the proposed sites of the power station itself, it is also situated across the existing Grootegeluk mine.

There were two power evacuation Alternatives. Alternative 1:a Matimba – Witkop loop-in line; and Alternative 2: a Matimba – Medupi loop-in line.

Conclusions from Scoping Study:

» Overall the Goedehoop Option 1 was recommended as the most suitable option for the **ashing facility,** with option 2 a close second. However during scoping Exxaro responded that it is not desirable for them to have the ashing facility located on Farm Goedehoop from a land-use perspective. **Option 2** (Appelvlakte Option) is therefore recommended as the preferred alternative at this stage.

During scoping it was also recommended that the possibility of locating the ashing facility on Graaffwater 456 (the same farm as the power station site option 1) also be investigated option will be assessed in the EIA phase.

These are the only siting alternatives being considered in this EIA report.

4.2. Design or Layout Alternatives

A preliminary layout for the power station and associated infrastructure has been provided for investigation and assessment (refer to Appendix A). Detailed geo-referenced layout drawings are still to be completed based on the on-site sensitivities identified in this EIA study.

4.3. Technology Alternatives

Cennergi have only considered coal-based generation as a technology option as the project is being proposed in response to the DoE's Coal Baseload IPP Procurement Programme. At this stage Cennergi cannot consider the inclusion of biomass, CSP and other renewable technologies as part of the project, as the DoE process does not make allowance for this. The power station design can however take this into consideration for inclusion in later stages of the project life cycle should the DoE procurement programme make allowance for this.

Technology alternatives considered for the project include:

» The **fuel combustion technology** – conventional pulverised coal fired or circulating fluidised bed boiler technology; and
» **Cooling Systems technology** – the power station will make use of dry cooling technology, either direct or indirect.

These are described below and are assessed within this EIA.

4.3.1. Fuel Combustion Technology

Technologies originally considered include conventional pulverised coal fired or circulating fluidised bed boiler technology. A basic description of the technologies is provided below (more details are provided in Chapter 3).

a) Conventional Coal Fired Power Station

A conventional coal-fired power station produces electricity by the burning of pulverised coal and air in a steam generator, where it heats water to produce steam. The steam flows through a series of steam turbines which spin an electrical generator to produce electricity. The exhaust steam from the turbines is cooled, condensed back into water, and returned to the steam generator to start the process over. These plants provide most of the electrical energy used in many countries, i.e. a tried and tested method.[3]

This technology was scoped out as it would require will require Flue Gas Desulphurisation which will double the water required for the power station. In addition , because the coal has a CV 15.5 Mj/kg there would be a requirement for a washing plant at the coal mine. This will double the water required at the coal mine which is why CFB (described below) is the technology alternative being considered in this EIA report.

b) Circulating Fluidised Bed Boiler Technology

Fluidised bed combustion (FBC) is another technology used for power plants. There are different designs of FBCs, namely two major groups, atmospheric systems (FBC) and pressurised systems (PFBC), and two minor subgroups, bubbling (BFB) and circulating fluidized bed (CFB)[4].

CFBs suspend solid fuel (such as coal / biomass) on upward-blowing jets of air during the combustion process. It results in a turbulent mixing of gas and solids. The tumbling action, much like a bubbling fluid, provides effective chemical reactions and heat transfer. The CFB has a cyclone filter to separate solid material from the hot flue gases which leave the exhaust of the furnace. CFB reduces the amount of sulphur emitted in the form of SO_x emissions. The solids from the filter are re-circulated into the bed. By using this technology, SO and NO emissions are reduced because a sorbent, such as limestone, can be used efficiently. Also, because the operating temperature is low, the amount of NO gases formed is lower than those produced using conventional technology.

CFB technology is the only technology capable of meeting the objectives of the project in terms of fuel characteristics and maintaining a low emissions profile and for this reason is the only alternative power generation technology alternative assessed within this EIA.

4.3.2. Cooling Systems technology

The steam that is produced and converted to mechanical energy at a power plant must be recovered through condensation (conversation of the steam (vapour) to water). Cooling systems for a coal-fired power station can be either wet-cooled, direct dry-cooled or indirect dry-cooled systems. Dry-cooling results in resource saving in terms of water conservation, and is generally utilised in water-stressed environments. Due to the study area being water-

[3]http://en.citizendium.org/wiki/Conventional_coal-fired_power_plant
[4] (http://en.wikipedia.org/wiki/Fluidized_bed_combustion).

stressed only dry-cooling systems is being considered for the project. The two dry-cooling systems which could be used are briefly described below.

a) Direct Dry cooling

In this system (illustrated in **Figure 4.1**), the steam from the turbines goes to dry-cooling element or a heat exchanger. Fans are used to blow air over the condenser causing water vapour to change into liquid. The liquid (water) is pumped back to the boiler for re-use. No cooling towers are needed for this system; therefore water loss by evaporation is prevented. This system is utilised at Matimba Power Station located near Lephalale, and will also be used by Medupi Power Station (under construction). Issues associated with this technology include increased noise levels as a result of the additional fans required.

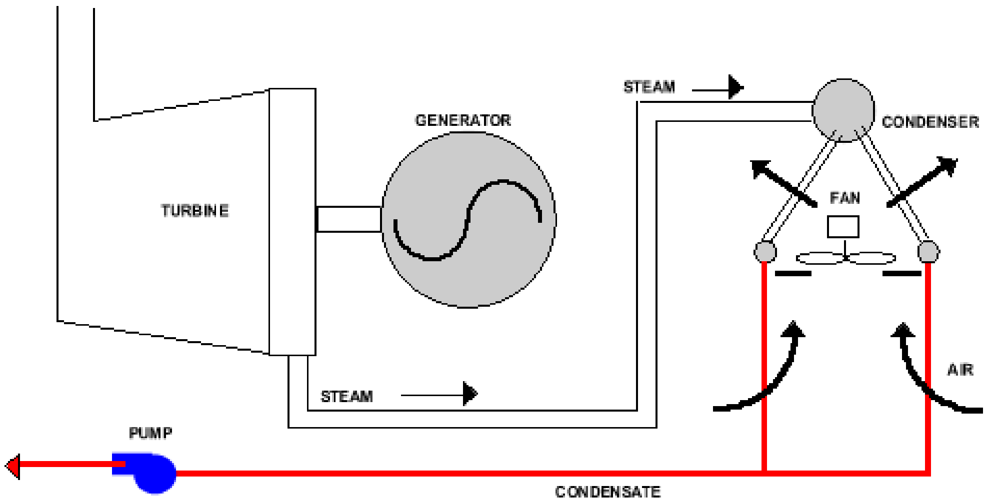


Figure 4.1: Direct dry cooling system[5]

b) Indirect Dry cooling

This method is illustrated in Figure 4.2. A cooling tower and cooling water (from a water resource) is required. Warm water from the condensers is pumped to cooling towers. Within the cooling tower, bundles of cooling elements are arranged in rings. Cooling water is sent into the elements and cooled water returns to the condenser for re-use. This system prevents water loss by evaporation, as it is a closed system. This system is utilised at the Kendal Power Station located near Witbank in the Mpumalanga Province. Associated issues include the requirement for additional land for development, and additional visual impacts associated with the large cooling towers required.

[5] http://www.emt-india.net/process/power_plants/condenser&cooling_sys.htm

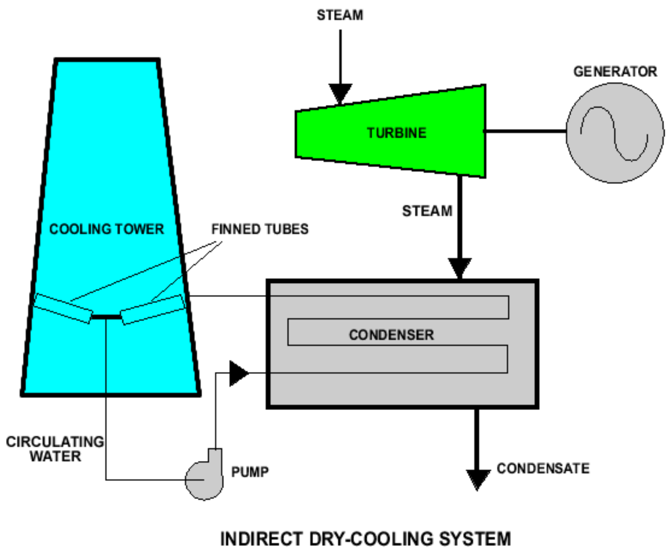


Figure 4.2: Indirect dry-cooling system [6]

Through the technical feasibility studies undertaken for the project, direct dry technology has been selected as the preferred technology for implementation at the power station. This is the alternative assessed within this EIA.

4.3.4. Operational Alternatives – Pollution Control

Due to environmental and health impacts that could pose a risk during the operation of the coal-fired power station, methods are considered for ash (waste) management and air emissions control.

a) Ash management

The ash management system will use dry-ashing (no water used). Wet ashing uses a large volume of water and is therefore not considered suitable for this project.

Above-ground ash dumping (where ash is stacked in an ash dump within the power station area and the ash dump is rehabilitated (using topsoil and vegetation)) will be utilised. The practice of ashing into the mine pit is not considered to be a feasible option. In this option, the ash is not separated from the coal by means of any type of membrane, and bringing it into contact with the acidic coal will result in metals and other toxic substances leaching out of the ash, at least over a long time period. Previous studies have concluded that this option is not suitable from an environmental perspective due to the potential for groundwater contamination and the low potential for mitigation.

[6] http://www.emt-india.net/process/power_plants/condenser&cooling_sys.htm

Wastewater generated at the power station will be utilised for dust suppression at the ash dump.

The possibility of 'in-pit ashing' was explored as a possible ash management option. Coal qualities for drill core samples from 2013 were investigated by Exxaro. The report found that in-pit ashing was not feasible based on the type and grade of coal to be used at the power station.

b) Air Emission Control

Burning of coal releases CO_2, SOx, NOx, and other pollutants into the atmosphere and air pollution abatement technologies are being explored to minimise associated impacts. The use of air emissions control measures such as use of electrostatic precipitators/fabric filters are also considered. The commitment in this regard is to achieve minimum emission that will be defined in the Air Emissions License.

4.3. Power Line / Grid Connection Alternatives

Two power evacuation alternatives were considered at scoping:

» Alternative 1:a Matimba – Witkop loop-in line; and
» Alternative 2: a Matimba – Medupi loop-in line

Based on the findings of the scoping study, potential impacts associated with the proposed alternatives are expected to be similar. Power line Alternative 2, although slightly longer than alternative 1, makes use of existing corridors of transformation, limiting the potential direct impacts to some extent. This alternative is therefore considered the preferred option and localised areas of sensitivity can be avoided through local realignment options. Power Line **Alternative 2** is therefore the only power line alternative considered in the EIA phase. A corridor of 500m wide as been considered within this assessment.

4.3. Siting Alternatives

There are a number of sites under consideration for the various elements of the development.

At the Scoping Stage there were two site options under consideration for the Power Station, five site alternatives for the ashing facility and two grid connection alternatives. The scoping phase recommended the alternative 1, Graaffwater power station site. This is the only power station site that is being considered at the EIA stage.

Goedehoop alternative 1 was recommended as the most suitable option for the ashing facility at the scoping stage, with option 2 (Appelvlakte) a close second. However the landowner responded that it is not desirable for them to have the ashing facility located on Farm

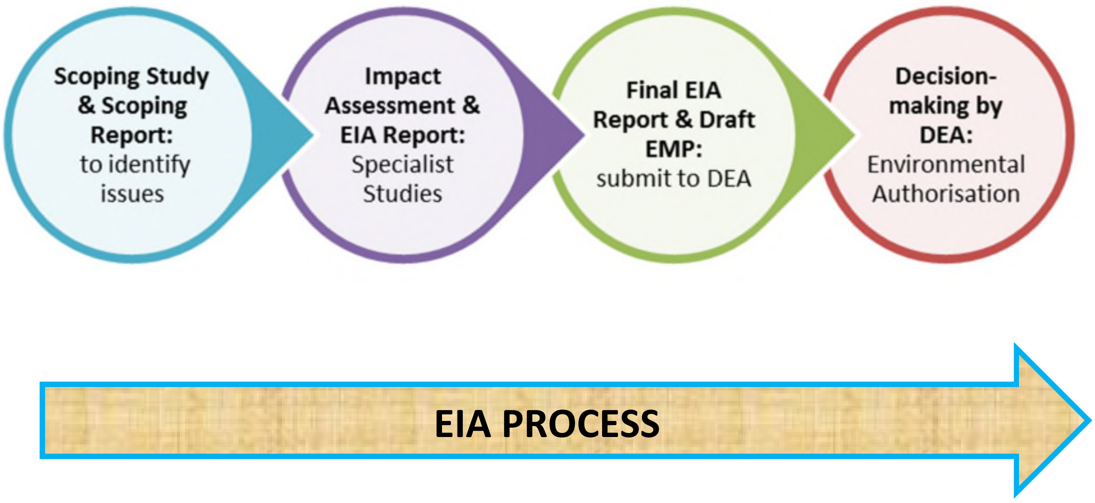
Goedehoop from a land-use perspective. Option 2 was therefore recommended as the preferred alternative at this stage.

During scoping it was also recommended that the possibility of locating the ashing facility on Graaffwater 456 which is the same farm as the power station site alternative 1 should also be investigated during the EIA phase.

At the end of the Scoping Phase therefore two of the ashing facilities (i.e. Appelvlakte and Graaffwater 456) considered were recommended for consideration during the EIA phase.

APPROACH TO UNDERTAKING THE EIA PROCESS CHAPTER 5

An Environmental Impact Assessment (EIA) process refers to that process (dictated by the EIA Regulations) which involves the identification of and assessment of direct, indirect and cumulative environmental impacts associated with a proposed project. The EIA process forms part of the project feasibility assessment and comprises two phases: i.e. **Scoping Phase** and **EIA Phase**. The EIA process culminates in the submission of an EIA Report (including an environmental management programme (EMPr)) to the competent authority for decision-making. The EIA process is illustrated below:



The EIA for the proposed project has been undertaken in accordance with the EIA Regulations published in Government Notice 38282 of 8 December 2014, in terms of Section 24(5) of the National Environmental Management Act (NEMA; Act No 107 of 1998). This process was undertaken in support of the application for Authorisation in terms of NEMA, as well as in support of the application for a waste license in terms of the requirements of the NEM: Waste Act (Act No. 59 of 1998).

This section provides a brief overview of EIA Regulations and their application to this project. NEMA is national legislation that provides for the authorisation of certain controlled activities known as "listed activities". In terms of Section 24(1) of NEMA, the potential impact on the environment associated with these listed activities must be considered, investigated, assessed and reported on to the competent authority (the decision-maker) charged by NEMA with granting of the relevant environmental authorisation. As this is a power generation project which is considered to be of national importance, and the project requires licensing for hazardous waste activities, the National Department of Environmental Affairs (DEA) is the competent authority. Therefore, Cennergi requires authorisation from the National Department of Environmental Affairs (DEA), with the Limpopo Department of Economic Development, Environment and Tourism (LEDET) acting as commenting authority. In order to obtain this authorisation, Cennergi acknowledges the need for comprehensive, independent environmental studies to be undertaken in accordance with the EIA Regulations of December 2014. An integrated application for authorisation and waste licence has been submitted to DEA, and the project has been assigned Application Reference number **14/12/16/3/3/3/211**.

The need to comply with the requirements of the EIA Regulations ensures that developers are provided the opportunity to consider the potential environmental impacts of a project early in the project development process, and assess if environmental impacts can be avoided, minimised or mitigated to acceptable levels. Comprehensive, independent environmental studies are required to be undertaken in accordance with the EIA Regulations to provide the competent authority with sufficient information in order for an informed decision to be taken regarding the project. Cennergi has appointed Savannah Environmental (Pty) Ltd, as independent Environmental Assessment Practitioner, to conduct the required Environmental Impact Assessment (EIA) process for the proposed project.

An EIA is also an effective planning and decision-making tool for the project proponent. It allows the environmental consequences resulting from a facility during its establishment, operation and decommissioning to be identified and appropriately managed. It provides the opportunity for the developer to be forewarned of potential environmental issues, and allows for resolution of the issue(s) reported on in the Scoping and EIA reports as well as dialogue with affected parties.

5.1. Relevant Listed Activities

5.1.1. Listed Activities in terms of NEMA

In terms of Sections 24 and 24D of NEMA, as read with Government Notices R983, R984 and R985, a Scoping and EIA process is required for the proposed project. The key listed activity contained in GN984 which triggered a full EIA process is Listed Activity 1: The construction of facilities or infrastructure, for the generation of electricity where the output is 20 megawatts or more, as the coal-fired power plant will have an electricity generation capacity of up to 1200MW. The table below contains all the listed activities in terms of the EIA Regulations of 8 December 2014 which apply, and for which an Application for Authorisation has been submitted. The table also includes a description of those project activities which relate to the applicable listed activities.

Table 5.1: Listed activities in terms of the EIA Regulations of 8 December 2014 which apply to the project

Notice No.	Activity No :	Description of listed activity
GN 983, December 2014	11	The construction of facilities or infrastructure for the transmission and distribution of electricity - (i) outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts ***Construction of temporary power lines for electricity that is required during construction***
GN 983, December 2014	12	The development of— (iii)bridges exceeding 100 square metres in size; where such development occurs— (a) within a watercourse; (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse; — ***Drainage lines occur on the site. These could be impacted by the proposed project.***
GN 983, December 2014	19	The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from— (i) a watercourse; (ii) the seashore; or (iii) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater ***Drainage lines occur on the site. These could be impacted by the proposed project.***
GN 983, December 2014	24	The development of— (ii) a road with a reserve wider than 13,5 meters, or where no reserve exists where the road is wider than 8 metres; ***Access roads to the site and within the site will be required.***
GN 984, December 2014	1	The development and related operation of facilities or infrastructure for the generation of electricity from a non-renewable resource where the electricity output is 20 megawatts or more.

Notice No.	Activity No :	Description of listed activity
		The power station is planned to have a generating capacity of up to 1200MW
GN 984, December 2014	4	The construction of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of more than 500 cubic metres. ***Storage of dangerous substances (such as fuel, oils, etc.) would be required at the power station.***
GN 984, December 2014	6	The development of facilities or infrastructure for any process or activity which requires a permit or licence in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent. ***A Water Use License will be required in terms of Section 21(g) - Disposal of water or water containing waste that may detrimentally affect a water resource.*** ***An Air Emissions License is required under the NEM: AQA release of emissions to atmosphere which requires a license also requires an EIA.***
GN 984, December 2014	9	The construction of facilities or infrastructure for the transmission and distribution of electricity with a capacity of 275 kilovolts or more, outside an urban area or industrial complex. ***400kV power lines are planned to be constructed from the power station to the grid connection point.***
GN 984, December 2014	15	The clearance of an area of 20 hectares or more of indigenous vegetation **The footprint of the 1200MW facility will cover an area of up to 500 ha**
GN 984, December 2014	28	Commencing of an activity, which requires an atmospheric emission license in terms of section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)

Notice No.	Activity No :	Description of listed activity
		An Air Emissions License is required under the NEM: AQA for the release of emissions from the power station to atmosphere.

5.1.2. Listed Activities in terms of NEM: Waste Act

In terms of Government Notice 912 published in terms of the NEM: Waste Act, a waste license is required for the activities listed in Table 1.2.

Table 5.2: Summary of the GN 912, listed activities number and short description of the waste activities that requires authorisations under the Waste Act

Regulation Notice and Activity No	Description of listed activity
GN 921, 29 August 2013, Category B, Activity 7	The disposal of any quantity of hazardous waste to land ***The power station will require the construction of a lined ash disposal facility over an area of ~500ha. The ash produced through the power generation process is considered to be hazardous.***
GN 921, 29 August 2013, Category B, Activity 10	The construction of facilities for a waste management activity listed in Category B of this schedule (not in isolation to associated activity). ***The power station will require the construction of a lined ash disposal facility over an area of ~500ha. The ash produced through the power generation process is considered to be hazardous.***

The EIA process was conducted in accordance with the requirements of the EIA Regulations of December 2014 and in terms of Section 24(5) of the National Environmental Management Act (NEMA; Act No 107 of 1998), in support of the NEMA and waste licence applications for the proposed project.

5.2. Scoping Phase

The Scoping Phase of the EIA process refers to the process of identifying potential issues associated with the proposed project, and defining the extent of studies required within the EIA Phase. This is achieved through an evaluation of the proposed project, involving the project proponent, specialists with relevant experience, and a public consultation process with key stakeholders (including government authorities) and interested and affected parties (I&APs).

In accordance with the EIA Regulations, the main purpose of the Scoping Phase is to focus the environmental assessment in order to ensure that only potentially significant issues and reasonable and feasible alternatives are examined in the EIA Phase. The Draft Scoping Report provided stakeholders with an opportunity to verify that the issues they have raised through the process to date have been captured and adequately considered, and provides a further opportunity for additional key issues for consideration to be raised. This Final Scoping Report incorporated all issues and responses raised during the public review of the Draft Scoping Report prior to submission to DEA. The Final Scoping Report was accepted by DEA in April 2016 (refer to Appendix C). The additional information requested by DEA in the acceptance letter and the location of the requested information in this report is detailed in the table below.

Table 5.3: DEA requirement and reference to Section in EIA Report

DEA requirement for EIA	Section in report
a) The geology of the area	Chapter 6, section 6.6
b) The type of aquifer (and if dolomite, major or minor aquifer)	Chapter 6, section 6.8
c) Hydrogeology of site	Chapter 6, section 6.8 and Appendix E
d) Groundwater quality on site	Chapter 6, section 6.8 and Appendix D
e) Hydrocensus of groundwater quality in the area	Hydrocensus included as part of groundwater study: Appendix D
f) Potential impact of the activity on groundwater users (if any)	Chapter 7, section 7.8 and groundwater study (Appendix D)
g) Groundwater monitoring plan in terms of quantity and quality	Included as part of groundwater assessment report – Appendix F and EMPr Appendix N
h) Historical groundwater monitoring data (if available)	Chapter 6, section 6.8
i) Stormwater management plan	A basic erosion and stormwater management plan is included as Appendix A of the EMPr (Appendix N). A more detailed stormwater management plan will be compiled prior to construction.
j) Design drawings designed by a professional engineer	Refer to Appendix O for design drawing.
k) Each liner must be specified	Appendix O
l) Information on services required on site e.g. sewage, refuse removal, water & electricity. Who will supply these services and has an agreement and confirmation of capacity been obtained.	Services required will include: sewage, refuse removal, water & electricity. No agreement has been obtained for these, nor any

DEA requirement for EIA	Section in report
	confirmation of capacity. These will be obtained once the EA is received.
m) A construction and operational phase EMPr to include mitigation and monitoring measures	EMPr included as Appendix N
n) Should a water use license be required proof of application for a license must be submitted	WULA will only be applied for once EA is received.
o) Ways of re-using and recycling builders rubble must be identified	A Waste Management Plan shall be developed in accordance with the requirements of the Waste Act and West Classification Regulation which include reusing and recycling of construction waste. A basic waste management plan is included as part of the EMPr (Appendix N)
p) Thresholds for bulk water transportation infrastructure must be determined and the activities applied for to be amended accordingly.	The connection point has not yet been determined. This activity has been removed from the EIA and a separate process will be initiated once the connection point is known. The application form will be amended accordingly.
q) The extent of the clearance of indigenous vegetation must be determined and the activities applied for amended accordingly	For the 1200MW facility: Power plant = 50ha Ash dump = 360 ha Coal stockpile = 40 ha Raw water dam = 2 ha Total = 452ha up to 500ha The application form has been amended accordingly.

5.3. EIA Phase

The EIA Phase for the proposed project aims to achieve the following:

- » Provide a comprehensive assessment of the social and biophysical environments affected by the proposed project.
- » Assess potentially significant impacts (direct, indirect, and cumulative, where required) associated with the proposed project.
- » Comparatively assess any feasible alternatives proposed.
- » Identify and recommend appropriate mitigation measures for potentially significant environmental impacts.
- » Undertake a fully inclusive public participation process to ensure that I&APs are afforded the opportunity to participate, and that their issues and concerns are recorded.

The EIA Report addresses potential direct, indirect, and cumulative impacts (both positive and negative) associated with all phases of the project including pre-construction, construction, operation and decommissioning. In this regard the EIA Report aims to provide the relevant authorities with sufficient information to make an informed decision regarding the proposed project.

5.3.1. Tasks completed during the EIA Phase

The EIA Phase for the proposed Tshivhaso Power Station and associated infrastructure has been undertaken in accordance with the EIA Regulations published in Government Notice GN38282 of December 2014, in terms of Section 24(5) of NEMA (Act No. 107 of 1998 as amended). This chapter serves to outline the EIA process that was undertaken.

5.3.2 Authority Consultation

The National DEA is the competent authority for this application. A record of all authority consultation undertaken is included within this EIA report. Consultation with the regulating authorities (i.e. DEA and Limpopo LEDET) has continued throughout the EIA process.

The following will be undertaken as part of this EIA process:

» Submission of the draft EIA Report to DEA for review and comment during the public review period (30 days).
» Submission of a final EIA Report to DEA following a public review period for the draft EIA (30 days).
» Notification and Consultation with Organs of State that may have jurisdiction over the project, including provincial and local government departments, and State Owned Enterprises.
» Provide an opportunity for DEA and LEDET representatives to visit and inspect the proposed site and the study area.

A record of the authority consultation in the EIA process is included within **Appendix C**.

5.3.3. Public Involvement and Consultation

The public participation process has been undertaken in accordance with the requirements of the EIA Regulations of December 2014. The aim of the public participation process is primarily to ensure that:

» Information containing all relevant facts in respect of the proposed project was made available to potential stakeholders and I&APs.
» Participation by I&APs was facilitated in such a manner that all potential stakeholders and I&APs were provided with a reasonable opportunity to comment on the proposed project.
» Comments received from stakeholders and I&APs were recorded and incorporated into the EIA process.

In order to accommodate the varying needs of stakeholders and I&APs within the study area, as well as capture their inputs regarding the project, various opportunities for stakeholders and I&APs to be involved in the EIA Phase of the process will be provided, as follows:

» Opportunity for review of the draft EIA Report for a 30-day period from **13 September 2016 – 14 October 2016.**
» Focus group meetings and an Open Day (pre-arranged and stakeholders invited to attend - for example with directly affected and surrounding landowners) during the Draft EIA Report review period.
» One-on-one consultation, where required.
» Telephonic consultation sessions (consultation with various parties from the EIA project team, including the project participation consultant, lead EIA consultant as well as specialist consultants).
» Written, faxed or e-mail correspondence.

Comments raised by I&APs over the duration of the EIA process will be synthesised into a Comments and Response Report. The Comments and Response Report will include responses from members of the EIA project team and/or the project proponent. Where issues are raised that the EIA team considers beyond the scope and purpose of this EIA process, clear reasoning for this view is provided.

Public participation documentation from the process is included in Appendix C as well as a Comments & Response Report.

5.3.4. Assessment of Issues Identified through the EIA Process

Issues which require investigation within the EIA Phase, as well as the specialists involved in the assessment of these impacts are indicated in Table 5.1 below.

Table 5.3: Specialist studies undertaken within the EIA Phase

Specialist	Area of Expertise	Refer Appendix
Riaan Robbeson, Dewald Kamffer, Lukas Niemand, (Bathusi Environmental Consulting)	Ecology	Appendix D
Johan Mare (Menco)	Surface Water & Ground Water	Appendix E1 and E2
Morne de Jager (EAR)	Noise	Appendix F
Mark Zunkel (uMoya-NiLU)	Air Quality and Health	Appendix G
Jaco Jansen (Savannah Environmental) – Peer Reviewed by Garry Patterson (Agricultural Research Council)	Agricultural potential and soils	Appendix H
Jaco van der Walt (HCAC)	Heritage	Appendix I

Specialist	Area of Expertise	Refer Appendix
John Almond (Natura Viva)	Palaeontology	Appendix J
Jon Marshal (Afzelia)	Visual	Appendix K
Harmke Immink (Promethium Carbon)	Climate Change	Appendix L
Elena Broughton (Urban Econ)	Socio-economic	Appendix M

Specialist studies considered direct, indirect, cumulative, and residual environmental impacts associated with the development of the proposed project. Issues were assessed in terms of the following criteria and scoring system:

- The **nature**, a description of what causes the effect, what will be affected, and how it will be affected
- The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development), regional, national or international. A score of between 1 and 5 is assigned as appropriate (with a score of 1 being low and a score of 5 being high)
- The **duration**, wherein it is indicated whether:
  - The lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1
  - The lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2
  - Medium-term (5–15 years) – assigned a score of 3
  - Long term (> 15 years) - assigned a score of 4
  - Permanent - assigned a score of 5
- The **magnitude**, quantified on a scale from 0-10, where a score is assigned:
  - 0 is small and will have no effect on the environment
  - 2 is minor and will not result in an impact on processes
  - 4 is low and will cause a slight impact on processes
  - 6 is moderate and will result in processes continuing but in a modified way
  - 8 is high (processes are altered to the extent that they temporarily cease)
  - 10 is very high and results in complete destruction of patterns and permanent cessation of processes
- The **probability of occurrence**, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale, and a score assigned:
  - Assigned a score of 1–5, where 1 is very improbable (probably will not happen)
  - Assigned a score of 2 is improbable (some possibility, but low likelihood)
  - Assigned a score of 3 is probable (distinct possibility)
  - Assigned a score of 4 is highly probable (most likely)
  - Assigned a score of 5 is definite (impact will occur regardless of any prevention measures)

- The **significance**, which is determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high
- The **status**, which is described as either positive, negative or neutral
- The degree to which the impact can be reversed
- The degree to which the impact may cause irreplaceable loss of resources
- The degree to which the impact can be mitigated

The **significance** is determined by combining the criteria in the following formula:

S = (E+D+M) P; where

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- **< 30 points:** Low (i.e. where this impact would not have a direct influence on the decision to develop in the area)
- **30-60 points:** Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated)
- **> 60 points:** High (i.e. where the impact must have an influence on the decision process to develop in the area)

As the developer has the responsibility to avoid or minimise impacts and plan for their management (in terms of the EIA Regulations), the mitigation of significant impacts is discussed. Assessment of impacts with mitigation is made in order to demonstrate the effectiveness of the proposed mitigation measures. A draft EMPr is included as **Appendix N**.

5.3.5. Assumptions and Limitations

The following assumptions and limitations are applicable to the studies undertaken within this EIA Phase:

- All information provided by the developer and I&APs to the environmental team was correct and valid at the time it was provided.
- It is assumed that the development site identified by the developer and their engineers represents a technically suitable site for the establishment of the proposed power station and associated infrastructure.

» It is assumed that the grid connection solution is feasible and that the developer has consulted with Eskom in this regard.
» Conclusions of studies undertaken and this overall Impact Assessment assume that any potential impacts on the environment associated with the proposed development will be avoided, mitigated, or offset.
» This report and its investigations are project-specific, and consequently the environmental team did not evaluate any other power generation alternatives.

Refer to the specialist studies in **Appendices C – N** for specialist study specific limitations.

5.4. Legislation, Policies and Guidelines which have informed the EIA Process

The following legislation and guidelines have informed the scope and content of this EIA Report:

» National Environmental Management Act (Act No 107 of 1998).
» EIA Regulations, published under Chapter 5 of the NEMA (GNR543, GNR544, GNR545, and GNR546 in Government Gazette 33306 of 18 June 2010).
» Guidelines published in terms of the NEMA EIA Regulations, in particular:
  * Companion to the National Environmental Management Act (NEMA) Environmental Impact Assessment (EIA) Regulations of 2010 (Draft Guideline; DEA, 2010).
  * Public Participation in the EIA Process (DEA, 2010).
» International guidelines – the Equator Principles and IFC Performance Standards (including Environmental, Health and Safety Guidelines for Thermal Power Plants).

Several other Acts, Standards, or guidelines have also informed the project process and the scope of issues addressed and assessed in the EIA Report. A review of legislative requirements applicable to the proposed project is provided in the **Table 5.4.**

Table 5.4: Relevant legislative permitting requirements applicable to the proposed Tshivhaso Power Station

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
National Legislation			
Constitution of the Republic of South Africa (Act No. 108 of 1996)	In terms of Section 24, the State has an obligation to give effect to the environmental right. The environmental right states that: "Everyone has the right - » To an environment that is not harmful to their health or well-being; and » To have the environment protected, for the benefit of present and future generations, » through reasonable legislative and other measures that: » Prevent pollution and ecological degradation; » Promote conservation; and » Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."	Applicable to all authorities	There are no permitting requirements associated with this Act. The application of this clause however implies that environmental impacts associated with proposed developments are considered separately and cumulatively. It is also important to note that in the "right to an environment clause" include that justifiable economic and social development should be promoted, through the use of natural resources and ecologically sustainable development.
National Environmental Management Act (Act No 107 of 1998)	The EIA Regulations have been promulgated in terms of Chapter 5 of the Act. Listed activities which may not commence without an environmental authorisation are identified within these Regulations. In terms of S24(1) of NEMA, the potential impact on the environment associated with these listed activities must be assessed and reported on to the competent authority charged by NEMA with granting of the relevant environmental authorisation.	Department of Environmental Affairs – competent authority Limpopo LEDET - commenting authority	The listed activities triggered by the proposed project have been identified and assessed in the EIA process being undertaken (i.e. Scoping and EIA). This EIA Report will be submitted to the competent and commenting authority in support of the application for authorisation.

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	In terms of GN R983, R984and 985 of 2014, a Scoping and EIA Process is required to be undertaken for the proposed project.		
National Environmental Management Act (Act No 107 of 1998)	In terms of the Duty of Care Provision in S28(1) the project proponent must ensure that reasonable measures are taken throughout the life cycle of this project to ensure that any pollution or degradation of the environment associated with this project is avoided, stopped or minimised. In terms of NEMA, it has become the legal duty of a project proponent to consider a project holistically, and to consider the cumulative effect of a variety of impacts.	Department of Environmental Affairs	While no permitting or licensing requirements arise directly by virtue of the proposed project, this section has found application during the EIA Phase through the consideration of potential impacts (cumulative, direct, and indirect). It will continue to apply throughout the life cycle of the project.
Environment Conservation Act (Act No 73 of 1989)	National Noise Control Regulations (GN R154 dated 10 January 1992)	Department of Environmental Affairs Limpopo LEDET Local Authorities	Noise impacts are expected to be associated with the construction & operation phase of the project and are not likely to present a significant intrusion to the local community. Therefore is no requirement for a noise permit in terms of the legislation.
National Water Act (Act No 36 of 1998)	Water uses under S21 of the Act must be licensed, unless such water use falls into one of the categories listed in S22 of the Act or falls under the general authorisation (and then registration of the water use is required).	Department of Water and Sanitation	The following Section 21 water uses have been identified for the proposed project, in terms of which a Water Use License will be required: » 21(b) storing water;

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	Consumptive water uses may include the taking of water from a water resource and storage - Sections 21a and b, however these are not anticipated. Non-consumptive water uses may include impeding or diverting of flow in a water course - Section 21c; and altering of bed, banks or characteristics of a watercourse - Section 21i.		» 21(c) impeding or diverting the flow of water in a watercourse; » 21(g) disposing of waste in a manner which may detrimentally impact on a water resource; » 21(i) altering the bed, banks, course or characteristics of a watercourse
Minerals and Petroleum Resources Development Act (Act No 28 of 2002)	A mining permit or mining right may be required where a mineral in question is to be mined (e.g. materials from a borrow pit) in accordance with the provisions of the Act. Requirements for Environmental Management Programmes and Environmental Management Plans are set out in S39 of the Act. S53 Department of Mineral Resources: Approval from the Department of Mineral Resources (DMR) may be required to use land surface contrary to the objects of the Act in terms of section 53 of the Mineral and Petroleum Resources Development Act, (Act No 28 of 2002): In terms of the Act approval from the Minister of Mineral Resources is required to ensure that proposed activities do not sterilise a mineral resource that might occur on site.	Department of Mineral Resources	As no borrow pits are expected to be required for the construction of the facility, no mining permit or right is required to be obtained. Anglo has gas prospecting rights over sections of land owned by Exxaro. A Section 53 application is required to be submitted to the DMR for the proposed development area.
National Environmental Management: Air Quality Act (Act No 39 of 2004)	S21 – Listed activities requiring an Air Emissions License.	Department of Environmental Affairs	Solid fuel combustion installations using solid fuel for electricity generation are Listed Activities

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	Minimum emission standards are set for Listed Activities. The minimum emission standards are defined for existing and new plants in Government Notice 893 of 22 November 2013. Measures in respect of dust control (S32) and National Dust Control Regulations of November 2013. Measures to control noise (S34) - no regulations promulgated yet. The Act provides that an air quality officer may require any person to submit an atmospheric impact report if there is reasonable suspicion that the person has failed to comply with the Act.		(Category 1: Sub-category 1.1) in term of Section 21 of the NEM:AQA. Therefore an Air Emissions License must be obtained for the project. Measures in respect of dust control (S32) and the National Dust Control Regulations of November 2013.
National Heritage Resources Act (Act No 25 of 1999)	» Stipulates assessment criteria and categories of heritage resources according to their significance (S7). » Provides for the protection of all archaeological and palaeontological sites, and meteorites (S35). » Provides for the conservation and care of cemeteries and graves by SAHRA where this is not the responsibility of any other authority (S36). » Lists activities which require developers any person who intends to undertake to notify the responsible heritage resources authority and furnish it with details regarding the location,	South African Heritage Resources Agency	An HIA has been undertaken as part of the EIA Process to identify heritage sites (Appendix I). Should a heritage resource be impacted upon, a permit may be required from SAHRA.

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	nature, and extent of the proposed development (S38). » Requires the compilation of a Conservation Management Plan as well as a permit from SAHRA for the presentation of archaeological sites as part of tourism attraction (S44).		
National Environmental Management: Biodiversity Act (Act No 10 of 2004)	» Provides for the MEC/Minister to identify any process or activity in such a listed ecosystem as a threatening process (S53) » A list of threatened and protected species has been published in terms of S 56(1) - Government Gazette 29657. » Three government notices have been published, i.e. GN R 150 (Commencement of Threatened and Protected Species Regulations, 2007), GN R 151 (Lists of critically endangered, vulnerable and protected species) and GN R 152 (Threatened or Protected Species Regulations). » Provides for listing threatened or protected ecosystems, in one of four categories: critically endangered (CR), endangered (EN), vulnerable (VU) or protected. The first national list of threatened terrestrial ecosystems has been gazetted, together with supporting information on the listing process including the purpose and rationale for listing ecosystems, the criteria used to identify listed ecosystems, the implications of listing ecosystems, and summary statistics and national maps of listed ecosystems (National Environmental Management: Biodiversity Act:	Department of Environmental Affairs	Under this Act, a permit would be required for any activity which is of a nature that may negatively impact on the survival of a listed protected species. An ecological study has been undertaken as part of the EIA Phase. As such the potentially occurrence of critically endangered, endangered, vulnerable, and protected species and the potential for them to be affected has been considered. This report is contained in Appendix D.

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	National list of ecosystems that are threatened and in need of protection, (G 34809, GN 1002), 9 December 2011). » This Act also regulates alien and invader species.		
Conservation of Agricultural Resources Act (Act No 43 of 1983)	» Prohibition of the spreading of weeds (S5) » Classification of categories of weeds & invader plants (Regulation 15 of GN R1048) & restrictions in terms of where these species may occur. » Requirement & methods to implement control measures for alien and invasive plant species (Regulation 15E of GN R1048).	Department of Agriculture	This Act will find application throughout the life cycle of the project. In this regard, soil erosion prevention and soil conservation strategies must be developed and implemented. In addition, a weed control and management plan must be implemented. The permission of agricultural authorities will be required if the Project requires the draining of vleis, marshes or water sponges on land outside urban areas.
National Forests Act (Act No. 84 of 1998)	According to this Act, the Minister may declare a tree, group of trees, woodland or a species of trees as protected. The prohibitions provide that 'no person may cut, damage, disturb, destroy or remove any protected tree, or collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, except under a licence granted by the Minister'.	National Department of Forestry	A licence is required for the removal of protected trees. The presence of protected trees on the site was determined through the ecological impact assessment undertaken for the project (refer to Appendix F)
National Veld and Forest Fire Act (Act 101 of 1998)	In terms of S21 the applicant must ensure that the firebreak is wide and long enough to have a reasonable chance of preventing the fire from	Department of Agriculture, Forestry and Fisheries (DAFF)	While no permitting or licensing requirements arise from this legislation, this Act will find

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	spreading, not causing erosion, and is reasonably free of inflammable material. In terms of S17, the applicant must have such equipment, protective clothing, and trained personnel for extinguishing fires.		application during the construction and operational phase of the project.
Hazardous Substances Act (Act No 15 of 1973)	This Act regulates the control of substances that may cause injury, or ill health, or death due to their toxic, corrosive, irritant, strongly sensitising or inflammable nature or the generation of pressure thereby in certain instances and for the control of certain electronic products. To provide for the rating of such substances or products in relation to the degree of danger; to provide for the prohibition and control of the importation, manufacture, sale, use, operation, modification, disposal or dumping of such substances and products. Group I and II: Any substance or mixture of a substance that might by reason of its toxic, corrosive etc, nature or because it generates pressure through decomposition, heat or other means, cause extreme risk of injury etc., can be declared as Group I or Group II substance Group IV: any electronic product; and Group V: any radioactive material. The use, conveyance, or storage of any hazardous substance (such as distillate fuel) is prohibited without an appropriate license being in force.	Department of Health	It is necessary to identify and list all the Group I, II, III, and IV hazardous substances that may be on the site and in what operational context they are used, stored or handled. If applicable, a license is required to be obtained from the Department of Health.

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
Development Facilitation Act (Act No 67 of 1995)	Provides for the overall framework and administrative structures for planning throughout the Republic. S (2-4) provide general principles for land development and conflict resolution.	Local Municipality	The applicant must submit a land development application in the prescribed manner and form as provided for in the Act. A land development applicant who wishes to establish a land development area must comply with procedures set out in the Act.
National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)	The Minister may by notice in the Gazette publish a list of waste management activities that have, or are likely to have, a detrimental effect on the environment. The Minister may amend the list by – » Adding other waste management activities to the list. » Removing waste management activities from the list. » Making other changes to the particulars on the list. In terms of the Regulations published in terms of this Act (GN 912), a Basic Assessment or Environmental Impact Assessment is required to be undertaken for identified listed activities. Any person who stores waste must at least take steps, unless otherwise provided by this Act, to ensure that:	National Department of Water and Environmental Affairs (hazardous waste) Provincial Department of Environmental Affairs (general waste)	A waste license is required for the disposal of waste to land (ash) and for the construction of the ash disposal facility associated with the power station. General waste handling, storage and disposal during construction and operation is required to be undertaken. The DWAF (1998) Waste Management Series: Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste will also need to be considered.

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	» The containers in which any waste is stored, are intact and not corroded or in » any other way rendered unlit for the safe storage of waste. » Adequate measures are taken to prevent accidental spillage or leaking. » The waste cannot be blown away. » Nuisances such as odour, visual impacts and breeding of vectors do not arise; and » Pollution of the environment and harm to health are prevented.		
Subdivision of Agricultural Land Act (Act No 70 of 1970)	Details land subdivision requirements and procedures. Applies for subdivision of all agricultural land in the country	Department of Agriculture	Subdivision of land may be required in terms of S24 and S17 of the Act.
National Road Traffic Act (Act No 93 of 1996)	» The technical recommendations for highways (TRH 11): "Draft Guidelines for Granting of Exemption Permits for the Conveyance of Abnormal Loads and for other Events on Public Roads" outline the rules and conditions which apply to the transport of abnormal loads and vehicles on public roads and the detailed procedures to be followed in applying for exemption permits are described and discussed. » Legal axle load limits and the restrictions imposed on abnormally heavy loads are discussed in relation to the damaging effect on road pavements, bridges, and culverts. » The general conditions, limitations, and escort requirements for abnormally dimensioned loads and vehicles are also discussed and reference is	» South African National Roads Agency Limited (national roads) » Provincial Department of Transport	An abnormal load/vehicle permit may be required to transport the various components to site for construction. These include route clearances and permits will be required for vehicles carrying abnormally heavy or abnormally dimensioned loads. Transport vehicles exceeding the dimensional limitations (length) of 22m. Depending on the trailer configuration and height when loaded, some of the power station components may not meet specified dimensional limitations (height and width).

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	made to speed restrictions, power/mass ratio, mass distribution, and general operating conditions for abnormal loads and vehicles. Provision is also made for the granting of permits for all other exemptions from the requirements of the National Road Traffic Act and the relevant Regulations.		
Provincial Legislation & Guidelines			
Limpopo Environmental Management Act / LIMA (Act 7 of 2003)	This Act provides for the sustainable utilisation of wild animals, aquatic biota and plants; provides for the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora; provides for offences and penalties for contravention of the Act; provides for the appointment of nature conservators to implement the provisions of the Act; and provides for the issuing of permits and other authorisations. Amongst other regulations, the following may apply to the current project: » Boundary fences may not be altered in such a way as to prevent wild animals from freely moving onto or off of a property; » Aquatic habitats may not be destroyed or damaged; » The owner of land upon which an invasive species is found (plant or animal) must take the necessary steps to eradicate or destroy such species.	Limpopo Department of Economic Development, Environment and Tourism	A collection/destruction permit must be obtained from LEDET for the removal of any protected plant or animal species found on site. Additionally, a permit for the disturbance or destruction of indigenous species must be applied for.

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	The Act provides lists of protected species for the Province.		
The Waterberg-Bojanala Priority Area Air Quality Management Plan and Threat Assessment (December 2015)	» Characterisation of the baseline air quality in the WBPA » Quantification of the potential threats posed to ambient air quality by emissions from future energy-based projects in the WDM up to 2030. » The development of the WBPA AQMP and its supporting Implementation Plan.	Department of Environmental Affairs	No permitting requirements arise from the guideline. It is taken into account in the air quality assessment (Appendix G)

Table 5.5: Standards applicable to the Tshivhaso Power Station project

Theme	Standard	Summary
Air	South African National Standard (SANS) 69	Framework for setting and implementing national ambient air quality standards
	SANS 1929: Ambient Air Quality	Sets limits for common pollutants
Noise	SANS 10328:2003: Methods for Environmental Noise Impact Assessments	General procedure used to determine the noise impact
	SANS 10103:2008: The Measurement and Rating of Environmental Noise with Respect to Land Use, Health, Annoyance and Speech Communication	Provides noise impact criteria
	National Noise Control Regulations	Provides noise impact criteria
	SANS 10210: Calculating and Predicting Road Traffic Noise	Provides guidelines for traffic noise levels
Waste	DWAF (1998) Waste Management Series. Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste	DWAF Minimum Requirements
	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) – National norms and standard for the storage of waste.	» Provides uniform national approach relating the management of waste facilities » Ensure best practice in management of waste storage » Provides minimum standards for the design and operation of new and existing waste storage

Theme	**Standard**	**Summary**
Water	Best Practise Guideline (G1) Stormwater Management DWS2006	Provides guidelines to the management of stormwater
	South African Water Quality Guidelines	Provides water quality guidelines

DESCRIPTION OF THE AFFECTED ENVIRONMENT CHAPTER 6

This section of the report provides a description of the environment that may be affected by the proposed power station and associated infrastructure at the site for the proposed Tshivhaso Coal-Fired Power Plant. Aspects of the biophysical, social and economic environment that could be directly or indirectly affected by, or could affect, the proposed development have been described. This information has been sourced from both existing information available for the area as well as field data, and aims to provide the context within which this EIA is being conducted. A more detailed description of each aspect of the affected environment is included within the specialist reports contained within Appendices C - M.

6.1 Location of the Study Area and Site

Regionally, the study area is located within the western part of Limpopo Province.

The proposed site is located approximately 25km north-west of Lephalale within the Lephalale Local Municipality, which falls within the Waterberg District Municipality. The proposed site is located north of the Grootegeluk Coal Mine, Matimba Power Station and the Medupi Power Station and adjacent to the proposed Thabametsi coal mine.

The R510 between Groblers Bridge Border Post and Thabazimbi is an arterial route giving access to the study area from the east. The R33 runs eastward off the R510. Other roads in the study area are classed as secondary roads and give access to Stockpoort (north-west) and Steenbokpan (west).

The towns of Marapong, Onverwacht and Lephalale represent the populated places within the study area, and lie to the south-east of the proposed site at distances ranging from approximately 13km, 21km to 25km respectively. The Lephalale Local Municipality has an average population density of 4.7 people per km².

6.2 Character of the Surrounding Region

The site is located in close proximity to the Grootegeluk mine, two coal-fired power stations – Medupi Power Station (soon-to-be-commissioned) and Matimba Power Station - and the proposed new coal mine development (Thabametsi). In addition, other mining and power generation projects are proposed within the broader area. The project site is located within the Limpopo Coal, Energy and Petrochemical cluster, the Lephalale Local Municipality Industrial Corridor and the Waterberg coalfields. Extensive mineral resources (coal) are located within the Lephalale Local Municipality area. The Lephalale Local Municipality is acknowledged to be on the verge of major economic development within the mining and power production industries as government policy stated that the Limpopo Coal, Energy and Petrochemical Cluster is a means of utilising the potential of the Waterberg Coal Field to produce energy for the national economy.

6.3 Land Use

In general the land-use of the region consists of a dynamic mosaic of land-uses including industry, mining, game farms, limited agriculture and residential land-use. Prominent land use in the vicinity of the study area is the Grootegeluk Mine, located to the south of the site, and the Matimba Power Station, located to the south-west of the site. Further afield is the Medupi Power Station, which is still under construction, located ~15km to the south west, and the Matimba Ash Dump ~17km to the south- west.

There are extensive game farm and hunting operations within the broader study area, three of which fall within the project area. Livestock and agriculture are practiced to a lesser extent. Industrial infrastructure in the study area includes the railway line to the Grootegeluk Mine and major power line infrastructure associated with both the mine and the power stations. These existing power lines are mostly located to the south-west of the proposed site.

Some agricultural land use is evident (yet limited) in the east and north of the study area and along the Mokolo River. It may be expected that agricultural homesteads associated with this land use are to be found throughout the study area. Outside of the urban, industrial and mining areas, land cover is mostly thicket and bushland with large patches of woodland in the west and south of the study area, as well as along the Mokolo River. Vegetation types include Sweet Bushveld and Mixed Bushveld.

There are a number of protected areas to the east and south of the proposed development area. These include: the D’nyala Nature Reserve, the Hans Strijdom Nature Reserve and the Marakele National Park. These areas are approximately 24km, 41km and 64km from the proposed development respectively. There are a number of private nature reserves that are generally located in the Lowland Landscape Character Area. These include the Fahad Reserve, which is approximately 26km to the north east of the proposed development, and the Grootwater Reserve, which is approximately 28km to the south east of the proposed development and to the south of the D’nyala Nature Reserve.

The character of the general region is typified by significant recent developments. The result is nodal type developments dispersing from a central area. Historically the larger region was characterized by natural woodland and savanna habitat with extremely limited transformation levels. Land use in the region varies between game farming and cattle farming that utilized the natural savanna habitat. Extremely little arable agriculture is practiced, mainly because of relatively low rainfall and poor soils that predominate in the region. Recent mining developments and other infrastructure developments such as power stations, a more defined and intricate road infrastructure, housing, residential developments and a significant expansion of Lephalale, have resulted in large-scale transformation of natural habitat of the region. Significant increases in habitat transformation, fragmentation and isolation have been noted in recent time. The project area is situated in the Lephalale Municipality, which comprises approximately 1 960 140 ha, of which 94.4 % is currently regarded as untransformed (BGIS, 2009).

The contribution of mining within the Lephalale Municipal area to GDP is significant at 59.21 %. Electricity contributes 11.33 % to the GDP and its contribution to the Waterberg electricity sector is at 69.65 %. Other sectors that have a significant contribution to the Waterberg GDP per sector include agriculture, mining, and manufacturing. Agriculture (38.85 %) is the sector that employs the largest part of the workforce and is followed by community services (15.71 %) (Lephalale Municipality IDP, 2013). As part of the Waterberg biosphere, Lephalale area has pristine natural beauty and an abundance of fauna and flora in some areas. Lephalale offers a variety of scenic contrasts and encompass the unique Waterberg wilderness with extraordinary beauty, which boasts superb vistas, mountain gorges, clear streams and rolling hills. Rich in geological sites, rock art is a strong draw-card for the region, suggesting links to previous generations. Hence, the importance of tourism industry to the economy of the area is likely to continue to grow into the future. This is likely to be related to the hunting and ecotourism industries, but could also be linked to any expansion of the industrial operations in the area and the related business tourism. Agriculture, especially red meat production, is one the potential economic activities which is likely to grow in the municipal area. Lephalale Local Municipality has natural resources that give it a competitive and comparative advantage in Mining, Energy, Tourism and Agriculture (Lephalale Municipality IDP, 2013).

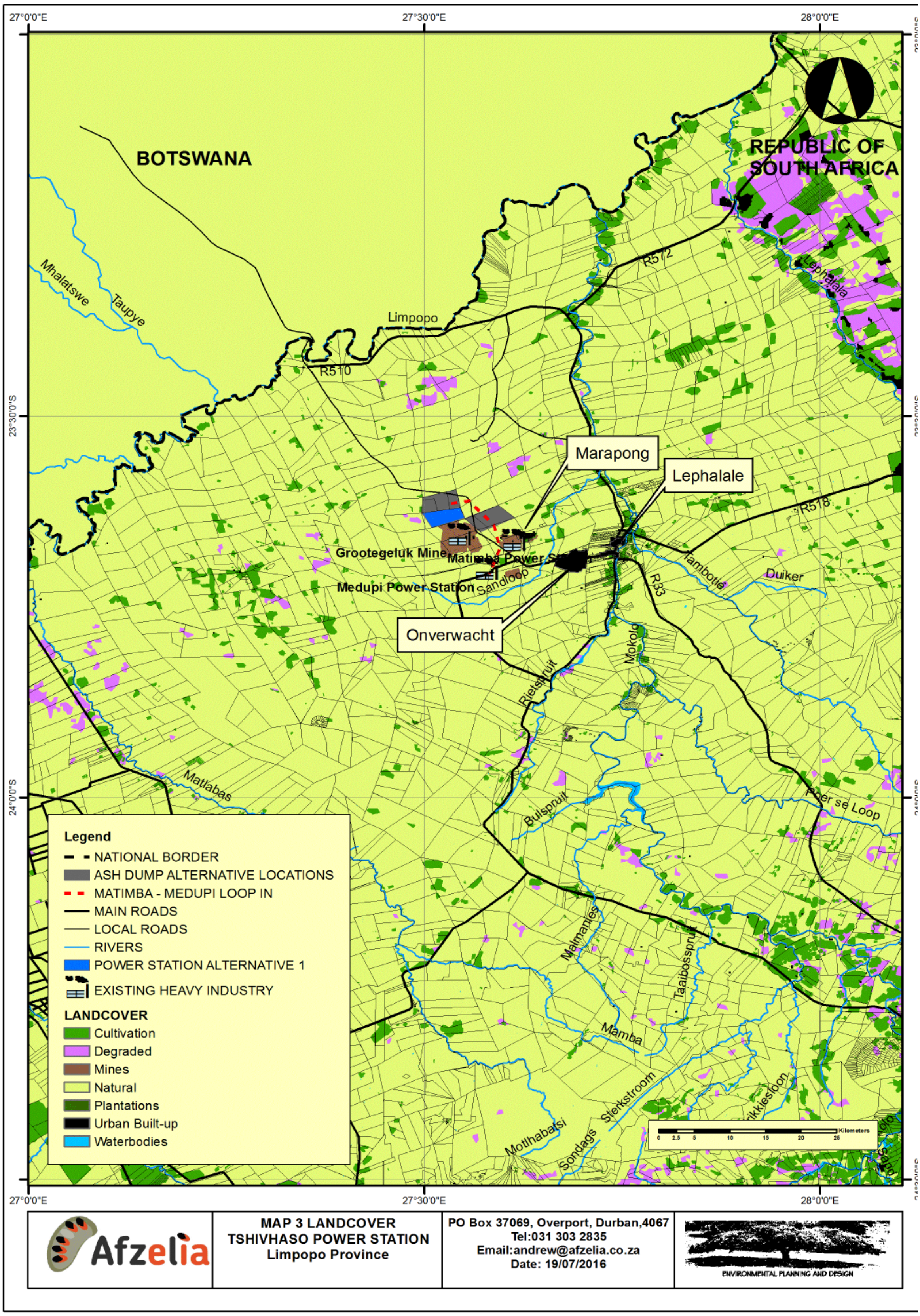


Figure 6.1: Land cover / land use map

6.4 Climate

Maximum temperatures during summer exceed 30°C and maximum winter temperature averages 23°C. The proposed site is located in an area that receives summer rainfall. Precipitation usually occurs in the form of convectional thunderstorms. The average annual rainfall is approx. 600 mm, with the high rainfall experienced in the months between October and March.

6.5 Topography

The broader study area occurs on land that ranges in elevation from about 810m above sea level (asl) along the drainage lines in the north east, to about 930m asl in the west. The most prominent topographical features in the area are the mines and ash dumps. The largest of these is the Grootegeluk mine dump to the south of the site which rises to a height of about 99m asl. The terrain immediately surrounding the proposed site has an even slope (slope gradient equal to, or less than 2.15%), whilst the terrain type of the region is described as plains.

The perennial Mokolo River bisects the far north-eastern corner of the study area, and its non-perennial tributary, the Sandloop, traverses the study area from south west to north east. The proposed site for the power station is located along the southern slope of a weak ridge that forms the western watershed boundary of the Mokolo River catchment. The Oliphantspad homestead is located near the approximate top of this ridge.

6.6 Geology

The Ellisras Basin comprises a comparatively small outlier of Karoo Supergroup (Carboniferous to Jurassic) sedimentary rocks in Limpopo Province that forms an easterly extension of the extensive Kalahari Basin of Botswana (Catuneanu *et al.* 2005, Johnson *et al.* 1996, 2006, Mtimkulu 2009). The basin presently extends about 80 km north-south and 35 km east-west. In structural terms the basin has the form of a west-east orientated half-graben and is of Karoo age. It is bounded by the Zoetfontein Fault Zone in the north. Here the Karoo Supergroup succession is thickest (*c*. 550 m, though some estimates are much higher) and faulted against Archaean basement rocks of the Limpopo Belt. The Karoo sedimentary wedge thins gradually towards the south where it abuts against Proterozoic sediments of the Waterberg Group along the Eenzaamheid Fault Zone (Fourie *et al.* 2014). Waterberg rocks form the basement to the Karoo succession throughout the central and southern portions of the Ellisras Basin.

In general, the levels of surface exposure of the Karoo Supergroup sediments within the Ellisras Basin are very poor; most stratigraphic information has been obtained from boreholes, supplemented recently by airborne geophysical surveys (Brandl

1996, Johnson *et al.* 2006, Fourie *et al.* 2014 and references therein). Late Carboniferous to Early Jurassic correlatives of the Dwyka, Ecca, Beaufort and Stormberg Groups of the Main Karoo Basin have been recognised here see also Bordy *et al.* 2010). The wide spectrum of depositional settings represented in the Ellisras Basin include glacio-lacustrine and glacio-fluvial towards the base through prodelta and delta platform, braided and meandering rivers, alluvial fans as well as desert aeolianites towards the top. The Karoo sedimentary succession is capped by basaltic lavas of the Letaba Formation, dated *c*. 180 Ma, which are placed within the Lebombo Group and also correlated with the Early Jurassic Drakensberg Group (Duncan & Marsh 2006). Coal deposits are well-developed within the lower portion of the Karoo Supergroup succession and these are likely to prove a major source of minable coal in future, with possibly over half of the South Africa's remaining coal reserves. Displacement along the post-Karoo Daarby Fault has generated separate blocks of coal at shallow depths that are suitable for open-cast mining. Currently the only large-scale exploitation of coals from the Ellisras (= Waterberg) Basin is at Grootegeluk Mine, situated just to the south of the present study area and
c. 20 km west of Lephalale).

Four sedimentary subunits of the Karoo Supergroup within the Ellisras Basin are mapped within the present study area underlying basaltic volcanic rocks of the Letaba Formation (Lebombo Group). These are the Swartrant and Grootegeluk Formations that are correlated with the Early to Middle Permian Ecca Group, the Eendragtpan Formation that is correlated with the Beaufort Group and the Clarens Formation within the Stormberg Group. The sedimentology and environmental interpretation of these formations have been outlined in the Ellisras geology sheet explanation by Brandl (1977; see earlier references therein) and summarised by Johnson *et al.* (2006).

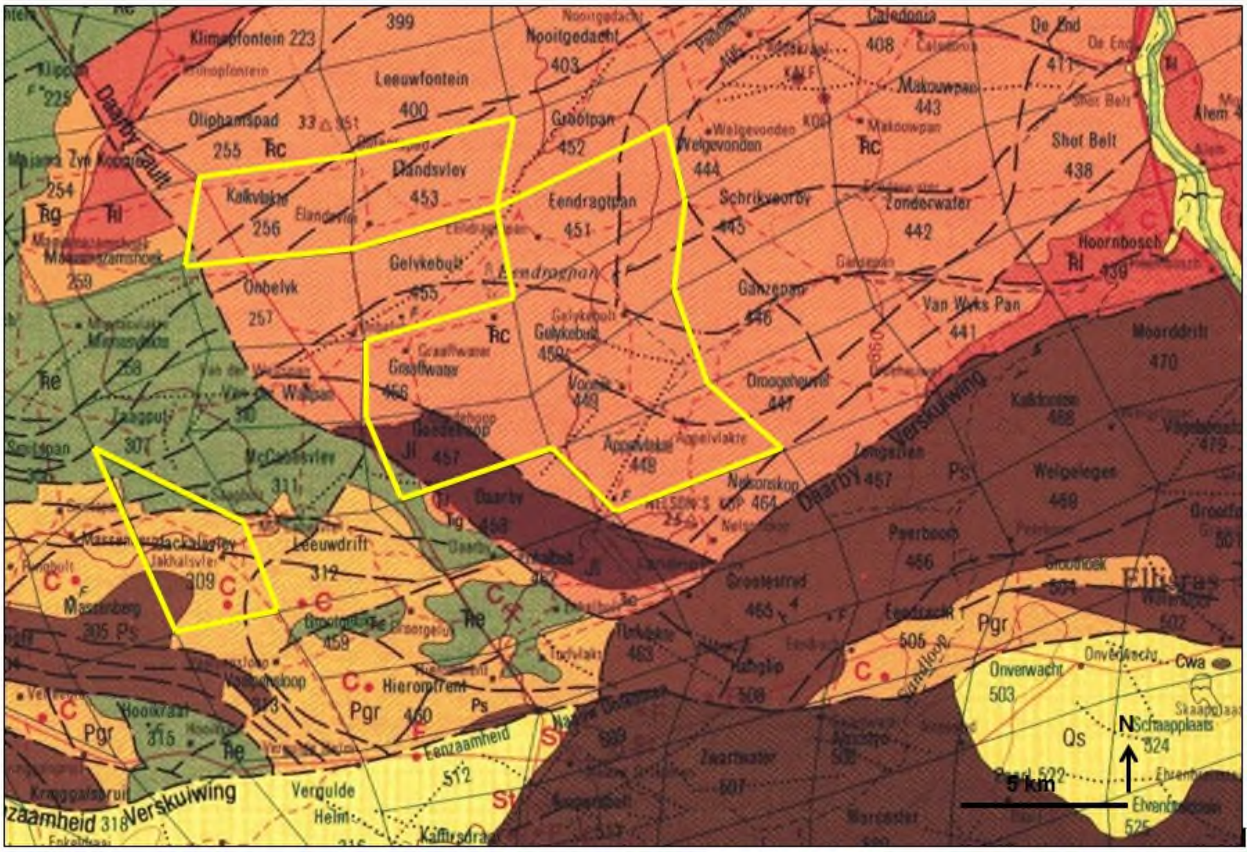


Figure 6.2. Extract from 1: 250 000 geology sheet 2326 Lephalale (Ellisras) showing the outline of the land parcels involved in the proposed Tshivhaso Coal-fired Power Plant study area (yellow polygon). The red "C" symbols refer to identified coal occurrences associated with the Grootegeluk Formation (Note C marked in Jakhalsvley 209). The main subunits of the Karoo Supergroup represented here include: Swartrant Formation (Ps, brown); Grootegeluk Formation (Pgr, beige); Eendragtpan Formation (Tre, grey-green); Clarens Formation (TRc, pink); Letaba Formation (Jl, dark brown); Late Caenozoic superificial sediments (soils, alluvium, gravels) are not mapped at this scale with the exception of Tertiary calcrete (Tc) to the north.

Swartrant Formation

The basal zone of the Swartrant succession consists of interbedded sandstone and siltstone overlain by coarser, cross-bedded sandstones and then a 1-meter thick coal seam with a seat earth at the base. These lower beds are interpreted in terms of a prograding delta prism with delta-top swamp deposits at the top. The middle zone has a laterally-extensive transgressive sandstone at the base followed by laminated mudrocks with dispersed dropstones attributed to suspension deposition in a glacio-lacustrine lake setting. The lacustrine mudrocks are overlain by prograding delta front sediments followed by delta-top deposits comprising thinly-interbedded coals and mudrocks. Coarse-grained, cross-bedded sandstones of the upper zone in the south of the basin containing thin coals and plant rootlet horizons are interpreted as fluvial deposits on the delta top or paralic floodplain. The

Swartrant Formation has been correlated with the Lower to Middle Ecca Group of the Main Karoo Basin.

Grootegeluk Formation
This formation is built up of cyclically-repeated facies including laminated to massive mudstone, carbonaceous shale and coal. It has been correlated with the Vryheid Formation (Middle Ecca) of the Main Karoo Basin. A 2m-thick tonstein (kaolinitic mudstone) – possibly a palaeosol or tuff - lies at the base of the formation and constitutes an important chronostratigraphic marker. Thick, mineable seams of coal are found within the lower part of the formation and constitute the main target of coal exploitation in the Ellisras Basin. A well-developed, fine-scale micro-cyclicity within the middle part of the Grootegeluk Formation features interlaminated sub-millimetric layers of bright coal (vitrinite), dull coal (inertinite), pollen-rich exinite and carbonaceous shale. The depositional pattern is attributed to a phase of delta abandonment in a tectonically stable setting. Tundra-type peats repeatedly flourished within poorly-drained floodplain swamps under the influence of a fluctuating water table and oxygenation levels. Most of the Grootegeluk coals are regarded as autochthonous, with subordinate allochthonous coals derived from transported plant debris. Low sulphur content as well as the abundance of concretionary siderite suggest the coals formed in freshwater settings with low ambient oxygen levels (*cf* Faure *et al.* 1996).

Eendragtpan Formation
This unit is correlated with the Permo-Triassic Beaufort Group of the Main Karoo Basin and is dominated by fine-grained variegated mudrocks, ranging from greyish towards the base with an increasing proportion of reddish-purple hues towards the top. Coloration reflects increasing oxidation levels during deposition as well as variable redox conditions during diagenesis. Pale reduction spots are ubiquitous while coalified material is absent. The depositional setting is interpreted as a well-drained floodplain. On the basis of geochemical and mineralogical data the mudrocks were deposited in a freshwater setting and once contained organic matter that has been subsequently degraded (Faure *et al.* 1996).

Clarens Formation
The Clarens Formation represents a geographically widespread succession of arid desert aeolian sands of Early Jurassic age and constitutes the final depositional phase within a number of Karoo sedimentary basins in southern Africa (Johnson *et al.* 2006 and refs. therein, McCarthy & Rubidge 2005). In the Ellisras Basin the Clarens sandstones reach a thickness of *c*. 130 m and are moderately well-exposed compared with most of the underlying Karoo Supergroup succession, locally forming prominent hills and ridges; most of the outcrop area is mantled in pale, fine-grained sand, however (Brandl 1996). The creamy to pinkish sandstones are typically massive, well-sorted and fine-grained, with occasional coarse sands and pebbly horizons. Sand grains are well-rounded but typical large-scale aeolian dune

cross-sets are rarely preserved. Coarser facies are interpreted as deposited by small ephemeral streams feeding inland sebkhas.

Letaba Formation

The Letaba Formation is a thick succession of picritic (olive-rich) mafic lavas within the lower part of the Early Jurassic Lebombo Group that is recognised widely within the northern portion of the South Africa as well as Zimbabwe, Botswana and Zambia (Duncan & Marsh 2006). They crop out in a small area of the Ellisras Basin, to the northeast of the Grootgeluk coal mine where borehole data indicates a thickness of 125 m (Brandl 1996). Bedrock exposures in shallow excavations here indicate purplish and greenish-grey amydaloidal lavas with flow units of about one meter thick.

Superficial deposits

Google earth© satellite imagery shows that the present study area some 20 km to the northwest of Lephalale is situated in flat-lying to gently undulating terrain between 880 and 950 m amsl. The area is dominated by typical dry Kalahari bushveld with occasional small pans but no major water courses. The large Grootegeluk open cast coal mine and Medupi power station (currently under construction) lie just to the south of the proposed site. Due to the easily-weathered and –eroded nature of the Karoo Supergroup bedrocks, and especially the mudrock-dominated portions of the succession, there is very little topographic relief in the region and the bedrocks are largely or entirely mantled by a surface sands (*cf* Almond 2015). According to Brandl (1996), the extensive surface sands were largely emplaced by sheetwash processes subjected to limited aeolian reworking, with a secondary contribution from weathering of local Karoo Supergroup sandy lithologies. Small, shallow water courses are associated with fine alluvial sands, silts and dispersed fine gravels of Quaternary of younger age. The alluvium as well as pan deposits are usually extensively calcretised, with the formation locally of a massive subsurface calcrete hardpan. According to Netterberg (1969) the calcretisation is mainly a Mid-Pleistocene phenomenon. Calcrete-dominated areas are typically dominated by *Acacia* thornveld (darker green in satellite images) while arid bushveld with tree genera such as *Terminalia*, *Combretum* and Maroela predominates elsewhere. Between the trees there are tall grasses and reddish-brown or greyish sandy soils (Almond 2015). The various late Caenozoic superficial deposits in the study region are not shown on geological maps at 1: 250 000 scale.

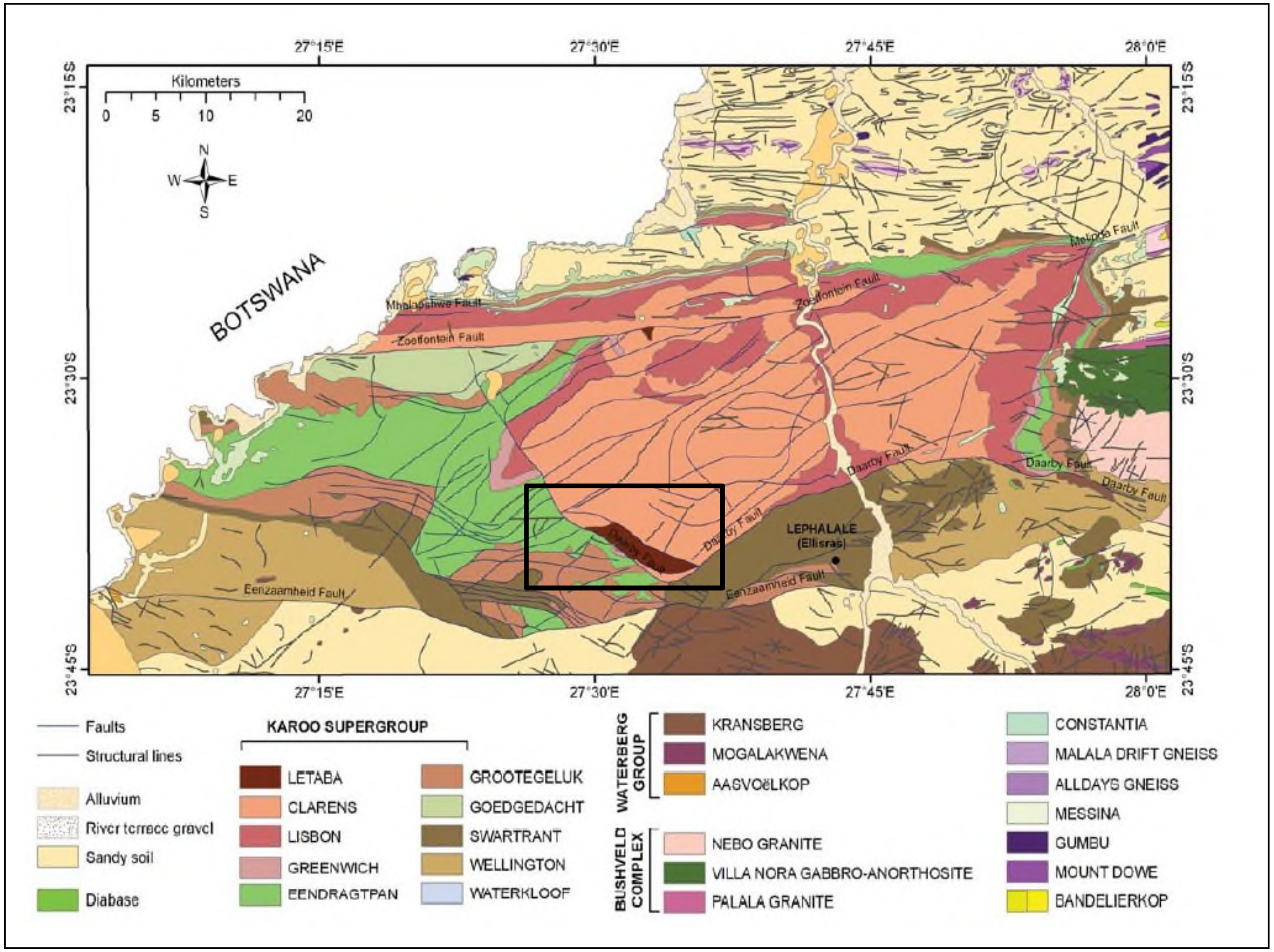


Figure 6.3: Geological map of the Ellisras Basin, Limpopo Province (From Fourie et al. 2014). The approximate location of the present study area towards the southern basin margin is shown by the black rectangle.

6.7 Surface Water

6.7.1 Affected Catchments

Affected River Basin

The surface water study area for the Tshivhaso Coal-Fired Power Plant falls within the Limpopo Water Management Area. The area receives early to mid-summer rainfall that varies between 300 mm and 600 mm per year. Due to the low rainfall that is experienced in the Limpopo Province, relatively little surface runoff is generated in the Limpopo Water Management Area (WMA). The various drainage areas for the Limpopo WMA are described in **Error! Reference source not found.** of the specialist report. The runoff is highly seasonal, variable with intermittent flow in many of the tributaries. The exception in the Limpopo WMA is the Waterberg which is relatively well-watered with strong base-flows.

Most of the surface runoff in the WMA is contributed by the Mokolo and Mogalakwena Rivers. Both of these rivers originate in the Waterberg and drain much of the Waterberg catchment.

Figure 6.4: Delineation of the Mokolo Water Management Area

The Mokolo River and Matlabas River are two of the seven major rivers in the Limpopo WMA. The catchments are mostly independent of each other and the rivers drain into the Limpopo River. The Crocodile (West) and Marico WMA borders the Limpopo WMA in the south-west.

Mokolo Sub-catchment

The Mokolo catchment is situated in the Limpopo Province and covers an area of 8387 km^2. The catchment stretches from the Waterberg Mountains through the upper reaches of the Sand River, and includes the Mokolo Dam and a number of small tributaries that join the main Mokolo stem up to the point of confluence with the Limpopo River. The smaller tributaries of the Mokolo River include the Tambotie, Rietspruit and Poer-se-Loop.

Water use in the Mokolo catchment comprises 87% agricultural use with 13% allocated for industrial use (which include mining and power generation) as well as domestic water supply to the Water Service Provider sectors.

The Mokolo River and its tributaries rise in the western part of the Waterberg between 1200 and 1600 m asl. The Mokolo originates in a flattish, open area with numerous koppies and flows northerly through a steep gorge emerging above the town of Vaalwater. From Vaalwater the river flows through a flat area until it enters the Mokolo Dam. It flows through another gorge before entering the Limpopo Plain near the confluence with the Riet Spruit. From the confluence the Mokolo River flows through flat sandy areas until it reaches the Limpopo River.

Matlabas Sub-catchment

The Matlabas sub-catchment is largely undeveloped with limited water resources and use. The area covers 6 014 km^2. The catchment is dry with non-perennial flow and hence no sustainable yield. The limited water use in the Matlabas is mostly from groundwater, which is under exploited.

There are no significant dams in this catchment and a significant portion of the water need is augmented from groundwater sources due to low assurance of the run-off river yields. New water use allocations in this key area can only be made from groundwater or from additional yield which could conceivably be created by the construction of dams.

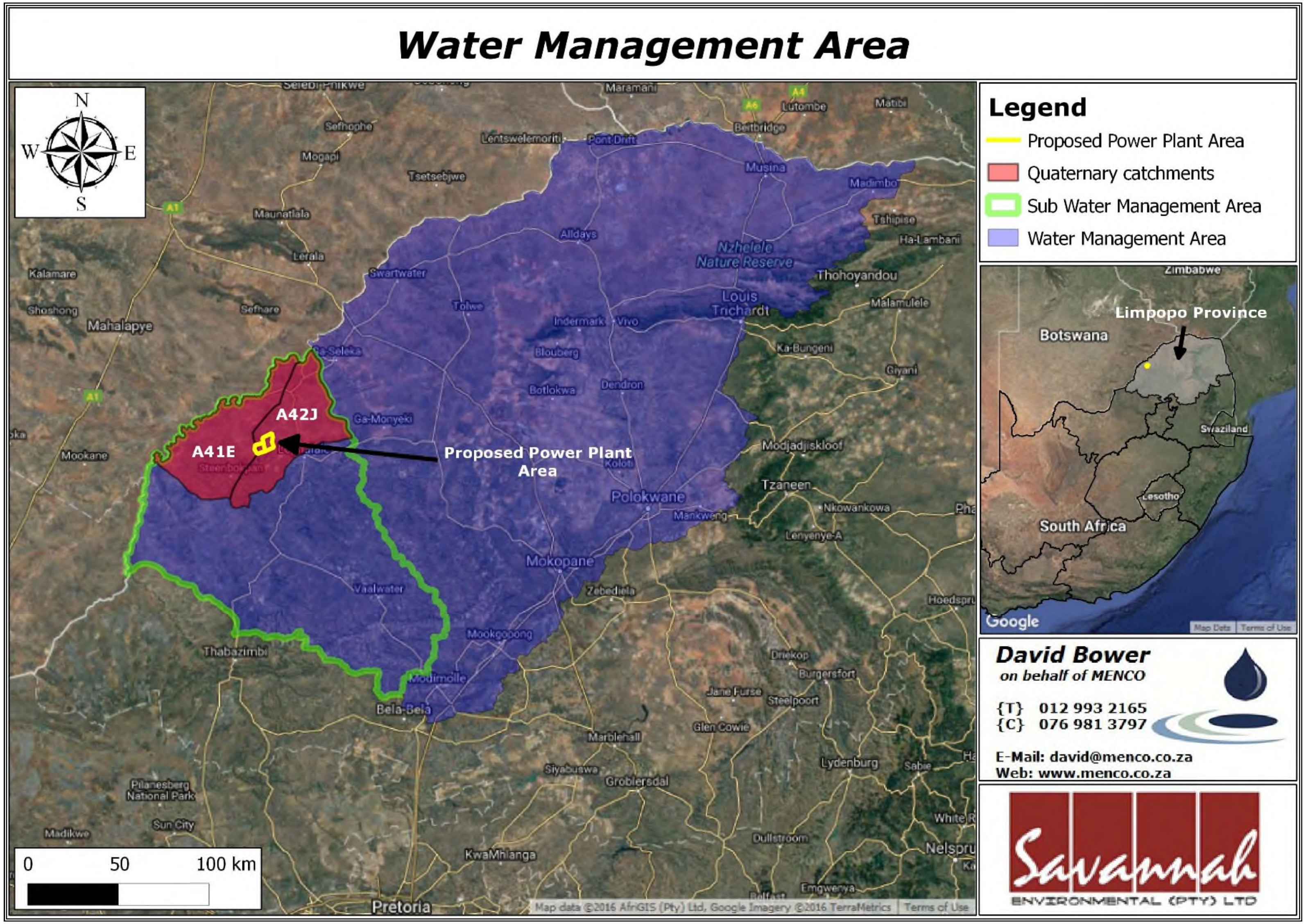


Figure 6.5: Study area in relation to the A42J and A41E catchment

6.7.2 Surface water quality and quantity

The water quality for the affected catchment is contained in Table 6.1: Background water quality data for Mokolo River. It is evident that the water quality is good with no variable exceeding the Target Water Quality Range (TWQR) for drinking water.

Table 6.1: Background water quality data for Mokolo River

Variable	90332	90334	TWQR
Electrical Conductivity in mS/m	8.1	8.8	<70
pH	7.1	7.4	6.5 – 9.0
Sodium as Na in mg/l	5.2	6.5	<100
Potassium as K in mg/l	1.7	1.4	0-50
Calcium as Ca in mg/l	5.1	5.0	<32
Magnesium as Mg in mg/l	2.3	2.7	<30
Chloride as Cl in mg/l	6.7	7.9	0-100
Sulphate as SO_4 in mg/l	4.6	4.8	0-200
Total Alkalinity as TAL in mg/l	23.2	27.2	-
Fluoride as F in mg/l	0.14	0.13	0-1
Phosphate (PO_4) as P in mg/l	0.02	0.017	<5
Nitrate (NO_3) and Nitrite (NO_2) as N in mg/l	0.015	0.05	<6
Ammonium (NH_4) as N in mg/l	0.12	0.033	0-1

The project area falls within quaternary drainage areas A41 and A42. A preliminary determination of Reserve for Water Quantity in terms of sections 14(1)(b) and 17(1)(a) of the NWA had been conducted to support water use license applications. The water quantity for the main affected catchment (A42) is contained in **Table** 2.

Table 6.2: Water Quantity Reserve for the A42E quaternary drainage area

EWR	QC	Resource	PES	Reserve[7] (Basic Human)	Interim Flow[8]	MAR[9]	Present Flow[10]
1A	A42C	Mokolo	C/D	0.048	Maintain	84.84	68.8
1B	A42E	Mokolo	B/C	0.09	Maintain	135.03	109.0
	A42F	Mokolo	B/C	0.103	Maintain	196.2	163.2
3	A42G	Mokolo	B/C	0.111	Maintain	214.5	156.5
4	A42G	Mokolo	C	0.111	Maintain	253.3	176.5
5	A42G	Mokolo floodplain	D	As for EWR 4			

[7] *Total Reserve equals the present day hydrology inclusive of Ecological Reserve and Basic Human Needs*
[8] *Maintenance of the current operating of the system was recommended as interim measure*
[9] *Natural Mean Annual Runoff at EWR sites measured in million m^3/annum*
[10] *Present day flow (based on 2007) in million m^3/annum*

In order to maintain the present day flow downstream of the Mokolo Dam up to EWR 4 site, the operating rule that has been applied by DWS to release water to irrigators downstream of the dam must remain in force. This entails the release of 16 million m^3 per annum if the dam is at 50% of its full supply capacity (FSC) and 5 million m^3 if the storage drops to below the 50% FSC. It should be noted that water from the Mokolo Dam is fully allocated.

According to the Internal Strategic Perspective as conducted by DWS (Report WMA 01/000/0304), it is reported that at present the water availability and water use in the catchment are in balance. The water demand will however increase with the new developments proposed in the Mokolo River catchment (expansion of mining activities and new power stations).

6.7.3 Wetlands

Based on the hydro-geomorphic setting, a depression type wetland was identified in the project area. The depression is surrounded by wilderness and is maintained by sheet flow originating on adjacent sub-catchments that feeds into the depression system. Flow within this wetland is predominantly sub-surface and surface flow is generated as a result of rainfall events. It is expected that the flows will be of low energy due to the flat slope of the wetland and the fact that the landscape is covered by natural vegetation preventing the formation of a channel in the system.

The depression wetland is a typical seasonal wetland system and only has surface water resembling a pan during the wet season. It will be required to conduct a follow-up visit during the wet season in order to verify the existence of surface water. If the existence of an open water system is validated, water quality data needs to be obtained to provide additional baseline information on the depression wetland in order to ensure a more accurate description of the PES of the system.
The field survey has also revealed that the wetland soils at several auger points fluctuated from being permanently waterlogged to seasonal mottling. PES for the Eendragt wetland is Class B (largely natural). The overall classification in terms of the EIS is High, indicating that the wetland is considered of Local Importance.

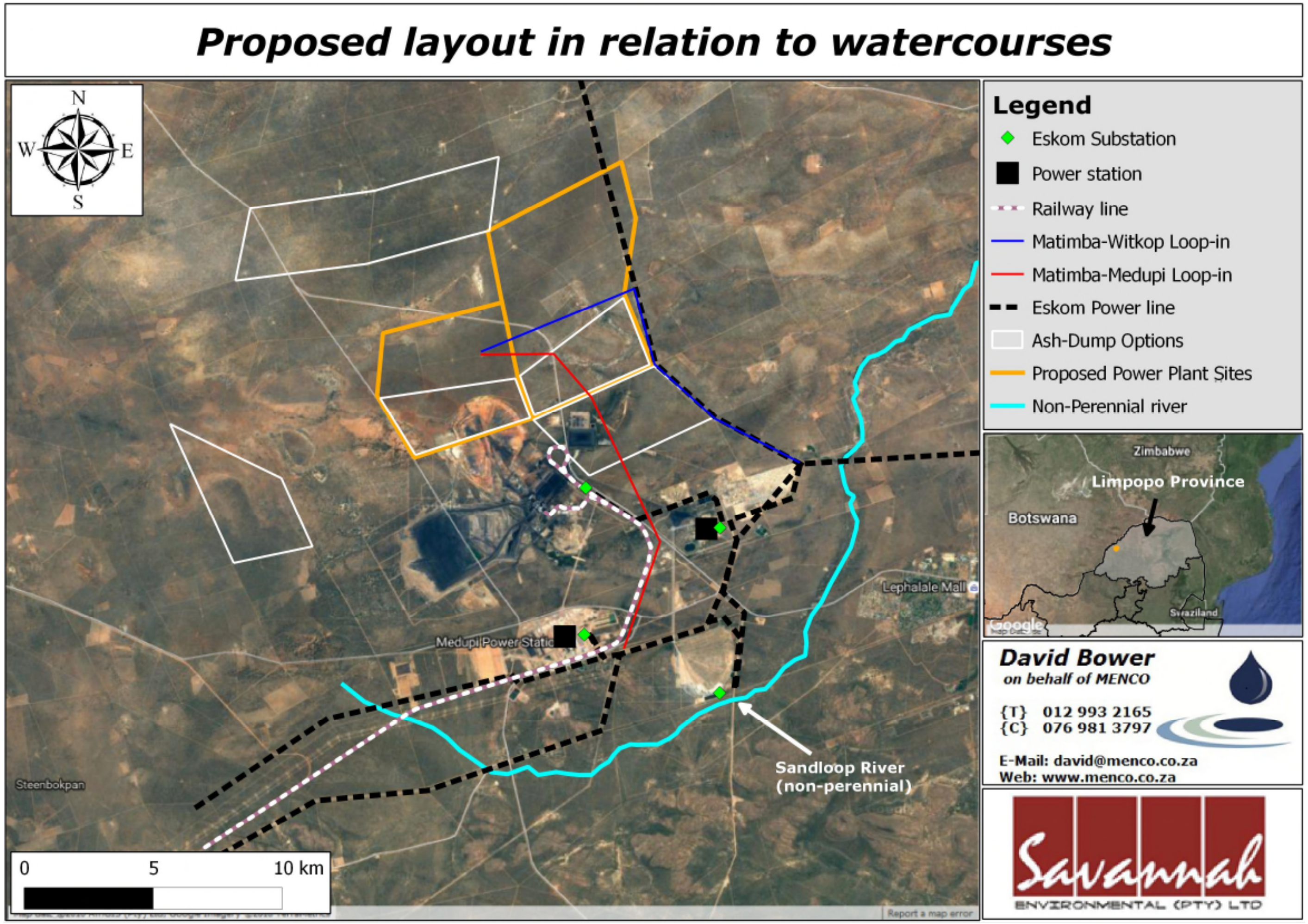


Figure 6.6: Proposed infrastructure in relation to water resources

6.8. Groundwater

6.8.1 Regional geology

The investigated area falls within the 2326 Ellisras 1:250 000 geology series map and is situated approximately 20 km north-west of Lephalale, Limpopo. The proposed power station is situated in the Ellisras basin of the Karoo Super Group, which extends from the Limpopoo River in the west to Ga-Monkeki in the east covering a surface area of approximately 1200 km. Regionally the rocks of the Clarens Formation, Eendragtpan Formation, Lisbon Formation and the Lethaba Formation can be found.

The Clarens Formation forms a layer of well sorted fine grained sandstone that is approximately 130m thick in the Ellisras Basin. The sandstone in this formation is mostly cream-coloured but can have light pink colours locally and is thought to be of Aeolian origin. Variegated mudstones make up the Eendragtpan Formation. These mudstones are generally purplish-red in colour and attain a maximum thickness of 110m. The Lisbon Formation is comprised of dominantly red, massive mudstones and siltstones as well as minor sandstones. These rocks were probably deposited on an extensive flood plain and have a fairly constant thickness of 100-110m. The rocks of the Lethaba Formation are also present regionally. This formation is composed of basaltic rocks.

The generally horizontally disposed sediments of the Karoo Supergroup are typically undulating with a gentle regional dip to the south. The extent of the coal is largely controlled by the pre-Karoo topography. Steep dips can be experienced where the coal buts against pre-Karoo hills. Displacements, resulting from intrusions of dolerite sills, are common. There is also a number of approximately east-west and north-south trending faults in the area. From the sheet of 2326 Ellisras geology series map it is evident that the cream coloured aeolian sandstone and the red mudstones of the Eendragtpan outcrop in the area. The coal bearing rocks of the Grootgeluk Formation also outcrop to the north of the site. This group is approximately 110m thick and consists of coal, carbonaceous shale and mudstone.

The local geology is best concluded from information obtained from exploration borehole logs from the National Groundwater Archive. Three hundred and nine boreholes logs were used to derive a statistical analysis of the borehole logs for the proposed power station area. A number of faults traverse the proposed power station site. Two of the approximately east-west trending faults and approximately north-south trending fault lies beneath the area of the proposed ash dump. The north-south trending fault is called the Daarby Fault and it runs though the east- west faults displacing them slightly.

6.8.2. Aquifers

The study area is situated in the Limpopo Water Management area. On a regional and local scale the hydrogeology consists of intergranular and fractured aquifers of the Karoo Supergroup, with both arenaceous (sandstone) argillaceous (mudstone) rocks present. Blow yields of 0.3 – 3.0l/s can be expected regionally.

The hydrogeology of the area can be described in terms of the saturated and unsaturated zones.

Saturated Zone
In the saturated zone, at least two aquifer types may be inferred from knowledge of the geology of the area:

» An intermediate aquifer formed by fracturing and faulting of the Karoo sediments.
» Aquifers formed within the more permeable coal seams and sandstone layers.

Although these aquifers vary considerably regarding geohydrological characteristics, they are seldom observed as isolated units. Usually they would be highly interconnected by means of fractures and intrusions. Groundwater will thus flow through the system by means of the path of least resistance in a complicated manner that might include any of these components.

Fractured Karoo rock aquifers
The area consists of consolidated sediments of the Karoo Supergroup and consists mainly of sandstone and shale and coal beds of the Clarens and Eendracht Formation. The geology map for the area indicates a number of faults and fractures in the area and from experience it can be assumed that numerous major and minor fractures do exist in the host rock. These conductive zones effectively interconnect the strata of the Karoo sediments, both vertically and horizontally into a single, but highly heterogeneous and anisotropic unit.

Aquifers associated with coal seams
The coal seam forms a layered sequence within the hard rock sedimentary units. The margins of coal seams or plastic partings within coal seams are often associated with groundwater. The coal itself tends to act as an aquitard allowing the flow of groundwater at the margins.

Unsaturated Zone

The unsaturated zone is likely to consist of colluvial sediments at the top, underlain by residual sandstone of the Clarens Formation that becomes less weathered with depth. The thickness of the unsaturated zone can be determined from water levels measured during the hydrocensus.

Experience of Karoo geohydrology in this area, indicates that recharge to the shallow groundwater aquifer is relatively low, less than 3% of the Mean Annual Precipitation.

Local Hydrogeology

Based on borehole logs obtained from the NGA, slug testing and literature, the following local hydrogeological description (within the aquifer boundary) from top (surface) to bottom (Dwyka Tilites) can be deduced as follows:

» **Shallow weathered aquifer (unconfined)**
This aquifer comprises of weathered arenaceous sandstones and shales. The Ecca and Clarens sediments are weathered below surface throughout the area. The upper aquifer is associated with this weathered zone and water is found deep below the surface. The hydraulic conductivity value for the aquifer is estimated at 1x10 m/d to 0.10 m/d. The estimated thickness of the aquifer ranges from a minimum of 1 m to a maximum of 45.41 m at a mean of 8.05 m. Water levels measured in this aquifer ranged from 14.41 to 22.39 meters below ground level.

» **Deeper fractured aquifer (confined)**
The pores within the Karoo and more specifically the Ecca and Clarens sediments are too well-cemented to allow any significant flow of water. All groundwater movement therefore occurs along secondary structures, such as fractures and joints in the sediments. These structures are better developed in competent rocks, such as sandstone, hence the better water-yielding properties of the latter rock type. It should be emphasised, however, that not all secondary structures are water-bearing. Many of these structures are constricted because of compression forces that act within the earth's crust. The chances of intersecting a water-bearing fracture by drilling decrease rapidly with depth. At depths of more than 30 m, water-bearing fractures with significant yield were observed to be spaced at 100 m or greater. The estimated thickness of the aquifer ranges from a minimum of 2 m to a maximum of 89 m at an mean of 30.2 m. Water levels measured in this aquifer ranged from 35.02 to 53.56 m below ground level.

The main source of recharge into the upper aquifer is rainfall that infiltrates the aquifer through the overlying unsaturated zone. Rainfall that manifests as surface run-off and drains to streams may also subsequently enter the shallow aquifer by infiltrating the stream bed (Grobbelaar, 2001). Water impoundments and features such as tailings dams may constitute additional recharge sources in certain areas. The rainfall ultimately recharging the upper aquifer is estimated at less than 3%. A higher proportion of infiltration may occur in areas where the natural permeability is increased, such as the increased fracturing associated with high extraction mining. Generally accepted values for recharge in high extraction areas are between 5 % and 7 %. Recharge of the deep Karoo aquifer occurs from the shallow Karoo aquifer through permeable fracture systems that link the two aquifers. The natural distribution of such fracture systems is highly variable, and the recharge of the deep aquifer is expected to be some orders of magnitude lower than for the shallow aquifer. However, induced fracturing associated with mining can extend from the deep aquifer up to the surface and provides a relatively direct and highly permeable recharge route. The magnitude of recharge by this route depends on the extent of mining and the nature of the induced fracture pattern.

6.8.4 Borehole information

Seventeen boreholes were found during the hydrocensus of which 12 boreholes are either not in use or used for monitoring purposes. This is denoted as "other" uses. Four boreholes are used for livestock watering.

During the hydrocensus, 16 boreholes were available for groundwater level measurement. The groundwater levels varied between a minimum of 11 m and a maximum of 59 m below ground level.

Based on measured water levels the relationship between topography and static groundwater level is highly erratic, most likely due to large scale groundwater abstraction in the area as well as complex faulting.

The groundwater flow is mainly from topographical high to low areas, eventually draining to the local streams.

More detail is provided in Table 7 of the groundwater report (Appendix F)

6.9. Vegetation

The study area corresponds to the Savanna Biome and more particularly to the Central Bushveld Bioregion as defined by Mucina & Rutherford (2006) and comprehends an ecological type known as Limpopo Sweet Bushveld (Mapping Unit SVcb 19; Mucina & Rutherford, 2006). It is predominantly located on extensive plains that are irregularly interspersed by tributaries of the Limpopo River. This vegetation type extends from the lower reaches of the Crocodile and Marico Rivers down into the Limpopo River valley. It comprises short, open woodland dominated by *Acacia mellifera* and *Dichrostachys cinerea* as well as taller tree species such as *A. robusta, A. burkei, Terminalia sericea, A. erioloba* (Camel Thorn), and *A nigrescens* (Knob Thorn). The high palatability of the graminoid stratum makes this vegetation type highly suitable for game and cattle farming land uses.

The Limpopo Sweet Bushveld is Least Threatened and extensive in geographic coverage. It is however poorly conserved (e.g. D'Nyala Nature Reserve) even though it straddles many privately owned game farms. It is transformed by cultivation, but future threats include the mining of coal and urbanisation. Approximately 5 % is transformed by cultivation. Though limited by low rainfall, this is a good area for game and cattle farming due to the relatively high grazing capacity of sweet veld, but overgrazing frequently occurs. The Central Bushveld endemic herb *Piaranthus atrosanguinalis* occurs in this vegetation type.

The flora of the sites is recognised as *Acacia erubescens – Stipagrostis ciliata* woodland that is typical of the region and representative of the flora of the region. The following communities were recognised from the TWINSPAN classification (refer to Figure 6.7):

» *Eragrostis rotifer - Echinochloa holubii* ephemeral pans representing small water bodies and shallow depressions that tend to hold surface water when inundated. This habitat type was uncommon on the study area and mainly confined to a few depressions located on the northern part of the Farm Graaffwater;
» *Acacia mellifera - Acacia tortilis* microphyllous woodland on clay soils community, representing vegetation that is prominent along the drainage lines and on clay soils that are characterised by a high prominence of dense *Acacia* woodland; and
» *Combretum zeyheri - Eragrostis pallens* undifferentiated broad-leaf woodland on sandy soils is prominent and by far the most dominant habitat on the study area. It corresponds to deep, highly leached sandy soils, and is earmarked by a high prominence of medium to tall semi-deciduous woodland.

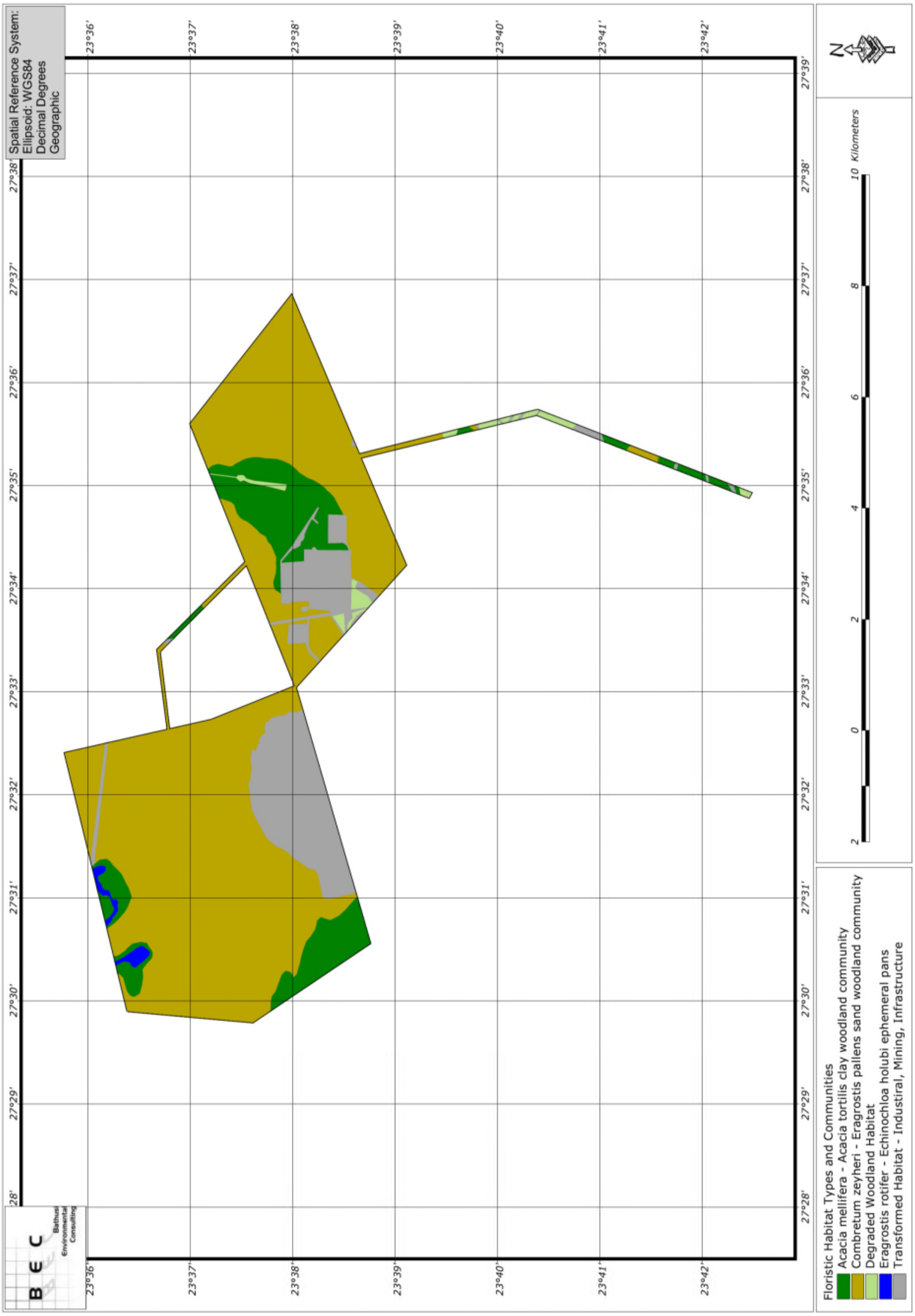


Figure 6.7: Floristic units of the study sites

6.10. Fauna and avifauna

6.10.1 Fauna

The 18 mammals recorded for the two Q-degree grids of the study area include two bats, one hare, seven carnivores, one pangolin, one pig, two giraffes and four bovids. This diversity of mammals includes three regionally listed red data species, namely Cheetah, Brown Hyaena and Temminck's Ground Pangolin.

The close relationship between vegetation units and specific faunal composition has been noted in several scientific studies and broadly speaking, floristic macro-habitats are regarded representative of faunal habitat diversity for a given area. The preliminary macro-habitats described in this document are considered ecologically distinctive and descriptive of the faunal habitat diversity of the study area. The following general faunal habitats are found within the boundaries of the study area:

<u>*Transformed Faunal Habitat*</u>
Significant fragments of the study area have been transformed because of mining and industrial development associated with power generation. These transformed areas have lost the ecological ability to sustain any natural faunal assemblage or community; the lack of natural vegetation and absence of original ecological functions and processes has resulted in 'ecological wastelands' in these transformed fragments within the landscape. Due to the low biodiversity potential and poor ecological quality of the transformed faunal habitats of the study area, these fragments are considered to have very low faunal sensitivities regarding the potential and anticipated impacts associated with the proposed project. Consequently, these habitat fragments have high development potential considering the proposed project, especially when situated close to other transformed areas. Concentrating habitat transformation to smaller, isolated areas limits cumulative impacts, particularly within landscapes that include both significant industrial development and natural faunal habitats of significance (as is the case with the study area region).

<u>*Untransformed Terrestrial Woodland Habitat*</u>
The study area falls within the Limpopo Sweet Bushveld regional vegetation community of the Central Bushveld Bioregion and Savanna Biome of South Africa. Untransformed terrestrial woodland habitat of the study area is unlikely to include significant natural ecological variation and habitat feature diversity. It is likely that the variations of the remaining faunal woodland habitat would be a result habitat degradation, fragmentation, edge effects and variable ecological management. The faunal sensitivity of the different untransformed terrestrial faunal woodland habitat fragments will depend on the specific habitat characteristics of each fragment. Habitat status, level of degradation, landscape connectivity, red data hosting ability and ecological diversity will likely determine the specific faunal sensitivity of each habitat fragment. The anticipated variation in the faunal

sensitivities of these habitat fragments is likely to result in disparities in the suitability and development potential of these fragments within the project scope.

Faunal Wetland Habitat
The Bushveld region in which the study area is situated, normally receives about 400 mm of rain per year, most of which occur during midsummer. The arid nature of the region complicates wetland delineation and confounds an understanding of the ecological processes and biodiversity functions of the wetlands of the study area region. Wetlands of arid regions are seldom obvious and their processes not well understood. Within the arid landscape, wetlands are scarce and unique; the presence of arid wetlands significantly enhances the biodiversity and ecosystem process diversity of an area. The wetlands of the study area are considered to exhibit high faunal sensitivities, irrespective of the habitat status; wetlands are known to have high restoration potential and their ecological importance cannot be overestimated.

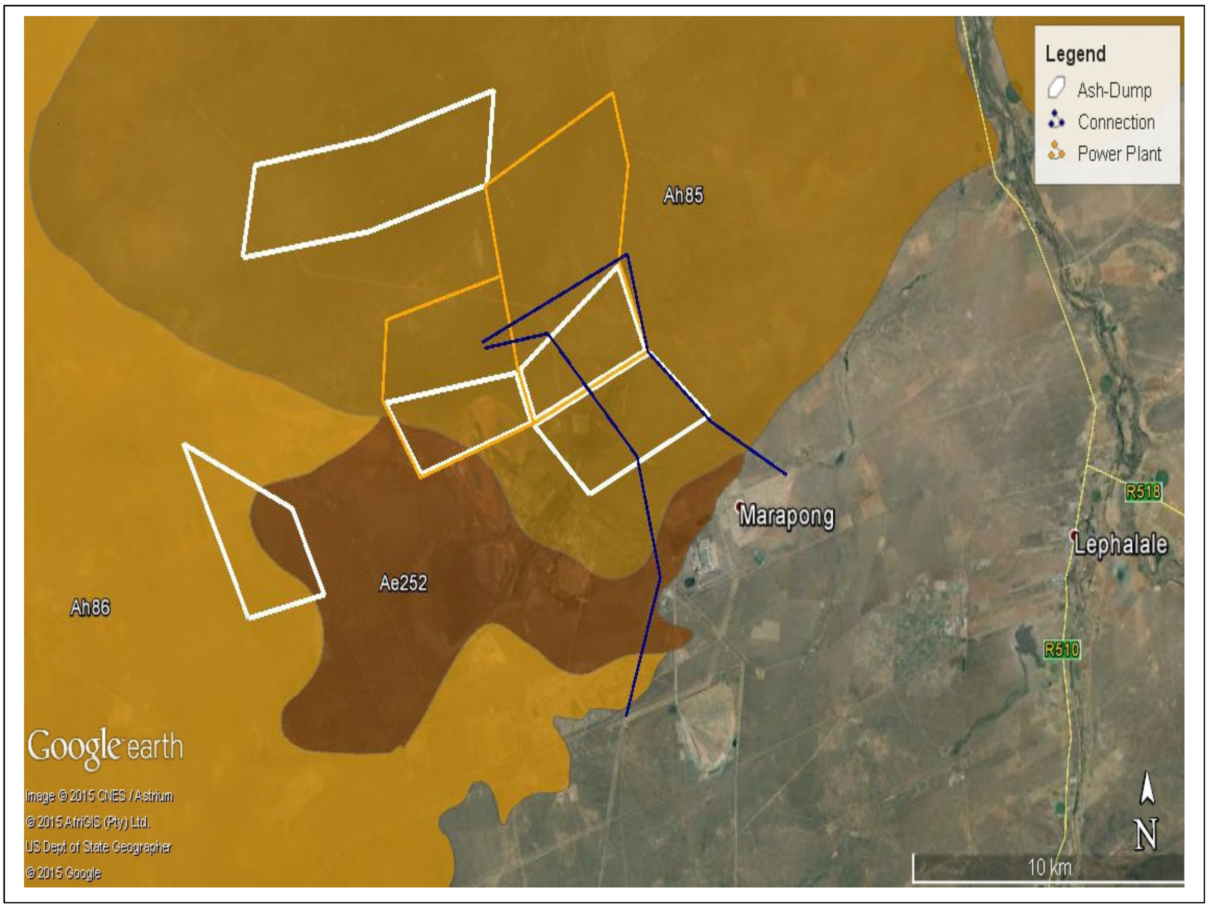
6.10.2 Avifauna

According to the South African Bird Atlas Project (SABAP1 (Harrison et al., 1997) & SABAP2), approximately 318 bird species have been recorded in the quarter degree square that are sympatric to the study region. This equates to approximately 31 % of the approximate 972 species listed for the southern African subregion (and approximately 27 % of the 849 species recorded within South Africa). However, recent records suggest that the study area is more likely to sustain on average 108 species (www.sabap2.adu.org.za).

A cluster analysis of the bird abundance values and composition in the area suggests two distinct bird associations (apart from an outlier group) based on vegetation structure (e.g. microphyllous vs. broad-leaved woodland) and soil texture (clay soils vs. sandy soils). It was evident that the contribution of the depressions, dams and the secondary open woodland towards the differentiation between the different bird associations was negligible. Although some of these habitat types (e.g. pollution control dams) hold aquatic-associated species, these occurred at such low abundances that they do not influence the analysis. In addition, these habitat types are geographically "embedded" within the microphyllous woodland and are spatially auto-correlated to the dominant bird composition. The depressions are also invariably located on soil forms with high clay content, which were responsible for the dominance of microphyllous woodland and subsequent colonisation of typical "thornveld" bird species.

Noteworthy species of conservation concern include the regionally near-threatened Kori Bustard (*Ardeotis kori*), the critically endangered African White-backed Vulture (*Gyps africanus*), the endangered Martial Eagle (*Polemaetus bellicosus*), the endangered Bateleur (*Terathopius ecaudatus*) and the endangered Lappet-faced Vulture (*Torgos tracheliotos*) - all considered to be regular to fairly regular foraging visitors on the study area (with the exception of the Lappet-faced Vulture and Bateleur which are considered as irregular or uncommon foraging visitors to the area).

6.12 Land Types (Soils) and Agricultural Potential



Land types Ah85 and AH86 cover the largest area within the study area. Red and yellow well-drained sandy soils with a high base status occur. The main soil forms present are Clovelly and Hutton. An Orthic A horizon rarely deeper than 200mm is found directly on top of a Red Apedal B or Yellow-Brown Apedal B. There are plinthic horizons present and sandy soil occurs at depth in the area.

Land type Ae252 covers a small area of the site and is very similar to the land type Ah. The land type does not contain plinthic Longlands soil form such as Ah. The unshaded area is not considered in the study as it has no development proposed on it. Soils in this area are fairly similar to the other two areas which are described.

Small differences may occur within the site boundaries with regards to topography, soil depth and erodibility. These uncertainties will be cleared up during the EIA phase field inspection.

The underlying geology is dominated by sedimentary rocks such as sandstone and siltstone. Different soil properties are all available on the AGIS website. The most relevant properties are described here:

The generalised soil pattern for the area is CM which is red soils with a high base status, and AR2 which may be described as red and yellow, sandy well drained soils with a high base status and minimal development, with or without intermittent diverse soils.

Oxidic soils have a B horizon that has a colour directly related to the mineralogy of the area. Soil classes provided by the source indicate that freely drained, unstructured soils occur on more than 60% of the site. Soil horizons indicative of the group are Clovelly and Hutton.

There are also cumilic soils present which are complementary to the lithosols but are found in lower areas of the landscape where deposition is ongoing (Fey, 2010). Soil horizons indicative of the cumulic group are neocutanic or neocarbonate B, regic sand, deep E or stratified alluvium and carbonate which occur in Tukulu, Oakleaf, Montagu, Augrabies, Namib, Vilafontes, Kinkelbos, Fernwood, Coega, Plooysburg and Dundee soil forms (Fey, 2010). It is unlikely that most of these cumulic soil forms are present on site.

The low rainfall and hot conditions in the area, despite the generally deep loamy sand soils, mean that the prevailing dryland arable agricultural potential is low, so any impacts on this will be minimal.

6.13 Social Characteristics of the Study Area and Surrounds

The population of any geographical area is the cornerstone of the development process, as it affects the economic growth through the provision of labour and entrepreneurial skills, and determines the demand for the production output. Examining population dynamics is essential in gaining an accurate perspective of those who are likely to be affected by any prospective development or project. This sub-section describes the status quo of the study area's population at its current state.

6.13.1. Population size

Spatially, Lephalale is the largest municipality within the Waterberg DM, yet the total population of 115 766 accounts for only 17% of the District's population and 16.6% (equivalently 29 881 households) of its household numbers (Quantec, 2015). The population has increased by 26.3% from 85 272 in 2001, implying an average annual population growth rate of 2.6% over the ten-year period. Approximately 22.7% (26 228 people) of the municipality's population resides in Marapong, while 15.2% (17 638) resides in Lephalale town and the remaining population resides in the rest of the municipality. According to the Lephalale LM's IDP, the population growth within Lephalale Town node is among the highest in Limpopo and reflects the influx of people to work on the construction of the Medupi Power Station and the local coal mine expansion projects. A large portion (45.2%) of the population in the LM resides in tribal areas, while 39.8% resides in urban areas, and the rest (15%) lives in on farms. This depicts the rural nature of the Lephalale LM.

6.13.2. Race, gender and language spoken

The majority (90.1%) of the people in the municipality are Black African; 7.9% of the population is White, with other population groups making up the remaining 2%. Sepedi is the language most spoken in the LM. The male population (54.3%) exceeds the female population (45.7%). According to the Lephalale LM IDP, this can be attributed to the high incidence of contract workers and male professionals coming into the municipality in pursuit of employment opportunities.

6.13.3. Age profile

The youth (aged between 15 and 34 years) make up the majority of the people living in the Lephalale LM (43.4%), followed by the group between the ages of 35 and 64 years with 26.4%. Considering the working age group that is between the ages of 15 and 64 years, the municipality has a slightly bigger percentage of working age males than females, which is again attributed to the influx of male workers and job seekers to the area.

The population in the area is characterised by a high dependency ratio (43.2%) with 26.1% of the population within the ages of 0 to 14 and over 65 years old (4.1%). The implications of this population structure are a higher demand for the provision of social and physical facilities, like schools, primary health care centres, etc.

6.13.4. Education

In terms of education levels in the LM, 8.6% of the adult population (over 20 years of age) have no education at all, while 49.5% have primary or secondary education (Stats SA, 2015). Those with higher educational qualifications accounted for 10.4% of the population. In Lephalale, a much lower percentage (1.9%) of individuals older than 20 has no formal schooling, while in Marapong, 2.9% has no formal schooling. Over half of the individuals (58%) aged 20 and older within Lephalale town have completed Matric or have a higher education qualification. Within Marapong, only 28% of the individuals aged 20 and older have completed Matric or have a higher education qualification

6.13.5. Income levels

The average household income in the Lephalale LM is about R10 052 (2015 current prices), with 12% of the households earning no income at all. Overall, 46.2% of the households within the local municipality earns up to R3 200 per month. In Lephalale, 12.5% of households have no income, and only 12.7% earns between R1 and R3 200 per month. The town has an average household income of R28 425 per month. This clearly illustrates the increase in welfare of the local households, which could be attributed to the creation of employment opportunities in specific sectors stimulated by the development in the area. On the other hand, 16.4% of the households in Marapong earn no income while about four in every ten households earns up to R3 200 per month.

6.13.6. The economy and labour force

The structure of the economy and the composition of its employment provide valuable insight into the dependency of an area on specific sectors and its sensitivity to fluctuations of global and regional markets. Knowledge of the structure and the size of each sector are also important for the economic impact results' interpretation, as it allows the assessment of the extent to which the proposed activity would change the economy, its structure and trends of specific sectors.

The Limpopo Province contributes about 7.1% to the country's Gross Domestic Product (GDP). In 2013, the economy of the Lephalale LM was valued at R6 161 million in current prices (Quantec, 2014). The LM contributed 12.2% to the economy of the Waterberg District and made a contribution of 2.9% to the Province's economy. Over a period of ten years (2003-2013), the municipality's economy grew at a negative Compounded Average Growth Rate (CAGR) of 1.9% per year. This was lower than the district and provincial average growth rates of 0.8% and 2.6%, respectively.

The growth of the Lephalale economy in the past few years was largely stimulated by the primary sector, particularly mining. More than 60% of the local economy is derived from the mining activities, and specifically coal mining. These activities are directly dependent on the demand for coal created by the local energy generating sector, thus it can be suggested that the sustainability of the existing local employment opportunities are indirectly reliant on the future growth of the local electricity generating industry and other industries that use coal as production inputs.

Mining has shown significant growth in contribution to the GDP-R over the past decade, from 37.9% in 2003 to 62.6% in 2013. Agricultural contribution on the other hand, has declined from 6.5% in 2003 to 5.0% in 2013. The propelled growth of the mining sector is primarily due to the advance in development of the Limpopo Coal, Energy and Petrochemical Cluster. Based on the statistics provided by Quantec Research (2015), the mining sector was the only industry that increased in real size between 2003 and 2013.

Employment is the primary means by which individuals who are of working age may earn an income that will enable them to provide for their basic needs and improve their standard of living. As such, employment and unemployment rates are important indicators of socio-economic well-being. The following paragraphs examine the study area's labour market from a number of perspectives, including the employment rate and sectoral employment patterns.

The Census 2011 data indicates that the Lephalale LM reported about 80 753 people within the working-age population. Of these, 45 464 people were economically active, while roughly 44% of the working age population were not economically active (NEA), that is, persons aged 15–64 years who were neither employed nor unemployed at the time of the survey, including discouraged job seekers. The employed labour in the LM was estimated at 35 386, while the unemployed population was estimated at 10 078, reflecting an unemployment rate of 22.2%. This was lower than the country's unemployment rate of 29.7%.

In comparison, in the town of Lephalale, 8 967 of the working age population was employed, with only 663 of them unemployed. This means that 6.9% of the labour force in Lephalale was unemployed. On the other hand, 4 819 of the working age population was not economically active. In Marapong, the unemployment situation was worse, with an unemployment rate of 26.4%.

More than two thirds of the employed individuals in the Lephalale LM were employed in the formal sector, and only 13% were employed in the informal sector. Private households provided for 13.8% of the employment opportunities in the municipality. In Lephalale, 84% of the employment opportunities were provided by the formal sector and only 6.2% came from the informal sector. In Marapong, 80.5% of the population was employed in the formal sector while only 6.3% was employed in the informal sector; 11.8% of the employed people residing in Marapong worked for private households.

In terms of the structure of employment, the agricultural sector was the most important economic sector in the LM, contributing 24.5% of the total employment opportunities. This was followed by the trade and mining sectors, which made contributions of 20.3% and 16.9% to the total employment, respectively. Considering the above, it is clear that four out of ten jobs in the local area are created by the primary sector. One of the goals outlined in the NDP (2011-2030) is to ensure development of a stable economy. Essentially, a stable economy is less reliant on the primary and secondary sectors than the tertiary sector, as an economy easily affected by trade and global economic spin-offs is unstable. Therefore, an economy dominated by the tertiary or services sector is more desirable as it reduces the risks associated with fluctuations in demand for commodities.

Over the period between 2003 and 2013, the mining and transport sectors were the only sectors that showed significant growth in employment, while the other sectors fluctuated between periods of growth and decline. The sector showing the largest loss of employment within the period was the agricultural sector. Agricultural activities are labour-intensive; therefore, a small decline in the size of that sector would generally lead to greater losses of jobs. Agriculture is historically one of the building blocks of the Lephalale economy. A decline in this sector would most definitely worsen the quality of lives and welfare of the affected households, which would force them to move to areas that offer greater potential to find employment.

It is envisaged that the development of the Limpopo Coal, Energy and Petrochemical cluster (Lephalale LED, 2008) in the Lephalale LM is expected to reverse the trends observed in the area in the past few years. With the expected development of the mining industry in the area and establishment of new associated industries, employment opportunities within both the mining and secondary industry are expected to grow. These developments are expected to maximise local economic spin-offs leading to the creation of new employment opportunities in the services sector, thus contributing to the sustainable development of the local economy.

6.14. Heritage and Paleontological Profile

6.14.1. Palaeontology

The palaeontology of the Karoo Supergroup succession of the Ellisras Basin of Limpopo Province is very poorly known, largely due to the very low levels of bedrock exposure here (Almond 2015).

Plant macrofossils of the Permian *Glossopteris* Flora, including compression or impression fossils of leaves as well as plant roots ("*Stigmaria*") in seat earths, are well represented within the lower part of the Ellisras Basin succession comprising Ecca Group equivalents, namely the Swartrant, Goedgedacht and Grootegeluk Formations. There have been no published systematic studies of these coal floras, although good exposures are now available in the Grootegeluk Mine west of Lephalale. Future open cast mining of the Ellisras Basin coals should provide excellent opportunities to sample and study these poorly known Limpopo palaeofloras. The palynology (pollen, spores *etc*) of portions of the Ellisras Basin has been described in a monograph by MacRae (1988). Dinosaur remains and various invertebrate trace fossils have been reported in the area since the 1920s. They include possible representatives of the Late Triassic "*Euskelesaurus*" Assemblage Zone and Early Jurassic *Massospondylus* Assemblage Zone found in the upper part of the Ellisras Basin Karoo succession (Lisbon Formation) that is correlated with the Elliot Formation of the Main Karoo Basin. Sparse dinosaur remains (bones, teeth, trackways) of the *Massospondylus* Assemblage Zone might also be expected within the Early Jurassic desert deposits of the overlying Clarens Formation and fossilised plant roots have been recorded here (Brandl 1996).

The volcanic Letaba succession is not known to be fossilferous in the Ellisras Basin. It is noted that significant fossil plant assemblages are known, however, from sedimentary intercalations between lava flows of the correlated Drakensberg Group of Lesotho (Anderson & Anderson 1985, p. 44) and similar palaofloras might likewise be present within the Lebombo Group succession.

No fossil remains were recorded from the very poorly-exposed Karoo Supergroup bedrocks or the overlying Late Caenozoic superficial sediments (*e.g.* calcrete hardpans, calcretised alluvium) to the west of the present study area during a recent field assessment by Almond (2015).

The majority of the study area for the proposed Tshivhaso Coal-fired Power Plant and associated ash dump is underlain by sedimentary rocks of the Karoo Supergroup (Eendragtpan and Clarens Formations) as well as volcanic rocks of the Lebombo Group (Letaba Formation) that are all of low palaeontological sensitivity.

6.14.2. Heritage Sites identified within the Study Area

The study area is characterised by a featureless flat landscape characterised by thick sand cover and veld grass with some mining activities on the farm Appelvakte. The lack of any ephemeral or permanent water sources and the lack of raw material suitable for manufacturing of stone tools possibly attribute to the marked paucity of archaeological sites in the study area and during the survey no archaeological sites were recorded. Three demolished ruins were however recorded. These features are indicated on the 1:50 000 maps of the study area and are presumably not older than 60 years.

The first structure (Feature 5071) consists of the demolished remains of a rectangular structure with modern clay bricks. Cultural material consists of glass bottles and other industrial artefacts scattered around a deflated midden. The second structure (Feature 5081) is constructed of sundried mud bricks and is marked by cement slab flooring. The third

Feature (5092) consists of several demolished structures; all that is left are the cement slabs where these structures used to stand. A large midden with modern glass bottles etc. are also noted here. These structures are totally demolished and are of no heritage or architectural value. Although no graves were noted in these areas it is very possible that some graves might occur associated with these features. The structures are of low significance but if graves are present the graves are of high social significance and this should be confirmed through community liaison prior to development.

Table 6.3: Recorded features with co-ordinates.

LABLE	TYPE SITE	LONGITUDE	LATITUDE	ELEVATION
5071	Ruin	27° 30' 34.3907" E	23° 36' 29.0269" S	920.9041
5081	Ruin	27° 31' 59.1383" E	23° 35' 57.5377" S	920.4534
5092	Ruin	27° 35' 03.2891" E	23° 37' 28.3945" S	880.0382

ASSESSMENT OF IMPACTS CHAPTER 7

This chapter serves to determine the significance of the positive and negative environmental impacts (direct, indirect, and cumulative) associated with the development of the proposed Tshivhaso Power Station. This assessment is undertaken for all the phases of the project's development and for all the facility's components which will comprise of the following:

» Access roads within the project locality boundaries, and upgrading and tarring of the existing provincial road from the current gravel transition point to the Power Plant.
» Coal Stockpile area (sized for a ~30-days capacity of ~700,000 tonnes) and overland conveyors from Thabametsi Mine, with transfer house battery-limit situated at boundary with Thabametsi Mine, to Power Plant.
» Raw-Water Storage Dam, Pump-stations and Reservoirs.
» Coal stockyard loading and offloading facilities, adjacent to Power Island.
» Power plant production areas (including Power Island Units/s and Balance-of-Plant, offices, operations, logistics and maintenance area/s).
» Water and Waste-Water Treatment facilities, adjacent to Power Island.
» Engineered Ash disposal facilities and overland conveyors (~5-km^2 in extent).
» Pollution and Storm-water Control Facilities and Dams
» An HV-Yard and Substation, adjacent to the Power Plant.
» Overhead power lines to connect into the Eskom grid. A 400-kV overhead line is proposed which will require a servitude 55m wide and will be ~ 20km in length. The power generated is planned to be evacuated into the electricity grid at a point to be determined in consultation with Eskom.

The development of the project will comprise the following phases:

» *Pre-Construction and Construction* – will include preconstruction surveys; site preparation; establishment of access roads, electricity generation infrastructure, water supply infrastructure, power line servitudes, conveyor servitudes, construction camps, storage facilities, laydown areas, transportation of components/construction equipment to site; and undertaking site rehabilitation and establishment and implementation of a waste and stormwater management plan.
» *Operation* – will include sourcing of water and water treatment; operation of the facility and the generation of electricity; deposition of ash on ash dump; and site operation.
» *Decommissioning* – depending on the economic viability of the plant, the length of the operational phase may be extended. Alternatively decommissioning will include site preparation; disassembling of the components of the facility; clearance of the site and rehabilitation. Note that impacts associated with

decommissioning are expected to be similar to construction. Therefore, these impacts are not considered separately within this chapter.

7.1. Potential impacts identified during the Scoping Study required to be assessed

Areas or issues identified through the Scoping process as requiring assessment in the EIA Phase include the following:

» Ecological impacts;
» Agricultural and land-use impacts;
» Impacts on surface water resources including watercourses and wetlands;
» Impacts on groundwater resources;
» Air quality impacts from the proposed power station and ash disposal facility;
» Noise impacts;
» Heritage impacts
» Visual impacts;
» Social impacts;
» Climate change impacts;
» Cumulative impacts for all of the above.

Sensitive environmental receptors identified during the Scoping phase, in terms of which the significance of the impacts has been assessed, included the following:

» Social-receptors (formal residential areas) in close proximity the project site;
» Noise sensitive receptors;
» Air Quality sensitive receptors;
» Visually sensitive receptors;
» Rivers / tributaries of rivers and wetlands;
» Areas of flora and faunal sensitivity;
» Heritage sites.

These aspects of environmental concern and sensitive environmental receptors have been assessed during the EIA Phase. These sensitivities have accordingly been mapped based on the detailed field studies undertaken (refer to Figure 7.1).

7.2. Methodology for the assessment of potentially significant impacts

7.2.1 Rationale for the assessment of the preferred site

A broader site of approximately 250km^2 comprising the farms Graaffwater 456, Goedehoop 457, Eendragtpan 451, Geylkebult 450 and Vooiruit 449, Kalkvlakte 256, Elandsvley 453, Jackalsvlei 309 and Appelvlakte 448 was evaluated within the scoping study for the purpose of establishing the proposed Tshivhaso Power Station and ash dump. Following the Scoping Phase of the EIA Process, it was concluded that the farm Graafwater was preferred for the power station based on environmental sensitivity of the area and technical constraints. This assessment therefore only considers potential environmental impacts associated with the development of the proposed power station on this farm portion.

After the scoping phase Goedehoop Option 1 was recommended as the most suitable option for the ashing facility. Option 2 (Appelvlakte Option) was recommended as the second preferred alternative. The option of placing the ashing facility on the same site as the power station (Graafwater) was also considered as an alternative. Following the completion of the scoping process, it was indicated that Goedehoop is no longer available for development due to landowner considerations. Therefore, only Appelvlakte and Graafwater have been considered as alteratives for the location of the ashing facility within this EIA process.

Two alternative power line corridors were considered within the scoping study. It was concluded that power line Alternative 2 (Matimba – Medupi Loop-In), although slightly longer than Alternative 1, makes use of existing corridors of transformation, limiting the potential direct impacts to some extent. This alternative is therefore considered the preferred option and localised areas of sensitivity can be avoided through local realignment options. This assessment therefore only considers potential environmental impacts associated with the development of the proposed power line within this corridor.

7.2.2 Assessment of issues and impacts

The assessment of potential issues has involved key input from specialist consultants, the project developer, key stakeholders, and interested and affected parties (I&APs). In order to assess the potential impacts a preliminary layout of the facility was provided by the developer for consideration by the specialist consultants (refer to Appendix A). In terms of this proposed layout, the footprint of development associated with the proposed project is expected to be as follows:

» Power Plant - 50ha;
» Ash Dump – 500ha (extending over a 40-year period);
» Strategic Coal Stockpile - 100ha (providing for a stockpile for 30 days); and
» Raw-Water Dam - 2ha.

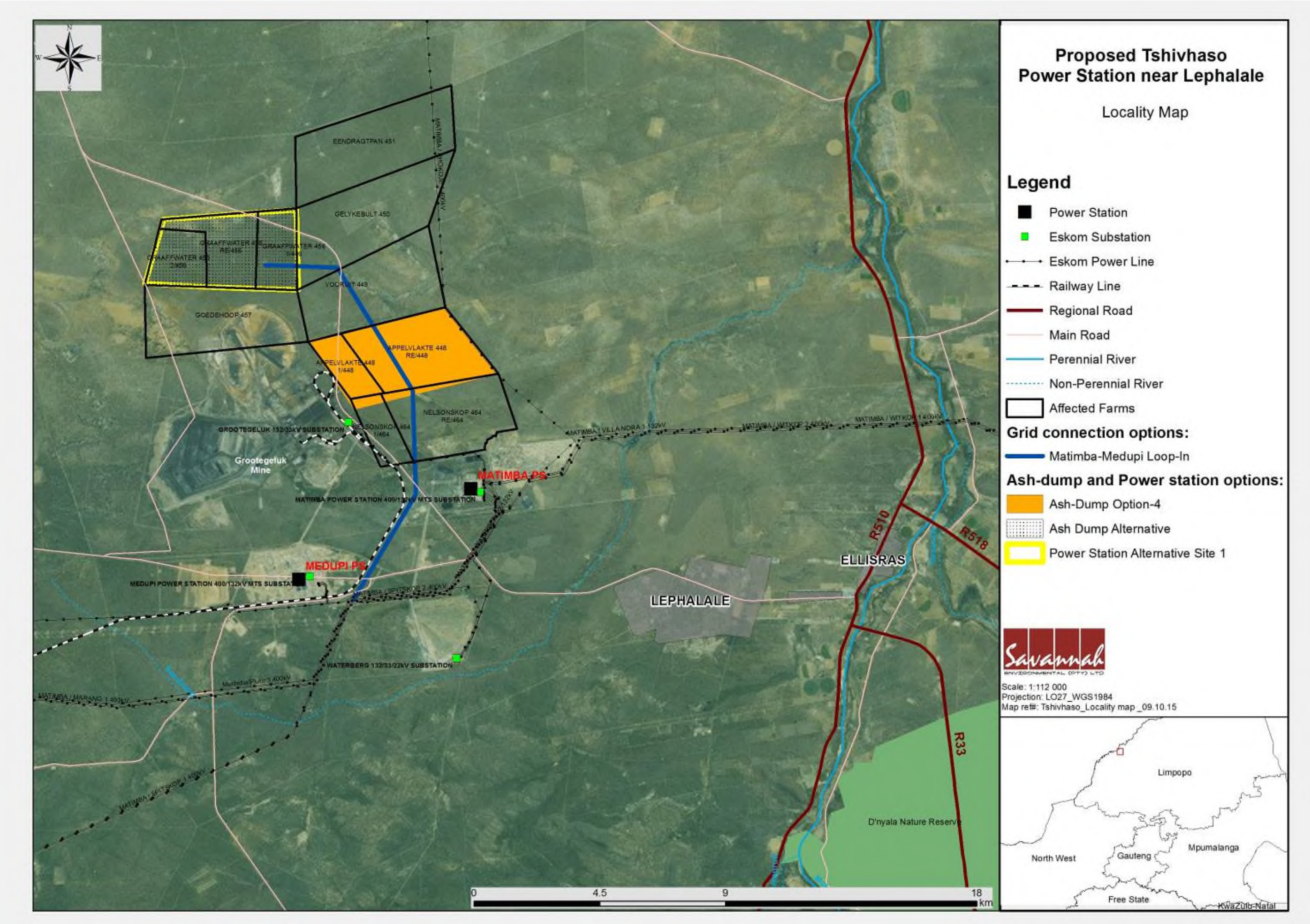


Figure 7.1: Area assessed for the proposed Tshivhaso Power Plant, ash disposal facility alternatives and power line alignment (blue)

In addition, waste treatment and management activities have been considered in the assessment of impacts. These activities relate specifically to:

» Liquid waste disposal
» Solid waste disposal
» Waste storage and separation
» Waste transport
» Solid waste disposal

Direct, indirect and cumulative impacts were assessed in terms of the requirements of the EIA Regulations and the methodology presented in Section 5.3.4 of this report.

7.3. Assessment of the Potential Impacts associated with the proposed Power Station and Associated Infrastructure

This section of the report presents a summary of the impacts identified and assessed for the proposed project. Details of the methodology of assessment and impact assessment determination by each specialist are included within the specialist reports contained within Appendices C – N.

7.4 Potential Impacts on Ecology

7.4.1 Results of Impact Assessment - Flora

The flora of the sites is recognised as *Acacia erubescens – Stipagrostis ciliata* woodland that is typical of the region and representative of the flora of the region. The following communities were recognised from the TWINSPAN classification:

» *Eragrostis rotifer - Echinochloa holubii* ephemeral pans representing small water bodies and shallow depressions that tend to hold surface water when inundated. This habitat type was uncommon on the study area and mainly confined to a few depressions located on the northern part of the Farm Graaffwater;
» *Acacia mellifera - Acacia tortilis* microphyllous woodland on clay soils community, representing vegetation that is prominent along the drainage lines and on clay soils that are characterised by a high prominence of dense *Acacia* woodland; and
» *Combretum zeyheri - Eragrostis pallens* undifferentiated broad-leaf woodland on sandy soils is prominent and by far the most dominant habitat on the study area. It corresponds to deep, highly leached sandy soils, and is earmarked by a high prominence of medium to tall semi-deciduous woodland.

The largest extent of impacts within the floristic environment is likely to result due to direct (physical) effects of land clearing activities and losses of vegetation. Direct impacts include any effect on the vegetation, including locally endemic species, populations or individual species of conservation importance, as well as on overall species richness, diversity and abundance. These effects include impacts on genetic variability, population dynamics, overall species existence or health and on habitats important for species of conservation consideration. Impacts on sensitive, restricted or protected habitat types are included in this category, but only on a local scale. These impacts are mostly measurable and easy to assess, as the effects thereof are immediately visible and can be determined to an acceptable level of certainty. Impacts of a direct nature include the following:

» Loss of plant taxa (individuals, stands, populations) of conservation importance (threatened taxa) as well as plan taxa of conservation concern (declining status, provincially protected taxa);
» Loss of natural vegetation (physical modifications, removal, damage) and local depletion of plant taxa, reduction of phytodiversity; and
» Loss of atypical, sensitive, conservation important habitat types or ecosystems of restricted abundance.

In contrast, indirect impacts are not always immediately evident and can consequently not be measured at a specific moment in time; the extent of the effect is frequently at a scale that is larger than the actual site of impact, but usually restricted to a local scale (and not regional). A measure of estimation, extrapolation, or interpretation, is therefore required to evaluate the significance of these impacts and is usually a factor of the sensitivity of the receiving surrounding environment. This type of impact typically results in adverse effects or deterioration of surrounding areas due to uncontrolled, development related activities. In addition, the ecological functionality of the immediate and surrounding area could be adversely affected by development, with particular reference to the ecological interaction between plants and animals. The aesthetic appeal of the region, although a subjective and highly debatable attribute, is regarded a potential receiver of landscape changes through the addition of industrial developments, ashing facilities, linear infrastructures, etc. Lastly, one of the most important impacts of indirect measures is represented by the alteration of floristic characteristics of the surrounding areas through the introduction and proliferation of plants with an exotic nature or encroachment characteristics. Impacts of an indirect nature include the following:

» Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc., also including Impacts on habitat types that are associated with plants of conservation importance (decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.);
» Altered quality and ecological functionality (including fire, erosion) of surrounding areas and natural habitat;
» Exacerbated encroachment of invasive, exotic and encroacher plant species; and
» Decreased aesthetic appeal of the landscape.

Quantification of impacts of the Power Plant and associated infrastructure on the floristic environment

Nature of impact: Direct impacts on/ losses of flora species of conservation importance and concern and habitat associated with these species, with particular reference to protected tree species occurring in the study sites. Impacts are unavoidable because of land clearing activities, but are generally restricted to the immediate area. This impact is restricted to the construction phase, but is permanent		
	Without mitigation	***With mitigation***
Extent	Regional (3)	Regional (3)
Duration	Permeant (5)	Permeant (5)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Probable (4)
Significance	***High (80)***	***Moderate (56)***
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Unavoidable impacts on protected trees/ conservation important plants will occur, irrespective	

	of mitigation measures, albeit restricted to local footprint
Mitigation Measures: Extent of impact likely to restricted to site only. Selected species and individuals should be rescued and replanted at suitable localities, specific reference to required landscaping and rehabilitation of development areas. Permitting requirements need to be met prior to destruction of any protected plant species.	
Residual Impacts: Sterilised landscapes with no propensity for species of conservation concern, decline in population sizes and numbers, continual decline in habitat availability	

Nature of impact: Loss of vegetation through transformation		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	Definite (5)
Significance	**High (65)**	**Moderate (550)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Restrict losses of vegetation to footprints Avoid unnecessary loss of vegetation Ensure proper rehabilitation and landscaping Group developmental structures	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of biodiversity on a local scale, increased pressure on natural resources, sterilised landscapes, increased fragmentation of habitat	

Nature of impact: Direct impacts on/ losses of atypical, sensitive and conservation important habitat types or ecosystems of particularly restricted occurrence, also with reference to habitat types where conservation important plants are likely to persist		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	High (4)	Probable (3)
Significance	**Moderate (52)**	**Moderate (33)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes	

Mitigation Measures:	Restrict footprints to areas where low floristic sensitivity has been indicated, avoid areas of higher floristic sensitivity. Avoid peripheral or unnecessary losses of natural vegetation, ensure proper rehabilitation and landscaping practices, ensure nodal developments by grouping developments structures, avoid the uncontrolled spread of infrastructure; access roads, power lines, conveyor lines, etc.
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of biodiversity on a local scale, increased pressure on natural resources, sterilised landscapes, increased fragmentation of habitat

Nature of impact: Impact on surrounding areas of natural habitat, such as habitat changes, surface water runoff, fragmentation and habitat isolation, etc. It is generally expected to be of low significance due to a moderate sensitivity of surrounding areas. Also includes species changes brought about from alien and invasive encroachment		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Low (2)
Probability	High (4)	Probable (3)
Significance	**Moderate (48)**	**Low (27)**
Status (positive or negative)	Negative	
Reversibility	Moderately reversible, the nature of impacts are such that activities on the development site can be adapted to avoid impacts in surrounding areas	
Irreplaceable loss of resources?	Low	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Restrict development to footprints areas Avoid peripheral or unnecessary losses or deterioration of natural vegetation, ensure proper rehabilitation and landscaping practices	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat	

Nature of impact: Impacts on ecological connectivity and ecosystem functioning. Although the site is regarded homogenous in nature, it does contribute towards local ecological functionality in providing in the life requirements of numerous plants and animals.		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)

Magnitude	Moderate (6)	Low (4)
Probability	High (5)	High (5)
Significance	**High (70)**	**Moderate (55)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	Limit development to footprint area, avoid impacts in adjacent habitat, implement biodiversity monitoring programmes, alien and invasive management programmes	
Residual Impacts:	Fragmented, isolated portions of natural habitat, sterile landscapes, increased anthropogenic pressures on natural resources	

Nature of impact: Encroachment of invasive, exotic and encroacher plant species		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate 6	Low (4)
Probability	High (4)	Probable (3)
Significance	**Moderate (52)**	**Moderate (30)**
Status (positive or negative)	Negative	
Reversibility	Reversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Implement biodiversity monitoring programmes, alien and invasive management programmes, early detection and eradication programmes	
Residual Impacts:	Degraded landscapes, loss of aesthetic appeal, poor species diversity	

Nature of impact: Loss of aesthetic appeal of the landscape		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (2)	Low (2)
Probability	High (5)	High (4)
Significance	**Moderate (50)**	**Moderate (36)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	No	
Can impacts be mitigated?	Yes, to some extent	

Mitigation Measures:	Rehabilitation and landscaping plants that aims to simulate the natural environment
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat

Nature of impact: Increased exploitation of natural resources due to increased human presence and resource requirements		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Moderate (36)**	**Low (24)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	Public awareness programmes, implementation of biodiversity monitoring protocols, search and rescue operations, landscaping programmes making use of local species and vegetation	
Residual Impacts:	Low floristic diversity, potential increase in threat status to certain taxa, exacerbated losses of phytodiversity, changes to local flora patterns	

Nature of impact: Accelerated developments patterns on a local and regional level implies significant increases in local and regional habitat fragmentation and isolation levels		
	Without mitigation	**With mitigation**
Extent	**Regional (3)**	**Regional (3)**
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (4)	Probable (4)
Significance	**Moderate (56)**	**Low (48)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	No	
Mitigation Measures:	Generic mitigation measures, development of a regional programme/ framework that identifies areas of concern and opportunity, typically such as an Environmental Management Framework, that takes development opportunities and constraints into consideration on a	

	regional scale. Consider nodal development regions to avoid uncontrolled spread of developments
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat

Nature of impact: Cumulative impacts on conservation obligations & targets. The conservation status of ecological habitat is regarded Least Concerned and the loss of the site is not expected to result in an escalation of the threat level on a local or regional scale. Habitat loss is however, permanent and local development patterns indicate accelerated losses of natural habitat.		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (2)	Low (2)
Probability	High (4)	Probable (3)
Significance	**Moderate (40)**	**Low (27)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	No	
Mitigation Measures:	Generic mitigation measures, containment, prevention of spread of cumulative impacts, possible development of a Offset Programme/ conservation programme	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat, sterile landscapes	

Figure 7.1 Floristic sensitivity map

7.4.2 Results of Impact Assessment - Fauna

The study area was investigated during the vegetation survey for signs or the presence (observations) of amphibians, reptiles, birds and mammals. Several red data species are likely to occur in the area.

» The Giant Bullfrog, *Pyxicephalus adspersus*
» The Cheetah, *Acinonyx jubatus*
» The Brown Hyaena, *Parahyaena brunnea*
» Temminck's Ground Pangolin *Smutsia temmincki*

Direct impacts represent those that are indisputably a result of the proposed project and unequivocally influencing the fauna of the region. They are immediate and physical in nature and often irreversible and permanent. Anticipated direct impacts of the proposed project on the fauna of the study area include:
» Impacts on/ losses of fauna taxa of conservation importance and habitat associated with CI species;
» Loss of natural habitat, including essential habitat refugia; and
» Depletion of faunal diversity, human/ animal conflict situations.

Indirect impacts are mostly "spill-over" impacts that are removed from direct impacts by time and/or space. They might occur later on, even post closure, or in faunal habitat fragments located next to or close to the directly affected area. Indirect impacts might be immediate or delayed, they are often not easily linked to the project itself and their manifestations are often subtle. Indirect impacts might also be irreversible and permanent or rescindable and temporary. Anticipated indirect impacts of the proposed project on the fauna of the study area and surrounds include:
» Degradation of untransformed habitat in areas surrounding the project area;
» Indirect impacts on movement/ migration patterns of animals, ecological interaction and processes, including the introduction of invasive and non-endemic species; and
» An increase in edge effects in the project areas.

Impacts of the Power Plant on the faunal environment

Nature of impact: Direct impacts on/ losses of fauna species of conservation importance and concern and habitat associated with these species. Impacts are unavoidable because of land clearing activities, but is generally restricted to the immediate area. This impact is restricted to the construction phase, but is permanent. Animals are generally mobile and will evacuate towards other suitable areas, but unforeseen losses are expected		
	Without mitigation	***With mitigation***
Extent	Regional (3)	Regional (3)

Duration	Permanent (5)	Medium (3)
Magnitude	Very high (10)	Moderate (6)
Probability	High (4)	Probable (3)
Significance	***High (72)***	***Medium (36)***
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Unavoidable impacts on conservation important animals will occur, irrespective of mitigation measures, albeit restricted to local footprint	
Mitigation Measures:	Extent of impact likely to restricted to site only. Ensure the absence of, particularly, sessile species, through a thorough walkdown (search and rescue) of development areas. Ensure the absence of larger animals through frequent patrols, particularly prior to development	
Residual Impacts:	Sterilised landscapes with no propensity for species of conservation concern, decline in population sizes and numbers, continual decline in habitat availability	

Nature of impact: Losses of natural habitat through physical transformation, modifications, removals and damage. Also includes the losses of natural refugia, such as termitaria, dead trees, etc.		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (5)	Probable (5)
Significance	**High (65)**	**Medium (55)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, to some extent	
Can impacts be mitigated?	No	
Mitigation Measures:	Restrict losses of natural habitat to footprints, avoid peripheral or unnecessary losses of natural habitat ensure proper rehabilitation of areas outside development footprints, ensure nodal developments by grouping developments structures, avoid the uncontrolled spread of infrastructure	
Residual Impacts:	Decreased aesthetic appeal, loss of biodiversity on a local scale, increased pressure on natural resources, sterilised landscapes, increased fragmentation of habitat	

Nature of impact:

Depletion of faunal diversity through direct losses, evacuation of unfavourable habitat by animals, including the introduction of invasive and non-endemic species. Construction and operation creates opportunities for human/ animal conflict situations, with reference to potentially dangerous animals, snaring, trapping and killing (vehicular events)		
	Without mitigation	**With mitigation**
Extent	**Local (2)**	**Local (2)**
Duration	Permanent (5)	Medium (3)
Magnitude	Moderate (6)	Low (4)
Probability	High (4)	Probable (3)
Significance	**Moderate (52)**	**Low (27)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Control of human movement in adjacent natural habitat, frequent patrols, biological monitoring programmes, animal control (vervet monkeys, feral cats, rats, baboons, dogs, etc). Ecological sound management of construction areas, with reference to waste management, food sources, etc.	
Residual Impacts:	Depletion of faunal diversity, presence of invasive species, genetic modification of population, increased presence of unwanted (opportunistic) species	

Nature of impact: Decreased habitat quality of surrounding areas due to peripheral impacts such as spillages, litter, increased erosion, contaminants, etc.		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Minor (2)
Probability	High (4)	Probable (3)
Significance	**Medium (48)**	**Low (27)**
Status (positive or negative)	Negative	
Reversibility	Moderately reversible, the nature of impacts are such that activities on the development site can be adapted to avoid impacts in surrounding areas	
Irreplaceable loss of resources?	Low	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Implement generic monitoring programme and mitigation measures that are aimed at identifying and preventing the uncontrolled spread of impacts into adjacent areas of natural habitat	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat	

Nature of impact: Indirect impacts on movement/ migration patterns of animals and ecological interaction and processes		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	High (4)
Significance	**High (70)**	**Medium (40)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Low	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	Limit development to footprint area, avoid impacts in adjacent habitat, implement biodiversity monitoring programmes, alien and invasive management programmes	
Residual Impacts:	Fragmented, isolated portions of natural habitat, sterile landscapes, increased anthropogenic pressures on natural resources, changes to normal migration patterns on a local scale	

Nature of impact: Exacerbated increases of edge effects of the project areas		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	High (4)	Probable (3)
Significance	**Medium (52)**	**Low (30)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	No	
Mitigation Measures:	Implement biodiversity monitoring programmes, ensure proper restoration and rehabilitation of construction areas subsequent to construction	
Residual Impacts:	Degraded landscapes, loss of aesthetic appeal, poor species diversity	

Nature of impact: Accelerated developments patterns on a local and regional level implies significant increases in local and regional habitat fragmentation and isolation levels		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)

Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Minor (2)
Probability	High (4)	Probable (3)
Significance	**Medium (48)**	**Low (30)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	No	
Mitigation Measures:	Generic mitigation measures.	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat	

Nature of impact: Cumulative depletion of faunal taxa, assemblages and communities, with specific reference to the conservation important species		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Low (2)
Significance	**Medium (36)**	**Low (24)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	Implementation of biodiversity monitoring protocols, search and rescue operations	
Residual Impacts:	Low faunal diversity, potential increase in threat status to certain taxa, exacerbated losses of faunal diversity, changes to local faunal patterns	

Figure 7.2: Faunal sensitivity map for the study area

7.4.3 Results of Impact Assessment - Avifauna

Ardeotis kori is globally listed as near-threatened (BirdLife International 2013a) while a recent conservation assessment has downgraded it from regionally vulnerable to near threatened (Taylor et al., 2015). *A. kori* is a large terrestrial bird with a preference for lightly wooded savanna which is nowadays mainly encountered on larger conservation areas and game farms (Taylor et al., 2015; BirdLife International, 2013a). Although it could occur on nearly any part of the study area (excluding the mine area), optimal foraging habitat was observed from the western parts of Farm Graaffwater and Goedehoop and the northern parts of Graafwater. These areas correspond to open (historically cleared) woodland.

Impacts of the Power Plant on the avifaunal environment

Nature of impact: Direct impacts on/ losses and displacement of bird species of conservation importance and concern, and habitat associated with these species, with particular reference to large-bodied birds of prey and large terrestrial bird species. Impacts are unavoidable because of land clearing activities and the particular large home range size of focal bird species. This impact is restricted to the construction and operational phase, and is permanent		
	Without mitigation	***With mitigation***
Extent	Regional (4)	Regional (4)
Duration	Permanent (5)	Permanent (5)
Magnitude	High (8)	Medium (6)
Probability	Definite (5)	Definite (5)
Significance	***High (85)***	***High (75)***
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Unavoidable impacts on bird species will occur, irrespective of mitigation measures, albeit restricted to local footprint. Aim to avoid construction on important and sensitive bird habitat (e.g. habitat with high and medium-high avifaunal sensitivities)	
Mitigation Measures:	Extent of impact likely to restricted to site only. Avoid areas of high or medium-high avifaunal sensitivities by applying changes to the layout plan where necessary	
Residual Impacts:	Sterilised landscapes with no propensity for species of conservation concern, decline in population sizes and numbers, continual decline in habitat availability	

Nature of impact: Losses of natural habitat through physical transformation, modifications, removals and damage. Also includes the loss of habitat containing high avifaunal diversity on a local scale and reduction in species richness and diversity		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)

Duration	Permanent (5)	Permanent (5)
Magnitude	Medium (6)	Low (4)
Probability	Definite (5)	Definite (5)
Significance	**High (65)**	**Medium (55)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, to some extent	
Can impacts be mitigated?	No, especially since these habitat types (mainly microphyllous woodland) are widespread and cover large surface area of proposed site	
Mitigation Measures:	Restrict losses of natural habitat to footprints, avoid peripheral or unnecessary losses of natural habitat, ensure proper rehabilitation and landscaping practices, ensure nodal/clustering of developments by grouping developments structures, avoid the uncontrolled spread of infrastructure. Allow infrastructure on areas of low sensitivity.	
Residual Impacts:	Decreased species richness, low evenness values, subsequent loss of biodiversity on a local scale, increased pressure on natural resources, sterilised landscapes, increased fragmentation of habitat	

Nature of impact: Direct impacts on/ losses of azonal habitat types or ecosystems of particularly restricted occurrence containing unique avifaunal compositions on a local scale - many of these areas also provide habitat for threatened and near threatened bird species		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	High (8)	Medium (6)
Probability	High (4)	Probable (3)
Significance	**Medium (60)**	**Medium (39)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Restrict losses of natural habitat to footprints, avoid peripheral or unnecessary losses of natural habitat, ensure proper rehabilitation and landscaping practices, ensure nodal/clustering of developments by grouping developments structures, and avoid the uncontrolled spread of infrastructure. Allow infrastructure on areas of low sensitivity. Remove prominent large dead trees and re-instate during rehabilitation (where necessary). Re-instate and re-locate artificial watering holes/points.	

Residual Impacts:	Increase in habitat fragmentation and isolation, local decrease in bird richness, increased competition between bird species and individuals of the same species for natural resources, sterilised landscapes, increased fragmentation of habitat

Nature of impact: Impact on surrounding areas of natural habitat, such as habitat changes, surface water runoff, fragmentation and habitat isolation, etc. It is generally expected to be of low significance due to a moderate sensitivity of surrounding areas, although areas of high/medium-high sensitive occur nearby (drainage lines and open woodland)		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	High (4)	Probable (3)
Significance	**Medium (56)**	**Medium (33)**
Status (positive or negative)	Negative	
Reversibility	Moderately reversible, the nature of impacts are such that activities on the development site can be adapted to avoid impacts in surrounding areas	
Irreplaceable loss of resources?	Low	
Can impacts be mitigated?	Yes	
Mitigation Measures:	Implement generic monitoring programme and mitigation measures that are aimed at identifying and preventing the uncontrolled spread of impacts into adjacent areas of natural habitat	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat	

Nature of impact: Impacts on ecological connectivity and ecosystem functioning. Although the site is regarded homogenous in nature, it does contribute towards local ecological functionality in providing in the life requirements for many bird species and bird associations		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	Definite (5)
Significance	**High (70)**	**Medium (55)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes, to some extent	

Mitigation Measures:	Limit development to footprint area, avoid impacts in adjacent habitat, implement biodiversity monitoring programmes and maintain ecological connectivity with habitat of similar structure
Residual Impacts:	Fragmented, isolated portions of natural habitat, sterile landscapes, increased anthropogenic pressures on natural resources and reduced species richness relating to loss of specialised species and increased colonisation by unspecialised (generalist) species

Nature of impact: Increased exploitation of natural resources due to increased human presence and resource requirements		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (42)**	**Medium (36)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	Yes, to some extent	
Mitigation Measures:	Public awareness programmes, implementation of biodiversity monitoring protocols, and demarcation of suitable areas for development (mainly on habitat with low sensitivity.	
Residual Impacts:	Low bird diversity, and continued displacement of bird species. Potential colonisation of feral (alien) species resulting in increased competition and localised displacement of native bird species	

Nature of impact: Accelerated patterns in development on a local and regional level implies significant increases in local and regional habitat fragmentation and isolation levels		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	High (8)	Moderate (6)
Probability	High (4)	High (4)
Significance	**High (64)**	**Medium (56)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	No	

Mitigation Measures:	Implement generic mitigation measures,
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat

Nature of impact: Cumulative impacts on conservation obligations & targets. The conservation status of ecological habitat is regarded Least Concerned and is not part of an Important Bird and Biodiversity Area. The loss of the study area is not expected to result in an escalation of the threat level on a local or regional scale. Habitat loss is however permanent and local development patterns indicate accelerated losses of natural habitat and the displacement of large-bodied terrestrial and birds of prey species		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Minor (2)
Probability	High (4)	Probable (3)
Significance	**Medium (48)**	**Low (27)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources?	Yes, but only on a local scale	
Can impacts be mitigated?	No	
Mitigation Measures:	Generic mitigation measures, containment, prevention of spread of cumulative impacts, possible development of a Offset Programme/ conservation programme (also with emphasis on large-scale migration/dispersal corridors)	
Residual Impacts:	Increase in habitat fragmentation and isolation, loss of natural habitat, sterile landscapes	

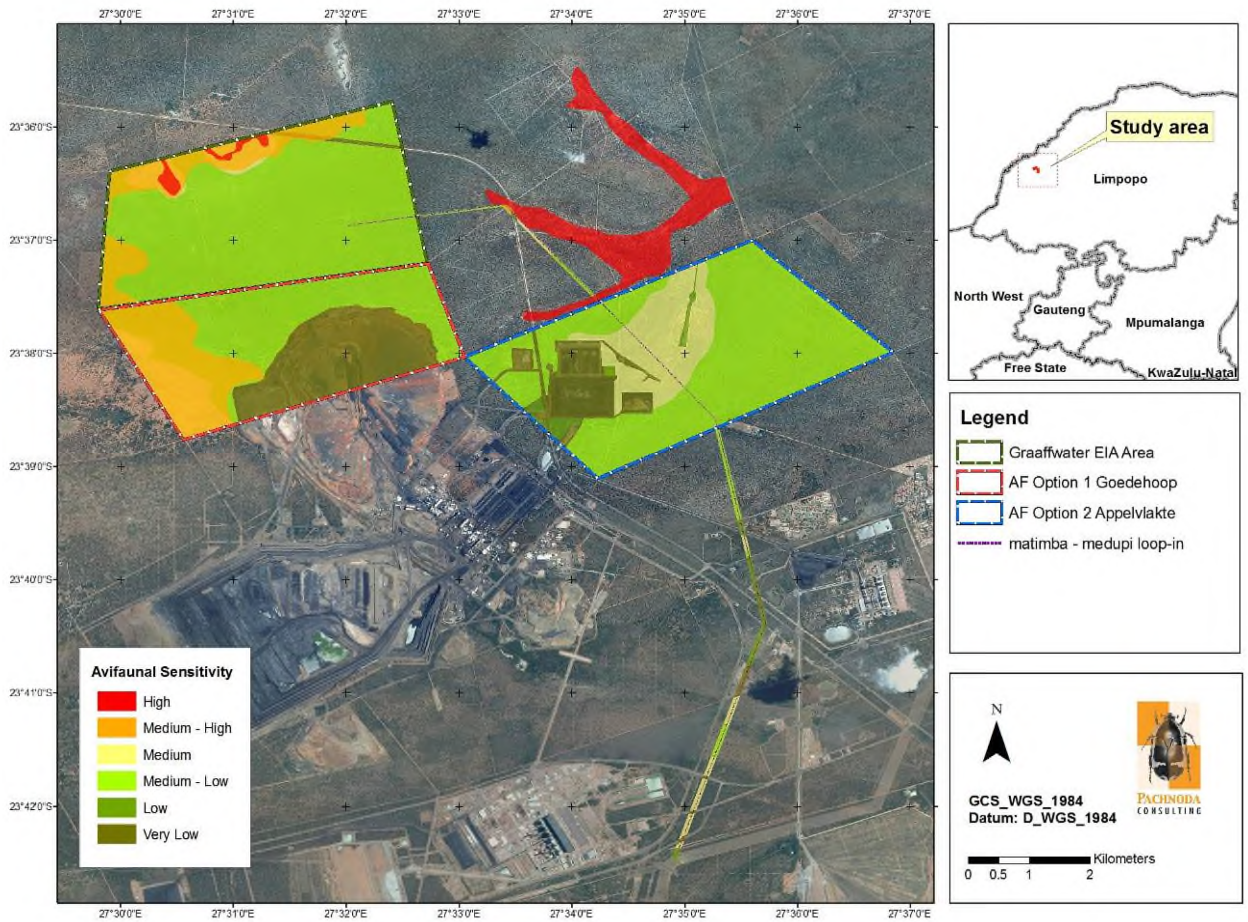


Figure 7.3: A sensitivity map illustrating the avifaunal importance and ecological function of the respective habitat units on the proposed study area

7.4.2 Comparison of Ash-Dump Alternatives

Flora

No clear alternative between either Appelvlakte or Graaffwater is presented at this stage. This is heavily dependent on the exact placement of the power station footprint and the availability of sufficient land for the ashing facility. However, considering the potential spread of industrial land uses on a local scale, a slight preference for Graaffwater is expressed, taking cognisance implications of technical feasibilities in terms of the Matimba Power Station.

Fauna

Even though impacts remain largely similar, the estimated significance pre- and post-mitigation of these impacts for Graaffwater is significantly compared to Appelvlakte. Based on the ecological characteristics of Graaffwater, the effectiveness of mitigation measures will be significantly less on Graaffwater than on Appelvlakte. In short, to effectively alleviate pressures on the fauna of the region, the farm Appelvlakte is recommended as the preferred alternative for the ashing facility site.

Avifauna

The majority of impacts on the avifaunal discipline are therefore expected to be of high to moderate significance, and could be mitigated to moderate levels of significance. However, Graaffwater consists of a higher proportion of sensitive habitat (e.g. habitat with a high and medium-high avifaunal sensitivity) compared to Appelvlakte, which is also anticipated to accommodate a higher density of threatened and near threatened bird taxa. In addition, Appelvlakte has experienced a number of existing impacts and mining infrastructure, effectively compromising the ability of this area to some extent, to harbour ecologically important species and avifaunal assemblages. Therefore, it is the conclusion that the Farm Appelvlakte represents a "more feasible" placement option for the ashing facility

7.4.3 Implications for project implementation

» Adequate mitigation measures must be taken to ensure that impacts on high sensitive environments near the proposed plant are avoided.
» Compilation and implementation of awareness programmes to prevent accidental and/ uninformed killing of birds and animals with particular reference to snaring, traditional beliefs, capturing, introduction of pets, etc.
» Permitting requirements need to be met prior to destruction of any protected plant species.

Power Line:

- » Avoid spanning of drainage lines and open woodland habitat where a high incidence of large bodied terrestrial birds or birds of prey are evident.
- » Avoid spanning areas in close proximity to pans, dams or artificial watering holes or areas where game tend to congregate, or areas holding large trees that are used for roosting sites.
- » Fit "Double loop flight diverter (BFD) to earth wire at the following:
  (a) spanning drainage lines, dams or depressions,
  (b) when in close proximity (within 100 m of alignment) to dams, depressions or drainage lines,
  (c) spanning arable lands, old cultivated land or open woodland.
- » Where possible, re-align alignment away from large drainage line on Gelykebult.
- » Where possible, placement of the power line alongside existing power lines will increase the visibility of the earth wires.

7.4.5 Conclusions and Recommendations

An appraisal of the potential and likely impacts on the floristic environment indicated the no immediate Red Flags were identified. Several high sensitivity areas were identified. Furthermore, the application of detailed and site-specific mitigation measures is required to ameliorate significant impacts to an acceptable significance level.

A number of direct, indirect and cumulative (negative, adverse) impacts on the faunal components of the site and region are expected to result from the proposed project. An appraisal of the significance of these impacts prior to mitigation procedures, points toward a number of significant impacts; the majority of impacts are however of a moderate significance. All impacts are of moderate significance post-mitigation. The application of dedicated and site-specific mitigation measures are expected to ameliorate significance of impacts to an acceptable status.

Based on observations and an appraisal of collated data for avifauna in the study area, no immediate Red Flags were identified. However, an evaluation of the expected and likely impacts on the avifaunal component of the study areas revealed that certain sensitive parts of the study area rated as being of high sensitivity should be excluded from the proposed development. Furthermore, the application of detailed and site-specific mitigation measures is required to ameliorate significant impacts to an acceptable significance level.

7.5 Potential Impacts on Soils and Agricultural Potential

7.5.1 Results of Impact Assessment

The construction phase of the proposed Power Plant will have some potential negative environmental impacts on the soil of the area such as:

- The loss of agricultural grazing land due to the direct impact by the infrastructure's footprint during the developmental stage of the project and thereafter, i.e. all phases. The loss of agricultural land would be permanent, but the prevailing low dryland production potential would lessen the impact somewhat.
- A change in the natural condition of the site may lead to significant erosion of the soils unless appropriate management is implemented. Once the surface characteristics are changed through anthropogenic means, wind and water will change the land surface of the site. Construction of roads – gravel or tar - will subject moderate - large surface areas of the land to erosion and transportation vulnerability and this could potentially be the biggest impact during the construction phase.
- Vegetation removal will definitely occur and may lead to open patches which are susceptible to the elements. Erosion can result in significant loss and deterioration of soil resources and may occur during all phases of the project unless appropriate management is implemented. Erosion would be limited in significance if properly mitigated.
- Poor topsoil management may lead to the loss of nutrient rich topsoil. Levelling of slopes/topographical high points, excavations for discharge water and building rubble storage.
- Soil contamination due to accidental spills of fuel and hydraulic fluid when drilling into soil etc.
- Soil compaction by heavy vehicle movement, excavation operations, soil removal and restoration
- Wind erosion through disturbance of topsoil which leads to structural degradation.

Based on the above, the major potential impacts on the natural resources of the study area are expected to be: 1) the loss of land available for agricultural activities due to the construction of the various types of infrastructure, 2) potential increased risk of soil erosion, and 3) impacts on soil resources as a result of contamination.

Impacts of the Power Plant on soils and agricultural potential

Nature of impact: **Loss of agricultural land** Land that is no longer able to be utilized due to construction of infrastructure		
	Without mitigation	**With mitigation**
Extent of impact	Site only (1)	Site only (1)
Duration of impact	Permanent (5)	Permanent (5)

Probability of impact	Highly probable (3)	Highly probable (3)
Severity of impact	Low (1)	Low (1)
Significance of impact	Low (21)	Low (21)
Mitigation factors	The main mitigation would be to ensure that as little pollution or other non-physical disturbance occurs, especially with the construction of storage areas, such as ash dumps etc. Before such structures are established, topsoil to a depth of at least 300 mm should be removed and stockpiled for later rehabilitation purposes.	
Residual impacts	None	

Nature of impact: **Increased risk of soil erosion** Removal of topsoil by the action of wind or water due to removal of vegetation		
	Without mitigation	**With mitigation**
Extent of impact	Local (1)	Local (1)
Duration of impact	Long-term (4)	Long-term (4)
Probability of impact	Highly probable (3)	Highly probable (3)
Severity of impact	Low (1)	Low (1)
Significance of impact	Low (15)	Low (15)
Mitigation factors	The main mitigation would be to ensure that the footprint for vegetation removal is restricted to the minimum necessary for the various construction phases of the project. In addition, appropriate soil conservation measures to combat wind erosion (windbreaks, geotextiles on the soil surface and immediate re-establishment of vegetation) should be implemented and monitored on at least a six-monthly basis.	
Residual impacts	Loss of soil from erosion would lead to loss of soil resources	

Cumulative soil impacts are discussed in Chapter 8. No residual impacts are expected to occur.

7.5.2 Comparison of Alternative sites for ash dump

There is no preference regarding the alternative areas considered for the ashing facility as the land type within both alternatives is similar.

7.5.3 Implications for project implementation

» It is not possible to mitigate the impacts associated with loss of agricultural potential. However, the project site is situated in an area characterised by mining and industrial development and is not considered to be viable agricultural land contributing to food security within the province.
» Erosion control measures will need to be implemented in order to minimise the risk in this regard. An erosion management plan for both the construction and operation phase must be compiled and implemented.

7.5.4 Conclusions and Recommendations

Although the area is currently classified as grazing land, there is evidence that the capacity to support livestock is very small and surrounding areas would suffice for grazing alternatives were this facility to be developed. Dust generation from construction would be a significant and ongoing impact requiring management.

Soil erosion is likely to be the most significant impact on soils. Loose topsoil has to be managed as well, or wind will lead to surface creep of the sand and loss of nutrient rich top soil. Mitigation procedures will ensure that medium to long term impacts may be avoided or at least reduced.

The overall impacts of the proposed facility on agricultural potential and soil conditions will be low but permanent. The impacts are reduced mainly because of the climatic conditions and the low agricultural and grazing potential of the site. There have never been any substantial commercial farming practices on the property because of the dominant climatic conditions and prevailing soil conditions.

Soil and rock type properties tend to be very homogenous in the area and the whole site can be more efficiently utilised for power generation than any other practise. The preferred development site (Graafwater) is not regarded as a viable commercial dryland farming site and would be suited to house the power plant and ash dump.

The key findings of this study are:

» The development of the power station will have a low negative impact on agricultural resources and productivity.
» The significance of all agricultural impacts is influenced by the fact that the land is suitable for cultivation, although the depth constraints of the particular soils on site and climatic constraints make it marginal.
» Soils across the proposed power station site are dominated by deep to moderately deep, yellow, well drained sandy loam soils of the Clovelly, Avalon and Glencoe soil forms.
» Agricultural limitations are the depth constraints of the particular soils on site as well as competing land uses (industry and mining).

There are no fatal flaws on the site from a soils and agricultural perspective and the project can therefore be developed, with the use of good soil management measures, during all its phases.

7.6 Potential Impacts on Surface Water

7.6.1 Results of Impact Assessment

Based on Google observations, site visits and available topographical maps for the study area, as well as consideration of the infrastructure requirements of the proposed development of the Tshivhaso Coal-Fired Power Plant, the primary concern is the management of storm water runoff from the development sites, in particular the separation of clean and dirty water and the subsequent management of dirty water.

The site is relatively flat, with the natural drainage flowing in an easterly direction towards the Sandloop sub-catchment. In order to ensure that there is sufficient storage capacity to manage the additional water from the hard surfaces created y the Tshivhaso Coal-Fired Power Plant, an assessment of the storm water management plan for this section of the development will need to be undertaken as part of the WULA process.

Construction Phase impacts

The following activities during construction could potentially negative impacts on the surface water associated with the construction phase have been identified:

- Clearance of vegetation to prepare site for construction;
- Storage of hazardous chemical substances;
- Storage of fuel and oil;
- Cement and concrete batching;
- Transportation of material to site and the storage of material on site; and
- Dust as a result of construction activities.

Impacts associated with the above-mentioned activities can be adequately managed through the implementation of a construction Environmental Management Programme.

Nature: Alteration of the flow regime of the catchment resulting in loss of catchment yield, degradation of in-stream riparian habitat and associated decrease in water quality		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)

Probability	Likely (3)	Possible (2)
Significance	**36 (Medium)**	**20 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Minimize construction footprint to be outside watercourses and riparian zones; » Minimize disturbance to flow regime and prevent erosion » Develop and implement an appropriate stormwater management plan		
Residual Impacts: None		

Operational Phase Impacts

Several activities during the operational phase could contribute towards water quality deterioration. These impacts stem from contaminated runoff from the ash dump as well as the coal stockyard. In the event that pollution control facilities fail to contain poor quality water, spillages to the environment will cause negative impacts on the water quality and aquatic ecology of the region. The impact will be significant and long-term and will extend beyond the boundaries of the project area.

Nature: Raw materials, chemicals, liquid fuels and liquid waste products used in the operation of the power station could contaminate the water resources (surface and groundwater) in the area contributing towards water quality degradation.		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	Low (4)
Probability	Highly likely (4)	Likely (3)
Significance	**60 (High)**	**30 (Low/Medium)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: Implementation of water pollution control facilities such as PCD and storm water drainage system, oil and silt traps, separate clean and dirty water systems, adequate storage capacity and follow ZED policy, obtain water use authorisation, install monitoring program		
Residual Impacts: Possible build up of hazardous components within the footprint of the power station (ash dump, PCD, coal stockpile)		

Impacts on Water Availability

As with most rivers in the Limpopo Province, catchment pressure and limited water resources are causing reduced flows, which in turn are limiting the ability of the rivers to sustainably meet environmental (reserve) requirements. However, there is an on-going demand for development within the region that further stresses the available water resources. It is important for water reconciliation studies that these future developments be recognised and incorporated in the regional demand for the Lephalale area.

The Lephalale Municipality is dependent on the Mokolo Catchment for its for water supply and is anticipating a substantial bloom in the local economy. The following developments will have an increased demand for water supply:

» Eskom are investigating the possibility of expanding Matimba Coal-Fired Power Plant;
» In conjunction with the possible expansion to Matimba Coal-Fired Power Plant, a feasibility study is being undertaken for a water transfer scheme to the Mokolo Dam, including modifications to the dam (raising of the dam wall);
» Tshivhaso Coal-Fired Power Plant will be supplied with coal from the new Thabametsi Coal Mine;
» Marubeni is investigating the possibility to construct a IPP Power Plant (i.e. the authorised Thabametsi Power Station) in close proximity to the Tshivhaso Coal-Fired Power Plant;
» The development of the above industries will support the development of secondary industries. The result will be an increased demand for water supply from the Mokolo Scheme

Table 7.1: Water Demand on Quaternary Catchment A42J

Quaternary Catchment	Water Resource	Name of Applicant	Water Use	Volumes Abstracted
A42J	Mokolo River	Mr. W Spies	21(a)	35 000m^3/a
A42J	Mokolo River	Mokolo Irrigation Board	21(a)(b)	180 000m^3/a
A42J	Mokolo River	Commiphora Home Owners Association	21(a)(f)	49 000m^3/a
A42J	Sandloop River	Eskom Holdings (Matimba Power Station)	21(a)(b)(c)(e)(f)(g)(i)	6 500 000m^3/a
A42J	Sandloop River	Eskom Holdings (Medupi Power Station)	21(a)(b)(c)(e)(f)(g)(i)	2 600 000m^3/a
A42J	Mokolo River	Mr. JJ van der Westhuizen	21(a)	35 000m^3/a
A42J	Mokolo River	Mr. W Ross	21(a)	5 000m^3/a
A42J	Mokolo River	Mr. JC Malherbe	21(a)	70 000m^3/a

Total volume abstracted annually	**9 474 000 m^3/a**

Considering the water users within the catchment (Table 7.1) it is clear that the concern of water scarcity needs to be addressed to allow for the industrial development in the area. The project will use water from MCWAP2 which will not result in any reductions in the water supplied to agriculture

Storm water impacts

The management of storm water runoff is required to avoid spillage of contaminated water, reuse and recycling water and storm water wherever possible, treatment of water for reuse or discharge, and as a last resort, discharging storm water in compliance with Department of Water and Sanitation's limits. The mean annual precipitation for Lephalale is about 650 mm/year of which about 80% falls between October and March with rainfall peaking in January. The development of the Tshivhaso Coal-Fired Power Plant and hardened surfaces on the site would lead to an increase in runoff. Some of this runoff may be contaminated with oils or grease, or chemicals used on the IPP Power Plant site.

It would be practical to dispose of clean storm water runoff to the Sandloop. However, due to the distance to the river from the site (some 3km) it is proposed that a storm water detention dam be constructed to accommodate all runoff from the developed area. This water could be recycled and reused to reduce the demand for raw water supply. It is recommended that a number of considerations be taken into account in the design of the dam:

- Evaporation offers a practical solution due to the high mean annual evaporation of 2500 mm compared with the rainfall of 650 mm. Evaporation ponds are common practice in water resource management and are utilised by adjacent developments.
- If the dam is considered for pollution control purposes, it should be appropriately lined and available water be pumped to areas where it could be used for dust suppression.
- If pollution is expected from the power plant, a silt/oil trap should be constructed in the outfall pipeline to limit the impact thereof.
- The sizing of the storage dam would depend on what the water would be used for, the site geology, the hardened developed area as well as environmental considerations. The client proposed that the storage dam be constructed with a capacity of 120 000 m^3.

The mitigation of this potential impact needs to be addressed in the Environmental Management Programme.

Nature: Spillage of storm water containing waste could lead to water resource degradation		
	Without mitigation	**With mitigation**

Extent	Regional (3)	Local (2)
Duration	Long term (4)	Short term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Likely (3)	Possible (2)
Significance	**39 (Medium)**	**16 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: Pollution control infrastructure to be designed in accordance with GN 704 and GNR 634 specifications, water use to be licensed for appropriate regulation and control		
Residual Impacts: Sediments with increased toxicity levels		

Transportation and conveying impacts

Coal dust and spilled ash may have an impact on the Sandloop. The material being transported from the mines to the Tshivhaso Coal-Fired Power Plant is native to the area and the impact may only be a slight increase in the suspended sediment load in the Sandloop. However, the Sandloop is dry for most of the year and it flows infrequently during the high rainfall summer months. This impact would probably be very limited, and restricted to the site where the haul road or conveyor crosses the unnamed tributaries to the Sandloop. Mitigation of this potential impact needs to be addressed in the Integrated Water and Waste Management Plan.

Nature: Increase in the suspended sediment load in the Sandloop		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Short term (2)	Short term (2)
Magnitude	High (8)	Moderate (6)
Probability	Highly likely (4)	Likely (3)
Significance	**52 (Medium)**	**30 (Low moderate)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Minimize construction footprint to be outside watercourses and riparian zones; » Minimize disturbance to flow regime and prevent erosion » Compile work method statement/Riparian rehabilitation plan		
Residual Impacts: None		

Ash Disposal

Ash has the potential to pollute water resources which is generally associated with the change of pH of the water body. With the change of pH caused by the ash, salts and metals are mobilised that could leach into ground and surface water bodies. The method and mechanism of ash disposal will determine the extent and magnitude of the impact. The rate at which elements are leached from ash dumps depends on the form in which the element is present, the location of the element within the ash matrix as well as whether the pollutant has been absorbed onto the particle surface or not. Elements or pollutants in a chemically stable matrix are less readily available to be leached from the ash dump. The most likely elements to be leached from the ash dump are those that have adsorbed onto the surface of the ash particles.

Nature: The disposal of ash will contribute towards an increased risk of point and diffuse pollution in the catchment. Pollution of the environment will stem from ingress of runoff into the aquifer, spills from the system, dust fall out that could increase salinity within the catchment		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Likely (3)	Possible (2)
Significance	**Moderate (39)**	**Low (20)**
Status (positive or negative)	Negative	Negative
Reversibility	No	No
Irreplaceable loss of resources	Yes	No
Can impacts be mitigated?	Yes	
Mitigation: » Adherence to the requirements as depicted in NEMWA and NWA in terms of liner designs. » Adherence to GN 704 and GN 634 Regulations supported by civil engineering design reports » Monitoring of surface and groundwater resources		
Residual Impacts: Increased salinity of water resources		

Mitigation during operations:

» Containment dams should be managed with a freeboard of 0.8 m.
» Where applicable, re-use water in dams before using raw water sources.
» All pollution control facilities must be managed in such a way as to ensure that storage and surge capacity is available if a rainfall event occurs.
» Implement water conservation and water demand management strategies.
» Minimise disturbance to flow regime and prevent erosion.

» All hazardous chemicals must be stored on bunded surfaces and material safety data sheets should be present on site for all hazardous chemicals.
» Ensure that all spills are immediately cleaned up using the correct method as specified for the specific chemical / material.
» All pollution control facilities must be analysed for toxicity on at least three taxonomic groups using definitive screening acute toxicity testing methods at least once a year during the dry season.
» Surface water quality monitoring must be undertaken upstream and downstream of the project area on an ongoing basis to determine trends. Any significant change in quality from the previous results must be investigated and if the pollution originates on site an investigation as to the source of the pollution must be investigated and mitigation and rectifying measures implemented.

7.6.3 Comparison of Ash Dump Alternatives

The preferred site for the development will be on the farm Graaffwater 456. No perennial surface water streams or standing water bodies were observed on the property.

7.6.4 Implications for project implementation

» Development of an Integrated Water and Waste Management Plan (as part of the WULA).
» Wetland and riverine areas to be considered as no go zones unless authorisation is obtained,
» Compile and implement a stormwater management plan to ensure the separation of clean and dirty water systems;
» Containment of all contaminated water in dedicated pollution control design facilities.
» Adhere to GN 704 and GN 634 Regulations for design and implementation of pollution control dams, ash dump and coal stockpile.
» Re-use, recycle and minimise all waste water generated on the site.
» Implementation of compliance monitoring program with associated auditing and reporting.
» Obtain the necessary Water Use License from the DWS as regulatory authority.
» In terms of the construction phase of the power station the following management and mitigation measures are required to prevent and/or reduce environmental impacts:

7.6.5 Conclusions and Recommendations

The primary surface water impacts associated with the development of the Tshivhaso Coal-Fired Power Plant, ash dump and transport of coal to the power plant are the potential impacts on the regional water balance, water quality degradation due to waste water discharges, storm water management at the Tshivhaso Coal-Fired Power Plant, and possible impacts on the Sandloop where the haul road or conveyor system would cross the drainage system. The following conclusions can be made from this assessment:

» Tshivhaso Coal-Fired Power Plant site – an investigation of the impact on regional water resources found that water demand of the Tshivhaso Coal-Fired Power Plant would contribute significantly to the growth in demand on the local water supply system. The Department of Water and Sanitation is currently addressing the water needs for the catchment through the implementation of the MCWAP scheme.
» Ash dump site – A storm water management system should be designed for the Tshivhaso Coal-Fired Power Plant and ash dump site to ensure that sufficient storage capacity is created on site to accommodate storms with a 1:50 year return period (GN 704 Regulations), spillage frequencies should be less than 1 percent, taking into account the long-term rainfall record applicable to the project site and any abstraction for reuse from the storm water dams, and to ensure that there is efficient separation of clean water and dirty water. Only clean water should be discharged to the storm water system. Contaminated water should be contained and treated on site.
» The storm water management system should comply with the Department of Water Affairs' Best Practise Guidelines (DWAF, 2006). The EMPr for the Tshivhaso Coal-Fired Power Plant should also address measures to contain oil spills, good waste management practices, guidelines for the storage, handling, use and disposal of chemicals, etc.
» The disposal of effluent from the waste water treatment works needs to adhere to the Resource Quality Objectives set for the Mokolo River sub-catchment to prevent degradation of water quality and the River Health Class.
» Transportation corridor – Good dust suppression practices should be applied to prevent spillage of coal or ash material along the haul road or conveyor.
» A monitoring network for surface water needs to be implemented that is further supported by biological and wetland monitoring.
» Cennergi must apply for the identified water uses and conduct the required studies to compile an Integrated Water and Waste Management Plan.

7.7 Potential Impacts on Wetlands

The proposed Tshivhaso Power Plant project is located within an area of intensive game farming/ecotourism activities. In addition the historic mining activities in the catchment have led to moderate impacts on wetlands within the region that has resulted in an overall degradation of the wetland habitats. Existing impacts observed in the area include:

» Extensive grazing (game and livestock) along the boundaries of the wetland recorded on the farm Goedehoop to the north of the proposed development site;
» Slight erosion along gravel tracks and trampling by game (rhinoceros) within the farm Eendragtpan have led to increased sedimentation; and
» Presence of alien vegetation encroachment in disturbed areas.

No wetlands occur within the preferred site (Graafwater). A wetland was recorded to the immediate north of the site (refer to Figure 7.3). Wetlands recorded within the project area have a high biodiversity conservation value when considered on a national scale.

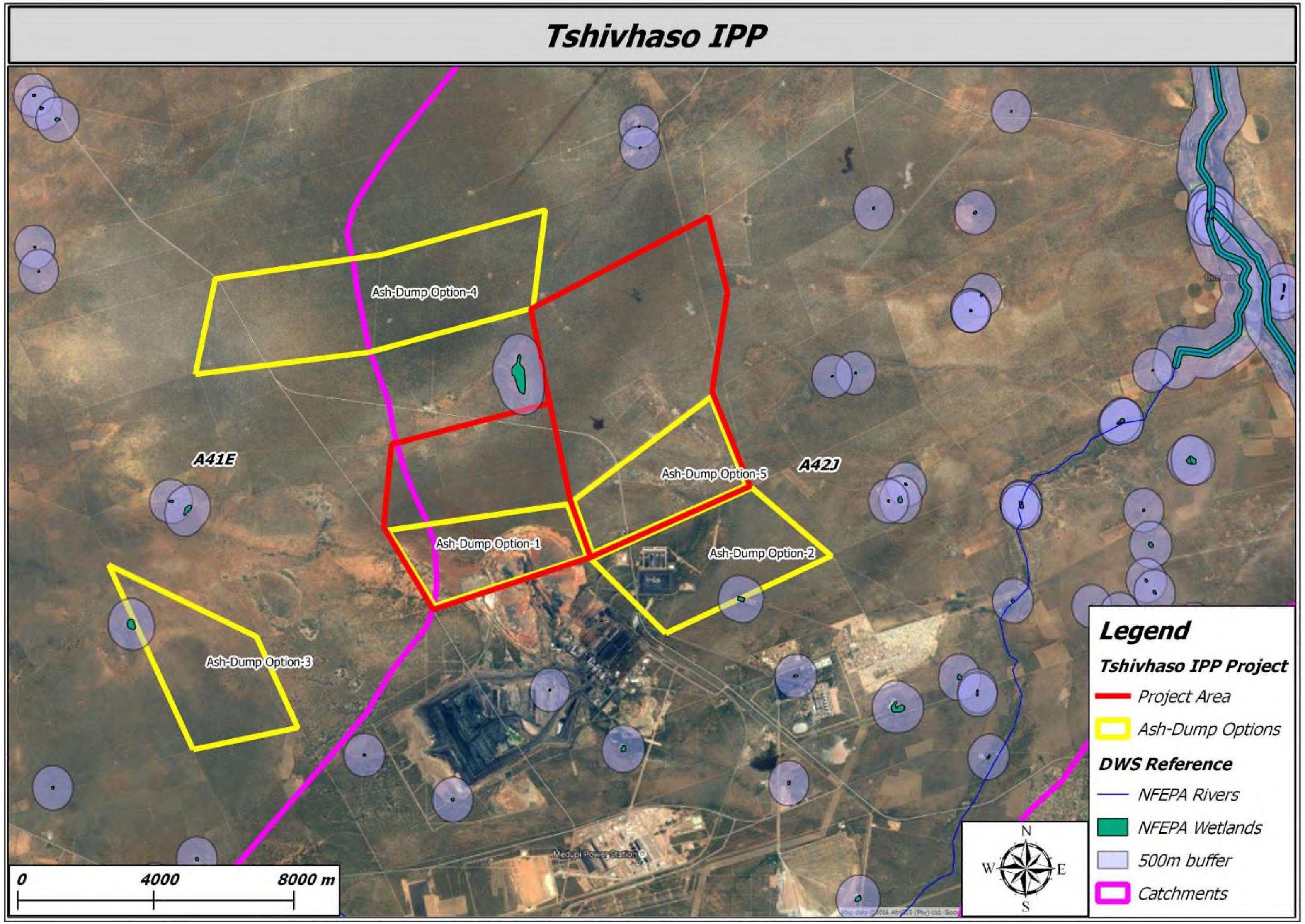


Figure 7.3: Delineated wetland areas within the project area and the appropriate wetland buffer zones (note that the map includes all areas originally identified at scoping although some of these site options have been excluded from the EIA.

7.7.1 Results of Impact Assessment

Construction Phase Impacts

Clearing of vegetation

There is a slight risk that vegetation clearance will result a low to moderate risk on loss of wetland biodiversity for the portion of the wetland that is in close proximity to the property boundary.

Nature: Alteration of the wetland riparian and vegetation regime due to clearance of natural vegetation causing a loss of biodiversity		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Low (4)
Probability	Possible (2)	Possible (2)
Significance	**20 (Low)**	**20 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Minimize construction footprint to be outside wetland buffer zone and riparian zones; » Minimize disturbance to flow regime and prevent erosion through the implementation of an appropriate stormwater management plan.		
Residual Impacts: Impact would remain after construction is completed		

Fencing

For access control and safety measures the project area needs to be fenced. Holes to be dug in close proximity to the periphery of the wetland boundary have the risk to impact on the wetland vegetation. The utilisation of the service road (as part of a servitude area) will cause compaction of wetland soils. Construction during the wet season will have an increased impact on the wetland area as vehicles may be trapped in wet soil conditions causing increased damage to vegetation. However, these activities during the construction phase have a low significance on the wetland. Based on the location of the power plant and ash dump boundary in relation to the wetland, the impact of the construction and fencing activities are considered low. No specific mitigation measures are required.

Nature: Damage to vegetation and soil compaction		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Low (4)
Probability	Possible (2)	Improbable (1)

Significance	**20 (Low)**	**10 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » No specific mitigation is required » Minimize construction footprint to be outside wetland and riparian zones; » Minimize disturbance to flow regime and prevent erosion through the implementation of an appropriate stormwater management plan.		
Residual Impacts: None		

Erosion Control

The change in land use that will take place within the project area where the natural vegetation will be cleared to allow for construction is considered to have a low-moderate risk to impact negatively on the depression wetland in terms of sedimentation. The exposed soils around the wetland are erodible and construction activities pose an increased risk that surface flow re-direction may lead to desiccation of the depression wetland.

Nature: Alteration of the flow regime contributes towards erosion of the catchment resulting in increased sediment, degradation of in-stream riparian habitat and associated decrease in water quality		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Likely (3)	Possible (2)
Significance	**39 (Medium)**	**20 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Compile Work Method Statement and Rehabilitation Plan » Minimize construction footprint to be outside watercourses and riparian zones; » Minimize disturbance to flow regime and prevent erosion through the implementation of an appropriate stormwater management plan.		
Residual Impacts: None		

Polluted Water Management

The non-perennial depression wetland located to the north of the power station development site appears to be driven by surface water flow inputs as well as groundwater or sub-surface flow input. The wetland is therefore directly dependant on the water flows from the immediate catchment for seasonal inundation. The soils around the wetland appear to be prone to erosion and storm water discharges to the wetland area may cause head gullies and channelization of the wetland coupled with sedimentation and siltation of the system. There is however a constant threat to the wetland regarding sediment trapping as the adjacent land use of livestock and game grazing has an increased risk of silt deposition into the wetland during wet conditions.

Nature: Storm water run-off contaminated with suspended solids causing water quality degradation. Storm water augmentation could result in siltation of wetland		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Likely (3)	Possible (2)
Significance	**36 (Medium)**	**20 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Minimize construction footprint to be outside watercourses and riparian zones; » Minimize disturbance to flow regime and prevent erosion		
Residual Impacts: None		

Operational Phase Impacts

Drainage alteration

During the Operational Phase water management infrastructure will be implemented. The run off from the dirty footprint of the power plant needs to be contained and the clean water area must be allowed to free drain into the environment. The separation of clean and dirty water system will cause a reduction in catchment yield. Clean runoff will be converted from sheet flow towards dedicated storm water trenches as the non-perennial drainage pathways will be consolidated to be managed as an integrated system.

Nature: Alteration of the flow regime of the catchment resulting in loss of catchment yield, degradation of in-stream riparian habitat and associated decrease in water quality		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Highly likely (4)	Possible (2)
Significance	**54 (Medium)**	**20 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Minimize construction footprint to be outside watercourses and riparian zones; » Maintain the prescribed buffer zone for wetland protection » Minimize disturbance to flow regime and prevent erosion		
Residual Impacts: None		

Ash dump pollution

The preferred option for the operation of the ash dump waste facility is earmarked for implementation on the farm Graaffwater. The locality of the facility is considered upstream of the identified wetland system (pan and wooded riparian systems) with a flat slope draining towards the east. Base-flow in an impacted aquifer could eventually contribute towards water quality deterioration with a resultant vegetation reduction. Overall a high impact could be expected that could cause wetland functionality to be sacrificed if the ash dump is not managed in a responsible manner.

Nature: Groundwater deterioration due to ingress of pollutants contained within an ash dump that infiltrates the aquifer. Pollution plume migration towards the wetland is considered a reality and coupled with surface water runoff and dust fall out a high impact could be expected if the waste facility is not managed properly.		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	Moderate (5)
Probability	Definite (5)	Highly Likely (4)
Significance	**75 (High)**	**44 (Medium)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	Yes	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Site selection required to identify area with least risk on the receiving environment » Civil engineering designs required with appropriate liner to minimise ingress of pollutants into aquifer » Implement groundwater monitoring program » Adhere to legal requirements as contemplated in NEMWA and NWA » Compile an IWWMP to support the water use application linked to the facility		
Residual Impacts: Long-term water quality problems (increased salinity)		

Siltation and sedimentation

The anthropogenic changes that have taken place within the region where the natural vegetation was replaced with power generation and mining activities has a moderate risk to impact negatively on the depression wetland systems in the area in terms of sedimentation. The exposed soils around the wetland located to the north of the development area are erodible and power plant construction activities pose a risk that surface flow re-direction may lead to desiccation of this wetland.

Nature: Increased hard surfaces associated with the power plant will result in concentrated runoff from clean and dirty areas. Dedicated pollution control structures such as PCDs, SWMD and the ash dump have the potential to spill and lead to diffuse pollution stemming from spillages. Rain events will further contribute towards increased runoff that could result in impacts of moderate significance.		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Long term (4)	Medium term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Highly likely (4)	Likely (3)
Significance	**54 (Medium)**	**27 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes

Mitigation: » Water management infrastructure to be designed in accordance with the specifications of GN 704 Regulations. » Operate containment facilities with 0.8 m free board to minimise risk of pollution.
Residual Impacts: None

Stormwater Management Infrastructure

The SWM infrastructure will consist of containment facilities, berms and trenches to channel all dirty water to a SWMD. Inadequate design capacity could result in illegal discharge of polluted water to the environment. The stormwater management infrastructure needs to isolate high potential pollution areas such as the coal stock yard from the environment. Inadequate and poor water management practices will have a high impact on the wetland system if illegal discharges end up in the wetland system

Nature: Illegal discharges and spills from inappropriately designed SWM systems have the potential to cause a high significance impact on the downstream sensitive receptors.		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Medium term (3)	Medium term (3)
Magnitude	High (8)	Low (4)
Probability	Definite (5)	Possible (2)
Significance	**60 (High)**	**18 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	Yes	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Design SWM system in accordance with GN 704 requirements » Adhere to principles contained in BPG: G1: Stormwater » Operate system with required 0.8 m free board » Separate clean from dirty water » Maximise clean runoff and minimise dirty water runoff footprint » Implement liner design to protect groundwater from pollution		
Residual Impacts: Long term water quality impacts causing gradual degradation of the sensitive receptors (wetlands)		

Leakage and Spillages

The power plant will operate utilizing 720 000 m^3 raw water (on an annual basis). The waste water supply network has a moderate risk to fail whereby the accidental spillages could have a moderate risk in terms of water quality deterioration.

Nature: Accidental spills and leakages from the raw water supply network as well conveyance of ash could result in impacts of moderate significance if not cleaned up immediately		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Short term (2)	Short term (2)
Magnitude	Moderate (6)	Low (4)
Probability	High (5)	Possible (2)
Significance	**50 (Medium)**	**16 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	Yes	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Conveyors should be covered » In event of pipe burst clean up should happen immediately » Report major incidents to regulatory authority as required in terms of Section 30 of NEMA		
Residual Impacts: None		

Decommissioning Phase Impacts

Demolition of Power Station Infrastructure

This activity is considered in the long-term as the power plant will have a lifespan of more than forty years. During the demolition of the power plant infrastructure pollution may occur due to pollutants, fr example, that are trapped in the ash pipe system, conveyors, boilers, coal storage plant and storage tanks. These pollutants when released into the environment will cause water quality degradation as sediments will be deposited within the sub-catchment feeding into the wetland system.

Nature: The removal of power plant infrastructure by means of blasting and demolition may result in the release of pollutants that could eventually cause water quality degradation. The released pollutants stemming from demolition activities, if not managed properly, could result in the degradation of the receiving environment.		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Short term (1)	Long term (4)
Magnitude	Low (4)	Low (4)
Probability	Definite (5)	Possible (2)
Significance	**35 (Medium)**	**16 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation:		

» Compile a Rehabilitation Strategic Implementation Program (RSIP) linked to a Closure Plan » Adhere to the mitigation measures as contained in the RSIP and IWWMP followed with monitoring to indicate steady state conditions
Residual Impacts: Long-term residual impacts stemming from the waste handling facilities will manifest in the catchment that could eventually contribute towards degradation of the wetland system.

7.7.3 Comparison of Alternative site for Ash Dump

The preferred site for the ash dam development will be on the farm Graaffwater 456. No perennial surface water streams or standing water bodies were observed on the property.

7.7.4 Implications for project implementation

» A minimum of 250 m buffer zone must be maintained around the wetland areas wherein no activities are allowed to take place in order to protect the integrity of the wetland as the wetland still remains a priority wetland in the region with a largely natural condition and high ecological importance and sensitivity class. This buffer zone should be clearly demarcated as a "NO GO" area to prevent any accidental entrance into the area.
» Should the development need to transgress the wetland areas, a water use license authorisation in terms of Section 39 or 40 of the National Water Act, 1998 (Act 36 of 1998) for the Section 21(c) and (i) uses must be applied for.
» Strict storm-water management practices must be applied and incorporated into management with the aid of a suitably qualified engineer to avoid disposal or spillage of any environmentally harmful materials or waste into the wetland.

7.7.5 Conclusions and Recommendations

The wetland within the project area has a high biodiversity conservation value when considered on a national scale. It is recommended that the following considerations be taken into account and applied accordingly to ensure protection of the natural resource and to prevent any further degradation of wetlands within the region:

» All conditions as stipulated in the Work Method Statement and Environmental Management Programme (EMPr) must be adhered to before commencement of construction activities.
» A minimum of 250 m buffer zone must be maintained around the wetland areas.
» Any activities that may potentially result in significant adverse effects on the wetlands in the area should be avoided
» Should the mitigation measures recommended fail to adequately protect the integrity of the wetland habitat, compensatory measures must be provided.

7.8 Potential Impacts on Groundwater

7.8.1 Results of Impact Assessment

Nature: **Leachate from the ash disposal facility which may potentially reach groundwater which could be detrimental to the aquifer system.**		
	Without mitigation	**With mitigation**
Extent	3	2
Duration	5	3
Magnitude	6	2
Probability	4	2
Significance	**56 - Medium**	**14 – Low**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Medium
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: • Surface hydrology design should include surface drainage and storm water diversion drains, to meet the requirements of the Water Act. This includes the separation of unpolluted from polluted surface water and the containment of polluted water on site in impoundments. Also, where leachate is generated, it must be contained separately from water which is only slightly polluted through contact with the waste. • In the case of hazardous waste disposal sites, the design must make provision for containment of hazardous waste. This implies the complete separation of the waste body and any associated leachate from the surrounding soil or rock strata, by means of a liner and a leachate collection system. • Leachate management is necessary at hazardous waste disposal sites, where significant leachate is generated. The design includes a liner underlying the site, as well as leachate collection and treatment measures. It must make provision for the control of significant seasonal or continuous leachate generation, predicted by means of the Climatic Water Balance, or the Site Water Balance. • Monitoring systems for surface and ground water pollution should be indicated. This will include the positions of both surface water sampling points and monitoring boreholes. • Drains must divert or contain the peak design storm of 50 year return period for the particular catchment area. The system must effectively separate unpolluted water that has not come into contact with waste, from polluted water. The upslope cut-off drains must divert clean storm water around the site and into the natural drainage system • "Polluted water, on the other hand, must be collected in toe drains, retained on the site and managed in accordance with the Department's directives. This may include controlled release, recycling and evaporation or treating with any leachate that has been collected." • "It is a Minimum Requirement that there is always an acceptable physical separation between the proposed waste body and the wet season high elevation of the ground water. This applies whether cover excavations take place on site or not. The minimum permissible separation is 2m."		

- Leachate collection is usually achieved using a graded underliner and drains which lead to a collection point or sump. Depending on soil quality, the underliner may be an engineered low permeability natural soil or clay liner, a geomembrane liner, or both.
- "All landfills have the potential to generate sporadic leachate. In all landfills, therefore, the base must be so sloped that any leachate formed, even sporadic leachate, is directed to a control point."
- The leachate treatment system will depend on the leachate composition and on the most appropriate method of treatment. This could be on-site chemical, physical or biological treatment, and/or off-site treatment where leachate is passed into a sewer or pipeline for treatment elsewhere.
- Clean, uncontaminated water, which has not been in contact with the waste, must be allowed to flow off the site into the natural drainage system, under controlled conditions. All drains must be maintained. This involves ensuring that they are not blocked by silt or vegetation.
- The Department requires a Water Quality Monitoring Plan as part of the permitting requirements. This involves background analyses, detection monitoring, investigative monitoring and post-closure monitoring. The Water Quality Monitoring Plan ensures that the water quality in the vicinity of a waste disposal site is regularly monitored and reported upon throughout its life, so that, where necessary, remedial action can be taken.

Residual:
A risk of leachate entering the groundwater is inherently always associated with waste disposal facilities. However, if the facility is managed correctly, this risk can be minimised to an acceptable level in which case receptors being exposed to the risk will be affected negligibly. This means that the impact upon the receptor will be minimal to none. Therefore, the residual risk, after lining of the facilities and correct routing of surface water around the facility, impacts upon receptors will be of an acceptable level.

7.8.3 Comparison of Alternative sites for Ash Dump

No boreholes are likely to be affected by the sulphate pollution plume from the ash dump for either of the site options within 100 years after operations have commenced with the exception of the destruction of LEP2. It should be noted that other privately owned boreholes, downstream of the site, may be affected if pumping takes place, as this may accelerate groundwater flow in the identified faults and subsequently, contaminant transport.

No preference can therefore be made between either of the options for the ash dump in terms of groundwater impacts.

7.8.4 Implications for project implementation

During the operational phase, no groundwater abstraction is expected. Therefore, no groundwater drawdown is expected from the power station and the current status in this regard, will be maintained. However, LEP 1 or LEP 2 is likely to be destroyed during the establishment of the ash dump, which can be considered to be an impact on groundwater quantity. This depends on the selected site for ash dump development. Also, should the power station extract groundwater for operational processes in future, it will be important to update the groundwater model with this information as receptors in the area may be impacted by this activity.

Water quantity and quality data should be collected on a regular, ongoing basis during operations. These data will be used to recalibrate and update the water management model, to prepare monitoring and audit reports, to report to the regulatory authorities against the requirements of the IWMP and other authorisations and as feedback to stakeholders in the catchment, perhaps via the CMA. The monitoring as recommended in the report should be established prior to operation. Geochemical analyses and modelling must be conducted on the material during operations to update the transport model refine geochemical predictions.

7.8.5 Conclusions and Recommendations

From the results of the field investigations and laboratory analyses, a conceptual hydrogeological model was compiled for the power station. This conceptual model is a simplified representation of the conditions at and in the vicinity of the power station, and will provide the framework during the development of the risk assessment and numerical flow and transport model The CSM illustrates that contamination is likely to seep from the base of the ash disposal facility into the unsaturated zone. This contaminated leachate is likely to contain elevated concentrations of Ca, Na, Cl, SO4 and metals such as Cu, Hg, Pb, Mn, Fe, Al, Cr etc. Perching of the discharged leachate may take place in the regolith underlying the ash disposal facility causing lateral flow which may reach neighbouring boreholes and is likely to contaminate the soil in the area. This will also cause a mounding of groundwater in the unsaturated zone. Therefore, monitoring of this shallow, perched aquifer will be required. Seepage from the ash disposal facility may also reach the saturated fractured aquifer over time. Although this may occur over a long period of time, due to the 40 m thick unsaturated zone, groundwater contamination and mounding of the groundwater table is a possibility. Therefore, monitoring of the deeper fractured aquifer will also be necessary as neighbouring boreholes may be affected. Due to large scale fracturing and faulting in the area, contamination has the potential to reach the neighbouring Grootgeluk opencast coal mine via preferential pathways. Flow is known to take place at higher velocities in the fault zones of this area and contamination could therefore travel much further in these structures as opposed to the weathered matrix blocks of the underlying aquifer.

The following measures should be implemented during operations:

» Waste residue deposits should be located as far away from surface water bodies as possible.

» Water management facilities should be designed to intercept and contain as much contaminated runoff and/or seepage as possible. The following facilities should be lined: Ash dumps
» Apply effective storm water management principles to ensure that clean runoff is maximised and diverted to the receiving water resource, while contaminated runoff is minimised and contained for reuse within the operation.
» Monitoring boreholes as discussed in the following sections will be required in strategic locations near the pollution source, to obtain information on the groundwater regime as well as for future monitoring purposes.
» Construct detailed water and salt balances that take account of climatic and operational variability, as a planning tool to ensure that all pollution control dams are adequately sized and that they are integrated into a robust water reuse and reclamation strategy to ensure that captured contaminated water is effectively reused within the operations and that system spillages to the environment are avoided.
» Proper storage, handling and monitoring of fuel and chemicals used on site to minimize the risk of spillages to the environment.
» Institute detailed monitoring systems that are capable of detecting pollution at the earliest possible stage, at all facilities where significant pollution potential exists, in order that this can lead to rapid and effective management actions to address the pollution source and minimize it to the full extent possible.
» Safety measures such as freeboard allowances etc should be included in designs of storm water control facilities to allow for sufficient storage capacity and to ensure that risks of overflows or spillages are minimized and environmental impacts are therefore avoided.
» Design, construct, maintain and operate any clean water system at the site so that it is not likely to spill into any dirty water system more than once in 50 years;
» Design, construct and maintain all water systems in such a manner as to guarantee the serviceability of such conveyances for flows up to and including those arising as a result of the maximum flood with an average period of recurrence of once in 50 years.
» Ensure that clean storm water is only contained if the volume of the runoff poses a risk, if the water cannot be discharged to watercourses by gravitation, for attenuation purposes, or when the clean area is small and located within a large dirty area. This contained clean water should then be released into natural watercourses under controlled conditions.
» Ensure the minimisation of contaminated areas, reuse of dirty water wherever possible and planning to ensure that clean areas are not lost to the catchment unnecessarily.
» Ensure that seepage losses from storage facilities (such as polluted dams) are minimised and overflows are prevented.

» Ensure that all possible sources of dirty water have been identified and that appropriate collection and containment systems have been implemented and that these do not result in further unnecessary water quality deterioration.
» Ensure that the water use practices on and around the ash deposit do not result in unnecessary water quality deterioration, e.g. use of the return water dam for storage of poorer quality water.
» Lining of the ash disposal facility must be considered to avoid seepage of contaminated water into the subsurface. Capturing contaminated water in the subsurface will be especially challenging due to the thick unsaturated zone underlying the proposed sites. In the event of a leakage from these facilities, a pump and treat system will most likely be required to address contamination issues.

7.9 Potential Impacts on Air Quality

7.9.1 Results of Impact Assessment

The DEA established an ambient monitoring station in Lephalale, with monitoring commencing in February 2013 (www.saaqis.org.za). The station is well removed from industrial sources and from the influence of residential fuel burning. It is located near a busy road, but is classified as an urban background site. The average 1-hour ambient NO_2 concentration at the site since monitoring started is 16 µg/m^3 which is significantly below the national ambient air quality standard of 200 µg/m^3. The average 24-hour SO_2 concentration is 7 µg/m^3 which is also well below the ambient air quality standard of 125 µg/m^3. The average 24-hour PM10 concentration is 34 µg/m^3. This background concentration is relatively high compared to the 2015 ambient standard of 75 µg/m^3, equivalent to nearly 50% of the standard.

In coal-fired power plants, crushed coal is burnt to generate heat, which in turn is used to heat water and generate steam. The steam then drives turbines that generate electricity. The combustion of coal results in emissions of numerous pollutants into the atmosphere. The major pollutants emitted from coal combustion at the Tshivhaso Power Station are SO_2, NO_X and particulates; and dust from the coal stockpile and ash dump. Maximum permissible hourly release rates for SO_2, NO_X and particulates are specified for these pollutants (DEA, 2013a). The potential effect of these pollutants is described here.

Known human health impacts of exposure to SO_2 and NO_2 are mainly respiratory effects such as narrowing of the airways, exacerbation of asthma and an influence on lung function. The effects of PM depend on the size and chemical composition of the particles. Particles with a diameter smaller than 10 µm (including PM10 and

PM2.5) that are inhaled may result in respiratory effects as well as cardiovascular effects.

The Tshivhaso Power station will utilise Circulating Fluidised Bed (CFB) combustors (boilers) which have the advantage that sulphur trapping can take place with the sorbent bed (limestone) in these boilers. This ensures a plant with relatively low emissions. In addition, the power station will utilise dry cooling technology and dry ashing due to water availability constraints.

Impacts can generally be categorised as direct, indirect or cumulative. Direct impacts are impacts that are caused directly by the project or activity in isolation of other sources and generally occur at the same time and place as the activity. Indirect impacts are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity. Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities.

For this study, direct impacts will result from the inhalation of NO_2, SO_2 and particulates (PM_{10}) emitted during the operational life of the Tshivhaso Power Station. Direct impacts will also result from exposure to dust generated from the coal stockpiles, ash dump; and from the construction of the Tshivhaso Power Station and decommissioning activities. Indirect impacts resulting from emissions of SO_2 and NO_2 from coal-fired power plants include their contribution to acidification in both dry and wet (acid rain) deposition. Further indirect effects are associated emissions of CO and CO_2. CO_2 is a Greenhouse Gas (GHG), adding to the global concentrations. CO is not considered a GHG, but is a strong precursor in the formation of ozone in the troposphere. The global warming potential of tropospheric ozone is equivalent to between 918-1022 tons of CO_2.

The Tshivhaso Power Station is proposed to be constructed on agricultural land, and is surrounded by vast tracts of agricultural land. There is a high concentration of large scale mining activities in the area (Grootgeluk and Grootestryd mine dump and Matimba ash dump). Eskom's Matimba Power Station is located to the south.

With respect to cumulative impacts, mining and agricultural activities, ash dumps, and domestic fuel burning in the area are identified as existing sources of dust. There will be a cumulative impact with dust generated during construction and decommissioning of the Tshivhaso Power Station, as well as during normal operations of the proposed coal stockpile and ash dump at the Tshivhaso Power Station.

The Tshivhaso Power Station is located in an area where there are no notable sources of dust, PM_{10}, NO_2 and SO_2 in the immediate vicinity of the site, i.e. within a 5 km radius. Motor vehicle traffic on the R510, R572, R518 and surrounding roads will have some influence on ambient air quality as will domestic fuel burning. The Matimba (existing), Medupi (under construction) and Thabametsi (authorised) Power Stations are located within a 15 km radius from the Tshivhaso Power Station and are important sources of NO_2, SO_2 and PM_{10} in the locality. It is therefore expected that there will be compounding of effects and hence cumulative impacts during operation of the Tshivhaso Power Station.

Average ambient concentrations measured at the DEA's monitoring site at Lephalale are considered representative of background concentrations. Predicted ambient concentrations resulting from emissions from the Tshivhaso Power Station are relatively localised and are indicated as very low for all modelled operational scenarios. The contribution to ambient concentrations beyond the immediate vicinity of the power station will be small. It is highly unlikely that they will result in exceedances of the national ambient air quality standards at the Lephalale monitoring site, and elsewhere in the area.

Air quality impacts

Nature: Air quality impacts are caused by the inhalation of NO_2, SO_2 and particulates (PM_{10}), which are contained in emissions from the Tshivhaso Power Station. The inhalation of the NO_2, SO_2 and PM_{10} at concentrations exceeding health-based air quality standards; and which are greater than the permitted number of exceedances per year, will result in negative health impacts.		
	Without mitigation	**With mitigation**
Extent	Local/municipal extending only as far as the local community or urban area (4)	Local/municipal extending only as far as the local community or urban area (4)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Moderate (6)
Probability	High (4)	High (4)
Significance (positive or negative)	medium (56) and negative	medium (56) and negative
Reversibility	Yes	
Irreplaceable loss of resources?	No	
Can impacts be mitigated?	Yes	
Mitigation: Plant engineers and operators are to ensure that the abatement technology that is to be installed is always in working order and maintained on a regular basis as per standard operating procedures.		
Residual Impacts: None		

Nature: Cumulative air quality impacts are caused by exposure to dust generated during construction activities and decommissioning of the Tshivhaso Power Station and by other existing sources in the vicinity of the power station. Dust has a nuisance impact and negatively affects quality of life by causing soiling, contamination, structural corrosion and damage to precision equipment, machinery and computers.		
	Without mitigation	**With mitigation**
Extent	Limited to site and immediate surroundings (2)	Limited to site and immediate surroundings (1)
Duration	Immediate (1)	Immediate (1)
Magnitude	Moderate (2)	Low (2)
Probability	High (3)	Low (2)
Significance (positive or negative)	**Low (24) and negative**	**Low (12) and negative**
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	N/A
Mitigation: Compile and implement an appropriate Dust management plan for all projects in the area.		
Residual Impacts: No		

Nature: The inhalation of NO_2, SO_2 and particulates (PM_{10}), which are contained in emissions from the Tshivhaso Power Station will result in health impacts as a result of air quality impacts. The inhalation of the NO_2, SO_2 and PM_{10} at concentrations exceeding health-based air quality standards; and which are greater than the permitted number of exceedances per year, will result in negative health impacts.		
	Without mitigation	**With mitigation**
Extent	Local/municipal extending only as far as the local community or urban area (4)	Local/municipal extending only as far as the local community or urban area (4)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Moderate (6)
Probability	High (4)	High (4)
Significance (positive or negative)	**Medium (48) and negative**	**Medium (48) and negative**
Reversibility	Yes	
Irreplaceable loss of resources?	No	
Can impacts be mitigated?	Yes	
Mitigation: Plant engineers and operators are to ensure that the abatement technology that is to be installed is always in working order and maintained on a regular basis as per standard operating procedures.		
Residual Impacts: None		

7.9.2 Comparison of Ash Dump Alternatives

The change in the location of the ash dump (modelled as Scenario 2 in the air quality assessment report – Appendix G) does not affect the dispersion of PM and will not make any difference to the impacts on air quality. Therefore there is no site preference in terms of air quality impacts.

7.9.3 Implications for project implementation

» An Air Emissions License (AEL) will be required to be obtained for the project from the AEL Authority for the area.
» Annual emission measurements will be required to assess compliance with the Minimum Emission Standards for Listed Activities (Government Gazette 37054, Notice No. 893 of 22 November 2013).
» The maintenance of an emission inventory with registration on the National Atmospheric Emission Inventory System (NAEIS) and annual reporting of emissions to the NAEIS (Government Gazette 38633, Notice No. R 283 of 2 April 2015) will be required.
» Roads should be tarred or traffic control measures implemented to limit vehicle-entrained dust from unpaved roads (e.g. by limiting vehicle speeds and by restricting traffic volumes). Unpaved road surfaces should be sprayed with a surfactant to ensure high moisture content which will bind the silt.
» The sidewalls of the ash dump should be vegetated as they rise, and the vegetation cover should be maintained to reduce the exposed area and limit wind entrainment.

7.9.4 Conclusions and Recommendations

The main findings of the air quality specialist study are:

Construction and decommissioning of infrastructure for the project

Impacts due to construction and decommissioning on ambient air quality concern particulate matter only and is expected to be of a temporary nuisance nature. Impacts will be limited to less than 1 km from the source and may impact on the property on which the site is to be constructed. These impacts are expected to have a **low significance**.

PM_{10} from the coal stockpile and ash dump at the Tshivhaso Power Station

The predicted 99th percentile 24-hour and annual average PM_{10} concentrations resulting from the coal stockpile and ash dump are also assessed in isolation to show their individual contribution in the ambient environment; and together to show the cumulative impact under normal operating conditions. A worst case cumulative impact considers the coal stockpile and ash dump where 100% of both areas are exposed to wind erosion. Two scenarios were assessed, where two different sites were used as the location of the ash dump. In all cases considered, predicted ambient concentrations resulting from the Tshivhaso Power Station are compliant with the current and future national ambient standards. The impacts associated with PM_{10} from the coal stockpile and ash dump have a **low significance**.

PM_{10} from the coal stockpile, ash dump and stacks at the Tshivhaso Power Station

When assessing PM_{10} from all sources at the Tshivhaso Power Station, (i.e. the four stacks, the coal stockpile and the ash dump in combination), it is assumed that 100% of the area for both the coal stockpile and ash dump is exposed to wind erosion. This constitutes a worst case scenario. The predicted 99th percentile 24-hour and annual average PM_{10} are assessed and predicted ambient concentrations resulting from the Tshivhaso Power Station are compliant with the current and future national ambient standards.

There is very little difference in ambient concentrations between the two different locations proposed for the ash dump. It is therefore concluded that the contribution of PM_{10} in the ambient environment are not dominated by the coal stockpile and ash dump, which are low level sources. The impacts associated with PM_{10} are attributed primarily to the stacks and have a **low significance**.

NO_2 from the stacks at the Tshivhaso Power Station

The predicted 99th percentile 1-hour and annual average NO_2 concentrations are assessed. Predicted ambient concentrations resulting from the Tshivhaso Power Station are compliant with national ambient standards and no exceedance of the standard is predicted within the Tshivhaso Power Station site or in residential areas around the site. The impacts associated with NO_2 have a **low significance**.

SO_2 from the stacks at the Tshivhaso Power Station

For SO_2 the predicted 99th percentile 1-hour, 24-hour and annual average concentrations complies with the national ambient standard for SO_2 and no exceedance of the standard is predicted within the Tshivhaso Power Station site or in residential areas around the site. The impacts associated with SO_2 have a low significance.

Indirect impacts at the Tshivhaso Power Station

Indirect impacts associated with the SO_2 and NO_2 emissions relate to acidification, and those associated with CO and CO_2 relate to global warming. The magnitude of indirect impacts associated with the operational scenarios relates to the relative contribution to acidification and global warming. While quantification of the relative contribution of the Tshivhaso Power Station is difficult, the contribution is considered to be relatively small in the national and global context. The significance of the indirect impacts is therefore anticipated to be **low** for all operational scenarios.

7.10 Potential Noise Impacts

Daytime (06:00 – 22:00) and night-time (22:00 – 06:00) operations were assessed within the Noise Impact Assessment. The most critical investigational times would be the night-time hours when a quiet environment is desired (at night for sleeping, weekends etc.).

7.10.1 Results of Impact Assessment

Ambient noise monitoring was undertaken for the area. While sound levels are higher closer to the activities of Grootegeluk Colliery and the Power Stations, areas away from these facilities were generally quiet. Sound levels for most of the area would be typical of a Rural Noise District (as per SANS 10103), and while sound levels may increase at times, this was mainly due to natural sounds (wind, birds, insects, etc.) and the area can be considered naturally quiet.

Considering the noise emissions from a number of conceptual activities associated with the proposed project, this assessment indicated a potential for a noise impact during the construction and operational phases, but this impact would be of low significance. This relates to both the day and night-time scenarios. This is mainly due to the existing high ambient sound levels measured in the area.

Construction Phase

Potential noise sources resulting from the development of the proposed power station during the construction phase include:

» Development of access roads,
» Site establishment (contractors camp, equipment and material storage, security and access control, security fence)
» Vegetation and topsoil removal,
» Establishment of the ash disposal facilities,
» Establishment of storage (coal stockpile footprints) facilities,
» Construction of infrastructure (foundations to completed for structures)

Blasting: Blasting may be required as part of the civil works to clear obstacles or to prepare open casts. However, blasting will not be considered during the EIA phase for the following reasons:

» Blasting is highly regulated, and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use the minimum explosives and will occur in a controlled manner. The breaking of obstacles with explosives is also a specialized field and when correct techniques are used, causes significantly less noise than using a rock-breaker.
» People are generally more concerned over ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast. However, these are normally associated with close proximity mining/quarrying.

Blasts are infrequent occurrences with a loud but a relative instantaneous character. Potentially affected parties generally receive sufficient notice (siren) and the knowledge that the duration of the siren noise as well as the blast will be over relatively fast, result in a higher acceptance of the noise. Note that noise from blasting can be controlled with the use of correct blasting methods.

Noise sensitive developments: Potentially sensitive receptors, also known as Noise-Sensitive Developments (NSDs), located close to the proposed development site (and alternative sites) were identified using Google Earth® during the Scoping Phase, confirmed during previous site visits (see Figure 7.7).

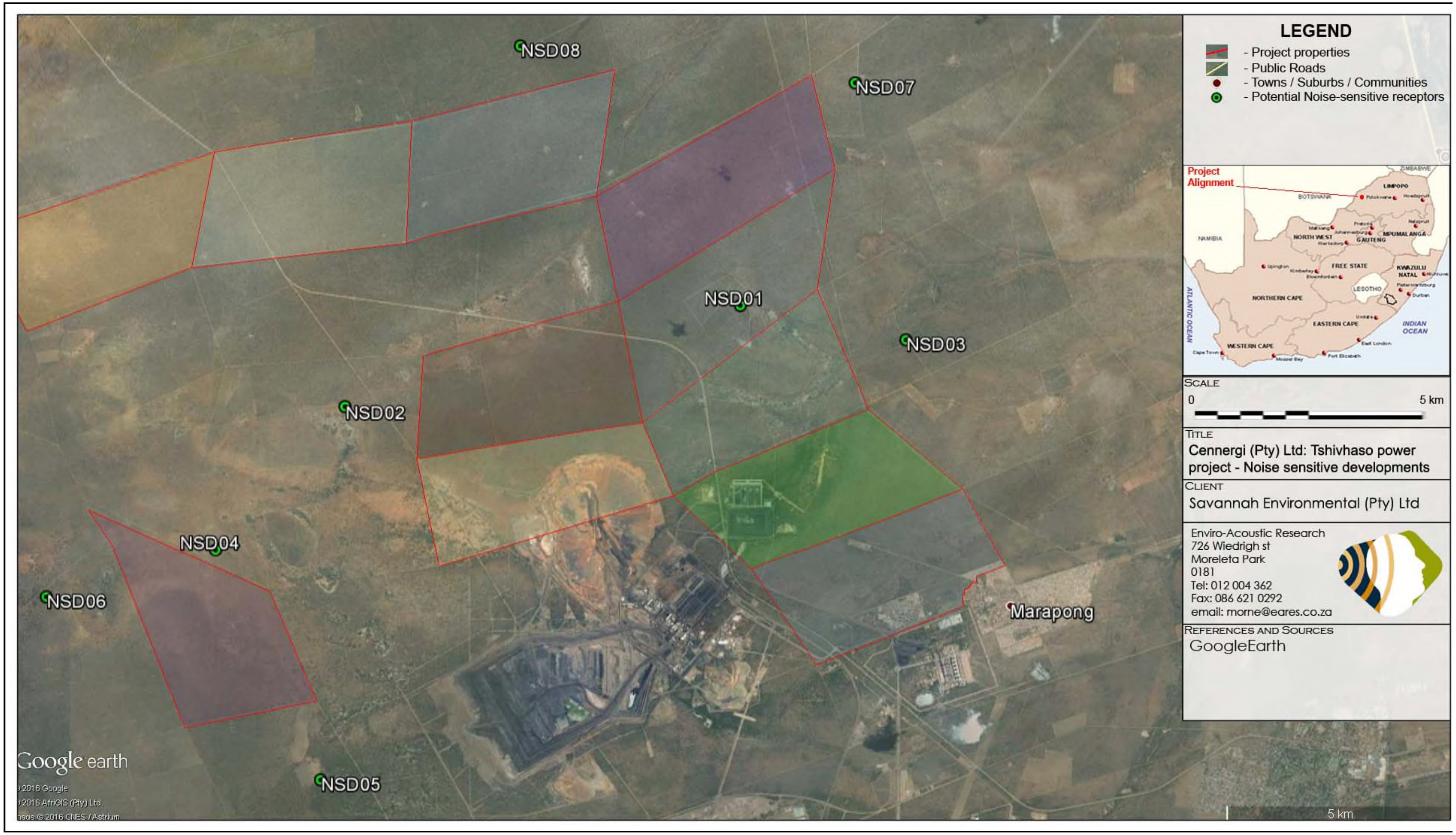

NSD08
NSD07
NSD01
NSD03
NSD02
NSD04
NSD06
NSD05
Marapong
Google earth
LEGEND
- Project properties
- Public Roads
- Towns / Suburbs / Communities
- Potential Noise-sensitive receptors
Project Alignment
SCALE
0
5 km
TITLE
Cennergi (Pty) Ltd: Tshivhaso power project - Noise sensitive developments
CLIENT
Savannah Environmental (Pty) Ltd
Enviro-Acoustic Research
726 Wiedrigh st
Moreleta Park
0181
Tel: 012 004 362
Fax: 086 621 0292
email: morne@eares.co.za
REFERENCES AND SOURCES
GoogleEarth

Figure 7.7: Aerial image indicating potentially noise-sensitive receptors relative to the proposed power station and ash disposal facility footprint indicating conceptualised construction activities (scenarios)

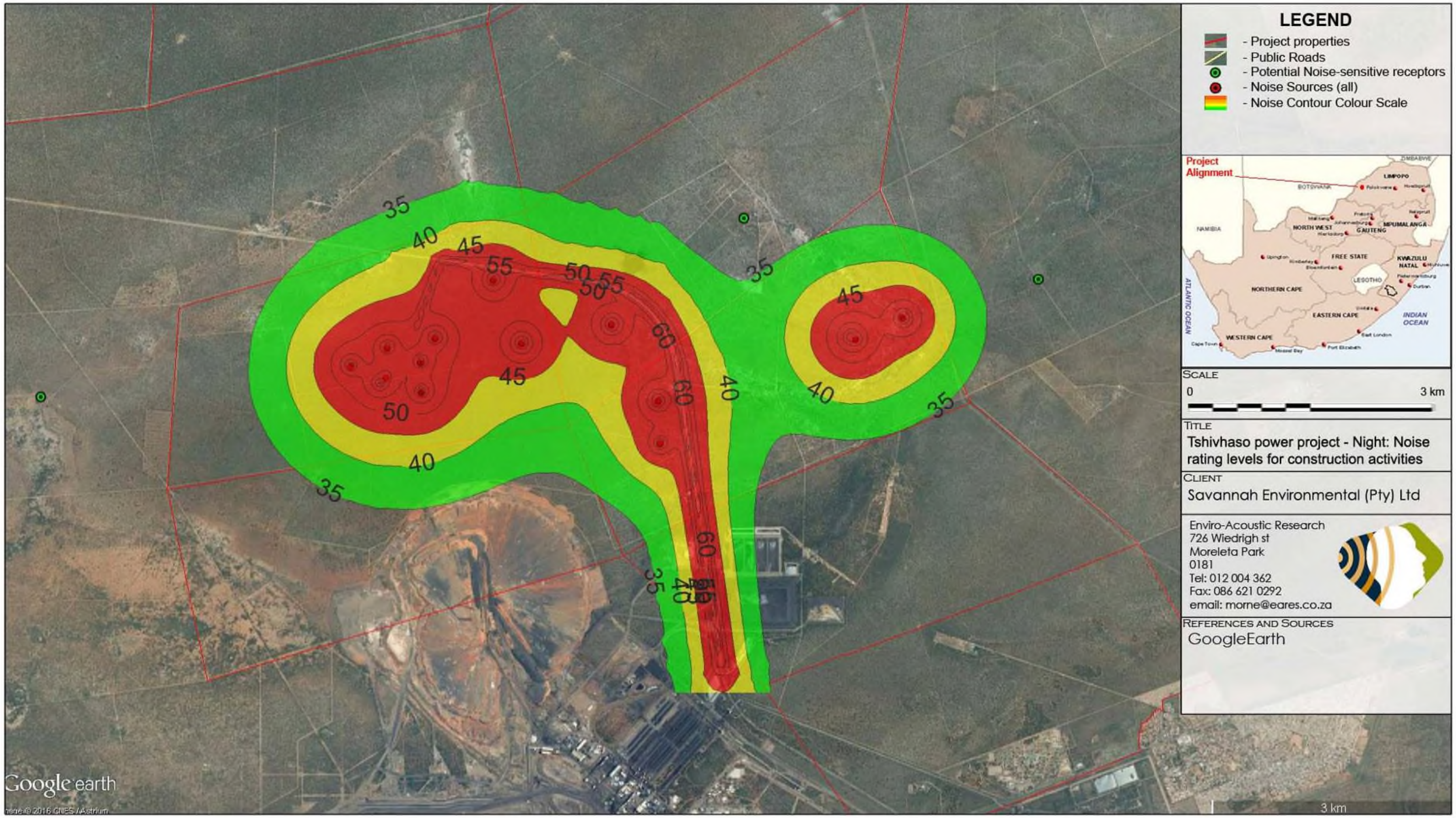


Figure 7.8: Construction noise - Contours of constant rating levels at night

Nature: Various construction activities taking place simultaneously.		
Receiver no		
All NSD	Noise levels below 35 dBA	Noise levels below 35 dBA
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Short (2)	Short (2)
Magnitude	Low (2)	Low (2)
Probability	Improbable (1)	Improbable (1)
Significance	**Low (7)**	**Low (7)**
Status (positive/negative)	Negative	Negative
Reversibility	Very High	Very High
Loss of resources?	No	No
Can impacts be mitigated?	Yes, discussed to ensure a low impact	Yes, discussed to ensure a low impact
Confidence in findings: Medium. As the location of the power station is not defined it assumes that the power station will be constructed far from the NSD identified.		
Mitigation: Significance of noise impact is low for the scenario as conceptualized. Mitigation are however highlighted for the developer to consider during the future planning stages to ensure that the significance of the noise impact remain low.		
Residual Risks: No residual noise risk exists.		

<u>Operation Phase:</u>

The main source of noise associated with the operation of the proposed power plant is associated with the intake and cooling fans, as well as material handling activities at the coal stockpile. Coal pulverising (if required), boilers, steam turbines and generators are generally constructed within fixed structures that will attenuate the noise from this equipment. Noise from ancillary services and activities such as pumps (boiler feed, water, chemical, condensate, vacuum), air compressors and onsite traffic generally is far less than the noise from the main sources.

Traffic during the operational phase will mainly be limited to workers and contractors travelling around the site, traffic associated with shift changes and traffic associated with the delivery of coal and limestone to the site. The assessment also indicated that there is a low potential of a noise impact during the operational phase.

Figure 7.9: Conceptual layout of operational activities

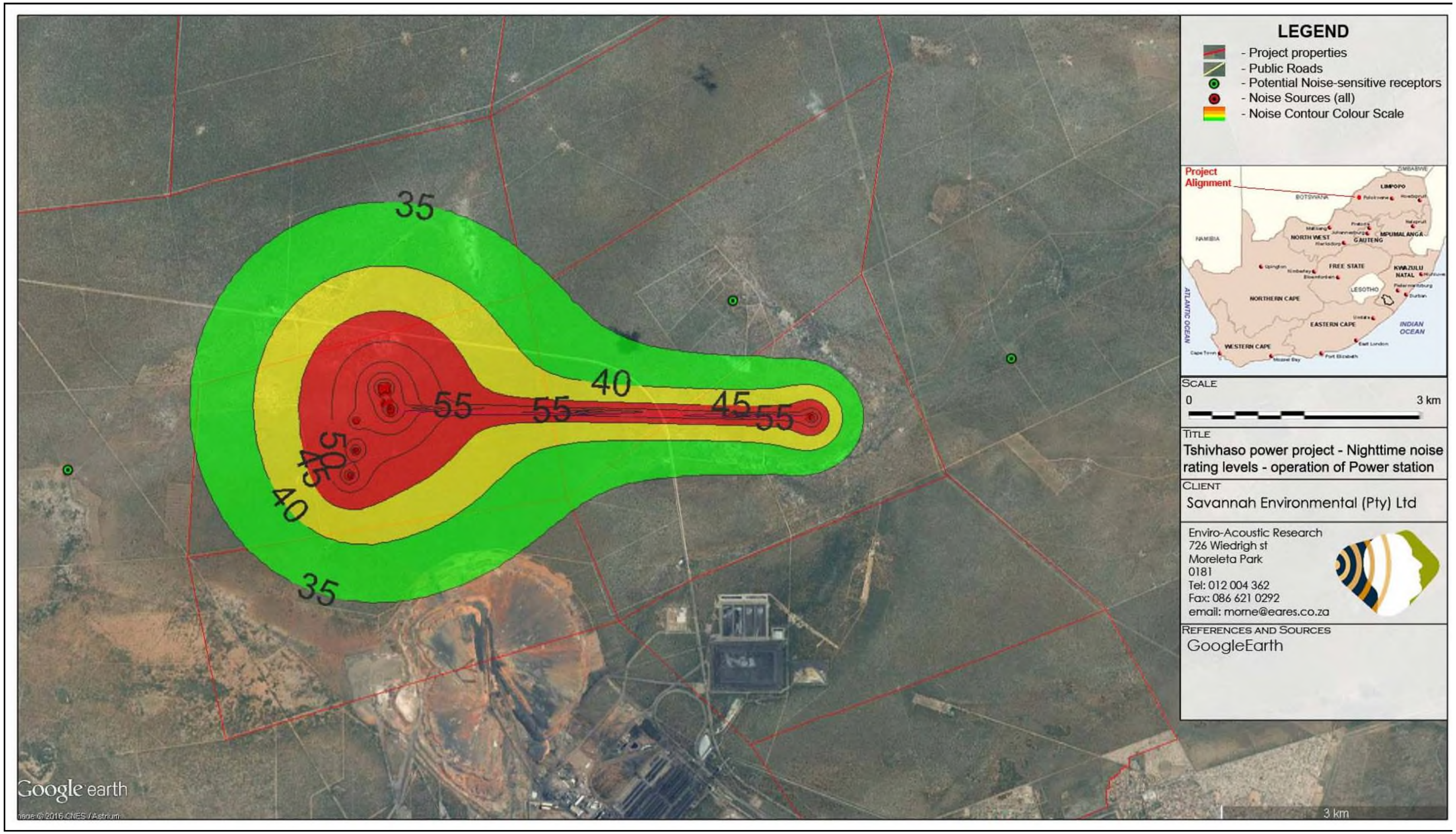


Figure 7.10: Night-time operational noise: Contours of constant rating levels

Nature: Various equipment and systems operating simultaneously		
Receiver no		
All NSD	Less than 35 dBA	Less than 35 dBA
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Long (4)	Long (4)
Magnitude	Low (2)	Low (2)
Probability	Improbable (1)	Improbable (1)
Significance	**Low (9)**	**Low (9)**
Status (positive/negative)	Negative	Negative
Reversibility	Very High	Very High
Loss of resources?	No	No
Can impacts be mitigated?	Yes, discussed to ensure a low impact	Yes, discussed to ensure a low impact
Confidence in findings: Medium. As the location of the power station within the site is not finalised it assumes that the power station will be constructed as far from the NSD identified.		
Mitigation: Significance of noise impact is low for the scenario as conceptualized. Mitigation are however highlighted for the developer to consider during the future planning stages to ensure that the significance of the noise impact remain low.		
Residual Risks: No residual noise risk exists.		

7.10.2 Comparison of Ash Dump Alternatives

In terms of acoustics, there is little preference whether the Ash Residue Deposit is developed on the Farm Appelvlakte or Graafwater. There is therefore no preferred alternative from a noise perspective.

7.10.3 Implications for project implementation

Although noise impacts are expected to be of low signficance during both construction and operation, it is recommended that the developer implement a line of communication (i.e. a help line) where complaints could be lodged. All potential sensitive receptors should be made aware of these contact numbers. The project should maintain a commitment to the local community and respond to concerns in an expedient fashion. Sporadic and legitimate noise complaints could develop and if valid, should be investigated.

The potential noise impact must be reviewed should the power station or any of the project components are developed closer than 2 000 m from any potential noise-sensitive receptors.

No active environmental noise monitoring is required due to the low significance for a noise impact to develop. However, should a reasonable and valid complaint about noise be registered, it is the responsibility of the developer to investigate this complaint. It is recommended that the noise investigation be done by an independent acoustic consultant.

7.10.4 Conclusions and Recommendations

As the impacts are expected to be of low significance, mitigation is not required. Generic measures are however recommended for the developer to note. Mitigation measures mainly relates to the planning phase, with the recommendation that the power station be located sufficiently away from potential noise-sensitive receptors. Measurement locations, frequencies and procedures are provided as a guideline for the developer to consider should there be a noise complaint.

Due to economic advantages, power generation does provide valuable employment, business opportunities and green energy. It must be noted when such projects are close to potential noise-sensitive receptors, consideration must be given to ensuring a compatible co-existence. This does not suggest that the sound from the facility should not be audible under all circumstances as this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source, but rather that the sound due to the power generation activities should be at a reasonable level in relation to the ambient sound levels.

While this project will have a noise impact on a number of the closest noise-sensitive receptors, these impacts are of **low significance** and can be considered insignificant. It is however important that the potential noise impact be evaluated should the fnal location of the power station or any associated systems be closer 2 000m from a confirmed NSD.

7.11 Potential Visual Impacts

7.11.1 Results of Impact Assessment

The following visual impacts were identified through the scoping study:

a) The proposed development could negatively impact on the character of the Lowland LCA which is largely a natural landscape which is an important tourism resource.
b) The proposed development could impact negatively on the Upland LCA which is a relatively natural landscape that is likely to be important as a tourism resource.
c) The proposed development could have a negative impact on adjacent urban areas.

d) The proposed development could be visible from important tourist routes in the area. These include the R518, the R512 and the R510 which are relatively major routes. It is likely that a number of minor, un-surfaced routes, will also be important from a tourism perspective and will need to be considered in the assessment.
e) The proposed development could impact negatively on the Riverine LCA which is likely to be important for tourism and recreational uses.
f) The proposed development could impact negatively on the D'nyala Nature Reserve.

These issues have been considered in the context of the Landscape Character Areas, visual effects identified and possible cumulative influence of other development in the area.

The figures which follow (Figures 7.11 – 7.14) indicate the likely Zone of Theoretical Visibility (ZTV) of the various elements identified above.

a) The tall stacks could be visible from the site to the limit of visibility to the north east and west. To the west and north-west from approximately 30km from the site these views are likely to be at least partially broken by landform. To the south, southeast and south west views of these extremely tall elements are likely to be largely screened by landform; however, occasional views of stacks are likely to be possible from hill tops and through valley lines. These views are likely to be at least partially screened however. These extremely tall elements could be visible from extended sections of the R512, the R510, the R518, Marapong, Onverwacht, Lephalale and the D'nyala Nature Reserve.
b) The generating units could be visible to the limit of visibility to the north, east and west. There is likely to be a view shadow that is created by the minor ridgeline to the north of both developments. To the south visibility will be limited by the Waterburg. The ZTV analysis does indicate that there is small chance of the power station being visible to the R510 as it approaches the Stockpoort Border Crossing.
c) **The visibility of PFA dump alternatives** is likely to vary considerably:
    - The Graafwater Alternative, being located at a relatively high elevation, could also be visible to the south, east and west.
    - The Appelvlakte Alternatives which are set at a relatively low level within the minor valley appears likely to result in the lowest visibility. This alternative is likely to be visible to the east to the limit of visibility.
d) **The visibility of the Overhead Power Line** is likely to be very similar. The ZTV analysis indicates it as being visible to the limit of visibility (25km) from the east and west, relatively screened from the north and visible intermittently from the south.

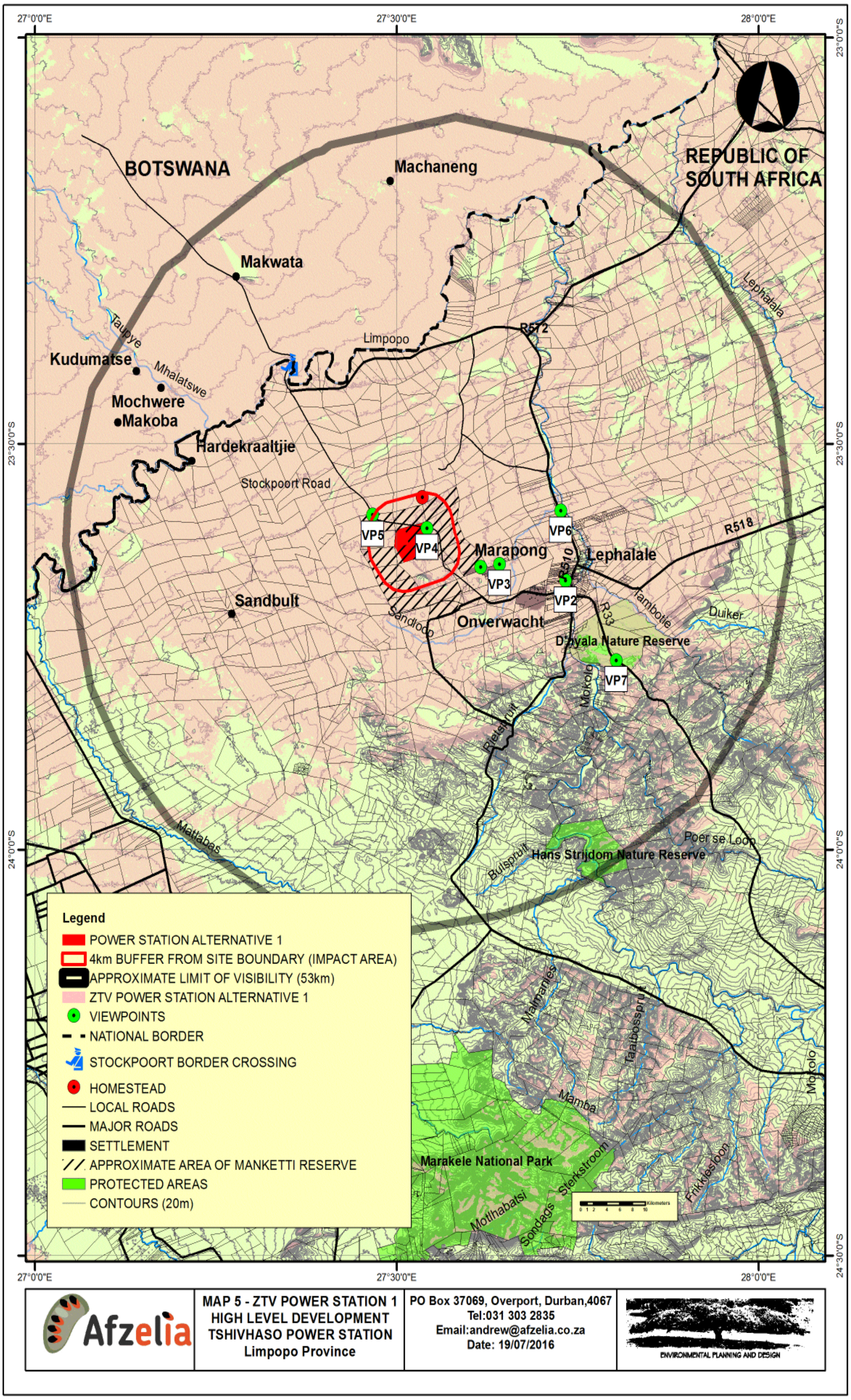


Figure 7.11 Zone of theoretical visibility for power station

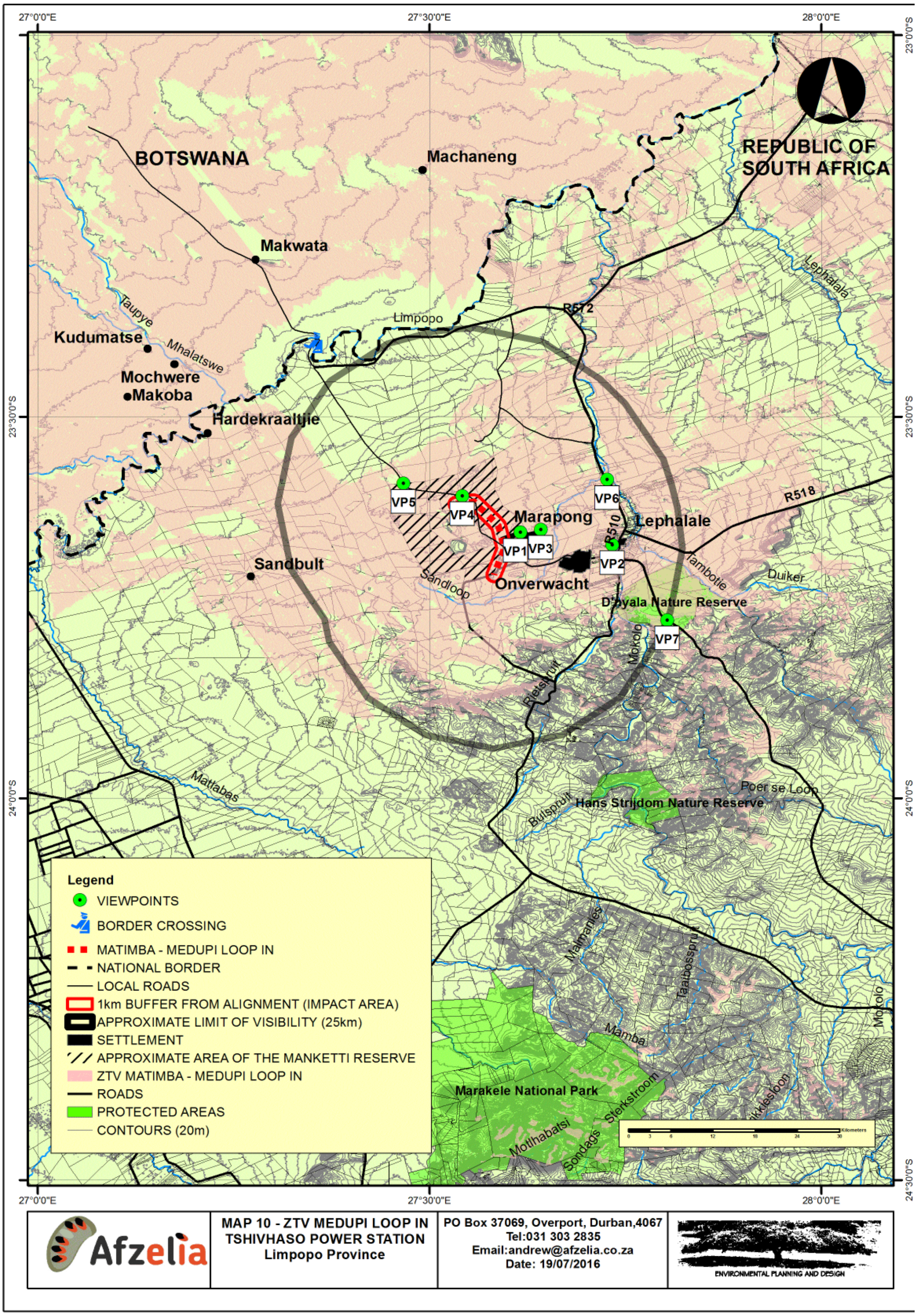


Figure 7.12 Zone of theoretical visibility for power line

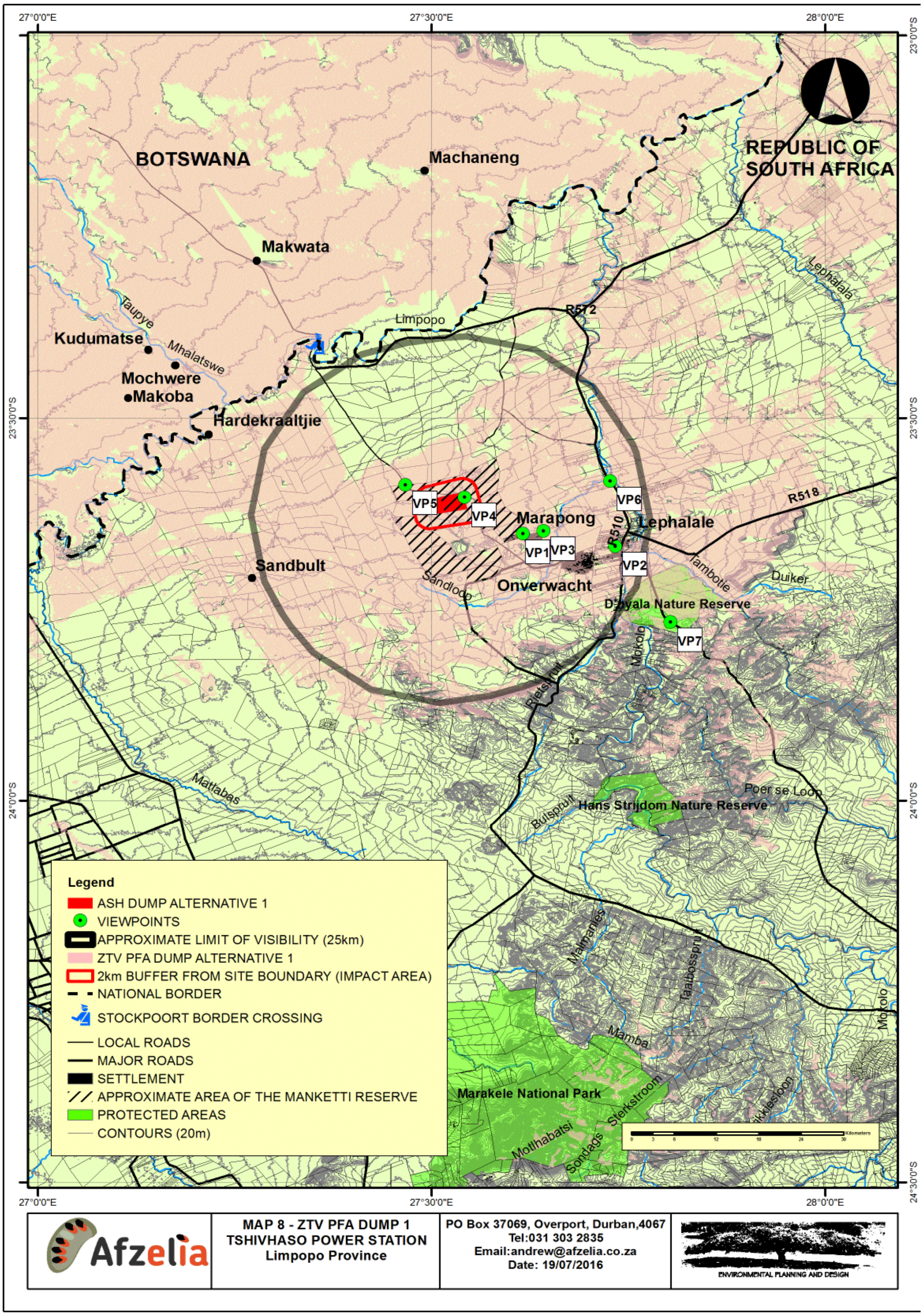


Figure 7.13 Zone of theoretical visibility ash dump option 1 (Graafwater)

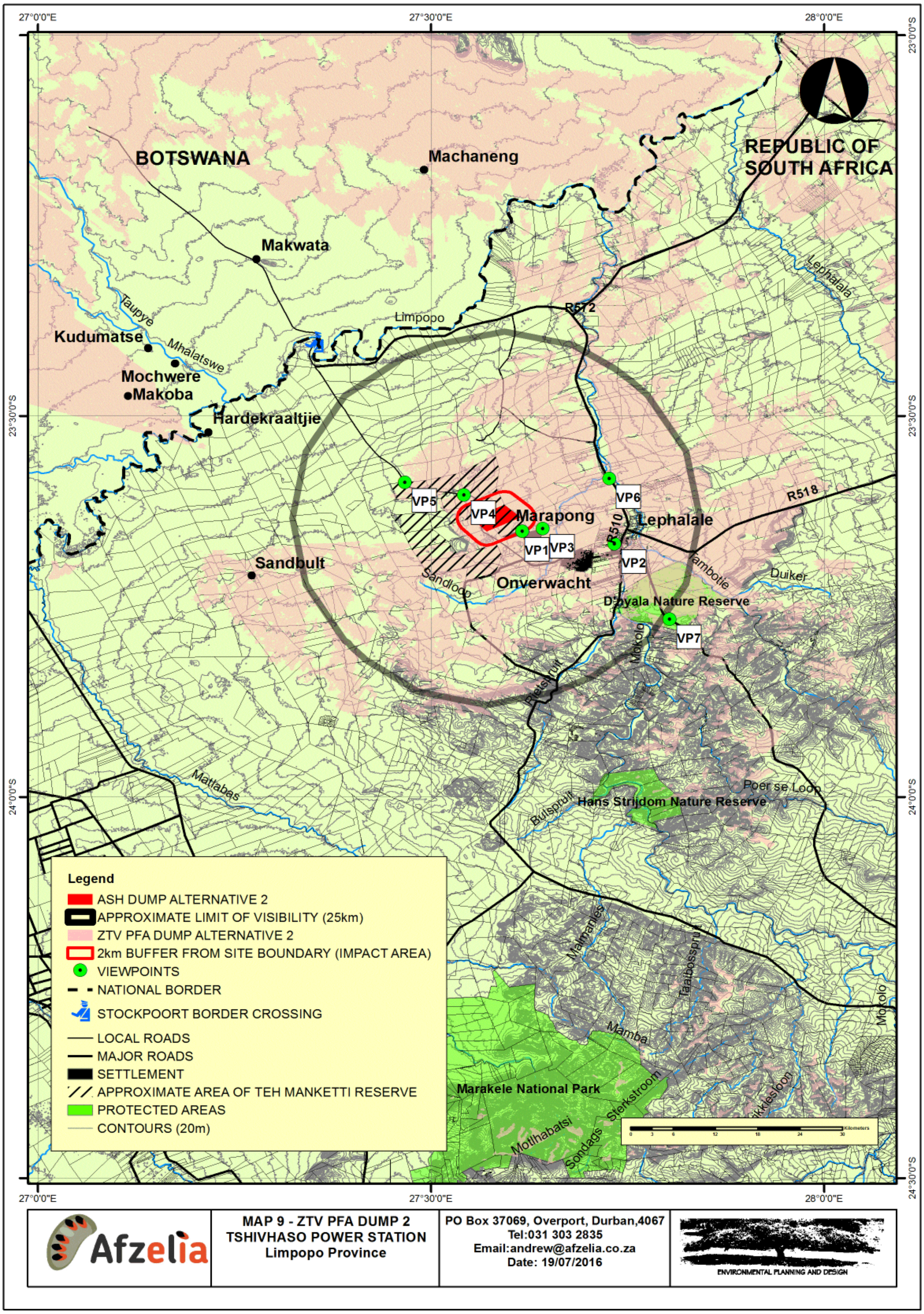


Figure 7.14 Zone of theoretical visibility ash dump option 2 (Appelvlakte)

Nature of impact: Industrialisation of the Lowland Landscape Character Area.

This impact relates to further industrialisation of the relatively natural landscape surrounding the Industrial LCA. This will occur if views of the proposed power station and associated infrastructure become visible and obvious from areas that currently are not impacted by views of industry. The area surrounding the Industrial LCA is used extensively for eco-tourism activities. Additional industrialisation of this landscape is likely to negatively impact on these activities.

The assessment indicates that due to the extent and height of surrounding vegetation, the proposed development including power station, ashing facility and overhead power line is likely to affect a relatively small area surrounding the development area. The lower elements including ashing facility, lower structures and overhead power line are only likely to have an impact on the natural landscape for approximately 2km. Beyond this distance the upper structures including the upper sections of the generator units and upper sections of the stacks are likely to be visible to the same extent as the existing Matimba facility. This is generally limited to a slightly greater distance of approximately 3-4km than the lower structures with the exception of areas where natural vegetation has been cleared.

The character of the rural landscape adjacent to the proposed development will be modified. It is possible that subject to planning and detailed design, it may be possible to minimise impact. It is likely that ashing facility 2 being located to the east of the industrial area would extend the impact to a greater degree than ashing facility 1 which is located on the same site as the proposed power station.

	Without mitigation	**With mitigation**
Extent	**Power Station Alternative 1** Regional **(3)** **Ashing Facility Alternative 1 (Graaffwater)** Site and immediate surroundings **(2)** **Ashing Facility Alternative 2 (Applevlakte)** Site and immediate surroundings **(2)** **Overhead Power Line (Medupi)** Site and immediate surroundings **(2)**	Regional, **(3)** Local **(1)** Local **(1)** Site and immediate surroundings **(2)**
Duration	**Power Station Alternative 1** Long term **(4)** **Ashing Facility Alternative 1 (Graaffwater)** Long term **(4)**	Long term **(4)** Long term **(4)**

	Ashing Facility Alternative 2 (Applevlakte) Long term **(4)** **Overhead Power Line (Medupi)** Long term **(4)**	Long term **(4)** Long term **(4)**
Magnitude	**Power Station Alternative 1** Minor **(2)** **Power Station Alternative 2** Low **(4)** **Ashing Facility Alternative 1 (Graaffwater)** Minor **(2)** **Ashing Facility Alternative 2 (Applevlakte)** Low **(4)** **Overhead Power Line Alternative 1 (WitKop)** Low **(4)** **Overhead Power Line (Medupi)** Minor **(2)**	Minor **(2)** Low **(4)** Minor **(2)** Low **(4)** Low **(4)** Minor **(2)**
Probability	**All Alternatives** Highly probable **(4)**	Highly probable **(4)**
Significance	**Power Station Alternative 1** Medium **(36)** **Ashing Facility Alternative 1 (Graaffwater)** Medium **(32)** **Ashing Facility Alternative 2 (Applevlakte)** Medium **(40)** **Overhead Power Line (Medupi)** Minor **(32)**	Medium **(36)** Low **(28)** Medium **(36)** Minor **(32)**
Status	For those people that are attracted to the area for its natural attributes and those	**Negative**

	travelling through the area for recreational and tourism reasons, it is likely that development of natural areas will be seen as a **negative impact**.	
Irreplaceable loss	The proposed development will industrialise a small area of existing natural landscape. **There will therefore be a small area of irreplaceable loss.** The broader impacts associated with the higher elements such as the upper sections of the stacks and generator units are however unlikely to cause irreplaceable loss as these elements will impact areas that are currently impacted by existing power stations.	**Small area of irreplaceable loss.**
Can impacts be mitigated?	**Yes** to a small degree	

Mitigation / Management:

Planning:

- Plan to maintain the height of structures as low as possible;
- Minimise disturbance of the surrounding landscape and maintain existing vegetation around the development.

Construction:

- Minimise disturbance and loss of vegetation;

Operations:

- Reinstate any areas of vegetation that have been disturbed during construction;
- Monitor rehabilitated areas post-decommissioning and implement remedial actions (monthly until establishment , thereafter at the middle and end of every growing season);
- Minimise disturbance and maintain existing vegetation as far as is possible both within and surrounding the development area;
- Colouring of taller structures should be such that they are not made prominent and preferably visually recede;
- Dust control at ashing facility must be implemented and maintained.

Decommissioning:

- Remove infrastructure not required for the post-decommissioning use of the site;
- Return all possible areas to their original state;
- Monitor rehabilitated areas post-decommissioning and implement remedial actions.

Residual Risks:

The residual risk relates to loss of natural landscape being obvious on decommissioning of the proposed project. In order to minimise this impact, it is critical that existing natural landscape areas in and around the development are maintained and protected and that effective rehabilitation is undertaken during and after construction as well as on closure of the plant.

Nature of impact: Industrialisation of Views from the Upland LCA

This impact relates to industrialisation of views from the north facing ridge of the Waterberg overlooking the existing industrial development area as well as the proposed development sites. Where views over the lowland are possible, the major structures associated with the existing power stations are highly obvious.

Without mitigation, due to their scale, it is possible that ashing facilities may also be obvious from this area. It is also possible that dust blow from the facilities could make them more obvious from a distance.

The overhead power line is highly unlikely to be obvious from this distance and so is not included in the assessment.

The impacts noted above could have negative implications for ecotourism activities in areas close to the development.

Views from this area are largely screened by dense natural vegetation. There are however a number of areas where roads and clearings open up long views over the landscape towards the Limpopo River.

The view from these areas already includes two major power station complexes as well as disturbance caused by ancillary infrastructure. The concern is that further industrialisation will significantly increase the extent of industrial development within the view.
The assessment has indicated that due to the distances involved, small scale development around the power stations tends to blend into the background whereas larger scale development including the generator units and stacks tends to stand out and is relatively obvious.

The proposed power station is slightly further from the Waterberg than existing power station sites. The proposed structures are also slightly smaller than the existing power stations. It is therefore likely that they will be slightly less obvious.

the proposed power station will be seen within the context of the existing Power Stations.

	Without mitigation	With mitigation
Extent	**Power Station Alternative 1** Regional **(3)** **Ashing Facility Alternative 1 (Graaffwater)** Regional **(3)**	 Regional, **(3)** Regional, **(3)**

	Ashing Facility Alternative 2 (Applevlakte) Regional **(3)**	Regional, **(3)**
Duration	**Power Station Alternative 1** Long term **(4)** **Ashing Facility Alternative 1 (Graaffwater)** Long term **(4)** **Ashing Facility Alternative 2 (Applevlakte)** Long term **(4)**	Long term **(4)** Long term **(4)** Long term **(4)**
Magnitude	**Power Station Alternative 1** Minor **(2)** **Ashing Facility Alternative 1 (Graaffwater)** Minor **(2)** **Ashing Facility Alternative 2 (Applevlakte)** Minor **(2)**	Minor **(2)** Small **(0)** Small **(0)**
Probability	**All Alternatives** Highly probable **(4)**	Highly probable **(4)**
Significance	**Power Station Alternative 1** Medium **(36)** **Ashing Facility Alternative 1 (Graaffwater)** Medium **(36)** **Ashing Facility Alternative 2 (Applevlakte)** Medium **(40)**	Medium **(36)** Low **(28)** Low **(28)**
Status	For those people that are attracted to the area for its natural attributes and those travelling through the area for recreational and tourism reasons, it is likely that development of natural areas will be seen as a **negative impact**.	**Negative**

<table>
<tr><td>Irreplaceable loss</td><td>The relatively small additional section of the view that will be industrialised will constitute a small area of irreplaceable loss.</td><td>Small area of irreplaceable loss.</td></tr>
<tr><td>Can impacts be mitigated?</td><td colspan="2">Yes to a small degree</td></tr>
<tr><td colspan="3">Mitigation / Management:
Planning:
Plan to maintain the height of structures as low as possible;
Minimise disturbance of the surrounding landscape and maintain existing vegetation around the development.
Construction
Minimise disturbance and loss of vegetation.
Operations:
Reinstate any areas of vegetation that have been disturbed during construction and on the ashing facility as work proceeds;
Monitor rehabilitated areas post-decommissioning and implement remedial actions (monthly until establishment , thereafter at the middle and end of every growing season);
Minimise disturbance and maintain existing vegetation as far as is possible both within and surrounding the development area;
control dust on the ashing facility
Colouring of taller structures should be such that they are not made prominent and preferably visually recede.
Decommissioning:
Remove infrastructure not required for the post-decommissioning use of the site;
Return all possible areas to their original relatively natural state;
Monitor rehabilitated areas post-decommissioning and implement remedial actions.</td></tr>
<tr><td colspan="3">Residual Risks:
The residual risk relates to loss of natural landscape being obvious on decommissioning of the proposed project. In order to minimise this impact, it is critical that existing natural landscape areas in and around the development are maintained and protected and that effective rehabilitation is undertaken during and after construction as well as on closure of the plant.</td></tr>
</table>

<table>
<tr><td>Nature of impact: Industrialisation of Views from the Urban LCA
The onsite analysis indicates that whilst long range views of higher structures associated with existing power stations may be visible from the urban edge, the majority of urban areas are insulated from significant impacts by both distance and the density of relatively natural vegetation that exists in the intervening landscape.

The one exception to the above noted conditions is the western and eastern edges of Marapong. On the western edge, Matimba power station structures overshadow the settlement and on the eastern edge overhead HV power lines dominate the landscape.</td></tr>
</table>

Because the distances from urban areas associated with the alternative power station locations are likely to be greater than those associated with existing power stations, in general terms, impacts associated with these structures is likely to be negligible.

The exception to this again however is Marapong where the Appelvlakte ashing facility could be located at a distance of approximately 3km from the northern edge of the settlement. In terms of views, existing vegetation is likely to help screen the ashing facility; however, dust could exacerbate the impact.

The retention of existing vegetation will be critical in maintaining general low levels of impact and will be particularly important for helping to minimise views and dust associated with the Appelvlakte ashing facility.

	Without mitigation	**With mitigation**
Extent	**Power Station Alternative 1** Regional **(3)** **Ashing Facility Alternative 1 (Graaffwater)** Site and immediate surroundings **(2)** **Ashing Facility Alternative 2 (Applevlakte)** Site and immediate surroundings **(2)** **Overhead Power Line Alternative 2 (Medupi)** Site and immediate surroundings **(2)**	Regional, **(3)** Local **(1)** Local **(1)** Site and immediate surroundings **(2)**
Duration	**Power Station Alternative 1** Long term **(4)** **Ashing Facility Alternative 1 (Graaffwater)** Long term **(4)** **Ashing Facility Alternative 2 (Applevlakte)** Long term **(4)** **Overhead Power Line Alternative 2 (Medupi)** Long term **(4)**	Long term **(4)** Long term **(4)** Long term **(4)** Long term **(4)**
Magnitude	**Power Station Alternative 1** Minor **(2)**	Small **(0)**

	Power Station Alternative 2 Minor **(2)** **Ashing Facility Alternative 1 (Graaffwater)** Small **(0)** **Ashing Facility Alternative 2 (Applevlakte)** Low **(4)** **Overhead Power Line Alternative 2 (Medupi)** Small **(0)**	Small **(0)** Small **(0)** Minor **(2)** Small **(0)**
Probability	**All Alternatives** Highly probable **(4)**	Highly probable **(4)**
Significance	**Power Station Alternative 1** Medium **(36)** **Ashing Facility Alternative 1 (Graaffwater)** Low **(24)** **Ashing Facility Alternative 2 (Applevlakte)** Medium **(40)** **Overhead Power Line Alternative 2 (Medupi)** Low **(24)**	Low **(28)** Low **(10)** Medium **(40)** Low **(24)**
Status	The community that could experience the highest impacts, (Marapong) is already impacted to a large degree by existing power station and infrastructure development. Long range views of additional development are unlikely to be considered to be negative however impacts that affect the quality of life within the settlement that could result from close development and dust blow from the Applevlakte ashing facility are likely to be seen as **negative**. The occasional long distance view of power station stacks that is likely to	**Negative to Neutral**

	result is not likely to be considered to be negative by most residents.	
Irreplaceable loss	The development of the Applevlakte ashing facility alternative in close proximity to Marapong could further erode the quality of the settlement **This will therefore be an irreplaceable loss.**	**Small area of irreplaceable loss.**
Can impacts be mitigated?	**Yes** to a small degree.	

Mitigation / Management:

Planning:

- Plan to maintain the height of structures as low as possible;
- Minimise disturbance of the surrounding landscape and maintain existing vegetation around the development.

Construction:

- Minimise disturbance and loss of vegetation.

Operations:

- Reinstate any areas of vegetation that have been disturbed during construction and on the ashing facility as work proceeds;
- Monitor rehabilitated areas post-decommissioning and implement remedial actions (monthly until establishment , thereafter at the middle and end of every growing season);
- Minimise disturbance and maintain existing vegetation as far as is possible both within and surrounding the development area;
- control dust on the ashing facility
- Colouring of taller structures should be such that they are not made prominent and preferably visually recede.

Decommissioning:

- Remove infrastructure not required for the post-decommissioning use of the site;
- Return all possible areas to their original state;
- Monitor rehabilitated areas post-decommissioning and implement remedial actions.

Residual Risks:

The residual risk relates to loss of natural landscape being obvious on decommissioning of the proposed project. In order to minimise this impact, it is critical that existing natural landscape areas in and around the development are maintained and protected and that effective rehabilitation is undertaken during and after construction as well as on closure of the plant.

Nature of impact: Industrialisation of Views from Tourists Routes

The proposed development could be visible from important tourist routes in the area. These include the R518, the R517, the R512 and the R510 which are relatively major routes. It is likely that a number of minor, un-surfaced routes, will also be important from a tourism perspective have therefore been considered in the assessment

The onsite analysis indicates that whilst long range views of higher structures may be visible from isolated sections, the majority of the major routes are insulated from significant impacts by both distance and the density of relatively natural vegetation that exists in the intervening landscape. A short section of the Stockpoort Road that starts within the Industrial LCA and ends close to the Stockpoort Border Post will be affected. This road however is already impacted by industrial development and motorists have to drive through the entire industrial area to use the road. Views over the proposed development will therefore not be a new experience. The proposed development could however extend the experience. Power Station Alternative 1 including the Graaffwater ashing facility is located to the south of the Stockpoort Road within an area that is already affected by the Grootegeluk Mine (a mine stockpile is visible over a short section of this road). Views of the proposed overhead power line are also likely to be visible from the affected section of the road. Views of industry are currently screened from all other unsurfaced roads. The proposed development alternatives will also be screened.		
	Without mitigation	**With mitigation**
Extent	**Power Station Alternative 1** Regional **(3)** **Ashing Facility Alternative 1 (Graaffwater)** Site and immediate surroundings **(2)** **Ashing Facility Alternative 2 (Applevlakte)** Site and immediate surroundings **(2)** **Overhead Power Line (Medupi)** Site and immediate surroundings **(2)**	Regional, **(3)** Local **(1)** Local **(1)** Site and immediate surroundings **(2)**
Duration	**Power Station Alternative 1** Long term **(4)** **Ashing Facility Alternative 1 (Graaffwater)** Long term **(4)** **Ashing Facility Alternative 2 (Applevlakte)**	Long term **(4)** Long term **(4)**

	Long term **(4)** **Overhead Power Line (Medupi)** Long term **(4)**	Long term **(4)** Long term **(4)**
Magnitude	**Power Station Alternative 1** Minor **(2)** **Ashing Facility Alternative 1 (Graaffwater)** Minor **(2)** **Ashing Facility Alternative 2 (Applevlakte)** Small **(0)** **Overhead Power Line (Medupi)** Small **(0)**	Minor **(2)** Small **(0)** Small **(0)** Small **(0)**
Probability	**All Alternatives** Highly probable **(4)**	Highly probable **(4)**
Significance	**Power Station Alternative 1** Medium **(36)** **Ashing Facility Alternative 1 (Graaffwater)** Medium **(32)** **Ashing Facility Alternative 2 (Applevlakte)** Low **(24)** **Overhead Power Line (Medupi)** Low **(24)**	Medium **(36)** Low **(10)** Low **(10)** Low **(24)**
Status	Generally the impact on tourist routes is low. The only route that could be impacted to a significant level is the Stockpoort Road which is already impacted by industrial development. Whilst this is an unsurfaced road and not a major route, unsurfaced roads are generally used by tourists to access game farms and eco-tourism attractions in the area.	**Negative**

	All roads therefore are likely to have a degree of importance for tourism. The further industrialisation of the landscape as seen from the road is likely to be considered as **negative** by tourists who are attracted to the area for its natural attributes.	
Irreplaceable loss	The development of a section of natural landscape as seen from the Stockpoort Road (power station alternative 2) will result in a **small area of irreplaceable loss.**	**Small area of irreplaceable loss.**
Can impacts be mitigated?	**Yes** to a small degree.	

Mitigation / Management:

Planning:

- Plan to maintain the height of structures as low as possible;
- Plan to locate main elements as far from the Stockpoort road as possible;
- Minimise disturbance of the surrounding landscape and maintain existing vegetation around the development.

Construction:

- Minimise disturbance and loss of vegetation.

Operations:

- Reinstate any areas of vegetation that have been disturbed during construction and on the ashing facility as work proceeds;
- Monitor rehabilitated areas post-decommissioning and implement remedial actions (monthly until establishment , thereafter at the middle and end of every growing season);
- Minimise disturbance and maintain existing vegetation as far as is possible both within and surrounding the development area;
- control dust on the ashing facility
- Colouring of taller structures should be such that they are not made prominent and preferably visually recede.

Decommissioning:

- Remove infrastructure not required for the post-decommissioning use of the site;
- Return all possible areas to their original state;
- Monitor rehabilitated areas post-decommissioning and implement remedial actions.

Residual Risks:

The residual risk relates to loss of views over natural landscape being obvious on decommissioning of the proposed project. In order to minimise this impact, it is critical that existing natural landscape areas in and around the development are maintained and protected and that effective rehabilitation is undertaken during and after construction as well as on closure of the plant.

Nature of impact: Industrialisation of Views from Riverine Areas This LCA is important for regional tourism with the Limpopo River and its tributaries being a key attraction beside which a number of lodges have been developed. It is however some distance (approximate minimum 20km) from the proposed development area. The onsite analysis indicated that due to distance and to screening that is provided largely by vegetation, existing industrial elements are generally not visible from this LCA. Therefore, the proposed development alternatives are also highly unlikely to be visible. It is possible that wind-blown dust from the ashing facilities could the impact over a wider area than anticipated. The key mitigation measure therefore is control of dust at the ashing facilities. This area is therefore unlikely to suffer significant impact.		
	Without mitigation	**With mitigation**
Extent	**Power Station Alternative 1** Regional **(3)** **Ashing Facility Alternative 1 (Graaffwater)** Site and immediate surroundings **(2)** **Ashing Facility Alternative 2 (Applevlakte)** Site and immediate surroundings **(2)** **Overhead Power Line (Medupi)** Site and immediate surroundings **(2)**	Regional, **(3)** Local **(1)** Local **(1)** Site and immediate surroundings **(2)**
Duration	**Power Station Alternative 1** Long term **(4)** **Ashing Facility Alternative 1 (Graaffwater)** Long term **(4)** **Ashing Facility Alternative 2 (Applevlakte)** Long term **(4)** **Overhead Power Line (Medupi)** Long term **(4)**	Long term **(4)** Long term **(4)** Long term **(4)** Long term **(4)**
Magnitude	**Power Station Alternative 1** Small **(0)**	Small **(0)**

	Ashing Facility Alternative 1 (Graaffwater) Small **(0)** **Ashing Facility Alternative 2 (Applevlakte)** Small **(0)** **Overhead Power Line (Medupi)** Small **(0)**	Small **(0)** Small **(0)** Small **(0)**
Probability	**All Alternatives** Improbable **(2)**	Improbable **(2)**
Significance	**Power Station Alternative 1** Low **(14)** **Ashing Facility Alternative 1 (Graaffwater)** Low **(12)** **Ashing Facility Alternative 2 (Applevlakte)** Low **(12)** **Overhead Power Line (Medupi)** Low **(12)**	Low **(14)** Low **(10)** Low **(10)** Low **(12)**
Status	The likelihood of impact on this area is low and should glimpses of the development be possible they are unlikely to be obvious. However, the further industrialisation of the landscape as seen from the area may be considered as **negative** by people who are attracted to the area for its natural attributes.	**Negative**
Irreplaceable loss	**No irreplaceable loss.**	**No irreplaceable loss.**
Can impacts be mitigated?	Mitigation for this impact does not appear necessary, however, it is possible that wind-blown dust from the ashing facilities could extent their impact over a wider area than anticipated. The key mitigation therefore is control of dust at the ashing facilities.	
Mitigation / Management: Operations: • control dust blow from ashing facility.		
Residual Risks: No residual risks.		

<table>
<tr><td colspan="3">Nature of impact: Industrialisation of Views from Homesteads and Bush Lodges
Homesteads and Bushlodges are assessed together because most farms in the area appear to have either a secondary or primary tourism use.

Due to the high level of VAC of the landscape, affected properties will be located within the Lowland LCA and within 4km of the proposed power station.

Whilst a large number of homesteads have been identified within the landscape, particularly in the area to the north of the proposed development, only one homestead was found within the potential impact area (4km buffer from the proposed power station) as indicated on Map 6. This homestead is approximately 3.5km from the edge of the proposed development site.

It is unlikely but possible that properties at a greater distance from the development may have long range views of the development. This is only likely to occur in areas where land has been cleared for agricultural use. In these areas the development is likely to be viewed in the context of the two existing power stations.

Only the upper sections of the proposed power station are likely to be visible.</td></tr>
<tr><td></td><td>Without mitigation</td><td>With mitigation</td></tr>
<tr><td>Extent</td><td>Power Station Alternative 1
Site and immediate surroundings (2)</td><td>Site and immediate surroundings (2)</td></tr>
<tr><td>Duration</td><td>Power Station Alternative 1
Long term (4)</td><td>Long term (4)</td></tr>
<tr><td>Magnitude</td><td>Power Station Alternative 1
Minor (2)</td><td>Small (0)</td></tr>
<tr><td>Probability</td><td>All Alternatives
Probable (3)</td><td>Improbable (2)</td></tr>
<tr><td>Significance</td><td>Power Station Alternative 1
Low (24)</td><td>Low (12)</td></tr>
<tr><td>Status</td><td>For those people that are attracted to the area for its natural attributes and those travelling through the area for recreational and tourism reasons, it is likely that development of natural areas will be seen as a negative impact.</td><td>Negative</td></tr>
<tr><td>Irreplaceable loss</td><td>No irreplaceable loss.</td><td>No irreplaceable loss.</td></tr>
<tr><td>Can impacts be mitigated?</td><td colspan="2">Yes</td></tr>
<tr><td colspan="3">Mitigation / Management:
Planning:
• Plan to maintain the height of structures as low as possible;
• Plan to locate the proposed power station to the south of the site area, maximising the distance between the higher elements and the homestead.</td></tr>
</table>

- Minimise disturbance of the surrounding landscape and maintain existing vegetation around the development.

Construction:

- Minimise disturbance and loss of vegetation;

Operations:

- Reinstate any areas of vegetation that have been disturbed during construction;
- Monitor rehabilitated areas post-decommissioning and implement remedial actions (monthly until establishment , thereafter at the middle and end of every growing season);
- Minimise disturbance and maintain existing vegetation as far as is possible both within and surrounding the development area;
- Colouring of taller structures should be such that they are not made prominent and preferably visually recede;
- Dust control at ashing facility must be implemented and maintained.

Decommissioning:

- Remove infrastructure not required for the post-decommissioning use of the site;
- Return all possible areas to their original state;
- Monitor rehabilitated areas post-decommissioning and implement remedial actions.

Residual Risks:

The residual risk relates to loss of natural landscape being obvious on decommissioning of the proposed project. In order to minimise this impact, it is critical that existing natural landscape areas in and around the development are maintained and protected and that effective rehabilitation is undertaken during and after construction as well as on closure of the plant.

Nature of impact: Industrialisation of Views from the D'nyala Nature Reserve

This impact relates to further industrialisation of views from the D'nyala Nature Reserve which is located on the Waterberg to the south east of the proposed development. It is only the north facing slopes within the reserve that are potentially impacted.

Where views over the lowland are possible, the major structures associated with the existing power stations are highly obvious at a distance of approximately 21km. This indicates that the proposed facility is likely to be visible all be it at a distance approaching 30km.

Without mitigation, due to their scale, it is possible that ashing facilities may also be obvious from this area. It is also possible that dust blow from the facilities could make them more obvious from a distance.

The overhead power line is highly unlikely to be obvious from this distance and so is not included in the assessment.

Views from this area are largely screened by dense natural vegetation. There are however a number of areas where roads and clearings open up long views over the landscape towards the Limpopo River.

The view from these areas already includes two major power station complexes as well as disturbance caused by ancillary infrastructure. The concern is that further industrialisation will significantly increase the extent of industrial development within the view. The on-site analysis indicated that due to the distances involved, small scale development around the power stations tends to blend into the background whereas larger scale development including the generator units and stacks tend to stand out and are relatively obvious. The proposed power station is slightly further from the reserve than existing power station sites. The proposed structures are also slightly smaller than the existing power station structures. It is therefore likely that they will be slightly less obvious. The proposed power station will be seen within the context of the existing Power Stations.		
	Without mitigation	**With mitigation**
Extent	**Power Station Alternative 1** Regional **(3)** **Ashing Facility Alternative 1 (Graaffwater)** Regional **(3)** **Ashing Facility Alternative 2 (Applevlakte)** Regional **(3)**	 Regional, **(3)** Regional, **(3)** Regional, **(3)**
Duration	**Power Station Alternative 1** Long term **(4)** **Ashing Facility Alternative 1 (Graaffwater)** Long term **(4)** **Ashing Facility Alternative 2 (Applevlakte)** Long term **(4)**	 Long term **(4)** Long term **(4)** Long term **(4)**
Magnitude	**Power Station Alternative 1** Minor **(2)** **Ashing Facility Alternative 1 (Graaffwater)** Minor **(2)** **Ashing Facility Alternative 2 (Applevlakte)** Minor **(2)**	 Minor **(2)** Small **(0)** Small **(0)**
Probability	**All Alternatives** Highly probable **(4)**	 Highly probable **(4)**
Significance	**Power Station Alternative 1** Medium **(36)**	 Medium **(36)**

	Ashing Facility Alternative 1 (Graaffwater) Medium **(36)** **Ashing Facility Alternative 2 (Applevlakte)** Medium **(40)**	Low **(28)** Low **(28)**
Status	For those people that are attracted to the area for its natural attributes and those travelling through the area for recreational and tourism reasons, it is likely that development of natural areas will be seen as a **negative impact**.	**Negative**
Irreplaceable loss	The relatively small additional section of the view that will be industrialised will constitute **a small area of irreplaceable loss.**	**Small area of irreplaceable loss.**
Can impacts be mitigated?	**Yes** to a small degree.	

Mitigation / Management:

Planning:

- Plan to maintain the height of structures as low as possible;
- Plan to locate main elements as far from the Stockpoort road as possible;
- Minimise disturbance of the surrounding landscape and maintain existing vegetation around the development.

Construction:

- Minimise disturbance and loss of vegetation.

Operations:

- Reinstate any areas of vegetation that have been disturbed during construction and on the ashing facility as work proceeds;
- Monitor rehabilitated areas post-decommissioning and implement remedial actions (monthly until establishment , thereafter at the middle and end of every growing season);
- Minimise disturbance and maintain existing vegetation as far as is possible both within and surrounding the development area;
- control dust on the ashing facility
- Colouring of taller structures should be such that they are not made prominent and preferably visually recede.

Decommissioning:

- Remove infrastructure not required for the post-decommissioning use of the site;
- Return all possible areas to their original state;
- Monitor rehabilitated areas post-decommissioning and implement remedial actions.

Residual Risks:

The residual risk relates to loss of natural landscape being obvious on decommissioning of the proposed project. In order to minimise this impact, it is critical that existing natural

landscape areas in and around the development are maintained and protected and that effective rehabilitation is undertaken during and after construction as well as on closure of the plant.

<table>
<tr><td colspan="3">Nature of impact: Industrialisation of Views due to development within the Manketti Nature Reserve
Manketti Reserve is the wildlife area of Grootegeluk Mine. The reserve is reported to be 16 000 hectares in extent and is located on land around the mine that is currently owned by Kumba Coal (Pty) Ltd.

In 2013, Exxaro indicated plans for expansion of the reserve as an offset area representative of plant communities impacted by existing and future developments.

Manketti also forms part of an ongoing monitoring programme conducted by Exxaro's Grootegeluk mine to assess the impact of mine operations on surrounding areas twice a year.

Manketti, was developed around the mine and adjacent industrial area in oreder to mitigate and monitor the impacts of industry on surrounding areas. As such the edges of the reserve that are closest to the Grootegeluk Mine and Matimba Power Station are currently impacted to a similar degree as might be expected by the proposed power station.

The proposed power station, overhead power line and ashing facility alternative 1 will reduce the area of the reserve.

The ashing facility alternative 2 will have no impact on the reserve.

The proposed mine, ashing facility alternative 1 and the grid connection will all be located within the existing reserve area. Given the current location of the reserve immediately adjacent to existing heavy industry, it is a given that the impact on the edges of the reserve will be similar after development of the proposed power station. The assessment therefore focused on the possible erosion of this buffer function. It found that there could be a loss of this to the north of the development area. The degree of this loss however is subject to the location of key elements of the development and the success of mitigation measures.

In short therefore, the Manketti Reserve plays a major role in mitigating the visual and other impacts of the industrial area on surrounding natural areas. The proposed development is not expected to negate this function but it could reduce its effectiveness particularly for areas to the north.</td></tr>
<tr><td></td><td>Without mitigation</td><td>With mitigation</td></tr>
<tr><td>Extent</td><td>Power Station Alternative 1
Site and immediate surroundings (2)</td><td>Site and immediate surroundings (2)</td></tr>
</table>

	Ashing Facility Alternative 1 (Graaffwater) Site and immediate surroundings **(2)** **Overhead Power Line (Medupi)** Site and immediate surroundings **(2)**	Site and immediate surroundings **(2)** Site and immediate surroundings **(2)**
Duration	**Power Station Alternative 1** Long term **(4)** **Ashing Facility Alternative 1 (Graaffwater)** Long term **(4)** **Overhead Power Line (Medupi)** Long term **(4)**	Long term **(4)** Long term **(4)** Long term **(4)**
Magnitude	**Power Station Alternative 1** Moderate **(6)** **Ashing Facility Alternative 1 (Graaffwater)** Low **(4)** **Overhead Power Line (Medupi)** Low **(4)**	Low **(4)** Minor **(2)** Minor **(2)**
Probability	**All Alternatives** Highly probable **(4)**	**Power Station Alternative 1** Probable **(3)** **Ashing Facility Alternative 1 (Graaffwater)** Probable **(3)** **Overhead Power Line (Medupi)** Improbable **(2)**
Significance	**Power Station Alternative 1** Medium **(48)** **Ashing Facility Alternative 1 (Graaffwater)** Medium **(40)**	**Power Station Alternative 1** Low / Medium **(30)** **Ashing Facility Alternative 1 (Graaffwater)**

<table>
<tr><td></td><td>Ashing Facility Alternative 2 (Applevlakte)
Medium (40)</td><td>Low (24)

Ashing Facility Alternative 2 (Applevlakte)
Low (16)</td></tr>
<tr><td>Status</td><td>For those people that are attracted to the area for its natural attributes and those travelling through the area for recreational and tourism reasons, it is likely that development of natural areas will be seen as a negative impact.</td><td>Negative</td></tr>
<tr><td>Irreplaceable loss</td><td>The loss of a section of the buffer area could constitute a small area of irreplaceable loss.</td><td>If mitigation is successful then the loss of buffer area will not constitute an irreplaceable loss</td></tr>
<tr><td>Can impacts be mitigated?</td><td colspan="2">Yes.</td></tr>
<tr><td colspan="3">Mitigation / Management:
Planning:
Plan to maintain the height of structures as low as possible;
Plan to locate main elements as far from the Stockpoort road as possible;
Minimise disturbance of the surrounding landscape and maintain existing vegetation around the development.
Construction:
Minimise disturbance and loss of vegetation.
Operations:
Reinstate any areas of vegetation that have been disturbed during construction and on the ashing facility as work proceeds;
Monitor rehabilitated areas post-decommissioning and implement remedial actions (monthly until establishment, thereafter at the middle and end of every growing season);
Minimise disturbance and maintain existing vegetation as far as is possible both within and surrounding the development area;
control dust on the ashing facility
Colouring of taller structures should be such that they are not made prominent and preferably visually recede.
Decommissioning:
Remove infrastructure not required for the post-decommissioning use of the site;
Return all possible areas to their original state;
Monitor rehabilitated areas post-decommissioning and implement remedial actions.</td></tr>
<tr><td colspan="3">Residual Risks:
The residual risk relates to loss of natural landscape being obvious on decommissioning of the proposed project. In order to minimise this impact, it is critical that existing natural</td></tr>
</table>

landscape areas in and around the development are maintained and protected and that effective rehabilitation is undertaken during and after construction as well as on closure of the plant.

7.11.2 Comparison of Alternatives

Of the alternatives considered, Graaffwater (Alternative 1) with the ashing facility on the same site as the power station is favoured from a visual perspective. This alternative will result in a more compact impact zone that really only has a significant visual effect on the existing industrialised area.

The development of the power station on Graaffwater (Alternative 1) with Appelvlakte ashing facility will result in an extension of the industrial impact zone to the east. This could have a small impact on the Marapong community which could be exacerbated by dust from the Appelvlakte ashing facility.

7.11.3 Implications for project implementation

Minimising the extent of obvious disturbance associated with the development is critical particularly from close viewpoints and for views from higher areas on the northern edge of the Waterberg. Undertaking rehabilitation of the facility on a progressive basis and ensuring that it has a reasonable cover of vegetation will help to minimise this impact. Dust control will also be critical in minimising wider impacts.

7.11.4 Conclusions and Recommendations

Whilst the assessment indicates that the development might be visible over a distance of more than 50km, in reality, the Visual Absorption Capacity of the surrounding landscape which is generally relatively flat and covered with dense natural vegetation will significantly reduce the impact area to the extent that the main impact area is likely to extend a distance of no more than 4km from the site boundary.

Beyond this range occasional views of higher structures such as stacks are possible only where the density of vegetation, particularly canopy trees, is limited. Views of lower structures are only possible where roads are aligned directly towards the development providing view corridors and where large scale clearing has occurred for agriculture or development. The latter case only occurs at distances from development generally in excess of 12km. Overviews from the northern edge of the Waterberg are also possible. These are also relatively long distance views (in excess of 20km).

This limitation means that the majority of visual impacts will be experienced close to the proposed development and either in or close to an area within which similar impacts are already experienced.

Of the more than 300 identified within the potential Zone of Theoretical Visibility only one homestead / bush lodge was identified as potentially being impacted.

The D'Nyala Reserve being located on the Waterberg overlooking the lowland will be the only formally protected area impacted. The impact will be minor and similar in nature to views over existing power stations from a small area of the reserve that are seen at a distance of approximately 21km. The views of the proposed power station will be seen from a distance of approximately 30km which is likely to mean that they will be less obvious than the existing facilities.

Of the private reserves that have been identified, only Exxaro's Manketti Reserve will be impacted. This reserve was established on land surrounding the Grootegeluk Mine with the intention of offsetting and monitoring impacts associated with the mine. It has served as an effective buffer protecting surrounding land uses from the intensive industrial operations that occur in the area. It is largely due to this initiative that the surrounding landscape is so well insulated from visual impacts associated with these operations. The proposed mine, ashing facility Alternative 1 and the grid connection will all be located within the existing reserve area. Given the current location of the reserve immediately adjacent to existing heavy industry, it is a given that the impact on the edges of the reserve will be similar to the current situation after development of the proposed power station. The assessment therefore focused on the possible erosion of this buffer function. It found that there could be a loss of this to the north of the development area. The degree of this loss however is subject to the location of key elements of the development and the success of mitigation measures.

Due to the extent of tourism traffic observed during the site visit, it has been assumed that all roads in the area are likely to have some tourism significance. Only approximately 7-8km of the unsurfaced Stockpoort Road which runs through and adjacent to the proposed power station site will be impacted in any significant way. Immediately to the south of the affected section, this road is already impacted my heavy industry including the Matimba Power Station and the Grootegeluk Mine. All other roads will be unaffected with the exception of occasional long range views from short sections of the R510 and R33. These views will be seen at a long distance (16km and 30km respectively) and will be seen in the context of the existing power stations.

Views from within urban areas of the existing power stations are limited to the western edges and to places where there is a degree of clearing of surrounding natural vegetation. It is generally highly expected to be unlikely that the proposed power station will increase this level of existing impact. The exception to this is the northern edge of Marapong which is located within 3km of the alternative 2 ashing facility. It is possible that, as it grows, the ash dump will become just visible between trees in the intervening landscape. Given current impacts associated with the existing Matimba Power Station on this community; the power station overshadows sections of the settlement, the possible view of the ashing facility through the tops of trees is not likely to be significant. It is possible however that dust blow could reinforce the industrial nature of this facility.

Considering the scale and nature of the proposed development, and the nature of the surrounding landscape, the visual impact that is likely to be experienced by the majority of identified sensitive receptors is anticipated to be of **low signifcnace**. More significant impacts are likely to be limited to areas that are already impacted by heavy industry including the two existing power stations and the Grootegeluk Mine.

7.12 Potential Impacts on Heritage Sites and Fossils

7.12.1 Results of Impact Assessment

No raw material suitable for stone tool manufacture occurs in the study area and no ceramics or stone walls attributed to the Iron Age were recorded within the study area. No further mitigation is recommended in terms of Section 35 of the NHRA for the proposed development to proceed.

In terms of the built environment of the area, no standing structures older than 60 years occur within the study area, although the remains of several dilapidated ruins of unknown age were found. From the 1: 50 000 topographic maps of the study area it is clear that no features of significance occurred in the area.

No burial sites were recorded within the study area. It should be noted that ruins such as the features that were recorded in the study area are known to be associated with unmarked graves. If any graves are located in future they should ideally be preserved in-situ or alternatively relocated according to existing legislation. A chance find procedure in this regard must be included within the EMPr for the project.

Due to the subsurface nature of archaeological remains and the fact that graves can occur anywhere on the landscape, it is recommended that a chance find procedure is implemented for the project as part of the EMPr.

Nature: During the construction phase activities resulting in disturbance of surfaces and/or sub-surfaces may destroy, damage, alter, or remove from its original position archaeological and paleontological material or objects.		
	Without mitigation	**With mitigation (Preservation/ excavation of site)**
Extent	Local (3)	Local (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (4)	Low (3)
Probability	Probable (3)	Not Probable (2)
Significance	**36 (Medium)**	**22 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes unless sites can be preserved.
Can impacts be mitigated?	Yes	Through preservation or excavation of sites.
Mitigation: Due to the lack of apparent significant archaeological resources no further mitigation is required prior to construction. It is however recommended that it should be established whether there are unmarked graves associated with the ruins and if so the graves should ideally be preserved in situ. If this is not possible the graves should be relocated following the correct procedures as per legislation. A Chance Find Procedure should be incorporated into the EMPr should any additional sites be identified during the construction process.		
Residual Impacts: If sites are destroyed this results in the depletion of archaeological record of the area. However if sites are recorded and preserved or mitigated this adds to the record of the area.		

Nature: Impacts on fossil resources		
	Without mitigation	**With mitigation (Preservation/ excavation of site)**
Extent	International (5)	International (5)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Moderate (6)
Probability	Not Probable (2)	Improable (1)
Significance	**32 (Low)**	**16 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes.
Can impacts be mitigated?	Yes	
Mitigation: » On site inspection should be done by a suitably qualified palaeontologist during preliminary excavations, once excavating has commenced.		

» Should the site yield significant palaeobotanical specimens, further site inspections must be arranged between the on-site geologist and palaeontologist. » A Section 35 permit application is required for the removal of any palaeontological material from the site. However, issuing a collections permit prior to any evidence of a heritage resource is not possible in terms of Section 35 of the National Heritage Resources Act (NHRA).
Residual Impacts: None

7.12.3 Comparison of Alternative Ash Dump sites

In terms of the location of the ash dump both the Graafwater and Appelvlakte alternatives are acceptable if the recommendations are adhered to.

7.12.4 Implications for project implementation

If during the pre-construction phase, construction, operations or closure phases of this project, any person employed by the developer, one of its subsidiaries, contractors and subcontractors, or service provider, finds any artefact of cultural significance or heritage site, this person must cease work at the site of the find and report this find to their immediate supervisor, and through their supervisor to the senior on-site manager.

On-site inspection should be done by a suitably qualified palaeontologist during preliminary excavations, once excavating has commenced.

7.12.5 Conclusions and Recommendations

No fatal flaws were identified in the heritage impact assessment study for the power station site or associated infrastructure. From an archaeological point of view there is no reason why the development should not proceed.

Construction of the proposed Tshivhaso Coal-fired Power Plant will involve substantial excavations into the underlying bedrocks as well as large-scale ground clearance (e.g. for access roads). The great majority of the study area to the north of the existing Grootegeluk opencast mine overlies Karoo Supergroup sedimentary rocks (Eendragtpan and Clarens Formations) as well as Lebombo Group volcanics that are of low palaeontological sensitivity. Significant impacts on local palaeontological heritage resources are not anticipated here. The power plant grid connection option under consideration is short with a small anticipated footprint (i.e. pylon footings). Although it traverses potentially fossiliferous Karoo Supergroup rocks, direct impacts on subsurface bedrocks are rated as negligible.

7.12 Potential Impacts on Climate Change

7.12.1 Results of Impact Assessment

Considering South Africa's emissions trajectory presented in the Intended Nationally Determined Contribution submitted in Paris in 2015 the project's annual emissions would remain within a range of 1.4% - 2.2% of national emissions in the period between 2025 and 2030. However, if the plant is still operational in 2050 it could account for as much as 2.0% - 4.1% of the declining forecasted national emissions. Based on the power plant's generation capacity it is likely to contribute as little as 0.3% of the national electricity supply. This suggests that the plant will become a very large emissions contributor relative to the national greenhouse gas emissions inventory.

Global anthropogenic climate change is caused by the accumulated greenhouse gas emissions from all the world's emitting sources. Considered in isolation, the greenhouse gas emissions from the Tshivhaso Power Plant are likely to have a very small if negligible impact on global climate change. Furthermore, it is not possible to directly or indirectly attribute any climate change effects to the greenhouse gas emissions from the power plant specifically. However, as with any issue of common concern, each actor / developer has an individual responsibility to minimise its own negative contribution to the issue. Thus, the project's environmental impact is considered here in terms of its contribution the national greenhouse gas emissions inventory. The impact summary, presented below, should be understood in light of this consideration.

Nature: The combustion of coal in the power plant produces greenhouse gas emissions which in turn contribute to the global phenomenon of anthropogenic climate change. Global climatic changes are likely to manifest in numerous global environmental effects although none that can be attributed directly or indirectly to greenhouse gas emissions of the power plant specifically. However, the contribution of the plant to national greenhouse gas emissions is quantifiable and very large.		
	Without Mitigation	**With Mitigation[2]**
Extent	Global (5)	Global (5)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (5)	Definite (5)
Significance	**High (75)**	**High (65)**
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Mitigation: In order to mitigate the project's contribution to the onset of climate change the power plant would need to mitigate its greenhouse gas emissions. Options for mitigating the		

power plant's greenhouse gas emissions primarily involve substituting the source of thermal energy away from coal towards more carbon neutral sources. This should be considered in the design of the facility such that this can be implemented post-2025 in order to ensure adherence toSouth Africa's commitments in terms of emissions reduction.
Residual risks: There are a vast number of other sources of greenhouse gas emissions around the world. Thus, even with efforts to mitigate the project's greenhouse gas emissions the risks associated with the onset of climate change will still be prevalent.

7.12.2 Comparison of Ash Dump Alternatives

There will be no difference in climate change impacts for either of the site options for the ash dump.

7.12.3 Implications for project implementation

As climate change is a global phenomenon caused but greenhouse gas emissions that diffuse across the entire atmosphere, the impact of the project's greenhouse gas emissions are considered to be of the largest extent possible. Although the lifetime of the plant is likely to be about 30 years the greenhouse gas emissions produced are typically assessed based on their 100 year global warming potential (GWP). Thus, the duration of the impact of the greenhouse gas emissions is considered as long term. Due to the Tshivhaso Power Plant's relatively large contribution to national emissions, its emissions impact is considered to have a moderate magnitude as an individual source. There is a general consensus amongst climate scientists that the probability that greenhouse gas emissions contribute to the onset of climate change is virtually certain and its impact will negatively affect the world's population. The overall significance of the power plant's impact with respect to greenhouse gas emission is high (score >60) based upon the extent, duration, magnitude and probability of the impact. The duration and nature of the impact of anthropogenic climate change will in many cases result in the irreversible loss of resources.

While there are options to mitigate the greenhouse gas emissions from the power plant these options are not able to change the extent, duration or probability of the impact that the greenhouse emissions will have on climate change. The magnitude of the greenhouse gas emissions impact is the only criteria that can be reduced by reducing the quantity of emissions.

The magnitude of the plant's emissions impact in terms of its contribution to the national greenhouse gas emissions can to some degree be reduced by the mitigation options presented in this study. This is represented in the reduced magnitude, and hence reduced significance score, for the project case with mitigation as recorded in the table above. The reduced score does still however qualify the greenhouse gas emissions impact of mitigated project case as high in significance. The cumulative nature of climate change impacts resulting from the greenhouse gas emissions from all the world's sources implies that there will still be risks associated with climate change even if the emissions from the Tshivhaso Power Plant are mitigated. Thus it is instructive to also contrast the impact of the power plant's greenhouse gas emissions (mitigated and unmitigated) against the technological alternative and national baseline.

7.13.4 Conclusions and Recommendations

The emissions trajectory for the power plant will essentially be locked-in once the final decision regarding the combustion technology is made. Once operational there will be limited potential for the plant to reduce its emissions over its lifetime other than the gradual addition of hybrid technologies such as biomass or solar thermal energy as detailed in the mitigation options.

Beyond this the state of the coal used in a circulating fluidised bed combustor can affect the heat output of the furnace which in turn affects the boiler and then the energy produced by the turbine. Wet coal has a high moisture content and thus burns less efficiently due to energy being consumed by evaporation (Bhattacharya *et al.*, 2013). Similarly the size of the coal particles used in a Circulating fluidised bed combustor can affect the completeness of fuel burning and heat generation. Coal that has become wet or crushed to the incorrect size may lead to the consumption of larger quantities of coal per MWh electricity produced. Consequently the burning of more coal per MWh leads to the emission of more CO_2 per MWh.

The management of coal stockpiles and maintenance of coal crushers are important areas for operational emissions management. It would be advisable to include these facilities as core areas within a Carbon Management Plan for the power plant. Such a plan could be modelled on the Plan Do Check Act (PDCA) approach within the ISO 9001 Quality Management System Requirements. Beyond the two priority areas mentioned in the specialist report (Appendix L), the plan should aim to incorporate carbon management into the everyday organisation practices of the power plant. In general a good governance structure with high level responsibility for carbon emissions and climate change assist in effectively implementing such management plans. Specifically, it is recommended that the management plan ensure that coal be stored appropriately so as to protect it from unnecessary moisture exposure. The storage and transportation of coal must also be managed in such a way that it does not crush the coal beyond its useful size. Maintaining the coal crushers will further ensure that the coal particles are optimally sized.

Monitoring is essential to tracking the effectiveness of any carbon management plan. Monitoring of the moisture content and size of the coal particles supplied to the furnace will be of particular interest for CFB combustion. This information should be supported by the monitoring of the coal storage conditions, transport systems and crusher performance. Furthermore, it will be valuable to monitor the on-site electricity demands as these form part of a plant's parasitic load requirements and effectively reduce the amount of exportable electricity per tonne of CO_2 emitted. The specific monitoring of carbon emissions will become a requirement as part of the carbon tax and may even require Tier 3 direct emissions measurement in the future. Thus is may be advisable to consider the inclusion of systems for emissions monitoring via direct measurement.

The inclusion of biomass into the fuel mix for the circulating fluidised bed combustor appears to be the most effective technological option to reduce the power plant's carbon emissions and impact on climate change. The inclusion of thermal energy from an additional CSP plant is similarly effective, although comparatively expensive in capital terms. The inclusion of 10% of thermal energy would require a 152MW plant to be built (without storage facilities). While there may be land available, the suitability of the topography may be another limiting factor.

By making provisions for the future instalment of CCS technologies, the Tshivhaso Power Plant will maintain the opportunity to significantly reduce its future carbon emissions and climatic impact. Having an effective carbon management plan and emissions monitoring system will assist in tracking and minimising greenhouse gas emissions on a daily basis.

It is concluded that the Tshivhaso Power Plant is likely to produce a significant amount of greenhouse gas emissions and account for a relatively large proportion of South Africa's greenhouse gas inventory. The overall significance of its impact on the national inventory is high and thus mitigation options must be pursued as part of a shared responsibility to the global issue of climate change. In meeting this objective it is suggested that the development of circulating fluidised bed combustion technology in the Tshivhaso Power Plant is expected to be the most suitable option based on the technological requirements of the Coal Baseload Programme. While it is expected to have comparable climatic impacts, in terms of carbon emissions, to pulverised fuel technologies, circulating fluidised bed technology has greater opportunities for emissions reductions through the future co-firing of biomass. It is recommended that the project developer seriously considers future opportunities related to the; co-firing with biomass, incorporation of solar thermal energy and the implementation of an effective monitoring plan.

7.13 Potential Socio-Economic Impacts

7.13.1 Results of Impact Assessment

Impact on mineral resources

The power plant, due to the nature of the footprint created by the facility and its infrastructure, will reduce or remove the availability of the natural resources beneath the surface of the land. The immediate area surrounding the proposed development, as well as the greater Limpopo area, is rich in mineral resources – particularly coal and coalbed methane. The construction of a power plant on the surface of the land could prevent these minerals from being explored on the same properties in the future. The impact is long term and will start with construction of the power station until its eventual decommissioning.

During construction and operations, i.e. once the power station is developed, the minerals beneath the ground cannot be extracted for economic use. Engagement with Anglo American (March 2016) revealed that this impact cannot be mitigated because it is not possible to drill horizontally in the affected areas. As such, vertical drilling is required, meaning that there cannot be any developments on the land if gas is to be extracted from beneath the surface. However, there is not permanent loss of resources since the minerals can be extracted after decommissioning of the plant.

Having said the above, the impact on sterilisation of mineral reserves is rated as improbable because of the uncertainty regarding the volume and economic value of reserves located on the affected sites. It should be noted, that initial coal bed methane projects planned to be undertaken by Anglo were located north of the area where the proposed power station is located, i.e. on Farm Nooitgedacht 403.

Nature: **Construction phase: The power plant will reduce or remove the availability of energy resources beneath the surface of the land during construction**		
	Without mitigation	**With mitigation**
Extent	(Local) 1	(Local) 1
Duration	(Short-term) 2	(Short-term) 2
Magnitude	(High) 8	(High) 8
Probability	(Probable) 3	(Improbable) 2
Significance	**(Medium) 33**	**(Low) 22**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No

Can impacts be mitigated?	No	No
Mitigation: » The impact cannot be mitigated because it will not be possible to extract minerals beneath the development during the time of construction » The developer should engage with Anglo American to discuss and align the future development plans		

Nature: **Operational phase: The power plant will reduce or remove the availability of energy resources beneath the surface of the land during operation**		
	Without mitigation	**With mitigation**
Extent	(Local) 1	(Local) 1
Duration	(Long-term) 4	(Long-term) 4
Magnitude	(High) 8	(High) 8
Probability	(Probable) 3	(Improbable) 2
Significance	**(Medium) 39**	**(Low) 26**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	No	No
Mitigation: » The impact cannot be mitigated because it will not be possible to extract minerals beneath the development during the time of construction » The developer should engage with Anglo American to discuss and align the future development plans		

Impact on water supply

The large quantities of water required to construct and operate a coal-fired power station will have an impact on the water supply in Lephalale and the broader Waterberg Municipality. According to the Waterberg IDP (2011/2012) water supply is a major challenge for the municipality, with water service backlog estimated at 3 280 units (Lephalale LM IDP). The proposed development will put extra stress on an already constrained water supply system. Although the Waterberg Municipality has systems in place to increase the supply of water to the area in the future, the proposed development will impact on water supply regardless – but will be particularly significant if water supply in the area does not improve. If there is not supplementation from MCWAP, then the project cannot proceed. Moreover, the percentage of households within the municipality that rely on boreholes, wells, rivers, and springs as a water source equates to about to 22.6% (Statistics South Africa, 2015). If these sources of water are polluted as a result of the construction and/or operation of the power plant, it will have a severe impact on the communities that rely on this water. Strict mitigation is therefore required to minimise this risk.

The impact in terms of water supply is long term in nature as the power station will require water to operate throughout its lifespan. After decommissioning, the power station will no longer require water and as such, the impact is reversible in the long-term. The impacts can be mitigated through utilisation of water from the MCWAP and by ensuring that ground water is not polluted during construction or operation phase through the implementation of appropriate mitigation and quality control measures. If measures are taken to minimise the impact on water supply, then the significance of the impact decreases.

Nature:

Construction phase: The construction will impact on the demand for water and the quality of ground water.

	Without mitigation	**With mitigation**
Extent	(Regional) 3	(Regional) 3
Duration	(Short-term) 2	(Short-term) 2
Magnitude	(High) 8	(Moderate) 6
Probability	(Definite) 5	(Highly Probable) 4
Significance	**(High) 65**	**(Medium) 44**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes

Mitigation:

» All effort must be made to ensure that the ground water is not contaminated because many households use ground water as a primary source of water.

» Water must be provided by the MCWAP system to absorb the additional demand. The municipality must also be clearly informed of the potential impact on demand for water so that there is sufficient time to plan for and mitigate this impact.

Nature:

Operational phase: The development will impact on the demand for water and the quality of ground water over the course of operation

	Without mitigation	**With mitigation**
Extent	(Regional) 3	(Regional) 3

Duration	(Short-term) 4	(Short-term) 4
Magnitude	(High) 8	(Moderate) 6
Probability	(Definite) 5	(Highly Probable) 4
Significance	**(High) 75**	**(Medium) 52**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » All effort must be made to ensure that the ground water is not contaminated because many households use ground water as a primary source of water. » Water must be provided by the MCWAP system to absorb the additional demand. The municipality must also be clearly informed of the potential impact on demand for water so that there is sufficient time to plan for and mitigate this impact.		

Loss of commercial farming activity

All directly affected portions for the proposed development currently have some form of farming on site. This is predominantly in the form of game farming and breeding. The development will sterilise the land on-site meaning that any farming activity currently present will have to cease. In the case of the game farming and breeding, it is possible to relocate the animals, which will minimise the negative impact; however, it is still impossible to engage in other agricultural practices on the farm until decommissioning of the plant. It is expected that this impact will occur during construction and continue throughout operation.

Nature: **Construction phase: Loss of commercial farming activity during construction**		
	Without mitigation	**With mitigation**
Extent	(Local) 1	(Local) 1
Duration	(Long-term) 2	(Long-term) 2
Magnitude	(Minor) 2	(Small) 1
Probability	(Definite) 5	(Highly Probable) 4
Significance	**(Low) 25**	**(Low) 16**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes

Mitigation:
» Relocating the animals to alternative land can mitigate against the overall economic loss

Nature: **Operational phase: Loss of commercial farming activity throughout operation**		
	Without mitigation	**With mitigation**
Extent	(Local) 1	(Local) 1
Duration	(Long-term) 4	(Long-term) 4
Magnitude	(Minor) 2	(Small) 1
Probability	(Definite) 5	(Highly Probable) 4
Significance	**(Medium) 35**	**(Low) 24**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Relocating the animals to alternative land can mitigate against the overall economic loss		

Impact on human capital

Impact on employment

The development of the Tshivhaso power station will positively impact on the community by creating a number of temporary and permanent job opportunities. It is estimated that up to 3 500 temporary jobs will be created on site during the construction phase and approximately 200 jobs during the operational phase. Considering the requirements for IPP projects, the following can be expected:

» At least 55% of the construction jobs will be filled by South African citizens, of which about a third will need to come from the local communities. Therefore, it can be deduced that potentially 1 925 employment opportunities will be created for South African citizens during construction and 630 of these will be made available for local communities.

» During operations, 85% of all permanent positions will need to be filled by South African citizens and 20% will need to be filled by those coming from the local community. This suggests that up to 40 permanent employment positions will be created for the local labour.

The development of other power and mining-related activity in Lephalale, specifically the Medupi power station, means that many workers in the area are dependent on the mining and utility sector's jobs as a source of income. The Tshivhaso power station will assist with providing cumulative job opportunities once the Medupi power station and other constructions are complete.

As mentioned in the NGPF, sustainable development through job creation is a key national development goal. This development achieves that goal by creating temporary jobs during the period of construction and long term jobs during operation. These jobs are not permanent because the operational jobs will cease upon decommissioning of the project - but operational jobs are long-term employment opportunities as opposed to the construction jobs which are short-term.

As there is currently commercial farming activity occurring on the directly affected farm portions, the jobs associated with these activities will be lost as a result of the development unless these jobs are moved to another property where the activity is required. While it is indicated that there is some mining activity planned for two of the directly affected portions, the predominant current use is game farming. According to the land owners, 18 people are employed on the directly affected portions, meaning that these employees will lose their jobs unless they are relocated to resume similar work on other portions. Overall, the potential loss of employment is negligible when compared with the potential gains from constructing and operating a coal-fired power station on the land.

In order to maximise the potential benefit from the impact, it is suggested that every effort is made to employ locally, where feasible.

Nature: **Construction phase; The construction of the Tshivhaso power station will positively impact on the community by creating a number of job opportunities (albeit temporary)**		
	Without enhancement	**With enhancement**
Extent	(National) 4	(National) 4
Duration	(Short-term) 2	(Short-term) 2
Magnitude	(Moderate) 6	(Moderate) 8
Probability	(Definite) 5	(Definite) 5

Significance	**(Medium) 60**	**(High) 70**
Status (positive or negative)	Positive	Positive
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes (enhance)	Yes (enhance)
Mitigation: » Where feasible, effort must be made to employ locally in order to create maximum benefit for the communities.		

Nature: **Operational phase: The operation of the Tshivhaso power station will positively impact on the community by creating a number of sustainable job opportunities.**		
	Without enhancement	**With enhancement**
Extent	(National) 4	(National) 4
Duration	(Long-term) 4	(Long-term) 4
Magnitude	(Low) 4	(Moderate) 6
Probability	(definite) 5	(definite) 5
Significance	**(Medium) 60**	**(High) 70**
Status (positive or negative)	Positive	Positive
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes (enhance)	Yes (enhance)
Mitigation: » The operator of the power station should be encouraged to procure materials, goods and services required for the operation of the facility from local suppliers to increase the positive impact in the local economy as far as possible » Where possible, local labour should be considered for employment to increase the positive impact on the local economy » Where feasible, local Small and Medium Enterprises should be approached to investigate the opportunities for supplying inputs required for the maintenance and operation of the facility.		

Impact on skills and knowledge

During this period, construction and operation employees will gain experience, knowledge and skills. The Lephalale and Waterberg Municipality areas have a large supply of low-skilled labour meaning that the power station is well suited to take advantage of this supply and assist in developing the skills of the employed individuals. Some of the currently employed individuals in the area may assume work at the proposed development after working on constructing the Medupi power station, which will extend their opportunity to become experienced in the industry. The impact is long term and irreversible as skills and knowledge are permanent impacts on individuals.

Jobs that require a high level of skill may require employees who do not currently reside within the local municipality. As such, some of the long-term employment opportunities will be taken up by skilled individuals from outside of the area.

The Lephalale IDP (2014/2015) states that Lephalale is considered as a Provincial Growth Point and a potential energy hub. The proposed development is therefore well suited to increase the skills of the population in line with the developmental direction of the area in order to sustain this development.

In order to maximise the positive impact, it is suggested that Cennergi provide training courses for employees where feasible to ensure that employees gain as much as possible from the work experience.

Nature:
Construction phase: during the construction period employees will gain experience, knowledge and skills.

	Without enhancement	**With enhancement**
Extent	(Regional) 3	(Regional) 3
Duration	(Permanent) 5	(Permanent) 5
Magnitude	(Low) 4	(Low) 5
Probability	(Definite) 5	(definite) 5
Significance	**(Medium) 60**	**(High) 65**
Status (positive or negative)	Positive	Positive
Reversibility	Low	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes (enhance)	Yes (enhance)

Mitigation:

» In order to maximise the positive impact, it is suggested that the project company provide training courses for employees where feasible to ensure that employees gain as much as possible from the work experience
» Facilitate the transfer of knowledge between experienced (particularly international) employees and the local staff
» Perform a skills audit to determine the potential skills that could be sourced in the area

Nature: **Operational phase: During the operation period employees will gain experience, knowledge and skills.**		
	Without enhancement	**With enhancement**
Extent	(Regional) 3	(Regional) 3
Duration	(Permanent) 5	(Permanent) 5
Magnitude	(Moderate) 6	(High) 8
Probability	(Definite) 5	(definite) 5
Significance	**(High) 70**	**(High) 80**
Status (positive or negative)	Positive	Positive
Reversibility	Low	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes (enhance)	Yes (enhance)
Mitigation: » In order to maximise the positive impact, it is suggested that the project company provide training courses for employees where feasible to ensure that employees gain as much as possible from the work experience. » Facilitate the transfer of knowledge between experienced (particularly international) employees and the local staff » Perform a skills audit to determine the potential skills that could be sourced in the area » Where possible train and empower local communities for employment in the operations of the power plant		

Impact on social capital

Change in the demographics of the area due to potential influx of workers and job seekers

Recent migration trends in the Lephalale LM suggest that workers are migrating into the municipality in response to the increased demand for construction workers. A change of demographics can bring about social ills. If jobs are taken up by immigrants then local communities might become upset and resort to violence. Increase in crime and social conflict incidents due to the influx of construction workers and job seekers into the area, property damages, theft and losses of assets on the nearby farms, including poaching, are all potential negative impacts associated with the change in demographic make-up of the area.

The proposed development will sustain this trend by further increasing the demand for workers to construct a power station. However, the demographics of the area have already significantly changed as a result of the other developments in the area to such a degree that the proposed development is not expected to have a significant impact, but rather extend the impact created by other projects. As mentioned above, many of the construction jobs created by the power station will be taken up by people previously working on Medupi and other projects. As such, fewer of the jobs will be available to individuals migrating into the area in search of work. The impact on the demographics of the area is a cumulative short-term impact of low significance and will be mitigated by prioritising local employment.

Nature: **construction phase: The proposed development will impact on the demographics of the area as a result of in-migration in response to job opportunities**		
	Without mitigation	**With mitigation**
Extent	(Regional) 3	(Regional) 3
Duration	(Short-term) 2	(Short-term) 2
Magnitude	(Low) 3	(Low) 3
Probability	(Highly Probable) 4	(Improbable) 2
Significance	**(Medium) 32**	**(Low) 16**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » The impact can be somewhat mitigated by employing individuals who were working on previous projects in the area so as to decrease the reliance on employees who in-migrate in search of work » Where feasible, effort must be made to employ locally in order to create maximum benefit for the communities and limiting in-migration.		

4.3.2 Improved standard of living for households

Employed individuals will increase the income of their respective households and therefore improve their standards of living. During construction and operational phases, the power station will employ local as well as external individuals. This employment will bring income into the households, which will increase the standard of living of these households and also increase the amount of money in the area stimulating further economic development. Individuals who *retain* employment through the new power station rather than gaining new employment will sustain the increased standard of living provided to their household and continue to generate savings as a result. While the construction benefits associated with this impact are short-term, the operational impacts are long-term. It is envisaged that many employment opportunities in high-skilled positions will be taken up by employees who are not from Lephalale LM; however, some of them will – and these individuals will increase the standard of living of their household for longer periods of time.

This impact is maximised by, where feasible, employing locally and ensuring that individuals who were working on other developments such as the Medupi power station, where they would have obtained necessary skills, are employed at the Tshivhaso power station.

The decommissioning phase will also increase the standard of living of households due to the income gained during this period. The procurement of services and goods required for decommissioning and spending of the income earned by people directly or indirectly benefiting from the project will contribute to the creation of multiple jobs. The impact will be relatively short-term, and not as significant as during the construction phase. Operational jobs will be lost during the decommissioning phase, highlighting the temporary nature of the jobs created.

Nature: **construction phase: Employed individuals will increase the income of their respective households and therefore improve their standard of living**		
	Without enhancement	**With enhancement**
Extent	(Limited) 2	(Limited) 2
Duration	(Short-term) 2	(Short-term) 2
Magnitude	(High) 8	(High) 8
Probability	(Highly Probable) 4	(Definite) 5
Significance	**(Medium) 48**	**(Medium) 60**
Status (positive or negative)	Positive	Positive
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes (enhance)	Yes (enhance)
Mitigation: » Employing locally will increase benefit to local households and the local area.		

Nature: **Operational phase: Employed individuals will increase the income of their respective households and therefore improve their standard of living**		
	Without mitigation	**With mitigation**
Extent	(Regional) 3	(Regional) 3

Duration	(Long-term) 4	(long-term) 4
Magnitude	(Low) 2	(Low) 2
Probability	(Probable) 3	(Probable) 4
Significance	**(Low) 27**	**(Medium) 36**
Status (positive or negative)	Positive	Positive
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes (enhance)	Yes (enhance)
Mitigation: » Employing locally will increase benefit to local households and the local area.		

Nature: **Decommissioning phase: Temporary increase in standard of living during decommissioning**		
	Without mitigation	With mitigation
Extent	(Regional) 3	(Regional) 3
Duration	(Short-term) 2	(Short-term) 2
Magnitude	(Low) 4	(Low) 4
Probability	(Highly Probable) 4	(Highly Probable) 4
Significance	**(Medium) 36**	**(Medium) 36**
Status (positive or negative)	Positive	Positive
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes (enhance)	Yes (enhance)
Mitigation: » Employ locally as far as feasibly possible		

Impact on cultural and spiritual capital

Impact on Tourism within the affected and indirectly affected areas.

The development of a coal-fired power station will add to the change of the spiritual and cultural feeling of the surrounding area, which will reduce its attractiveness as a tourist destination. This impact is envisaged to be relatively minor within the context of the area, because the surrounding area has already transformed significantly in recent years with new mining facilities and power stations being constructed. Tourists looking for an escape from modern cities and human intervention are less likely to want to visit areas with major industrial developments such as power stations, mines or other industrial developments close by as these developments take away from the experience. While the proposed development will add to this negative impact in the Lephalale LM, it is a long-term cumulative impact which will further extend the impact of other developments of a similar nature. It is therefore not envisaged to be a highly significant impact. However, it is still important to mitigate against these impacts through various measures. Adherence to mitigations measures proposed by the visual specialist and routine inspection of the lighting conditions.

Nature: **Construction phase: The construction of a coal-fired power station will change the spiritual and cultural feeling of the surrounding area which will reduce its attractiveness as a tourist destination**		
	Without mitigation	**With mitigation**
Extent	(Limited) 2	(Limited) 2
Duration	(Short-term) 2	(Short-term) 2
Magnitude	(Minor) 4	(Minor) 2
Probability	(Highly Probable) 4	(Highly Probable) 4
Significance	**(Low) 32**	**(Low) 24**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	No
Mitigation: » Mitigation proposed by visual and noise experts should be implemented as far as feasibly possible		

Impact on physical capital

Increased demand for housing

The proposed facility will increase the demand for housing to accommodate the employees. The interviews conducted with estate agents (2016/06/30) revealed that there is a shortfall of low- to middle-income houses. As a result of the influx of people seeking work at the energy-related developments in the area, demand for low income housing has increased at a faster rate than the local area's capacity to supply. As such, there is an immediate need for more low- and middle-low income housing units. The construction phase of the proposed development is therefore deemed to have a negative impact on the physical capital of the area by placing extra strain on an already strained housing market. However, in the long-term, the increased demand for housing is positive for the economy. The increased demand for housing from operation is perceived to be positive as it reflects improvement in the local economy, but in the short-term the construction phase is perceived as negative because of issues of undersupply. This impact could be partially mitigated if houses currently utilised for construction at Medupi and other developments in the area become available.

Nature: **Construction phase: The proposed facility will increase the demand for housing to accommodate the employees**		
	Without mitigation	**With mitigation**
Extent	(Regional) 3	(Regional) 3
Duration	(Short-term) 2	(Short-term) 2
Magnitude	(Moderate) 7	(Low) 5
Probability	(Highly Probable) 4	(Highly Probable) 4
Significance	**(Medium) 48**	**(Medium) 40**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Informing the municipality of the proposed development's potential impact on demand for housing is necessary in ensuring that more housing is planned in areas that are accessible from the project site » Hiring people who already reside within the area will decrease demand for new houses » Utilising housing which comes available from the completion of other construction in the area would minimise the impact.		

Added pressure on basic services and social and economic infrastructure

According to information supplied from municipal officials during interviews in 2016, the rapid development in the area as a result of Medupi and similar developments is creating difficulty in supplying basic services within the region. As already mentioned, the lack of low cost housing and water is a growing concern, which will increase if not addressed.

Large-scale projects such as power stations require the movement of significant volumes of construction material, as well as machinery and equipment. The transportation of these items places stress on road infrastructure potentially causing roads to degrade. According to Waterberg IDP (2011/2012) the state of the road infrastructure in Lephalale is poor. This is because of the stress placed on these roads from the transportation of materials to Medupi and other developments. Particularly, the R33 which runs through Lephalale is in need of a repair, as this road would be used by the proposed development. The impact on the road infrastructure in the Lephalale area will be short-term and will end when construction is complete. Upgrading of the roads could assist in mitigating these impacts.

The development will also place extra demand on social services. An already constrained health care system may face a challenge of needing to service a larger population as more people move into the area. While it is expected that many of the employment opportunities will be taken up by individuals currently working on construction projects in the Lephalale area, it may not be the case that all employees were already in the area as construction of the development may commence before Medupi is fully completed or when other coal-fired power stations (such as Thabametsi coal-fired power station) or other coal mines are being developed.

Nature: **Construction phase: Added pressure on basic services as a result of construction**		
	Without mitigation	**With mitigation**
Extent	(Regional) 3	(Regional) 3
Duration	(Short-term) 2	(Short-term) 2
Magnitude	(Moderate) 6	(Low) 5
Probability	(Highly Probable) 4	(Highly Probable) 4
Significance	**(Medium) 44**	**(Medium) 40**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes

Mitigation:

- Clearly inform the local municipality of the potential impact of the proposed project in order for the necessary preparations to take place
- Provide public transportation service for workers in order to reduce congestion on roads
- Partner with the local municipalities and other prominent users of the local roads to upgrade them to meet the required capacity and intensity of the vehicles related to the construction of the Thsivhaso Coal-Fired Power Station

Nature: **Operational phase: Added pressure on basic services during operation**		
	Without mitigation	**With mitigation**
Extent	(Regional) 3	(Regional) 3
Duration	(Long-term) 4	(Long-term) 4
Magnitude	(Moderate) 6	(Low) 4
Probability	(Highly Probable) 4	(Highly Probable) 4
Significance	**(Medium) 52**	**(Medium) 44**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes

Mitigation:

- Clearly inform the local municipality of the potential impact of the proposed project in order for the necessary preparations to take place.
- Maintenance of local roads so that vehicles can utilise them safely and without causing further damage
- Hiring locally in order to minimise the increase in demand for basic services

Impacts on financial capital

Impact on production

The capital and operational expenditure of the proposed development will impact on the production of the local economy. The economy of the Lephalale LM is valued at R6 161 million in current prices according to (Quantec, 2014), and contributes significantly to the Lephalale LM economy. The proposed development will increase the relative contribution of the Lephalale economy to broader Waterberg Municipality. The positive growth trends in the area are related to the advance in development of the Limpopo Coal, Energy and Petrochemical Cluster – whereby

Limpopo is envisaged to develop extensively through investment into the above sectors. The Tshivhaso power plant is aligned with this developmental path by contributing to the development of the Limpopo Province through the construction of a coal-fired power plant.

In terms of construction, the establishment of the power station will involve activities such as site and infrastructure development, civil works, building construction, and other business activities related to the construction of the proposed development. This will create demand for products which will stimulate industries within the region as supplies are sourced throughout the construction period. Considering the requirement stipulated by the Department of Energy, at least 40% of capital expenditure on the proposed power station will need to be localised. This includes among others procurement of the majority of steel power pylons, electrical and telecom cables, as well as valves and actuators from within South Africa. While it will not be possible to source all materials locally, if effort is made to use local suppliers as far as possible, the positive impact on the local economy will be increased.

During operation, the constant demand for services and products which the power station requires will continuously have a positive impact on the local economy. Furthermore, the operations of the proposed power station will increase the value of the utility sector in the local municipality, positively affecting its growth.

Upon the expiry of the Tshivhaso Coal-Fired Power Station Facility's lifespan, the facility would need to be decommissioned, demolished or upgraded. If the facility is decommissioned, the land will be rehabilitated in attempt to return it to the pre-project conditions. Spending on the disassembly of the components and rehabilitation of land will increase the demand for construction services and other industries, thus stimulating economic activity in the local area, albeit over a temporary period. As such, there is a positive impact on the local economy during the period of decommissioning. However, the significance of the impacts on the economic components during this phase will be lower than in the previous phases due to the following:

» Expenditure during the closure phase will be significantly lower than that during the previous phases, which means that it will generate lower positive impact; therefore, their magnitude will be lower than that observed during the construction and operational phases.
» The impacts will be of a short duration.

Nature: **Construction phase: Expenditure associated with the construction of the proposed development will impact on the production of the local economy.**

	Without enhancement	**With enhancement**
Extent	(National) 4	(National) 4
Duration	(Short-term) 2	(Short-term,) 2
Magnitude	(Moderate) 7	(High) 8
Probability	(Definite) 5	(definite) 5
Significance	**(High) 65**	**(High) 70**
Status (positive or negative)	Positive	Positive
Reversibility	Medium	Medium
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes (enhance)	Yes

Mitigation:

» Closer to the construction period, investigate whether the gap in the rental market will be created linked to the completion of the construction of the Medupi Power Station and when other industrial and mining developments in the area are expected to be launched
» The project developer should make effort to use locally sourced inputs where ever possible in order to maximize the benefit to the local economy.
» Organise local community meetings to advise the local labour on the project that is planned to be established and the jobs that can potentially be applied for
» Sub-contract to local construction companies where possible
» Local Small and Medium Enterprises should be approached to investigate the opportunities for supplying inputs required for the maintenance and operation of the facility, as far as feasible

Nature:
Closure phase: Positive impact on the local economy during the period of decommissioning from spending on the disassembly of the components and rehabilitation of land

	Without enhancement	**With enhancement**
Extent	(Regional) 3	(Regional) 3
Duration	(Short-term) 2	(Long-term) 2
Magnitude	(Low) 4	(Low) 4
Probability	(Definite) 5	(Definite) 5
Significance	**(Medium) 40**	**(Medium) 50**
Status (positive or negative)	Positive	Positive
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes (enhance)	Yes (enhance)

Mitigation: » Developers should make effort to use local inputs where ever feasible in order to maximize the benefit to the local economy and therefore the local municipality.

Impacts on political and institutional capital

Increased municipal revenue from the proposed development

The proposed development will provide much needed increased revenue to the municipality throughout construction and operation. This will include both the tax-related revenue collected by national government (i.e. VAT, payroll, and income taxes) and tax- and rates-related revenue collected by the local government (i.e. property rates, services rates, etc.).

As mentioned above, the social infrastructure in the Waterberg DM and Lephalale LM is in need of upgrading. The increased revenue from the proposed development will assist the municipality in providing sufficient housing, water, health services, etc. This impact is long term as it will continue until decommissioning of the power station. The impact may be limited is most of the employees come from Medupi as they will already be paying taxes in the area. However, where new employees are required, particularly in operation of the plant, they will provide new and additional revenue to the municipality.

Nature: **Construction phase: The proposed development will provide much needed increased revenue to the municipality throughout construction**		
	Without mitigation	**With mitigation**
Extent	(Regional) 3	(Regional) 3
Duration	(Short-term) 2	(Short-term) 2
Magnitude	(Moderate) 6	(Moderate) 6
Probability	(Probable) 3	(Probable) 3
Significance	**(Medium) 33**	**(Medium) 33**
Status (positive or negative)	Positive	Positive
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	No	No

Mitigation:

» None required

Nature:
Operation phase: The proposed development will provide much needed increased revenue to the municipality throughout operation

	Without enhancement	**With enhancement**
Extent	(Regional) 3	(Regional) 3
Duration	(Long-term) 4	(Long-term) 4
Magnitude	(Moderate) 5	(Moderate) 7
Probability	(Definite) 5	(Definite) 5
Significance	**(Medium) 60**	**(High) 70**
Status (positive or negative)	Positive	Positive
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	No	No

Mitigation:

» The project developer should make effort to use local inputs where ever feasible in order to maximise the benefit to the local economy and therefore the local municipality.

4.7.2 Investment in the local communities and economic development projects as part of a Social Economic Development and Enterprise Development plan

As part of the requirements imposed by the Department of Energy with respect to Social Economic Development and Enterprise Development plan, a portion of turnover generated by the facility during operations is encouraged to be invested into the development of the local area (i.e. up to 0.15% of operating revenue). This will have a positive impact on the standard of living, access to services, and enterprise development in the surrounding communities and broader municipal area.

In order to maximise this benefit, it is recommended that the plan be developed in consultation with local authorities and existing strategy documents to identify community projects that could be invested in and would result in the greatest social benefits. With regard to ED initiatives, focus should be on developing plans to support and create sustainable, self-sufficient enterprises. It is important that these plans be reviewed annually and where possible updated.

Nature: **Operation phase: Investment in the local communities and economic development projects as part of a Social Economic Development and Enterprise Development plan**		
	Without mitigation	**With mitigation**
Extent	(Regional) 3	(Regional) 3
Duration	(Medium-term) 3	(Medium-term) 3
Magnitude	(Low) 4	(Moderate) 6
Probability	(Definite) 5	(Definite) 5
Significance	**(Medium) 50**	**(Medium) 60**
Status (positive or negative)	Positive	Positive
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes (enhance)	Yes (enhance)
Mitigation: » In order to maximise this benefit, it is recommended that the SED and ED plans be developed in consultation with local authorities and existing strategy documents to identify community projects that would result in the greatest social benefits. With regard to ED initiatives, focus should be on developing plans to support and create sustainable, self-sufficient enterprises. It is important that these plans be reviewed annually and where possible updated.		

4.8 Provision of electricity into the national grid

The power station will provide the important national service of providing electricity into the national grid. Given the context of South Africa’s current electricity needs, this is an important development. The New Growth Path Framework (NGPF) states that the lack of access to energy is identified as a major concern for the growth of the economy, and increased access to energy would have a profound effect on achieving the goals of poverty and unemployment reduction. This proposed development therefore aligns with national developmental goals by assisting with meeting electricity generation targets in order to create sustainable socio-economic growth.

Nature: **Operation phase: The power station will provide the important national service of providing electricity into the national grid**		
	Without mitigation	**With mitigation**

Extent	(National) 4	(National) 4
Duration	(Long-term) 4	(Long-term) 4
Magnitude	(Low) 4	(Low) 4
Probability	(Definite) 5	(Definite) 5
Significance	**(Medium) 50**	**(Medium) 50**
Status (positive or negative)	Positive	Positive
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	No	No
Mitigation: » No mitigation required		

7.13.2 Comparison of Ash Dump Alternatives

There is no difference in social impacts between the Appelvlakte option and the Graafwater option. Either option is acceptable from a social perspective.

7.13.3 Implications for project implementation

- » The developer should engage with local authorities and business organisations to investigate the possibility of procurement of construction materials, goods, and products from local suppliers where feasible
- » Sub-contract to local construction companies where possible
- » Use local suppliers where feasible and arrange with the local Small and Medium Enterprises to provide transport, catering, and other services to the construction crew
- » Where possible, the local labour should be considered for employment to increase the positive impact on the local economy
- » The establishment of central recruitment offices in Lephalale and the enforcement of labour and recruitment legislation
- » The operator of the power station should be encouraged to procure materials, goods and services required for the operation of the facility from local suppliers to increase the positive impact in the local economy as far as possible
- » Where possible, the local labour should be considered for employment to increase the positive impact on the local economy
- » Local Small and Medium Enterprises should be approached to investigate the opportunities for supplying inputs required for the maintenance and operation of the facility, as far as feasible

7.13.4 Conclusions and Recommendations

The proposed development of the coal-fired power station and associated infrastructure is to be located outside the town of Lephalale, which forms part of the Lephalale LM in the Limpopo Province. Overall, it is clear that the proposed project has the opportunity to bring much needed investment into the area to revitalise the local economies and provide the local residents with jobs and sustainable income. The unemployment in the area is relatively high, and developments such as the one proposed would bring sustainable jobs for the locals, which could assist in relieving the issue of unemployment. Together with other projects planned for the area, it will also lead to the development of the supporting industries in the local economy and create an opportunity to revitalise the nearby towns and improve the standards of living and livelihoods of the local people.

Upon examination of potential socio-economic impacts, it was found that the positive impacts of job creation, economic stimulation, and social development outweigh negative impacts such as the potential stress on social delivery and water infrastructure, increase in demand for housing, potential sterilisation of energy reserves, and others.

Overall, based on the current developmental path of the Limpopo and Lephalale area, the proposed development is well suited for the location. The myriad of positive benefits associated with the construction and operation of the facility ensure that socio-economic benefit will accrue to the residents of the local municipality and although some negative impacts are identified – appropriate mitigation can assist in minimising these impacts.

7.14 Assessment of the Do Nothing Alternative

The 'Do-Nothing' alternative is the option of not constructing the proposed Tshvihaso Power Station. Should this alternative be selected, there would be no environmental impacts on the site due to the project as the facility would not be constructed.

South Africa's per capita greenhouse gas emissions are amongst the highest in the world due to reliance on fossil fuels using old technologies. The proposed project provides an opportunity for the implementation of newer technology power generation for baseload/mid-merit power generation from coal sources, with the potential to reduce emissions in the future through appropriate planning and design.

At both a provincial and national level, it should be noted that the Tshivhaso Power Station is not unique. In that regard, a number of coal-fired power station developments are currently proposed in the region. Therefore, when considering the desirability of the no go option for the specific project, the costs and benefits of the proposed project must be considered.

The implementation of the project is expected to result in a number of environmental costs, as detailed within this report. This could include:

» Direct loss of biodiversity, flora and fauna due to the clearing of land for the construction and utilisation of land for the project (which is limited to the development footprint). The majority of the site plays little role in the maintenance of ecological processes. The cost of loss of biodiversity is therefore expected to be limited.
» Visual impacts associated with the project. The cost of loss of visual quality to the area is expected to be low as a result of the location of the facility in relation to other industrial-type developments and limited numbers of sensitive visual receptors in the area.
» Change in land-use and loss of land available for agriculture on the development footprint. The cost in this regard is expected to be limited due to the low agricultural potential of the property.
» Impacts in terms of GHG emissions. Impacts in this regard can be managed through appropriate planning and design of the facility to meet the South African targets in this regard

Apart from impacts associated with GHG emissions, these costs are expected to occur at a local and site level and are considered acceptable provided the mitigation measures as outlined in this EIA and the EMPr are implemented. No fatal flaws associated with the proposed project have been identified.

The positive implications of establishing the project on the demarcated site include:

» The project will result in important socio-economic benefits at the local and regional scale through job creation, procurement of materials and provision of services and other associated downstream economic development. These will persist during the preconstruction, construction and operational phases of the project.
» The project is considered to be a suitable land use for the proposed site due to the low potential for commercial agriculture. Development of the facility will require the implementation of appropriate management actions which could have positive impacts on the surrounding areas specifically in terms of alien vegetation and erosion management.
» The project contributes towards the Provincial and Local goals for the development of additional power generation sources as outlined in the IRP 2010.

» The project is located within an area demarcated for industrial development at a Provincial and Local scale, and is located within an area where a number of industrial-type facilities already occur (facilitating consolidation of similar infrastructure). The location is therefore considered desirable.

The benefits of the project are expected to occur at a national, regional and local level. As the costs to the environment at a site specific level can be largely limited through the appropriate placement of infrastructure on the site within lower sensitivity areas, and impacts associated with GHG emissions can be managed through appropriate planning and design of the facility to meet the South African targets in this regard, the expected benefits of the project are expected to partially offset the localised environmental costs of the project.

The following impacts are anticipated with the implementation of the Do Nothing option:

South African Policy and electricity need: The National Integrated Resource Plan (IRP) developed by the Department of Energy has identified the need for power generation from coal as part of the technology mix for power generation in the country in the next 20 years. The need for the project at a national scale has therefore been determined. The 'do nothing' option will, therefore, not address this national need and may result in the electricity demands in the country not being met in the short-term. This has serious short- to medium-term implications for socio-economic development in South Africa.

Without the new proposed coal-fired power station in Lephalale, an alternative means of generating an additional 1200 MW capacity would be required to be sought from another power generation source or a similar source in another area. However, as more than 50% of the remaining coal reserves in the country are located in the Waterberg area, and optimal grid connection opportunities are available, not developing the project on the proposed site would see such an opportunity being lost. At a local level, the level of unemployment will remain the same and there will not be any transfer of skills to people in terms of the construction and operation of the power station. This power station is intended to be an IPP project to alleviate pressure on Eskom's baseload power supply in the short- medium term through independent power generation. Without the implementation of this project, this will not be achieved, and the greater power supply in the country will be compromised in the near future. This has potentially significant negative impacts on economic growth and social well-being. In addition, limitations on electricity supply may impact the environment in general due to local air quality impacts due to use of low quality coal for domestic purposes, collection of wood from natural areas, etc. Therefore, the no-go option is not considered as a <u>preferred</u> option from this perspective.

Land use: The current land-use is restricted by surrounding industry and mining expansion plans. Should the current land use activities continue, game farming and breeding on the site will continue. The project site is situated in an area characterised by mining and industrial development and is not considered to be viable agricultural land contributing to food security within the province. The potential to utilise the site sustainably and in an optimal way will therefore not be realised. The power station will make better economic use of the land because it will provide relatively higher socio-economic returns than the current land use. While it could withhold the mining of energy resources (gas) beneath the surface, it does not permanently remove them, meaning that these reserves can still be explored in the future. In addition, the consolidation of industrial-type infrastructure will contain the impacts associated with such developments within a node, and will aid in decreasing operational visual impacts to acceptable levels. The proposed development is therefore considered to be an optimal use of the land from a socio-economic and technical perspective for the time-period of the development.

Ecological processes: The majority of the site plays little role in the maintenance of ecological processes. The no-go alternative will therefore not play a role in maintaining any noteworthy ecological systems.

Socio-economic impact: The no-go alternative will result in the economic benefits discussed in section 7.13.1 not being realised and a subsequent loss of income and opportunities to local people, as well as additional capacity of power to the electricity grid. From this perspective the no-go alternative is not preferred.

At a broader scale, the benefits of additional capacity to the electricity grid and those associated with the introduction of energy would not be realised with the implementation of the no go option. The facility is proposed to contribute 1200MW which would have a major positive effect on the electricity supply for the country. The generation of this electricity offers a range of potential socio-economic benefits at a regional and national scale.

In conclusion, the implementation of the no go option would not contribute to the required electricity needs of the country and would not assist in job creation at a local and regional scale. This option is therefore not preferred.

ASSESSMENT OF CUMULATIVE IMPACTS CHAPTER 8

Cumulative impacts in relation to an activity are defined in the Environmental Impact Assessment Regulations as meaning "the impact of an activity that in itself may not be significant, but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area".

There is therefore a legislated requirement to assess cumulative impacts associated with a proposed development. This chapter considers whether the potential impacts associated with the proposed project become more significant when considered in combination with the other known or proposed power station and coal-mining related projects within the area which may have cumulative environmental impacts and implications.

8.1. Approach Taken to Assess Cumulative Impacts

The cumulative impacts that have the potential to be compounded through the development of the proposed power station and its associated infrastructure in proximity to other similar developments include impacts such as those listed below. The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location when considered together with other similar developments:

» Unacceptable loss of threatened or protected vegetation types or species through clearing, resulting in an impact on the conservation status of such flora or ecological functioning;
» Unacceptable risk to water resources resulting due to the increase in the extent of hard or impermeable surfaces in the greater area as well as additional potential pollutants in the area;
» Unacceptable risk to human health through impacts on air quality;
» Unacceptable noise impacts on the surrounding areas;
» Unacceptable loss of heritage resources;
» Complete or whole-scale change in sense of place and character of an area and unacceptable visual intrusion;
» Positive and negative contribution from a socio-economic perspective; and
» Contribution to climate change.

The scale at which the cumulative impacts are assessed is important. For example the significance of the cumulative impact on the regional or national economy will be influenced by similar developments throughout South Africa, while the significance of the cumulative impact at a local scale will only be influenced by similar developments that are in close proximity to each other, up to 30 km apart in this instance. For practical purposes a sub-regional scale has been selected for this cumulative evaluation.

In the sections below the potential cumulative impacts of other industrial-type developments within the region are explored (proposed and operational). The discussion and associated conclusions must be understood in the context of the uncertainty associated with the proposed development and the qualitative nature of the assessment.

8.2. Projects within the Study Area

Over 50% of South Africa's remaining coal reserves lie in the Waterberg coalfields, a 3 500km^2 expanse of Limpopo that stretches into Botswana and hosts almost 76 billion tonnes of in-situ inferred resources in 11 coal-bearing zones. The government has plans to proclaim the area as the Limpopo Coal, Energy and Petrochemical Cluster, as a means of utilising the potential of the Waterberg Coalfield to produce energy for the national economy. In order to exploit this resource, therefore, a number of new coal mines are proposed in the Waterberg area, and the expansion of existing coal mines is proposed. In addition, a number of coal-fired power generation facilities are located or proposed to be located within this region.

The project is proposed on the edge of an existing heavy industrial area which includes the existing Matimba Power Station; the Medupi Power Station, which at the time of reporting was under construction, and the Grootegeluk Coal Mine which supplies the Matimba Power Station.

Planned industrial-type developments in the region include:

» Thabametsi Power Station (1200MW) located to the north of the site (authorised)
» Thabametsi Coal Mine and associated infrastructure (authorised)
» Two new coal-to-liquid fuel plants are planned by Sasol (Mafutha 1 and 2) for the possible exploitation of gas resources (proposed development)
» Sekoko Coal Mine and associated infrastructure (proposed)
» Boikarabelo Power Station (260MW) and associated infrastructure (authorised)
» Vendanta Power plant (600MW) and associated infrastructure (proposed)
» Namane Power Station (600MW0 and associated infrastructure (proposed)
» Dalyshope Phase 1 Colliery and associated infrastructure (proposed)
» Char Plant (proposed)
» Ledjadja Coal (Pty) Ltd
» Mmamabula Energy Complex in Botswana (CIC Energy Corp); and

» Rezoning of properties in the project area for the development of a residential area and an industrial park

8.3. Assessment of Potential Cumulative Impacts

Significant cumulative impacts that could occur due to the development of the power station and its associated infrastructure in proximity to other industrial/mining type developments include impacts such as:

» Impacts on biodiversity
» Impacts on soils and agricultural potential
» Impacts on surface water resources
» Impacts on groundwater resources
» Impacts on air quality and human health
» Impacts on climate change
» Impacts on heritage sites
» Visual impacts
» Socio-economic impacts

8.3.1. Potential Cumulative Impacts on Biodiversity

The immediate area as well as the larger region is characterised by moderate to high levels of habitat loss and fragmentation as a result of numerous developments. Impacts of a cumulative nature on biodiversity, although estimated to be of moderate and low significance, represent a continuous, low level threat to biodiversity on a local and regional scale. The increase in industrial and mining activity in the region implies constant losses of natural habitat and species. This is exacerbated by the decline in environmental quality caused by peripheral and indirect impacts such as species invasion, degradation, contamination, disruption of ecological processes, habitat fragmentation and isolation, etc.

The conservation status of ecological habitat at the project site is regarded as Least Concern. The loss of the vegetation on the site is not expected to result in an escalation of the threat level on a local or regional scale. Habitat loss is however, permanent and local development patterns indicate accelerated losses of natural habitat.

Cumulative impacts of habitat destruction and the associated loss of species are regarded severe on a local and regional scale. Cumulative developments lead to exacerbation of anthropogenic encroachment and resource demands, such as housing, water, etc., which places remaining natural resources under increased pressure. Cumulative impacts on biodiversity as a result of the existing and planned developments (including the Tshivhaso Power Station) are therefore expected to be of **medium significance**.

Cumulative impact tables are presented in more detail in section 24.3 of the specialist report (Appendix C).

8.3.2. Potential Cumulative Impacts on Soils and Agricultural Potential

There are extensive game farm and hunting operations within the broader study area, of which three falls within the site boundary. Livestock and agriculture (limited) are practiced to a lesser extent. Cumulative impacts relate to the permanent loss of agricultural land for game and cattle farming as well as for crop production. Due to the large area affected by the proposed developments (more significantly the mining developments), impacts are potentially significant. Due to the limited crop production in the wider study area, the development of multiple developments within the region is not expected to affect food security in the region.

Due to the low potential of the proposed development site for agriculture, the main potential cumulative impact associated with the proposed project is expected to be soil removal due to wind erosion caused by developments off site. Due to the nature of the soil removal process, once topsoil is taken up into the atmosphere, wind action can deposit it over a large area and at a considerable distance, depending on the strength and duration of the wind acting upon the soils. With the implementation of appropriate mitigation, these impacts can be reduced.

Overall cumulative impacts on soils and agricultural potential are considered to be of **low significance**. Cumulative impacts are discussed in Table 5 of the specialist report (Appendix D)

8.3.3. Potential Cumulative Impacts on Surface Water Resources

Potential impacts on surface water relate to impacts on water quantity and quality in the region. The large number of developments (existing and proposed) within the Lephalale area, together with the expanding population (largely in response to job opportunities being created in the area) is placing pressure on the water resources in the area. The Department of Water Affairs (DWA) is currently implementing the first phase of the Mokolo and Crocodile (West) Water Augmentation Project (MCWAP), consisting of a new pump station with a total pumping capacity of $1.3m^3/s$ fed from the Mokolo Dam outlet works, and a new 42.7 km pipeline generally running parallel to the existing pipeline, from the pump station to the Point of Supply close to Matimba Power Station. The completion of MCWAP 1 will allow for the full abstraction of the unused yield from the dam still available for allocation. The second phase of the MCWAP project will supply additional water to the area thereby reducing the deficit for development. This phase includes the establishment of a transfer scheme from the Crocodile River (West) at Vlieëpoort near Thabazimbi to the Lephalale area.

The A41E and A42J quaternary drainage areas are earmarked for heavy industrial development. These developments include existing and proposed power plants such as Medupi, Grootegeluk, Thabametsi IPP Coal Fired Power Plant as well as the Tshivhaso Power Plant. These power plants are supplied with coal from the Grootgeluk Mine as well as the proposed Thabametsi coal mine.

Developments of this magnitude have a definite long-term impact on the environment. The waste related facilities have a potential to pollute with the concomitant long-term residual impact. The decreased wilderness land-use with a further increase in disturbed and dirty footprint areas may result in the permanent altering of the drainage characteristics of the Sandloop and its associated wetland systems consisting of pans (depressions) and a cluster of wooded drainage lines. Eventually there will be a loss of wetland diversity and wetland functionality within increased development within the catchment.

Impacts on surface water quality (including that within wetland systems) relate to possible sedimentation and contamination from activities associated with the proposed developments. The risks of this occurring increase with the increased number of developments. However, this impact can be successfully minimised through the implementation of appropriate management activities. Cumulative impacts in this regard are therefore expected to be of **low significance**.

8.3.4. Potential Cumulative Impacts on Groundwater Resources

Potential impacts on groundwater relate to impacts on water quantity and quality in the region. Groundwater quantity is potentially affected by opencast mining activities in the region. The establishment of the proposed power station will not affect groundwater quantity as no abstraction from groundwater resources is proposed. Therefore, the proposed project will not contribute to this impact.

Impacts on groundwater quality relate to possible contamination from activities associated with the proposed developments, specifically in terms of stockpiling of coal and waste management activities. The risks of this occurring increase with the increased number of developments. Specific areas of risk associated with the proposed project relate to the ash dump and coal stockpile at the power station, as well as the wastewater treatment works. Should these activities result in impacts on groundwater resources, cumulative impacts with the nearby mining activities (including the Thabametsi mine) may occur. Although these potential impacts could not be quantified (due to no data being available from other developments in the area), these impacts are potentially significant as the groundwater in the area is utilised by landowners for stock watering and potable supply. Appropriate management is therefore vital in this regard. In the instance of the proposed power station, the implementation and management of an appropriate liner system at both the ash dump and coal stockpile areas will minimise the potential for impacts in this regard, thereby reducing the risks of cumulative impacts in the region.

8.3.5. Potential Cumulative Impacts on Air Quality and Human Health

With respect to cumulative impacts, mining and agricultural activities, ash dumps, domestic fuel burning in the area are identified as existing sources of dust. There will thus be a cumulative impact with dust generated during construction and decommissioning of the Tshivhaso Power Station, as well as during normal operations of the proposed coal stockpile and ash dump at the Tshivhaso Power Station.

The Tshivhaso Power Station is located in an area where there are no notable sources of dust, PM_{10}, NO_2 and SO_2 in the immediate vicinity of the site, i.e. within a 5 km radius. Motor vehicle traffic on the R510, R572, R518 and surrounding roads will have some influence on ambient air quality as will domestic fuel burning. Eskom's Matimba and Medupi Power Stations, as well as the Thabametsi Power Station are located in a 15 km radius of the Tshivhaso Power Station and are an important source of NO_2, SO_2 and PM_{10} at that locality. It is therefore expected that there will be compounding of effects and hence cumulative impacts during operation of the Tshivhaso Power Station, as it is also coal-fired.

The probability of cumulative impacts from dust, PM_{10}, NO_2 and SO_2 emitted during normal operation of the Tshivhaso Power Station is considered to be high for all scenarios. The predictive modelling provides maximum expected ambient concentrations for each pollutant based on a worst-case meteorological scenario. These results show that predicted concentrations comply with the national ambient standard throughout the study domain. Despite this, some risk to health remains and the probability of direct and cumulative air quality impacts during the operation of Tshivhaso Power Station is considered to be high.

The extent of direct and cumulative dust impacts during construction and decommissioning are also considered to be limited to the site and its immediate surroundings and be of a nuisance nature only.

For the operational scenarios considered, the extent of direct impacts resulting from SO_2, NO_2 and PM_{10} are limited to the local/municipal area extending only as far as the local community or urban area. For the cumulative effect, limit values for SO_2 and NO_2 are exceeded over a small area around the power station site when emissions from current and future sources are considered. However, no exceedances are predicted at the Tshivhaso Power Station in isolation. The extent of indirect impacts (contribution to acidification in both dry and wet - acid rain - deposition) is local/municipal, extending only as far as the local community or urban area.

Cumulative impacts may result from the dust combining with that from other sources such as the mining and agricultural activities, tailings dams and domestic fuel burning in the area. The cumulative impact of dust emission is therefore considered to be moderate.

Predicted ambient concentrations of SO_2, NO_2 and PM_{10} during the operational scenarios of the Tshivhaso Power Station considered within this EIA are well below health-based air quality standards, with the exception of exceedances for the short term 1-hour and 24-hour limit values for SO_2 and NOx. However no exceedances of the permitted tolerance for the number of exceedances are predicted. The overall magnitude of direct impacts during operation is therefore considered to be low for all operational scenarios. From a cumulative impacts perspective, emissions from Tshivhaso Power Station marginally increase the existing ambient concentrations of all pollutants in the immediate vicinity and the surrounding areas.

The cumulative effect of these emissions with those from the Matimba Power Station, the Medupi and the proposed other power stations in the area are likely to result in exceedances of the ambient standards. The AQMP for the Waterberg-Bojanala Priority Area includes emission reduction requirements to further address this situation. Recommendations made to control/mitigate dust emissions during construction and decommissioning are included the EMP (Appendix N).

8.3.6. Potential Cumulative Impacts on Heritage Sites and Palaeontology

Archaeological sites are non-renewable and impact on any archaeological context or material will be permanent and destructive. However, no heritage sites will be impacted by the proposed Tshivhaso power station activities and no cumulative impacts are anticipated. The risk of significant cumulative impact in the region is therefore considered to be low. It still remains important to observe mitigation measures and to avoid identified sensitive heritage features as far as possible so as to minimise this risk further. Each proposed mining or industrial activity in the area is required to identify sites of heritage significance prior to development.

Through CRM studies for developments in the area, heritage sites are identified and protected from accidental damage, this can be regarded as a positive impact as it adds to the heritage database of the area. In terms of the cumulative impact of this and other developments in the area, as there are numerous developments of varying natures (i.e. mining development) in the area the impact on the heritage landscape and sites of low heritage significance is increased as these sites are destroyed through development. Implementation of Chance Find Procedures in the EMPr reduces cumulative impacts on heritage resources to acceptable levels.

Given the large scale of proposed as well as current mining in the region, the cumulative impacts entailed on local fossil heritage are expected to be high. Loss of fossil heritage resources through coal mining and associated developments can be partially mitigated through constructive collaboration between the palaeontological community and developers, including mine management, as outlined in the following section of the report. Residual negative impacts from loss of fossil heritage would then be partially offset by an improved palaeontological database for the study region as a direct result of appropriate mitigation. This is a positive outcome because any new, well-recorded and suitably curated fossil material from this palaeontologically under-recorded region would constitute a useful addition to our scientific understanding of the fossil heritage here.

8.3.7. Potential Cumulative Visual impacts

Large scale industrial development is already present in the area and includes the adjacent Grootegeluk mine, the existing Matimba Power Station and the Medupi Power Station currently under construction. These establishments are all located within the minor valley and have a led to significant landscape change within the area with large scale structures and spoil heaps being visible over a wide area. In addition associated infrastructure including railway lines, conveyors and overhead power lines are all highly obvious within the area. The affected landscape surrounding the existing industrial zone and the proposed development sites has a large degree of visual absorption capacity due to the relatively flat topography and dense natural vegetation.

The alternatives considered for the power station site are:

a) Graaffwater (Alternative 1) with ashing facility on the same site; and
b) Graaffwater (Alternative 1) with Appelvlakte ashing facility

Of these two alternatives, a) is likely result in all elements being located in close proximity to the existing Grootegeluk Mine dumps to the south of the Stokpoort Road and within an area that is already industrialised whereas b) will see the proposed ashing facility located more remotely from the power station site on the eastern edge of the existing industrial area and closer to existing settlement (Marapong).

The Graaffwater (Alternative 1) with Appelvlakte ashing facility will therefore increase the area of industrial influence to a greater degree than Graaffwater (Alternative 1) with ashing facility on the same site. It could therefore be considered that close proximity of the proposed power station and associated ashing facility on the preferred site (Graaffwater) to the coal supply and existing power stations (existing visual disturbances) effectively consolidates power generation infrastructure within this node.

The Medupi Loop-in power line alternative being considered for the project follows existing transmission line servitudes over a proportion of their length. It is also largely located in areas where screening provided by vegetation prevents major impacts from most public areas. Cumulative impacts associated with the grid connection are therefore expected to be limited.

8.3.8. Potential Cumulative Noise impacts

The Grootegeluk Colliery is located south of the proposed Tshivhaso project. Noises from the colliery may cumulatively add to operations noises from the power station. However the cumulative noise impact during construction and operation is rated as being of low significance based on projected noise rating levels.

While this project will have a noise impact on a number of the closest noise-sensitive receptors, these impacts are of low significance and can be considered insignificant. Cumulative impacts will therefore also be of low significance.

8.3.9. Potential Cumulative Socio-economic impacts

The existing and potential developments in the area present the potential for a number of cumulative socio-economic impacts. Impacts in this regard are expected to be both positive and negative and could occur during the construction and operational phases of the projects.

It is highly likely that if some or all of the proposed projects are approved by government, the demand for goods and services required for construction of similar facilities would grow. This could provide sufficient economies of scale and thus open opportunities for job creation, skills development and the establishment of new industries in the country and new businesses in the local area, specifically in the sectors that are not well-developed in the local economy. This could present positive socio-economic impacts at a local and regional scale as a result of economic upliftment, reduction of poverty and improvement in living conditions.

However, the numerous developments in the area may put pressure on certain local industries, from which products are required in the construction and that are usually sourced from nearby areas due to high transportation costs, for example river sand. Appropriate planning with respect to the activities and preliminary investigation into the local supply capabilities should mitigate this impact. Numerous developments planned for the area will most likely increase the number of job seekers migrating into the area which could have subsequent social impacts (such as conflict with local residents) and would place pressure on local services and housing availability. In addition, numerous developments in the area would impact on land available for agriculture and game farming. This could impact on the tourism industry which is focussed around the game farms in the area, with subsequent impacts on employment in this sector.

8.4 Conclusions Regarding Cumulative Impacts

Water and coal are key natural resources which drive the development of mines and power station developments. The Lephalale area is an identified node for coal and energy having been included as part of the Coal, Energy and Petrochemical Cluster identified by government. At this stage, more than 50% of South Africa's remaining coal reserves are located within the Waterberg Coalfield. Due to the development of the MCWAP by DWS, water is not currently a limiting factor in the area, although this is likely to become limiting in the future.

The development of additional coal-fired power stations within the surrounds of the Grootgeluk Coal Mine, the Matimba Power Station and the soon-to-be-commissioned Medupi Coal-Fired Power Station are referred to in the Waterberg DM IDP (2015/16). The district municipality's IDP highlights that the development of the Medupi Power Station presents an opportunity for future development of the region. The Lephalale LM IDP (2014/2015) reiterates this, stating, "Lephalale is destined to become a major growth point and preferred investment destination in the future and the potential for future investment is bountiful."

The development of the proposed Tshivhaso Power Station along with several other coal-fired power stations in the region will have negative and positive cumulative environmental, social and economic impacts. It is essential that each new coal-fired power station and related coal-developments (such as new coal mines) subscribe to sound environmental management during these projects' life-cycles (construction, operation, decommissioning and rehabilitation phases). This would require input from regulating authorities and applicants during the development of coal mine and power station projects in the region to ensure that cumulative environmental impacts are managed to acceptable levels.

Considering the findings of the specialist assessments undertaken for the project, the cumulative impacts for the proposed project will be acceptable and the majority are rated as being of **low to medium significance** with the implementation of appropriate mitigation. On this basis, the following can be concluded considering the Tshivhaso Power Station and associated infrastructure:

» The construction of the project will not result in the unacceptable loss of threatened or protected plant species. The proposed development is acceptable from an ecological perspective.

» The construction and operation of the project will not result in an unacceptable impact on water resources, provided recommended mitigation measures are implemented.
» The construction and operation of the project will not result in an unacceptable risk to human health through impacts on air quality.
» The construction and operation of the facility will not result in unacceptable noise impacts on the surrounding areas.
» The construction of the project will not result in unacceptable loss of or impact to heritage resources.
» The construction and operation of the project will not result in the complete or whole-scale change in sense of place and character of the area nor will the project result in unacceptable visual intrusion.
» South Africa's Integrated Resource Plan 2010-2030 was brought into effect in March 2011. However, tThe updated version is not yet approved and has been subject to intense political debate. It was devised as a 'living plan' for the future generation of electricity in the country. The plan can be used to make projections of the country's future generation capacities and their associated carbon emissions. These figures can be interpreted as a grid emissions factors for each period and present an estimated national baseline of emissions intensity. This presents a useful benchmark from which to compare the intensity of the Tshivhaso Power Plant.
» The emissions intensity of the Tshivhaso Power plant is 0.978 tonnes/MWh. This is comparable to the expected national emissions intensity projected for 2019.
» The project will not significantly increase the negative impact on the social environment. However, an increase in positive impacts, specifically as a result of job creation and socio-economic benefits, can be expected.

Based on a detailed evaluation, the construction and operation of the proposed Tshivhaso Power Station and associated infrastructure will not result in a significant contribution to cumulative impacts of similar projects in the area. It could also be considered that close proximity of the proposed power station to the coal supply and existing power stations (existing visual disturbances) effectively consolidates power generation infrastructure within this node.

CONCLUSIONS AND RECOMMENDATIONS CHAPTER 9

Cennergi, an Independent Power Producer (IPP) is proposing the construction of a coal-fired power station (the "Project") on a site near Lephalale in the Limpopo Province. The proposed coal-fired power station will have a generating capacity of up to 1 200 MW which is intended to provide electricity for integration into the national grid. The purpose of the proposed Tshivhaso Power Station is to provide baseload power to the national electricity grid.

The main infrastructure that is required for the Tshivhaso coal-fired power station includes*:*

» Access roads.
» Coal storage areas and bunkers. Coal is to be provided to the power station from the new Thabametsi mine to be established to the south-east of the site.
» Pipeline for water supply. Water is to be supplied from the allocation to Exxaro Coal from the Mokolo-Crocodile Water Augmentation Project (MCWAP2).
» Coal loading and offloading areas, as well as conveyor belts.
» Power plant production unit/s (boilers / furnaces, turbines, generator and associated equipment, control room).
» Ash dump.
» Wastewater treatment facilities (including Raw-Water Storage Dams, wastewater treatment works, purification works and reservoirs).
» A High Voltage Yard.
» 400kV overhead power line to connect into the Eskom grid (Matimba – Medupi loop-in line).
» Office and maintenance area/s.

The environmental impact assessment (EIA) for the proposed Tshivhaso Power Station has been undertaken in accordance with the EIA Regulations of December 2014, in terms of Section 24(5) of the National Environmental Management Act (NEMA; Act No 107 of 1998). The EIA Phase aimed to achieve the following:

» Provide an overall assessment of the social and biophysical environments affected by the proposed alternatives put forward as part of the project.
» Assess potentially significant impacts (direct, indirect and cumulative, where required) associated with the proposed project.
» Comparatively assess identified alternatives put forward as part of the project.
» Identify and recommend appropriate mitigation measures for potentially significant environmental impacts.
» Undertake a fully inclusive public involvement process to ensure that I&APs are afforded the opportunity to participate, and that their issues and concerns are recorded.

The conclusions and recommendations of this EIA are the result of the assessment of identified impacts by specialists, and the parallel process of public participation. The public consultation process has been extensive and every effort has been made to include representatives of all stakeholders in the study area.

9.1. Evaluation of the Proposed Project

The preceding chapters of this report together with the specialist studies contained within Appendices C - L provide a detailed assessment of the environmental impacts on the social and biophysical environment as a result of the proposed project. This chapter concludes the EIA process by providing a summary of the conclusions of the assessment of the proposed Thabametsi Power Station and associated infrastructure. In so doing, it draws on the information gathered as part of the EIA process and the knowledge gained by the environmental consultants during the course of the EIA and presents an informed opinion of the environmental impacts associated with the proposed project.

Impacts associated with the project relate to the following:

» Impacts associated with the power station and associated infrastructure, including the transmission lines
» Impacts associated with waste treatment and management activities

9.1.1. Impacts associated with the proposed power station and associated infrastructure

Potential impacts associated with the proposed power station are expected to occur during both the construction and operational phases. Several areas of sensitivity were identified from the specialist studies undertaken (refer to Figure 9.1).

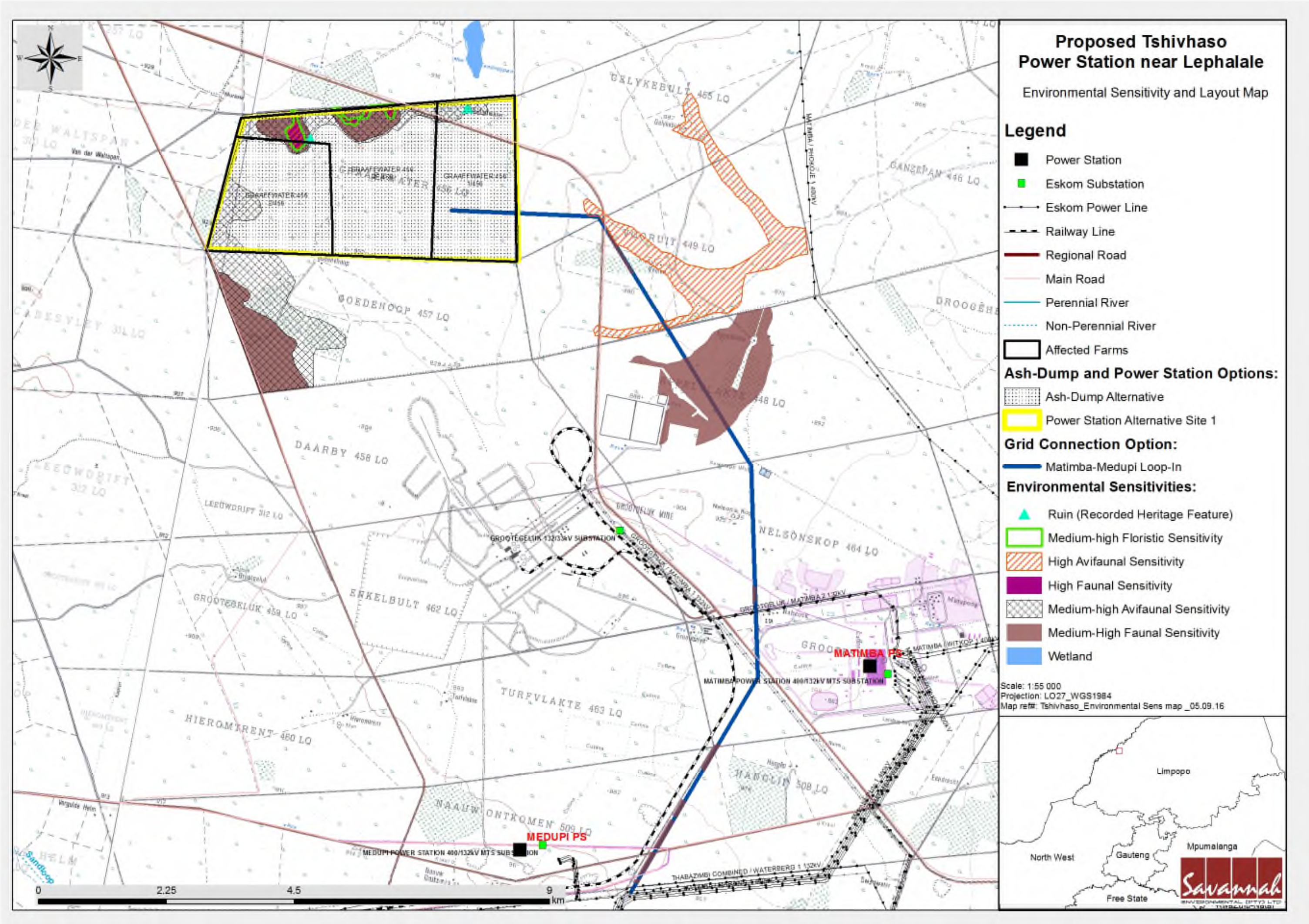


Figure 9.1 Sensitivity map for the project site.

Impact sources associated with the proposed power station and associated infrastructure are expected to include:

» ***Biodiversity impacts*** associated with the construction of the power station and associated infrastructure. While most of the expected impacts associated with this development to the actual footprint will be unavoidable, the success of mitigation will be determined by the success of preventing impacts from spreading outside the footprints of the development. Aspects such as infestation of surrounding habitat by alien and invasive species, the introduction of non-endemic and invasive animals, dust, effluents, contamination, hydro-carbons spillages, human-animal conflict situations, etc. will represent the ultimate challenge of the environmental management plan as these aspects will cause the spread and exacerbation of impacts into the natural environment caused by the development. The major objective of the environmental management programme of the development should therefore be the complete prevention and containment of any impact from the development that might cause harm to areas of surrounding natural habitat.

  Ultimately, the expected loss of natural resources from the site and immediate surrounds because of the development will result in significant, but localised, impacts on the natural environment. While a significant impact is expected on the protected trees that occur on the site, the conservation status and regional abundance of these species are not expected to be affected on a local or regional scale. The overall impact to pans/wetland areas for the project would be considered to be low, as mitigation measures can be adopted in order to avoid direct and indirect impacts on pans/wetland areas. Similarly, animals could potentially be affected severely, but the mobility of most species that are of conservation concern, renders the probability of this impact unlikely.

  Impacts of a cumulative nature, although estimated to result in moderate and low significance, represent a continuous, low level threat to biodiversity on a local and regional scale. The increase in industrial and mining activity in the region implies constant losses of natural habitat and species. This is exacerbated by the decline in environmental quality caused by peripheral and indirect impacts such as species invasion, degradation, contamination, disruption of ecological processes, habitat fragmentation and isolation, etc.

  In conclusion however, no specific impact was identified that would render the proposed development as an unacceptable threat to the biological environment or any specific aspect or species that are known to occur, or could potentially occur within the study area or required servitudes, provided that detailed, comprehensive and sensible environmental management principles are applied throughout the lifetime of the project.

» ***Impacts on Soils and Agricultural Potential*** associated with the construction phase (soil loss and erosion) and the operational phase (permanent loss of agricultural land). The development of the power station will have **low negative impact** on agricultural resources and productivity. The significance of all agricultural impacts is influenced by the fact that the land is suitable only as non-arable, moderate potential grazing land. Soils on the site are sandy in texture and have limited water holding capacity. Erosion potential could increase in areas disturbed on the site during construction unless appropriate mitigation is implemented. Impacts in this regard are however expected to be of **low significance** with the implementation of appropriate management measures.

There are no fatal flaws associated with agriculture on the site and the project can therefore be developed, with the use of good soil management measures, during all its phases.

» ***Impacts on Surface and Groundwater Resources*** related to construction and operation of the power station. Impacts on water resources are related to quality and quantity. Impacts on water quantity of local resources are not expected as water is not proposed to be abstracted from a natural resource in the area, but will rather be obtained through the MCWAP scheme being developed by the Department of Water and Sanitation[11]. The implementation of dry cooling and dry ashing is the preferred technology for the project in order to minimise water required thereby reducing impacts on water resources. Impacts on water quality relate to sedimentation and contamination during all phases of the project life-cycle. These impacts can be successfully managed through the implementation of appropriate mitigation and management measures, such as the use of appropriate liners for the ash dump and coal stockpile areas. Impacts on water resources are expected to be of **Medium to Low significance** post-mitigation. A Water Use License will be required to be obtained from the DWS. On-going water quality monitoring throughout the operational phase is required to be undertaken. A borehole monitoring network should be established for the site in order to monitor groundwater quality.

No fatal flaws were identified in the water resources assessment. From this perspective, therefore, there is no reason why the development should not proceed.

» ***Impacts on air quality and human health*** associated with the construction phase (dust) and the operational phase (emissions from the power station). Impacts associated with the construction phase are expected to be of low

[11] The impacts associated with this scheme have been considered through a feasibility study and impact assessment undertaken by the DWS.

significance. Impacts during operation relate to dust from the ash dump and coal stockpile as well as emissions (SO_2, NO_2 and PM10) from the power station. From the results of the modelling undertaken, air emissions are predicted to be below the national air emission standards. Impacts are expected to be of **moderate significance** for all emissions. Roads should be tarred or traffic control measures implemented to limit vehicle-entrained dust from unpaved roads (e.g. by limiting vehicle speeds and by restricting traffic volumes) and the sidewalls of the ash dump should be vegetated as they rise, and the vegetation cover should be maintained to reduce the exposed area and limit wind entrainment. An Air Emissions License (AEL) is required to be obtained for the power station from the AEL Authority. On-going monitoring will be required to be undertaken throughout the life of the power station.

No fatal flaws were identified in terms of air quality and health impacts. From this perspective, therefore, there is no reason why the development should not proceed.

» ***Noise impacts*** associated with the construction (short-term) and operational (long-term) phases. Impacts are expected to be more significant during the night (22:00 – 06:00) than during the daytime (i.e. 06:00 – 22:00). Impacts during both the construction and operational phases are however expected to be of **low significance**. No mitigation or routine noise monitoring is therefore required in the operation phase of the facility. Generic measures are however recommended for the developer to note. Mitigation measures mainly relate to the planning phase, with the recommendation that the power station be located sufficiently away from potential noise-sensitive receptors. Measurement locations, frequencies and procedures are provided as a guideline for the developer to consider should there be a noise complaint.

No fatal flaws were identified in terms of noise impacts. From this perspective, therefore, there is no reason why the development should not proceed.

» ***Visual impacts*** associated with power station and associated infrastructure. Potential visual impacts are expected to be of **Medium to low significance**. Location of tall elements close to the northern site boundary is likely to make the power station more obvious to routes, homesteads and game farm areas to the north. The location of main elements away from the existing industrial land uses could make the power station more obvious and increase cumulative impacts of industrial development particularly when viewed from the Upland LCA and the D'Nyala Nature Reserve. Vegetation clearance generally during construction could make the power station more visible to surrounding areas and loss of vegetation between the Stockpoort Road and the power station could make the development visible from the road.

The development should be planned to minimise visibility particularly from the Stockpoort Road and from areas to the north of the development as well as to minimise the apparent area of industrial development particularly when viewed from higher areas within the Upland LCA. Ensure that colours used particularly for larger elements within the development do not draw attention to the development particularly when viewed from a distance. Managing vegetation buffers during the operational period to ensure their effectiveness in screening the development from surrounding areas as well as consolidation of industrial-type infrastructure will aid in decreasing operational visual impacts to acceptable levels.

No fatal flaws were identified in terms of visual impacts. From this perspective, therefore, there is no reason why the development should not proceed.

» ***Impacts on Heritage Sites and Palaeontology*** during the construction phase.

In terms of the built environment of the area (Section 34), no standing structures older than 60 years occur within the study area, although the remains of several dilapidated ruins of unknown age were found. From the 1: 50 000 topographic maps of the study area it is clear that no features of significance occurred in the area.

No burial sites were recorded within the development area. It should be noted that ruins such as the features that were recorded in the study area are known to be associated with unmarked graves. If any graves are located in future they should ideally be preserved in-situ or alternatively relocated according to existing legislation. A chance find procedure in this regard must be included within the EMPr for the project.

The known site – Nelson's Kop located to the east of the site - will not be impacted by the proposed development. The impacts of the power line on heritage resources are expected to be low, but it is recommended that the final alignment should be submitted to a heritage walk down prior to construction.

No fatal flaws were identified in the heritage impact assessment study for the power station site. From an archaeological point of view there is no reason why the development should not proceed.

The great majority of the study area for the proposed Tshivhaso Coal-fired Power Plant and associated ash-dumps is underlain by sedimentary rocks of the Karoo Supergroup (Eendragtpan and Clarens Formations) as well as volcanic rocks of the Lebombo Group (Letaba Formation) that are all of low palaeontological sensitivity. Significant impacts on local fossil heritage resources are not anticipated here.

» ***Socio-economic impacts*** expected during both the construction and operation phases of the proposed project. The construction and operation of the power station is expected to have both negative and positive social and economic effects. From a socio-economic perspective, the positive effects in terms of construction, operation, and decommissioning of the coal-based power plant include an increase in national electricity capacity, economic development, job creation, increase in household income, and government revenue. However, the coal-based power station will be associated with a number of other negative effects that are more challenging to quantify and to offset. These are associated with the sense of place, property values, social pathogens, standards of living, and pressure on socio-economic infrastructure. Importantly, most of the negative impacts will be limited to the local economy or surrounding area, while positive effects will accumulate to the local and national economies. Considering that many of the negative impacts will also be possible to mitigate, although not completely eliminate, the trade-offs between negative and positive effects suggest that from the socio-economic perspective the project should be approved for development. The project will contribute to achieving local and national government developmental objectives at a relatively limited cost. Nonetheless, it is imperative that the construction, operation, and decommissioning of the project should be conducted in the most sustainable way with the primary objective of minimising, and where feasible, completely eliminating the potential for deterioration of human livelihoods, reducing business turnover, and altering the environment in the proposed area. This can be achieved to some extent through the prioritisation of using local labour and service providers, as well as through obtaining materials from local sources.

No fatal flaws were identified in terms of socio-economic impacts. From this perspective, therefore, there is no reason why the development should not proceed.

» ***Impacts on Climate Change.*** From the analysis undertaken within this EIA process, it is apparent that the proposed circulating fluidised bed combustor, fuelled with 100% coal, is in fact the most intensive in terms of carbon emissions. As such, it is the option that will have the greatest impact on climate change. While pulverised fuel will produce marginally less emissions, both technologies will produce emissions intensities above the forecasted 2025 national baseline, as expected from base load generation. Once operational there will be limited potential for the plant to reduce its emissions over its lifetime. For this reason, a hybrid technology which may allow for the gradual addition of biomass or solar thermal energy into the plant is strongly suggested.

The facility should be designed with this potential addition in mind. Making provisions for the future addition of carbon capture and storage systems presents another opportunity to reduce carbon emissions.

The management of coal stockpiles and maintenance of coal crushers are important areas for operational emissions management. It would be advisable to include these facilities as core areas within a Carbon Management Plan for the power plant. Such a plan could be modelled on the Plan Do Check Act (PDCA) approach within the ISO 9001 Quality Management System Requirements. Beyond the two priority areas mentioned in the specialist report (Appendix L), the plan should aim to incorporate carbon management into the everyday organisation practices of the power plant. In general a good governance structure with high level responsibility for carbon emissions and climate change assist in effectively implementing such management plans. Specifically, it is recommended that the management plan ensure that coal be stored appropriately so as to protect it from unnecessary moisture exposure. The storage and transportation of coal must also be managed in such a way that it does not crush the coal beyond its useful size. Maintaining the coal crushers will further ensure that the coal particles are optimally sized.

Monitoring is essential to tracking the effectiveness of any carbon management plan. Monitoring of the moisture content and size of the coal particles supplied to the furnace will be of particular interest for CFB combustion. This information should be supported by the monitoring of the coal storage conditions, transport systems and crusher performance. Furthermore, it will be valuable to monitor the on-site electricity demands as these form part of a plant's parasitic load requirements and effectively reduce the amount of exportable electricity per tonne of CO_2 emitted. The specific monitoring of carbon emissions will become a requirement as part of the carbon tax and may even require Tier 3 direct emissions measurement in the future. Thus is may be advisable to consider the inclusion of systems for emissions monitoring via direct measurement.

The Project is being developed in line with South Africa's energy policy framework. The magnitude of the GHG emissions from the project is expected to be very high. However new coal power plants will always have High (Negative) impacts from a GHG perspective due to the nature of their emissions, and this is not considered to be a fatal flaw provided that mitigation proposed is implemented.

» **Cumulative impacts**. Considering the findings of the specialist assessments undertaken for the project, the cumulative impacts for the proposed project will be acceptable and the majority are rated as being of **low to medium significance** with the implementation of appropriate mitigation. On this basis, the following can be concluded considering the Tshivhaso Power Station and associated infrastructure:

* The construction of the project will not result in the unacceptable loss of threatened or protected plant species. The proposed development is acceptable from an ecological perspective.
* The construction and operation of the project will not result in an unacceptable impact on water resources, provided recommended mitigation measures are implemented.
* The construction and operation of the project will not result in an unacceptable risk to human health through impacts on air quality.
* The construction and operation of the facility will not result in unacceptable noise impacts on the surrounding areas.
* The construction of the project will not result in unacceptable loss of or impact to heritage resources.
* The construction and operation of the project will not result in the complete or whole-scale change in sense of place and character of the area nor will the project result in unacceptable visual intrusion.
* The project will not significantly increase the negative impact on the social environment. However, an increase in positive impacts, specifically as a result of job creation and socio-economic benefits, can be expected.
* The greenhouse gas emissions from the power plant are highly cumulative in nature due to the global scope of climate change and the long durations that carbon emission are expected to remain in the atmosphere. As greenhouse gas emissions accumulate in the atmosphere the onset of climate change is likely to be accelerated and then sustained. South Africa's emissions reduction targets are also likely to be impacted by the plant's emissions.

Based on a detailed evaluation, the construction and operation of the proposed Tshivhaso Power Station and associated infrastructure will not result in a significant contribution to cumulative impacts of similar projects in the area. It could also be considered that close proximity of the proposed power station to the coal supply and existing power stations (existing visual disturbances) effectively consolidates power generation infrastructure within this node.

From the above conclusions of the specialist studies undertaken, it is concluded that the impacts associated with the construction and operation of the power station and associated infrastructure are expected to be of Medium to Low significance with the implementation of appropriate mitigation measures. No environmental fatal flaws were identified to be associated with the proposed project.

9.1.2. Impacts associated with waste treatment and management activities

Impacts associated with waste treatment and management activities relate to those associated with the ash dump and the wastewater treatment works. Potential impacts on surface and groundwater are anticipated should appropriate mitigation measures not be implemented. In terms of the assessment of impacts undertaken within this EIA study, impacts on water resources are expected to be of **Medium to Low significance** post-mitigation. On-going water quality monitoring throughout the operational phase is required to be undertaken. A borehole monitoring network should be established for the site in order to monitor groundwater quality. In addition, an appropriate Integrated Water and Waste Management Plan (IWWMP) must be developed and implemented for all phases of the proposed project.

9.1. Selection of Preferred Ash Dump Alternative

In general, the nature and extent of impacts identified to be associated with the ash dump alternatives is dependent on the site which is selected. From the specialist studies undertaken, various conclusions have been drawn regarding the preferred alternative for establishment of the ash dump. Table 9.1 provides a summary of the preferences in this regard.

Table 9.1: Ash Dump alternatives as nominated by the specialist studies

Issue	Graaffwater Option	Applevlakte Option
Biodiversity	Slightly preferred for flora	Preferred for avifauna and fauna
Wetlands & Surface Water	**Preferred**	Not preferred but acceptable
Groundwater	No preference	
Soils and agriculture	No preference	
Visual	**Preferred**	Not preferred but acceptable
Air Quality	No preference	
Noise	No preference	
Heritage	No preference	
Socio-economic	No preference	

In terms of the conclusions of the specialist studies, all alternatives are considered to be acceptable. Locating the ashing facility on the same site as the power station (**Farm Graaffwater**) is preferred from a visual and surface water perspective and is therefore nominated as the preferred option.

9.2. Overall Conclusion (Impact Statement)

The findings of the specialist studies undertaken within this EIA to assess both the benefits and potential negative impacts anticipated as a result of the proposed project conclude that:

» The impacts associated with the construction and operation of the power station and associated infrastructure are expected to be of Medium to Low significance with the implementation of appropriate mitigation measures.
» Several areas of sensitivity were identified within the project development area - refer to Figure 9.1. These areas must be taken into consideration when Cennergi plan their detailed on-site layouts.
» The Project is being developed in line with South Africa's energy policy framework. The magnitude of the GHG emissions from the project is expected to be very high. However new coal power plants will always have High (Negative) impacts from a GHG perspective due to the nature of their emissions, and this is not considered to be a fatal flaw provided that mitigation proposed is implemented.
» No environmental fatal flaws were identified to be associated with the proposed project.
» From the assessment of the ash dump alternatives, the option to locate the ash dump on Graaffwater (the same site as the power station) is preferred.
» CFB Technology is considered preferable over conventional pulverised fuel technology due to the potential to utilise lower grade coals in the area and the reduction of emissions with the implementation of this technology. This technology is however the most intensive in terms of carbon emissions. The facility should therefore be designed with the potential addition of biomass of solar thermal hybrid technology in mind. Making provisions for the future addition of carbon capture and storage systems presents another opportunity to reduce carbon emissions.
» Dry cooling and dry ashing are considered to be the preferred options as these will minimise the requirements for water.

9.3. Overall Recommendation

Based on the nature and extent of the proposed project, the local level of disturbance predicted, the benefits expected at a regional and national scale, the findings of the EIA, and the understanding of the significance level of potential environmental impacts, it is the opinion of the EIA project team that the project can proceed on condition that the mitigation measures specified in Chapter 7 and within the EMPr are observed and implemented.

Upon authorisation of the proposed project by the DEA, the following conditions must be included within the authorisation issued:

Management and compliance monitoring

- » All mitigation measures detailed within this report and the specialist reports contained within Appendices C to L must be implemented.
- » The Environmental Management Programme (EMPr) as contained within Appendix M of this report must be used to ensure compliance with environmental specifications and management measures. The implementation of this EMPr for all life cycle phases of the proposed project is considered to be key in achieving the appropriate environmental management standards as detailed for this project.
- » An independent Environmental Control Officer (ECO) must be appointed by the project developer prior to the commencement of any authorised activities. The ECO must monitor compliance with all applicable environmental legislation and requirements throughout the construction phase.

Design

- » Following the final design of the facility, a final layout indicating all relevant infrastructure and affected areas (permanent and temporary) must be submitted to DEA for review and approval prior to commencing with construction. This layout must consider all sensitive areas identified within the site and servitude corridors.
- » Develop and implement a stormwater management plan for the project considering all stormwater and water pollution control facilities such as Pollution Control Dams and storm water drainage system. Pollution control infrastructure is required to be designed in accordance with Regulation 636 of August 2013 published in terms of the NEM: Waste Act (Act No 59 of 2008).
- » An appropriate liner system must be installed at the ash disposal system to be designed in accordance with Regulation 636 of August 2013 published in terms of the Waste Act.
- » During construction, unnecessary disturbance to habitats should be strictly controlled and the footprint of the impact should be kept to a minimum.

Biodiversity maintenance and integrity

- » Conduct an ecological walk through survey for the power station and all associated infrastructure including power lines. Results of this survey must guide permitting requirements for the removal of protected trees from the selected property.
- » A detailed Alien and Invasive Plant Management Plan must be developed and implemented throughout the project life-cycle up to the decommissioning phase.
- » A rehabilitation programme that makes use of locally endemic or indigenous species must be developed and implemented.
- » Site rehabilitation of temporary laydown and construction areas to be undertaken immediately after construction is completed in an area.

» Limit the development to the facility footprint area and avoid impacts in adjacent habitats.
» Demarcation of suitable areas for development (mainly on habitat with low sensitivity) prior to commencement of construction.
» Undertake Search and Rescue of protected species within the development footprint prior to the undertaking of construction activities. All search and rescue must be undertaken in terms of a relevant permit obtained from the relevant conservation authority.

Air quality management
» Design and implement an air quality management plan for the operational phase of the power station.
» It is important that an emission control and reduction strategy for dust is designed and implemented, ensuring that the contribution to ambient concentrations is minimised. Roads should be tarred or traffic control measures implemented to limit vehicle-entrained dust from unpaved roads. The sidewalls of the ash dump should be vegetated as they rise, and the vegetation cover should be maintained to reduce the exposed area and limit wind entrainment. Stabilise open areas with dust palliative, gravel or similar.

Surface water and wetlands
» Where wetlands are impacted by the project, a rehabilitation programme must be prepared and implemented.
» A stormwater management plan demonstrating the separation of clean and dirty stormwater flows must be prepared and implemented.
» An Integrated Water and Waste Management Plan (IWWMP) must be developed and implemented for all phases of the proposed project.
» An Integrated Water Use License must be obtained from the Department of Water and Sanitation for all relevant water uses.

Groundwater
» Update the numerical model contained within the specialist EIA study against monitored data during operations.
» Water quantity and quality data should be collected on a regular, ongoing basis during operation. These data must be used to recalibrate and update the water management model, to prepare monitoring and audit reports, to report to the regulatory authorities against the requirements of the IWUL and other authorisations and as feedback to stakeholders in the catchment, perhaps via the CMA.
» The monitoring as recommended in the specialist geohydrology report should be established prior to operation. Geochemical analyses and modelling must be conducted on the material during operations to update the transport model and refine geochemical predictions.

Management of heritage features

» Conduct a heritage walk through survey for the power station and all associated infrastructure including power lines. Any heritage sites recorded during this survey could be mitigated by micro adjustments of the layout or through the recording of the site prior to destruction.
» Include a chance finds procedure within the EMPr for the project to address the procedures to follow in the event of unearthing archaeological or palaeontological material or graves during the construction process.

Waste management

» Monitoring of waste treatment and management facilities throughout all phases of the project should be undertaken.
» Develop and implement an Integrated Water and Waste Management Plan (IWWMP) for all phases of the project.

Noise monitoring

» No mitigation or routine noise monitoring is required in the operation phase of the facility. However, if noise measurements are conducted, annual feedback should be presented to all stakeholders and other Interested and Affected parties in the area.

Climate Change

» The facility should be designed with the potential addition of biomass of solar thermal hybrid technology in mind in order to reduce carbon emissions beyond 2025. Making provisions for the future addition of carbon capture and storage systems presents another opportunity to reduce carbon emissions.

Social impacts

» During the design and construction phase the developer should meet with local communities to determine their concerns and take into consideration any mitigating proposals. An appropriate grievance mechanism and communications plan should be designed and implemented for the project.
» Increase the local procurement practices and employment of people from local communities as far as feasible to maximize the benefits to the local economies.
» Develop and implement a traffic management plan for the construction and operational phases of the power station.

Mineral consent

» A Section 53 Application should be submitted to the Department of Mineral Resources (DMR) to ensure that proposed activities do not sterilise a mineral resource that might occur on site.

Rehabilitation and operations

» Site rehabilitation of temporary laydown and construction areas are to be undertaken immediately after construction.

The process of communication and consultation with the community representatives must be maintained after the closure of this EIA process, and, in particular, during the construction phase associated with the proposed project.

REFERENCES CHAPTER 10

Biodiversity

AGIS, 2007. Agricultural Geo-Referenced Information System, accessed from www.agis.agric.za on 2010.

ALEXANDER, G. & MARAIS, J. 2007. A Guide to the Reptiles of Southern Africa. Struik Publishers, Cape Town.

BARNES, K.N. 1998. *The Important Bird Areas of southern Africa*. BirdLife South Africa, Johannesburg.

BARNES, K.N. 2000. *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg.

BEGON, M., HARPER, J.L. & TOWNSEND, C.R. 1990. Ecology. Individuals, Populations and Communities. Blackwell Scientific Publications, USA.

BIRDLIFE INTERNATIONAL 2012. *Terathopius ecaudatus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012. http://www.iucnredlist.org/.

BIRDLIFE INTERNATIONAL 2012a. *Coracias garrulus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. http://www.iucnredlist.org/.

BIRDLIFE INTERNATIONAL 2013a. *Ardeotis kori*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013. http://www.iucnredlist.org/.

BIRDLIFE INTERNATIONAL 2013b. *Polemaetus bellicosus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013. http://www.iucnredlist.org/.

BIRDLIFE INTERNATIONAL 2013b. *Sagittarius serpentarius*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. http://www.iucnredlist.org/.

BIRDLIFE INTERNATIONAL 2015a. *Gyps coprotheres*. In: IUCN 2015. IUCN Red List of Threatened Species. Version 2015. http://www.iucnredlist.org/.

BIRDLIFE INTERNATIONAL 2015b. *Gyps africanus*. In: IUCN 2015. IUCN Red List of Threatened Species. Version 2015. http://www.iucnredlist.org/.

BIRDLIFE INTERNATIONAL 2015c. *Torgos tracheliotos*. In: IUCN 2015. IUCN Red List of Threatened Species. Version 2015. http://www.iucnredlist.org/.

BIRDLIFE SOUTH AFRICA. 2016. BirdLife South Africa Checklist of Birds in South Africa, 2016.

BRACKENBURY, J. 1995. Insects and Flowers. A Biological Partnership. Wellington House, London, UK.

BRANCH, B. 1998. Field Guide to Snakes and Other Reptiles of Southern Africa. Struik Publishers, Cape Town.

BRANCH, W.R. 1998. South African Red Listed Book – Reptiles and Amphibians. National Scientific Programmes Report No 151.

BROWN, L.H., URBAN, E.K. & NEWMAN, K. 1982. *The birds of Africa*. Vol. 1. London: Academic.

BUCKLAND, S.T., ANDERSON, D.R., BURNHAM, K.P., LAAKE, J.L. 1993. *Distance Sampling: Estimating abundance of biological populations*. Chapman and Hall, London.

CARRUTHERS, V. (ed.). 2000. The Wildlife of Southern Africa. A Field Guide to the Animals and Plants of the Region. Struik Publishers, Cape Town.

CARRUTHERS, V. 2001. Frogs & Frogging in Southern Africa. Struik Publishers, Cape Town.

CHANNING, A. 2001. Amphibians of Central and Southern Africa. Protea Book House, Pretoria.

CLARKE, K.R. & WARWICK, R.M. 1994. *Changes in marine communities: An approach to statistical analysis and interpretation*. Natural Environmental Research Council, United Kingdom.

COLWELL, R. K. EstimateS: Statistical estimation of species richness and shared species from samples. Version 8. Persistent URL <purl.oclc.org/ estimates>.

CONVENTION ON BIOLOGICAL DIVERSITY. Signed 1993 and ratified 2 November 1995.

COWLING, R. Foresight biodiversity report. Department of Science and Technology. South Africa. 2000.

DEL HOYO, J., ELLIOTT, A. & CHRISTIE, D.A. eds. 1992-2011. *Handbook of the Birds of the World*. Vol 1-16. Lynx Edicions, Barcelona.

DEL HOYO, J., ELLIOTT, A. & SARGATAL, J. 2001. *Handbook of the Birds of the World, vol. 6*: Mousebirds to Hornbills. Lynx Edicions, Barcelona, Spain.

DEL HOYO, J.; COLLAR, N. J.; CHRISTIE, D. A.; ELLIOTT, A.; and FISHPOOL, L. D. C. 2014. *HBW and BirdLife International Illustrated Checklist of the Birds of the World*. Lynx Edicions BirdLife International.

DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM. 2001. Environmental Potential Atlas. DEAT, Pretoria.

DESMET, P. G., HOLNESS, S., SKOWNO, A. & Egan, V.T. (2013). Limpopo Conservation Plan, v.2: Technical Report. Contract Number EDET/2216/2012. Report for Limpopo Department of Economic Development, Environment & Tourism (LEDET) by ECOSOL GIS.

DIPPENAAR-SCHOEMAN, A.S. 2002. Baboon and Trapdoor Spiders of Southern Africa: An Identification Manual. ARC – Plant Protection Research Institute, Pretoria.

DIPPENAAR-SCHOEMAN, A.S. & JOCQUE, R. 1997. African Spiders, an Identification Manual. ARC – Plant Protection Institute, Pretoria.

DU PREEZ, L. & CARRUTHERS, V. 2009. A Complete Guide to the Frogs of Southern Africa. Struik Nature, Cape Town.

EKOINFO & ASSOCIATES (WITH CONTIRBUTIONS FROM Pachnoda consulting cc). 2013. *SPECIALIST: Biodiversity Baseline Report For The Zonderwater Project Area, Limpopo Province - Contract No: 2089/72/CA*. A report compiled for Exxaro Resources.

ENDANGERED WILDLIFE TRUST. 2002. The Biodiversity of South Africa 2002. Indicators, Trends and Human Impacts. Struik Publishers, Cape Town.

ENDANGERED WILDLIFE TRUST. 2004. Red Listed Book of the Mammals of South Africa: A Conservation Assessment. CBSG Southern Africa, Parkview, South Africa.

EVANS, H.E. 1984. Insect Biology, Addison-Wesley Publishing Company, USA.

FEINSINGER, P. 2001. *Designing field studies for biodiversity conservation*. The Nature Conservancy. Island Press.

FILMER, M.R. 1991. Southern African Spiders. An identification guide. Struik Publishers, Cape Town.

GIANT BULLFROG CONSERVATION GROUP. 2004. www.giantbullfrog.org.

GIBBON, G. 2003. Roberts' Multimedia Birds of Southern Africa. Version 3. Southern African Birding cc, Westville.

GILL, F. & DONSKER, D. eds. 2012. *IOC World Bird Names* (v. 2.11).

GILL, F. & DONSKER, D. eds. 2016. *IOC World Bird Names* (v. 6.3).

GOVERNMENT GAZETTE [of the Republic of South Africa]. 2001. Amendments to the Conservation of Agricultural Resources Act, 1983 (Act No.43 of 1983). Government Gazette, 429 (22166) of 30 March 2001. Department of Agriculture, Republic of South Africa.

GROVE, A.J. & NEWELL, G.E. 1962. Animal Biology, 6th ed. revised. University Tutorial Press, London.

HACKETT, S.J., KIMBALL, R., REDDY, S., BOWIE, R.C.K., BRAUN, E.L., BRAUN, M.J., CHOJNOWSKI, J.L., COX, W.A., HAN, K-L., HARSHMAN, J., HUDDLESTON, C.J., MARKS, B.D., MIGLIA, K.J., MOORE, W.S., SHELDON, F.H., STEADMAN, D.W., WITT., C.C. & YURI, T. 2008. A phylogenomic study of birds reveals their evolutionary history. *Science* 320: 1763-1767.

HARDAKER, T. 2016. Southern African Bird List - Version 06 - 22 April 2016.

HARRISON, J.A., ALLAN, D.G., UNDERHILL, L.G., HERREMANS, M., TREE, A.J., PARKER, V. & BROWN, C.J. (eds.). 1997. *The Atlas of Southern African Birds. Vol. 1 & 2*. BirdLife South Africa, Johannesburg.

HENNING, S.F. & HENNING, G.A. 1989. South African Red Listed Book – Butterflies. South African National Scientific Programmes Report No 158.

HILDEBRAND, M. 1988. Analysis of Vertebrate Structure, 3rd ed. John Wiley & Sons, Inc., New York.

HOCKEY, P.A.R., DEAN, W.R.J. & RYAN, P.G. (eds.) 2005. *Roberts – Birds of Southern Africa, VIIth ed*. The Trustees of the John Voelker Bird Book Fund, Cape Town.

HOFFMAN T. & ASHWELL A. 2001. Nature Divided: Land degradation in South Africa. University of Cape Town Press, Cape Town

HOLM, E. 1986. Insekgedrag Menslik Betrag. Ekogilde cc, Pretoria.

HOLM, E. & MARAIS, E. 1992. Fruit Chafers of southern Africa. Ekogilde, Hartebeespoort.

HOLM, E. 2008. Inseklopedie van Suider-Afrika. Lapa Uitgewers, Pretoria.

http://sabap2.adu.org.za. South African Bird Atlas Project 2.

http://sabca.adu.org.za. South African Butterfly Conservation Assessment.

http://sarca.adu.org.za. South African Reptile Conservation Assessment.

INTERIM RED LISTED LIST OF SOUTH AFRICAN PLANT SPEICIES. (2004). Produced by the Threatened Species Programme (TSP) in collaboration with

National Botanical Institute (NBI), NORAD and the Department of Environment Affairs and Tourism (DEAT). www.sanbi.org.

IUCN Red List of Threatened Species. Version 2011.1. http://www.iucnredlist.org/.

IUCN Red List of Threatened Species. Version 2015. http://www.iucnredlist.org/.

IUCN Red List of Threatened Species. Version 2016. http://www.iucnredlist.org/.

IUCN. 2001. IUCN Red List Categories & Criteria. In: Red Listed Book of the Mammals of South Africa: A Conservation Assessment. CBSG Southern Africa, Parkview, South Africa.

JENKINS, A. R. 2005. *Lanner Falcon*. In: Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (eds) Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

KNOBEL, J. 1999. The magnificent natural heritage of South Africa. Sunbird Publishing, South Africa.

KURE, N. 2003. Living with Leopards. Sunbird Publishing, Cape Town.

LEEMING, J. 2003. Scorpions of Southern Africa. Struik Publishers, Cape Town.

LEROY, A. & LEROY, J. 2003. Spiders of Southern Africa. Struik Publishers, Cape Town.

LIEBENBERG, L. 2000. Tracks & Tracking in Southern Africa. Struik Publishers, Cape Town

Limpopo Environmental Management Act, 2003 (No 7 of 2003)

Limpopo Environmental Management Act, 2003 (No 7 of 2003)

MARNEWICK, M.D., RETIEF, E.F., THERON, N.T., WRIGHT, D.R. and ANDERSON, T.A. 2015. *Important Bird and Biodiversity Areas of South Africa*. Johannesburg: BirdLife South Africa.

MINTER, L.R., BURGER, M., HARRISON, J.A., BRAACK, H.H., BISHOP, P.J. & LOAFER, D., eds. 2004. Atlas and Red Listed Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington DC.

MUCINA, L. & RUTHERFORD, M.C. (eds.). 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia 19*. South African National Biodiversity Institute, Pretoria.

National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004).

PERRINS, C. & HARRISON, C.J.O. 1979. Birds: Their Life, Their Ways, Their World, Reader's Digest Ed. Elsevier Publishing Projects, New York.

PICKER, M., GRIFFITHS, C. & WEAVING, A. 2002. Field Guide to Insects of Southern Africa. Struik Publishers, Cape Town.

PRINGLE, E.L.L., HENNING, G.A. & BALL, J.B. 1994. Pennington's Butterflies of Southern Africa. Struik Publishers, Cape Town.

RALPH, C.J., SAUER, J.R. AND DROEGE, S. 1995. *Monitoring bird populations by point counts*. USDA Forest Service, General Technical Report PSW-GTR-149.

RETIEF, E & HERMAN, P.P.J. 1997. Plants of the northern provinces of South Africa: keys and diagnostic characters. National Botanical Institute, Pretoria.

SCHOLTZ, C.H. & HOLM, E. 1989. Insects of Southern Africa. Butterworths, Durban.

SIBLEY, C.G. & AHLQUIST, J.E. 1990. *Phylogeny and classification of birds*. Yale University Press, New Haven.

SKINNER, J.D. & SMITHERS, R.H.N. 1990. The Mammals of the Southern African Subregion. University of Pretoria, Pretoria.

SMITHERS, R.H.N. 1986. South African Red Listed Book – Terrestrial Mammals. South African National Scientific Programmes Report No 125.

SPECTOR, S. 2002. Biogeographic crossroads as priority areas for biodiversity conservation. Conservation Biology 16(6): 1480-1487.

STUART, C. & STUART, T. 2000. A field Guide to the Tracks and Signs of Southern and East African Wildlife. Struik Publishers, Cape Town.

SUTHERLAND, W.J. (ed.). 2006. Ecological Census Techniques, 2nd ed. Cambridge University Press, UK.

SUTHERLAND, W.J. 2006. *Ecological census techniques. A handbook*. 2nd Edn. Cambridge University Press.

SUTHERLAND, W.J., NEWTON, I. AND GREEN, R. E. 2004. *Bird Ecology and Conservation. A handbook of techniques*. Oxford University Press.

SWANEPOEL, D.A. 1953. Butterflies of South Africa. Where, When and How they fly. Maskew Miller Limited, Cape Town.

TARBOTON, W.R & ALLEN, D.G. 1984. The status and the conservation of birds of prey in the Transvaal. *Transvaal Mus. Monograph* 3.

TAYLOR, M.R. (ed.) In press. *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg.

TAYLOR, M.R., PEACOCK, F. and WANLESS, R. (eds.). 2015. *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg.

TAYLOR, P.J. 2000. Bats of Southern Africa. University of Natal Press, South Africa.

THREATENED SPECIES PROGRAMME (TSP). 2007. *Interim Red Data List of South African Plant Species*. Produced in collaboration with the National Botanical Institute (NBI), NORAD and the Department of Environmental Affairs and Tourism (DEAT).

TOLLEY, K. & BURGER, M. 2007. Chameleons of Southern Africa. Struik Publishers, Cape Town.

UNEP. 2002. Global Environment Outlook –3: Past, present and future perspectives. United Nations Environment Programme, Earthscan Publications Ltd, London.

VAN RIET, W., P. CLAASSEN, J. VAN RENSBURG, T. VILJOEN & L. DU PLESSIS. 1997. *Environmental Potential Atlas for South Africa*. J.L. van Schaik, Pretoria.

VAN WILGEN B.W. & VAN WYK E. 1999. Invading alien plants in South Africa: impacts and solutions. In: People and rangelands building the future.

VAN WYK B. & GERICKE N. (2000). People's Plants. Briza Publications, Pretoria.

VISSER D.J.L. (1984). The Geology of the Republics of South Africa, Transkei, Bophutatswana, Venda and Ciskei en the Kingdoms of Lesotho and Swaziland.

Fourth Edition. Department of Mineral and Energy Affairs. Republic of South Africa.

WATSON, D.M. 2003. The 'standardized search': An improved way to conduct bird surveys. *Austral Ecology* 28: 515-525.

WILSON, D.E. & MITTERMEIER, R.A. (eds.). 2009. Handbook of the Mammals of the World – Volume 1: Carnivores. Lynx Editions, Barcelona.

WOOD, J., Low, A.B., Donaldson, J.S., & Rebelo, A.G. 1994. *Threats to plant species through urbanisation and habitat fragmentation in the Cape Metropolitan Area, South Africa*. In: Huntley, B.J. (Ed.) Botanical Diversity in Southern Africa. National Botanical Institute, Pretoria.

WOODHALL, S. 2005. Field Guide to the Butterflies of South Africa. Struik Publishers, Cape Town.

www.nwgp.gov.za/Agriculture/NW_ENVIRONMENTAL_OUTLOOK

www.sabap2.adu.org.za

www.sabap2.adu.org.za

www.southafricanbiodiversity.co.za/endangered

WYNBERG R. 2002. A decade of biodiversity conservation and use in South Africa: tracking progress from the Rio Earth Summit to the Johannesburg World Summit on Sustainable Development. South African Journal of Science 98: 233-243.

Air Quality

CCINFO, (1998 and 2000): The Canadian Centre for Occupational Health and Safety database. http://ccinfoweb.ccohs.ca visited on 21 July 2003.

DEA, (2009): National Ambient Air Quality Standards, Government Gazette, 32861, Vol. 1210, 24 December 2009.

DEA, (2012a): National Ambient Air Quality Standard for Particulate Matter of Aerodynamic Diameter less than 2.5 micometers, Notice 486, 29 June 2012, Government Gazette, 35463.

DEA, (2012b): Guideline to Air Dispersion Modelling for Air Quality Management in South Africa, draft regulation.

DEA, (2015): Waterberg-Bojanala Priority Area Air Quality Management Plan and Threat Assessment, June 2015.

DEA, (2016): Regulation prescribing the Atmospheric Emission Licensing processing fee, Notice 250, Government Gazette, 39805, 11 March 2016

EAE, (2006): Encyclopaedia of the Atmospheric Environment, 2006, Nitrogen [Online], http://www.ace.mmu.ac.uk/eae/Air_Quality/Older/Nitrogen_Dioxide.html

Hurley, P. (2000): Verification of TAPM meteorological predictions in the Melbourne region for a winter and summer month. Australian Meteorological Magazine, 49, 97-107.

Hurley, P.J., Blockley, A. and Rayner, K. (2001): Verification of a prognostic meteorological and air pollution model for year-long predictions in the Kwinana industrial region of Western Australia. Atmospheric Environment, 35(10), 1871-1880.

Hurley, P.J., Physick, W.L. and Ashok, K.L. (2002): The Air Pollution Model (TAPM) Version 2, Part 21: summary of some verification studies, CSIRO Atmospheric Research Technical Paper No. 57, 46 p.

South African Weather Bureau (SAWB) (1992): Climate tables of South Africa, Climate Statistics, WB42.

United States Environmental Protection Agency (US EPA) (2015): Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources. Chapter 3: Stationary Internal Combustion Sources. http://www.epa.gov/ttn/chief/ap42/ch03/index.html. Visited 1 December 2015.

uMoya-NILU (2013): Atmospheric Impact Report in support of Eskom's application for exemption from the minimum emission standards and/or extension of the minimum emission standards compliance timeframes for the Matimba Power Station, Report No. uMN040-2013, October 2013.

WHO, (1999): Guidelines for Air Quality, World Health Organisation, http://www.who.int/peh/air/Airqualitygd.htm

WHO (2003): Health aspects of air pollution with particulate matter, ozone and nitrogen dioxide. Report on a WHO Working Group Bonn, Germany 13-15 January 2003, WHO Geneva.

WHO, (2005): Air Quality Guidelines, Global Update 2005 for particulate matter, ozone, nitrogen dioxide and sulfur dioxide, http://www.euro.who.int/__data/assets/pdf_file/0005/78638/E90038.pdf

Geohydrology

Department of water affairs and forestry (July, 2008). Water Management for Mine Residue Deposits. Best Practice Guideline for Water Resource Protection in the South African Mining Industry. Series A: Activity Guidelines.

Gerrit van Tonder, Yongxin Xu: RECHARGE program to Estimate Groundwater Recharge, June 2000. Institute for Groundwater Studies, Bloemfontein RSA.

Department of Water Affairs (DWA): www.dwa.gov.za

Johnson M.R., van Vuuren C. J., Visser J. N. J., Cole D. I., Wickens H. De. V., Christie A. D. M., Roberts D. L. and Bandl G. (2006). Sedimentary Rocks of the Karoo Supergroup. In The Geology of South Africa. Council for Geoscience. Pretoria.

DWAF 1996, South African water Quality Guidelines,Volume 1, Domestic Use 2nd Ed.

EAS 44600 Groundwater Hydrology, Lecture 14: Water chemistry 1, Dr Pengfei Zhang

Freeze, R. Allan, and John A. Cherry. 1979. *Groundwater*. Prentice Hall Inc, New Jersey.

The South African Groundwater Decision Tool (SAGDT), Manual Ver. 1 (Department of Water Affairs and Forestry)

Department of Water Affairs and Forestry & Water Research Commission (1995). A South African Aquifer System Management Classification. WRC Report No. KV77/95.

http://www2.jpl.nasa.gov/srtm/

Rodriguez, E., et al, 2005. An assessment of the SRTM topographic products. Technical Report JPL D-31639, Jet Propulsion Laboratory, Pasadena, California.

http://www3.dwa.gov.za/NGANet/Security/WebLoginForm.aspx

Barnes, S. L. et al. Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania. Pennsylvania Department of Environmental Protection

Department of Water Affairs and Forestry (DWAF). (1998). Minimum Requirments for the Water Monitoring at Waste Managmenet Facilities. CTP Book Printers. Capetown.

Guideline document EIA regulations (April 1998): Implementation of sections 21, 22 and 26 of the environment conservation act.

Noise:

1. Autumn, Lyn Radle, 2007: '*The effect of noise on Wildlife: A literature review'.*
2. Chapman *et al*. 2013: '*Spatio-temporal differences in the history of health and noise complaints about Australian wind farms: evidence for the psychogenic, "communicated disease" hypothesis'*. Sydney School of Public Health, University of Sydney

3. Equipment list and Sound Power Level source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm
4. Hartley, J.C., Stephen, R.O. 1992. '*A Paradoxical Problem. Can bush crickets discriminate frequency?'.* J. exp. Biol. 163, 359-365.
5. Kroesen and Schreckenberg, 2011. '*A measurement model for general noise reaction in response to aircraft noise'.* J. Acoust. Soc. Am. 129 (1), January 2011, 200-210.
6. Noise quest. 2010. '*Aviation Noise Information & Resources*': http://www.noisequest.psu.edu/pmwiki.php?n=Main.HomePage
7. Norton, M.P. and Karczub, D.G. 2003. '*Fundamentals of Noise and Vibration Analysis for Engineers*, Second Edition'.
8. SANS 10103:2008. '*The measurement and rating of environmental noise with respect to annoyance and to speech communication*'.
9. SANS 10210:2004. '*Calculating and predicting road traffic noise*'.
10. SANS 10328:2008. '*Methods for environmental noise impact assessments*'.
11. SANS 10357:2004. '*The calculation of sound propagation by the Concave method*'.
12. USEPA, 1971: *Effects of Noise on Wildlife and other animals*
13. World Health Organization, 2009, '*Night Noise Guidelines for Europe'.*
14. World Health Organization, 1999, '*Protection of the Human Environment; Guidelines for Community Noise'.*
15. World Health Organization, 1999; '*Noise quest, 2010*'; Journal of Acoustical Society of America, 2009'.

Socio-economic

Coaltech (2010). *Sustainable Development of the Waterberg Coalfields: Fact Base for the Scenario's for Optimal Settlement Patterns*

Davis, L. (2010, May). *The Effect of Power Plants on Local Housing Values and Rents*. Retrieved from http://*faculty*.haas.berkeley.edu/ldavis/pp.pdf

E. van Huyssteen and A. Botha, CSIR (2008 – Draft), *A National Overview of Spatial Trends and Settlement Characteristics*

Environmental Management Framework Report for the Waterberg District (2010)

Enquiry H8120 for Exxaro Resources Ltd (2011). *EIA, EMP, IWUL, AEL, WML AND Public Participation Process on IPP Base load Power Station and related infrastructure Development*

Government Gazette No. 34263 (May 2011). *Promulgated IRP*, Regulation Gazette No. 9531, Vol. 11

Integrated Development Plan for the Waterberg District Municipality (2011/2012)

Lephalale Municipality Integrated Development Plan (2011/2012)

Limpopo LED Capacity Building Programme (2008). *Lephalale Local Municipality Local Economic Development (LED) Strategy, Section B: Strategy Formulation*

National Planning Commission (2011). *National Development Plan: Vision for 2030*

Quantec Easy Data (2013). www.quantec.co.za

SA Yearbook (2009/2010). Agriculture, Forestry and Fisheries.

South African Department of Agriculture, Forestry and Fisheries (March 2012). *Quarterly Economic Overview of the Agriculture, Forestry and Fisheries Sector*, October 2011 – December 2011, Vol. 9, No.4.

Dr GC Dry, Wildlife Ranching South Africa (2010). *Commercial Wildlife Ranching's Contribution to the Green Economy*.

MetroGIS, 2014. *Visual Impact Assessment Report for the Proposed Thabametsi Coal-Fired Power Station near Lephalale, Limpopo Province*

EAR, 2014. *Noise Study for Environmental Impact Assessment for the Proposed Thabametsi Coal-Fired Power Station near Lephalale, Limpopo Province*

uMoya-NILU Consulting*, 2013. Air quality specialist study for the EIA for the Proposed Thabametsi Coal-Fired Power Station near Lephalale, Limpopo Province*

Surface Water

African Development Bank (2009). Executive Summary of South Africa: Environmental Impact Assessment for the Medupi Power Plant Project of Eskom

Department of Environmental Affairs and Tourism (DEAT) (2006). River Health Programme: State of the Rivers Report: The Mokolo River System, Pretoria

Department of Water Affairs (DWA) (2010). Economic Impact Assessment of the proposed Mokolo River Water Augmentation Project

Department of Water Affairs (DWA) 2009. Mkolo and Crocodile (West) Water Augmentation Project (MCWAP) Feasibility Study. Report No. P RSA A000/00/8809

Department of Water Affairs and Forestry (DWAF) (2003). Limpopo Water Management Area: Overview of Water Resources Availability and Utilisation: Report No. P WMA 01/000/00/0203

Department of Water Affairs and Forestry (DWAF) (2006). Best Practice Guideline G1 Storm Water Management. Department of Water Affairs and Forestry, Pretoria

Department of Water Affairs and Forestry (DWAF) (2007). Directorate National Water Resource planning: The Mokolo River Catchment – Validation of the Existing Lawful Use of Water. Report No. PWMA 01/A42/00/02007

Department: Water Affairs and Forestry (DWAF) (2007). Best Practice Guideline A4: Pollution Control Dams. Department of Water Affairs and Forestry, Pretoria

Exxaro (2012). Integrated Annual Report as published by Khumba Resources

Ninham Shand (2008). Proposed coal-fired power stations and associated infrastructure in the Waterberg, Limpopo: Draft Scoping Report. Report No. 4793/402719

Waterberg District Municipality (2011). Management Plan Report: Waterberg Biosphere Management Plan. Report prepared by Contour and Associates

Soils & Agriculture

Agricultural Research Council. Undated. AGIS Agricultural Geo-Referenced Information System available at http://www.agis.agric.za/.

Fey, M. 2010. Soils of South Africa. Cambridge University Press, Cape Town.

Water Research Commission. Undated. South African Rain Atlas available at http://134.76.173.220/rainfall/index.html.

Heritage

Aukema, J.1989. *Rain-making: a thousand year-old ritual?* South African Archaeological Bulletin 44: 70-72.

Biemond, W.M., 2005. The Iron Age sequence around a Limpopo River floodplain on Basinghall Farm, Tuli Block, Botswana, during the Second Millennium AD. Proceedings of the 12th Congress of the Pan African Archaeological Association for Prehistory and Related Studies, July, Gaborone, Botswana.

Deacon, H.J., Deacon, J. 1999. Human Beginnings in South Africa. David Philip, Cape Town.

Geskiedenisatlas van Suid-Afrika. Die vier noordelike provinsies. Edited by J. S. Bergh. 1999. Pretoria: J. L. van Schaik Uitgewers

Huffman, T.N., 1990. The Waterberg research of Jan Aukema. *South African Archaeological Bulletin* 45, 61-70.

Huffman, T.N. 2007. Handbook to the Iron Age. The archaeology of pre-colonial farming societies in Southern Africa. Pietermaritzburg: University of KwaZulu-Natal Press.

Huffman, T.N., Van der Walt, J. 2008. *Mafutha EBA: Cultural Heritage and Archaeology Report*. A field study prepared for Environmental Resources Management. Archaeological Resources Management, Johannesburg.

Huffman, T.N. Van der Walt, J. 2011. *Mafutha Heritage Report*. A field study prepared for Environmental Resource management, Sasol Technology, SRK Consulting and Sustainable Environmental Solutions. Archaeological Resources Management, Johannesburg.

Kuman, K., 1998. The earliest South African Industries. In: *Lower Palaeolithic Settlement of the Old World*. Eds by M.D. Petraglia and R. Korisetter, pp 151-186. Routledge Press, London.

Lombard, M. Wadley, L., Deacon, J., Wurz, S., Parsons, I., Mohapi, M., Swart, J. & Mitchell, P. 2012. *South African and Lesotho Stone Age sequence updated (I)*. South African Archaeological Bulletin 67(195): 120 - 144.

Lewis-Williams, J.D., 1981. *Believing and Seeing: Symbolic Meanings in southern San Rock Paintings*. Academic Press, London.

Mason, R.J., 1962. *The Prehistory of the Transvaal*. Witwatersrand University Press, Johannesburg.

Mitchell, P., 2002. *The Archaeology of Southern Africa*. Cambridge University Press, Cambridge.

Mucina, L. & Rutherford,M.C. 2006. The vegetation map of South Africa, Lesotho and Swaziland. SANBI, Pretoria.

National Heritage Resources Act NHRA of 1999 (Act 25 of 1999)

Pistorius, J.C.C. 2007. *A Phase 1 Heritage Impact Assessment Study for the Eskom Mmamabula Delta Project near Lephalale in the Limpopo Province of South Africa*. Prepared for PBA International.

SAHRA Report Mapping Project Version 1.0, 2009

South African Heritage Information System 2013

Van der Walt, J. 2012. Archaeological Scoping Report for the proposed IPP Waterberg Powerstation, Lephalale, Limpopo Province. Unpublished report.

Van der Ryst, M.M.1998. *The Waterberg Plateau in the Northern Province, RSA, in the Later Stone Age.* British Archaeological Reports (BAR) International Series 715. Oxford.

Van der Ryst, M.M., 2006. *Seeking Shelter: Later Stone Age Hunters, Gatherers and Fishers of Oliboompoort in the western Waterberg south of the Limpopo*. Unpublished doctoral thesis, University of the Witwatersrand, Johannesburg

Van Schalkwyk, J.A. 2005. *Heritage Impact Scoping Report for the Proposed New Matimba B Power Station. Lephalale District, Limpopo Province.* An unpublished report by the National Cultural History Museum on file at SAHRA as: 2005-SAHRA-0106.

Van Schalkwyk, J.A. 2011. *Heritage Impact Assessment Report for the proposed establishment of the Exxaro PV Plant on the farm Nelsonskop, Lephalale, Limpopo Province*. Prepared for Savannah Environmental (Pty) Ltd.

Van Schalkwyk, L & Wahl, E. 2014. Draft Phase 1 Heritage Impact Assessment Report:Proposed Zonderwater Project Area, Lephalale Local Municipality, Waterberg District, Limpopo Province, South Africa

Volman, T.P. 1984. Early prehistory of southern Africa. In: Klein, R.G. (ed.) *Southern African Prehistoryand Palaeoenvironments*: 169-220. Rotterdam: Balkema

Wadley, L., 1987. *Later Stone Age Hunters and Gatherers of the southern Transvaal*. BAR International Series 380, Oxford.

Wits Archaeological Database

<u>Wetlands</u>

Allan, D. G., Seaman, M. T. and Kaletja, B. (1995). The endorheic pans of South Africa. In Cowan, G. I. , editor, Wetlands of South Africa, South African Wetlands Conservation Programme Series, Pretoria: Department of Environmental Affairs and Tourism , 75-101.

DWAF, (2005). A practical field procedure for identification and delineation of wetlands and riparian areas. Department of Water Affairs and Forestry, Pretoria.

GOUDIE A.S. AND THOMAS D.S.G., (1985). Pans in Southern Africa with particular reference to South Africa and Zimbabwe. Zietschritt fur Geomorphologie NF. 29 pages 1-19.

KLEYNHANS, C.J. & LOUW, M.D. (2007). Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report.

Kotze, D.C. and Marneweck, G.C. 1999. Guidelines for delineating the boundaries of a wetland and the zones within a wetland in terms of South African Water Act. As part of the development of a protocol for determining the ecological reserve for wetlands in terms of the Water Act resource protection and assessment policy implementation process. Department of Water Affairs and Forestry, South Africa.

KOTZE, D.C., MARNEWECK, G.C., BATCHELOR, A.L., LINDLEY, D.C., & COLLINS, N.B. (2004). A Rapid assessment procedure for describing wetland benefits. Mondi Wetland Project.

KOTZE, D.C., MARNEWECK, G.C., BATCHELOR, A.L., LINDLEY, D.C., and COLLINS, N.B. (2007). A Technique for rapidly assessing ecosystem services supplied by wetlands. Mondi Wetland Project.

MACFARLANE, D.M., KOTZE, D.C., ELLERY, W.N., WALTERS, D., KOOPMAN, V., GOODMAN, P. & GOGE, C. (2009). A technique for rapidly assessing wetland health: WET-Health. WRC Report TT 340/08.

MARNEWECK, G.C. and BATCHELOR, A.L. (2002). Wetland inventory and classification. In Palmer, R.W., Turpie, J., Marneweck, G.C. and Batchelor, A.L. (Eds). Ecological and Economic Evaluation of Wetlands in the Upper Olifants River Catchment. Water Research Commission Report No K5/1162.

MARSHALL, T.R. & HARMSE, J.T. (1992). A review of the origin and propagation of pans. SA Geographer 19:9-21

National Water Act, 1998 (Act No. 36 of 1998) (NWA, 1998).

National Environmental Management Act (Act 108 of 1998).

Oberholzer P.J., Myburgh J.G., Ashton P.J., Coetzee J.J., Botha A.M. 2011. Bioaccumulation of aluminium and iron in the food chain of Lake Loskop, South Africa. Ecotoxicology and Environmental Safety 75:134-141 p.

Swanepoel C.M, and Barnard R.O. 2007. Discussion paper: Wetlands in Agriculture. ARC Report Number GW/A/2007/43.

Yu, C., Gao, B., Munoz-Carpena, R., 2012. Effect of dense vegetation on colloid transport and removal in surface runoff. *Journal of hydrology*.

Visual

Chief Directorate National Geo-Spatial Information, varying dates. *1:50 000 Topo-cadastral Maps and Data.*

CSIR/ARC, 2000. *National Land-cover Database 2000 (NLC 2000).*

DEADP, Provincial Government of the Western Cape, 2011. *Guideline on Generic Terms of Reference for EAPS and Project Schedules*

Department of Environmental Affairs and Tourism (DEA&T), 2001. *Environmental Potential Atlas (ENPAT) for the Limpopo Province*

National Botanical Institute (NBI), 2004. *Vegetation Map of South Africa, Lesotho and Swaziland (Unpublished Beta Version 3.0)*

Oberholzer, B. (2005). *Guideline for involving visual and aesthetic specialists in EIA processes: Edition 1.*

The Environmental Impact Assessment Amendment Regulations. In Government Gazette Nr 33306, 18 June 2010.