environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

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Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 718, 2009

PROJECT TITLE

Proposed 30-year Ash Disposal Facility at Kendal Power Station, Mpumalanga

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4.2 The specialist appointed in terms of the Regulations_

I, Kyle Harris, declare that --

General declaration:

I act as the independent specialist in this application;
I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
all the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Prime Africa Consultants

Name of company (if applicable):

20/05/2016

Date:

KENDAL 30-YEAR ASH DISPOSAL FACILITY

SUSTAINABILITY ASSESSMENT FOR KENDAL POWER STATION 30-YEAR ASH DISPOSAL FACILITY

FINAL REPORT

June 2016

Prepared for

Zitholele Consulting

Prepared by

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DECLARATION BY SPECIALISTS

The authors are independent specialists who do not have nor will have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed.

The authors performed this study in an objective manner, even where results in views and findings may not have been not favourable to the applicant.

There are no circumstances that compromised our objectivity in performing this work. We have no, and will not engage in, conflicting interests in the undertaking of the activity.

The authors further declare that we have expertise in conducting this specialist report.

We have disclosed to the applicant and the competent authority all material information in our possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of the report.

We realise that a false declaration is an offence in terms of Regulation 71 of the EIA Regulations, 2010 and are aware of the penalties on conviction of such an offence.

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Resource Economist (PhD)
Pr. Sci. Nat.

Signature of specialist

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13 June 2016

ACRONYMS

ADF	Ash Disposal Facility
AFS	Annual Financial Statement
CBA	Cost Benefit Analysis
COUE	Cost of Unserved Energy
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DWA	Department of Water Affairs
EMPr	Environmental Management Programme
ERE	Environmental and Resource Economic
FNPV	Financial Net Present Value
GDP	Gross Domestic Product
IWUA	Irrigation Water Use Association
MBSP	Mpumalanga Biodiversity Sector Plan
MEA	Millennium Ecosystem Assessment
MCA	Multi Criteria Analysis
NFEPA	National Freshwater Ecosystem Priority Areas
NPV	Net Present Value
NPSV	Net Present Social Value
RQO	Resource Quality Objective
SCBA	Social Cost Benefit Analysis
SANBI	South African National Biodiversity Institute
TEEB	The Economics of Ecosystems and Biodiversity
WACC	Working Average Cost of Capital
WMA	Water Management Area
WRCS	Water Resources Classification System

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Brief History of the Kendal Power Station

Kendal Power Station is located approximately 8 km southwest of Ogies, in the Nkangala District of Mpumalanga. Nearby towns include Delmas and eMalahleni, which are situated 30 km southwest and 33 km northeast of Kendal, respectively. Kendal is the largest indirect dry-cooled power station in the world, which means that it uses significantly less water in its cooling processes when compared to the conventional wet cooled power stations. Construction began on Kendal in 1982 and was completed in 1993. The power station has an installed capacity 4116 MW.

1.2 Problem Setting

The current ash disposal facility (ADF) of the Kendal Power Station is running out of space due to two reasons. Firstly, higher rates of ash disposal than originally planned for have resulted from higher ash content coal used for power generation. Secondly, as a result of South Africa's power supply shortages and the resultant load shedding crisis, the life span of Kendal has been extended to 2058.

This renders the available ash disposal space inadequate to accommodate continuation of disposal.

In order to meet the shortfall in available space, Eskom wishes to develop a new ADF, which would be able to accommodate almost 30 years of ash disposal (This sustainability assessment document deals with the development of this new 30-yr ADF. The required volume of ash to be accommodated is 176,2 million m^3 and the prosed ADF is able to accommodate 177,7 million $m^{3.}$ The total footprint of the ADF has been calculated at 404,7 ha and will reach a maximum height of 75 m.

As part of the Environmental Impact Assessment (EIA) process, four alternatives for the ADF were identified for baseline evaluation:

1. Site B;
2. Site C;
3. Site F; and
4. Site H.

Fourteen specialist studies were commissioned in order to determine the ideal site taking into consideration environmental, social and financial factors. These studies include:

1. Soils and Land Capability;
2. Surface Water;
3. Groundwater;
4. Wetlands;
5. Aquatic biodiversity;
6. Terrestrial Ecology;
7. Air Quality;
8. Noise Assessment;
9. Visual Assessment;
10. Social considerations;

11. Heritage considerations;
12. Traffic;
13. Geotechnical; and
14. Engineering considerations.

The Department of Environmental Affairs (DEA) issued an acceptance letter to the Final Scoping Report (FSR) in 11 September 2013 requesting that the EIR should include information on the following:

- Environmental costs vs benefits of the disposal facilities activity; and
- Economic viability of the facility to the surrounding area and how the local community will benefit.

This requirement necessitated the need to undertake this Sustainability Assessment

1.3 Scope of this Study

The scope of this study is to perform a sustainability assessment, with twofold purpose:

1. To guide the DEA through the process that had been followed in selecting the preferred site, Site H; and
2. To guide DEA in making an informed decision on the integrated environmental, economic and social impacts and consequences that Site H may incur to society, and how this may be mitigated.

1.4 Structure of the Document

The document is the final draft of the Sustainability Assessment. The document contains the following chapters:

- Chapter 2 develops the methodology of the sustainability assessment;
- Chapter 3 provides a systems description, setting the ecological and socio-economic background for the study;
- Chapter 4 conducts site selection and provides a comparative assessment of Sites B, C, F and H;
- Chapter 5 identifies the ecosystem services at risk in the preferred option;
- Chapter 6 conducts a social cost benefit analysis of the preferred option; and
- Chapter 7 puts forward the conclusion.

2 METHODOLOGY

2.1 Summary of Method: What is a Sustainability Assessment?

A sustainability assessment is concerned with the assessment of sustainable development impacts and consequences. It is different from other EIA specialist studies in the sense that it integrates ecological, economic and social consequences into a single analysis framework. This framework enables both comparative analysis and sustainability assessment.

In the absence of specific and official guidelines from the DEA on how to perform a sustainability assessment, this section investigates key legislation and international guidelines and proposes a 5-step method to be followed (Table 2-1).

In addition to assessing, in one integrated framework, the social, economic and environmental factors of a development project, the sustainability assessment is intended to justify the economic and social development components of the proposed development project; to provide an assessment of impacts on both current and future generations; and to meaningfully inform decision-making.

A sustainability assessment needs to address key requirements of the National Environmental Management Act 107 of 1998, as amended (NEMA) family of legislation (refer to section 2.2); it has to adopt the Millennium Ecosystem Assessment approach for integrating ecological-social-economic analyses (refer to section 2.3); it takes a social cost benefit analysis approach, using resource economics as an analytical tool (refer to section 2.4); it adopts the precautionary principle embedded within a risk assessment approach (refer to section 2.5); and it applies the mitigation hierarchy(refer to section 2.6).

A sustainability assessment takes as point of departure the tacit and other expert knowledge of the complex system under study. It relies on this knowledge to develop a hypothesis of the system. It also provides an evidence-based analytical framework for examining relationships that link ecosystems, society and the economy. Through the use of suitable socio-economic and ecological indicators, and a suitable economic valuation approach, it enables integration of ecosystem services, into the socio-economic analysis problem.

The methodology followed a 5-step process as set out in Table 2-1 below.

Table 2-1. Methodological notes: The methodology applied here followed a 5-step process

Step	Description	Discussion
1	System description	The system description explicitly identifies and assesses key ecological, social and economic production considerations
2	Assessment of alternatives and identification of preferred site	Multi-criteria assessment of the various specialist study domains, including identification of potential fatal flaws, and selection of the preferred site
3	Ecosystem service assessment	Identification of ecosystem services at risk
4	Social cost-benefit analysis / consequences assessment	Integrated resource- and socio-economic assessment of the consequences of the preferred site
5	Mitigation assessment	Mitigation measures applied and costed

2.2 NEMA: Assessing Sustainable Development

Although DEA do not yet have official guidelines for the performance of a sustainability assessment[1], it is common cause that the need for such an assessment arises from NEMA's stated objectives relating to sustainable development.

Accordingly, NEMA, in its Preamble, states as follows about sustainable development:

"the State must respect, protect, promote and fulfil the social, economic and environmental rights of everyone and strive to meet the basic needs of previously disadvantaged communities" … and …

"sustainable development requires the integration of social, economic and environmental factors in the planning, implementation and evaluation of decisions to ensure that development serves present and future generations; … and further …

"secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development".

NEMA defines the concept of sustainable development as follows:

"'sustainable development' means the integration of social, economic and environmental factors into planning, implementation and decision making so as to ensure that development serves present and future generations;"

NEMA provides some guidance on how sustainable development should be assessed.

In Section 2 par 4, NEMA recommends the consideration of all relevant (ecological impact) factors and specifically recommends an assessment of the following:

- disturbance of ecosystems and loss of biological diversity;
- pollution and degradation of the environment;
- disturbance of landscapes and sites that constitute the nation's cultural heritage;
- waste generated;
- responsible and equitable use and exploitation of non-renewable natural resources; and
- the development, use and exploitation of renewable resources and the ecosystems of which they are part with a view to not exceeding the level beyond which their integrity is jeopardized.

Crucially, Section 2 par 4 repeatedly emphasises the need for applying the mitigation hierarchy i.e. that where impacts or risks related to impacts cannot be altogether prevented or avoided, they are minimised and remedied.

NEMA is however more generic on the social and economic impacts. It recognises that social impacts could relate to:

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[1] NEMA par 5 (b) (ix) states: "*any other relevant environmental management instrument that may be developed in time*"

- equity ("equitable use and exploitation of non-renewable natural resources" (par 2(4)));
- human health and safety ("*any risks posed to … public safety and the health … of people*" (par 31 (1A) (b)));
- property (par 30(4)(a)); and
- human well-being ("*any risks posed to the … well-being of people*" (par 31 (1A) (b))).

In addition, the 2014 EIA guidelines has the several important requirements which are relevant to the sustainability assessment:

1. Describe the methodology adopted in carrying out the process and preparing the report;
2. Describe and motivate the need and desirability of the proposed activity, especially in the context of the preferred location;
3. Assess the direct and cumulative consequences, especially where there is irreversible loss of resources, using a risk-based approach;
4. Identify mitigation measures, conditions and monitoring requirements for inclusion in the Environmental Management Programme (EMPr) and environmental authorisation;
5. Describe assumptions, uncertainties and gaps in knowledge which relate to the assessment and mitigation measures proposed; and
6. Provide a reasoned opinion as to whether the proposed activity should or should not be authorised, at the preferred alternative development location.

All the above considerations are important in the execution of the sustainability assessment.

2.3 Integrated Ecological-Social-Economic Assessment: The MA

The NEMA family of legislation recognises the concept of human well-being and this lays the foundation for the assessment of social and economic well-being.

The Millennium Ecosystem Assessment (MEA), a United Nations initiative, had the objective of assessing the consequences of ecosystem change for human well-being. The overall aim of the MEA was to contribute to improved decision-making concerning ecosystem management and human well-being. The purpose of the MA was to develop a framework for assessing, in an integrated manner, the ecological, economic and social consequences that would result from, for instance, a development project of this nature.

The MA findings are contained in five technical volumes and six synthesis reports.

The key contribution of the MEA is a definition and framework for assessing well-being, i.e. the ecosystem services framework.

Since the 1990s, there is a growing literature that attempts to internalise ecosystems' attributes into development planning and policy analysis. In spite of these efforts, the value of ecosystems' assets and their services remain largely missing, and even when quantified, underestimated (Adamowicz 2004). This is attributed to our deficient understanding of the nature of the complex dynamics of the interactions between ecosystems' functioning and human well-being (Perrings 2006). Gaps in current scientific knowledge of the interdependence between the coupled socio-ecological systems translate into misinformed decision making and adoption of wrong policies and actions that fundamentally result in unsustainable use of these natural assets and weak willingness to conserve them. Several factors that characterize the complex dynamics of socio-ecological interdependence are the cause of this (Crafford, 2015). In response to these weaknesses, the MEA introduced a radical new approach (or framework) to the analysis of the interface of the ecology and the economy (Perrings, 2006). Central to this approach is the definition of the concept of ecosystem services. The MEA and The Economics of Ecosystems and Biodiversity (TEEB) define ecosystem services as the direct and indirect contributions (or benefits) of ecosystems to human well-being. They distinguish between four types of ecosystem services: provisioning, cultural, regulating and supporting services.

Sustainability in its broadest sense can be defined as balancing local and global efforts to meet human well-being needs without reducing natural capital (Magee *et al.* 2013). This implies reasonable and proactive decision-making and innovation that mitigates negative impact and maintains balance between ecological resilience, economic prosperity, political justice and cultural vibrancy to ensure a desirable planet for all species now and in the future.

The MEA further placed significant emphasis on natural capital (or the ecosystem balance sheet). The South African National Biodiversity Institute (SANBI, 2014) [ref] describes ecological infrastructure as a network of natural assets "*that conserve ecosystem values and functions and provide associated benefits to society*".

Two particular challenges associated with ecosystem services include the valuation of their baseline contributions to human well-being and the assessment of change against the baseline, resulting from a development project. The next two sections deal with these matters.

2.4 Social Cost-Benefit Analysis and the Resource Economics Discipline

2.4.1 Background

A social cost-benefit analysis (SCBA) is an internationally accepted approach for ensuring a balanced perspective and prioritised analysis of projects with multiple direct and indirect benefits and costs that span ecological, social and economic domains.

The primary concern of the discipline of environmental and resource economics is the application of economic theory and methods to environmental issues with social and economic consequences.

An SCBA follows international best practices in CBA methodology. Several methodologies are of interest here:

- The guideline of the European Commission on cost-benefit analysis of investment projects (2004);
- World Bank guidelines for cost-benefit analysis (World Bank 2010);
- A manual for cost benefit analysis in South Africa with specific reference to water resource development (Mullins *et al* 2007); and
- The MEA and TEEB frameworks of ecosystem services.

2.4.2 Financial Analysis

While the CBA encompasses more than just the consideration of the financial returns of a project, most project data on costs and benefits is provided by financial analysis. This analysis provides information on inputs and outputs, their prices and the overall timing structure of revenues and expenditures. In most cases, the purpose of the financial analysis is to use a project's cash flow forecasts to calculate suitable return rates. However, in this case, because the ADF will not be a direct revenue generating activity, the financial analysis will be used to estimate the financial net present value (FNPV) of the different sites, in order to compare sites. The financial analysis is made up of a series of Excel tables that collect the financial flows of the investment, in this case broken down by

- Capital costs; and
- Operating costs.

In order to correctly conduct the financial analysis for this study, careful attention must be paid to the following elements, if and where relevant:

- Time horizon;
- The determination of total costs;
- Adjustment for inflation;
- Selection of the appropriate discount rate; and
- Determination of the main performance indicators.

The time horizon is the number of years for which forecasts are provided. Forecasts regarding the future trend of the project should be formulated for a period appropriate to its economically useful life and long enough to encompass its likely mid/long term impact. In this case the time horizon is a 30-year construction and operations period.

The data for the cost of a project are provided by the sum of costs of capital and operating costs. These costs were estimated based on the conceptual designs for the ADF developed by Zitholele Consulting.

The ADF forms a part of the Kendal Power Station Operations and will not generate any direct revenues. The FNPV of different options can be used to compare the contribution of the various options to electricity prices in South Africa.

In project analysis, it is often customary to use constant prices. This means that prices are adjusted for inflation and fixed at a base-year. However, in the analysis of financial flows, as is done here, current prices are more appropriate; these are nominal prices effectively observed year by year.

To discount financial flows to the present and to calculate of net present value, the suitable discount rate must be defined. There are many theoretical and practical ways of estimating the reference rate to use to discount of the financial analysis. The key concept is that of the opportunity cost of capital. In studies of this nature, the problem of inter-generational equity is addressed through the choice of discount rate. In a project of this kind, the investor, i.e. Government through Eskom may choose one discount rate for a decision on a return on investment, whereas Government acting in the public interest may choose another. To demonstrate this, it is normal to conduct a sensitivity analysis within a range of discount rates.

Eskom requires real internal rates of return (IRR's) for brownfields projects such as Kendal may vary between 4 and 8%. These "hurdle rates" are the discount rates for its investment decisions. These rates are the sums of the elements WACC (Working Average Cost of Capital), Contingency, Profit Margin and Operational Gearing. The choice of discount rate for public investment projects reflects both expectations about consumption growth and the social rate of time preference – the rate at which society prefers consumption today over consumption in the future. The social rate of time preference is a welfare term. It measures the relative importance assigned by society to consumption by future generations. In South Africa, as in many countries in the developing world, the importance of improving the well-being of today's citizens implies a higher social rate of time preference than might be appropriate in high-income countries. In the UK, for example, the Green Book on appraisal of government investment recommends a rate of 3.5% for the first 30 years of any project, and low rates for projects evaluated over longer planning horizons. In this Study we apply a central rate of 4.00%, and test the sensitivity of the results to 6.00% and 8.00%.

2.4.3 Economic Analysis

The economic analysis appraises the project contribution to and impacts on the socio-economic welfare of the region / country. It is made on behalf of the whole society (region / country) instead of just the owner of the infrastructure like in the financial analysis.

The economic analysis, by means of the definition of appropriate conversion factors for each of the inflow or outflow items, outlines a table that includes benefits and social costs not considered by the financial analysis.

The logic of methodology allowing the transfer from financial to economic analysis consists of:

- The transformation of market prices used in the financial analysis into accounting prices (that amend prices distorted by market imperfections); and
- The consideration of externalities leading to benefits and social costs unconsidered by the financial analysis as they do not generate actual money expenditures or income (for example environmental impacts or redistributive effects).

As in the financial analysis, discounting is done based on the selection of a correct social discount rate and the calculation of the internal economic rate of return of the investment.

The CBA requires correct use of economic tools, especially with respect to value of the 'fiscal correction' and the value of the conversion factor for market prices affected by fiscal aspects. The following considerations are of importance:

- Prices of inputs and outputs to be considered for CBA should be net of VAT;
- Prices of inputs to be considered in the CBA should be gross of direct taxes; and
- In some cases indirect taxes/subsidies are intended as correction of externalities. Typical examples are taxes on energy prices to discourage negative environmental externalities. In this case, and in similar ones, the inclusion of these taxes in project costs may be justified, but the appraisal should avoid double counting (e.g. including both energy taxation and estimates of external environmental costs in the appraisal).

2.4.4 Externalities Corrections

The objective of this part of the CBA is to determine external benefits or external costs not considered in the financial analysis. Examples are costs and benefits coming from environmental impacts, time saved, and social and economic opportunity costs.

Sometimes valuing external costs and benefits may be difficult, even though they may be easily identified. The provisioning and cultural ecosystem services may be easier to value, whereas the regulating services (often the more important and valuable services) may be very difficult and time-consuming to value. The regulating services are really the production function linkages between ecosystems and human well-being.

In this case, some of the ADF impacts cause ecological damage, whose unmitigated effects, combined with other factors, will take place in the long run, and are difficult to quantify and value. In the absence of a full ecosystem services valuation study, we can make use of desktop indicators and risk assessment tools (also refer to section 2.5).

It remains important to list the externalities, in order to give the decision-maker more elements to make a decision, by weighing up the quantifiable aspects, as expressed in the economic rate of return, against the unquantifiable ones (see multi criteria analysis above).

Externalities should be given a monetary value, if possible. If not, they should be quantified by non-monetary indicators. In this case, the nature of the comparative analysis allows for non-monetary analysis of ecosystem services effects.

2.4.5 Key Indicators Used

After the correction of price distortions it is possible to calculate the financial and economic net present value (FNPV and ENPV) and to compare the various sites using this indicator (please note that the B/C ratio is not helpful in this analysis as the ADF does not produce a quantifiable direct revenue stream). The indicators used for analysis are:

- The financial net present value (FNPV) of the project;
- The contribution to electricity prices (Rand/kWh);
- The economic net present value (ENPV) of the project; and
- The net present social value (NPSV) of the project.

2.5 Precautionary Approach and Risk Assessment

NEMA requires that, in all assessments, a risk-averse and cautious approach is applied, based on current knowledge about the consequences of decisions and actions; (par 2(4)(a)(vii)) and requires the assessment of the significance of consequences (par 20(4)(a)(iv)).

The MEA has a particular view on a cautious approach, firstly that assessments play a useful role in clarifying where scientific uncertainties "*remain*" and secondly that uncertainties can either be "*used to argue for a 'wait and see' approach*", or can be used "*to argue for a precautionary approach*".

This requires further consideration. The precautionary principle is derived from the 1990 Bergen Declaration, which states, "*Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental* *degradation*" (Weinberg 2006). The precautionary principle is broadly analogous to 'probable cause' and it therefore requires a low standard of proof, and often forms the basis for environmental impact assessment decisions and authorisations. The precautionary principle obviously has important evidentiary implications for application of a production function approach in analysing complex systems. In the absence of a detailed production function, we can adopt a risk assessment approach, using the impact assessment analyses of the specialist studies. Risk here is defined as a function of the likelihood and consequence of a hazard to which relevant components of the water value chain would be exposed, or:

$$\text{Risk}_{\text{Value chain component}} = f\,(\text{likelihood, consequence})_{\text{Hazard}}$$

A hazard is the possible event to which the value chain component may be exposed, which has a potential to endanger or threaten this component. The consequence of the hazard is the magnitude of change in human well-being. The likelihood is an assessment of the probability of a risk scenario (i.e. a hazard / value chain component interaction) occurring. Refer to Appendix 1 for detailed risk assessment method description.

2.6 The Mitigation Hierarchy

NEMA is very clear that all risks to ecosystems need to be suitably mitigated. Under mitigation hierarchy, four steps are presented (adapted from DEA, 2013)

1. **Avoid/Prevent:** Refers to considering options in project location, sitting, scale, layout, technology and phasing to avoid impacts on biodiversity;
2. **Minimise:** Refers to considering alternatives in the project options in project location, sitting, scale, layout, technology and phasing that would minimise impacts on biodiversity and ecosystem services;
3. **Rehabilitate:** Refers to rehabilitation of areas where impacts are unavoidable and measures are provided to return impacted areas to near-natural state or an agreed land use after mine-closure. However, rehabilitation may fall short of replicating the diversity and complexity of the natural system.
4. **Offset:** Refers to measures over and above rehabilitation to compensate for the residual negative effects on biodiversity after every effort has been made to minimise and then rehabilitate impacts.

Avoidance and minimisation in this case mainly deals with site selection, basic footprint layout design and engineering design of the ADF.

Rehabilitation deals with rectifying damage to ecosystems and is dealt with through the EMPr and various licence conditions.

Offsets are required where natural ecosystems are destroyed and rehabilitation is not possible.

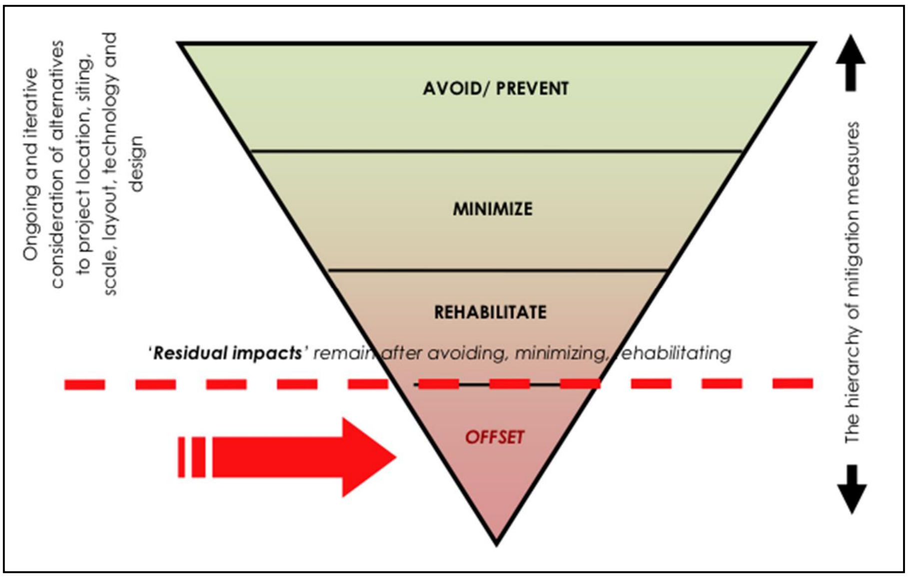

Figure 2-1. The mitigation hierarchy (Source: Macfarlane *et al*. 2014)

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3 SYSTEMS DESCRIPTION

The purpose of the Systems Description is to provide a setting for the key environmental, physical and socio-economic conditions, which are present in the study area. These conditions play an important role in the selection of the site alternative for the 30-yr ADF.

3.1 Energy Crisis in South Africa

It is common cause that South Africa is experiencing an energy crisis through its inability to supply sufficient power to the economy. Various estimates indicate that South Africa has forfeited as much as 1.5% of Gross Domestic Product (GDP) during 2015 as a result of load shedding.

In response the South African government has initiated a number of emergency measures to balance power supply and demand. This includes, reduction of demand through energy saving measures, development of a large-scale renewable energy Independent Power Producer (IPP) programme, and construction of two large new coal-fired power stations (Kusile and Medupi). In addition several short-term emergency measures include the full-time running peaker plants using diesel, and, in the case of Kendal, the expansion of the life of several existing power stations.

As noted earlier, the current ADF of the Kendal Power Station will not be adequate to meet future demand. Secondly, and more importantly, as a result of South Africa's power supply shortages and the resultant load shedding crisis, the life span of Kendal has been extended to 2053.

3.2 Environmental Characteristics

The Kendal Power Station is located within an environmental setting characterised by key biophysical, hydrological and wetland settings.

3.2.1 General Biophysical Characteristics

The study area is located in the Rand Highveld Grassland vegetation type on the border with the Eastern Highveld Grasslands in the grassland biome (Muncina & Rutherford 2006). The grassland biome covers approximately 28% of South Africa and is the dominant biome on the central plateau and inland regions of the eastern subcontinent (Manning 2009). Grasslands are situated in moist, summer rainfall regions, which experience between 400 mm and 2000 mm of rainfall per year. Vegetation consists of a dominant ground layer, comprising grasses and herbaceous perennials. Little or no woody plant species are present (Golder 2016).

According to Tainton (1999) the study area falls within 'fire climax grassland of potential savanna'. As this description suggests, the vegetation of the region would probably succeed to savanna (co-dominance of woody and grass species), but is maintained in a grassland

A broad band of Eastern Highveld Grassland extends to the south of Rand Highveld Grassland from Johannesburg in the east through to Bethel, Ermelo and Piet Retief in the west (Muncina & Rutherford 2006). Approximately 1 214 467 ha of Mpumalanga was originally covered by Eastern Highveld Grassland (Ferrar & Lötter 2007).

3.2.2 Hydrological Characteristics

Kendal Power Station is located in the Upper Olifants Catchment, which falls within the Olifants Water Management Area (WMA 04), specifically in the B20E and B20F quaternary catchments within the Wilge River sub-catchment.

The Olifants WMA is commonly divided into three management sub-areas; the Upper Olifants, Middle Olifants and Steelpoort, Lower Olifants sub-areas:

- Upper Olifants sub-area (within which the Kendal Power Station site is located) constitutes the catchment of the Olifants River down to Loskop Dam.
- Middle Olifants sub-area comprises the catchment of the Olifants River downstream from the Loskop Dam to the confluence with the Steelpoort River.
- Lower Olifants management zone represents the catchment of the Olifants River between the Steelpoort confluence and the Mozambique border.

The Olifants River originates near Bethal in the Highveld of Mpumalanga. The river initially flows northwards before curving in an easterly direction through the Kruger National Park and into Mozambique where it joins the Limpopo River before discharging into the Indian Ocean.

The main tributaries are the Wilge, Elands and Ga-Selati Rivers on the left bank and the Steelpoort, Blyde, Klaserie and Timbavati Rivers on the right bank. The Olifants River is shared by South Africa, Botswana, Zimbabwe and Mozambique (DWA 2011a).

The Wilge River catchment principally includes the towns of Bronkhorstspruit and Delmas as well as the Ezemvelo Game Reserve to the north. The catchments in the Olifants are further divided into Management Units (MU) and Kendal is located within MU 22. The Wilge catchment incorporates four rivers/streams including the Grootspruit, Saalboomspruit, Bronkhorstspruit and the Wilge River. The areas of the relevant quaternary catchments are given

Table 3-1. Catchment areas of B20E, B20F and Wilge River

Catchment	Area (km^2)
Quaternary B20E	620.0
Quaternary B20F	505.0
Quaternary B20G	522.0
Wilge River Catchment	4277.0
Quaternary B11F	428.0
Loskop Dam	4356.0

3.2.3 Wetlands

The recently published Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel *et al* 2011) (The Atlas) identified 791 wetland ecosystem types in South Africa based on classification of surrounding vegetation (taken from Mucina and Rutherford, 2006) and hydro-geomorphic (HGM) wetland type; seven HGM wetland types are recognised and 133 wetland vegetation groups, equating to 791 wetland ecosystem types.

The National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2012) undertook an ecosystem threat status assessment for each of the 791 wetland ecosystem types where each wetland ecosystem type was assigned a threat status based on wetland type as well as on wetland vegetation group. A summary of the findings for the four wetland ecosystem types expected to occur on site is provided in Table 3-2below.

Table 3-2. Summarised findings of the wetland ecosystem threat status assessment as undertaken by the National Biodiversity Assessment 2011: Freshwater Component (Nel *et al.*, 2011b) for wetland ecosystems recorded on site.

Wetland Ecosystem Type	Wetland HGM Type (WT)	Threat Status of WT	Protection level of WT	Wetland Vegetation Group (WVG)	Threat Status of WVG
Mesic Highveld Grassland Group 4_Floodplain wetland	Floodplain	CR	Zero protection	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Seep	Seep	EN	Zero protection	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Depression	Depression	CR	Hardly protected	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Channelled valley bottom	Channelled valley bottom	CR	Hardly protected	Mesic Highveld Grassland	CR

CR = Critically Endangered, implying area of wetland ecosystem type in good (A or B) condition ≤ 20% of its original area

EN = indicates Endangered, area of wetland ecosystem type in good condition ≤ 35% of its original area

3.3 Socio-economic systems

3.3.1 Overview

Formal economic activity in the WMA is highly diverse and is characterised by commercial and subsistence agriculture (both irrigated and rain fed), diverse mining activities, manufacturing, commerce and tourism (DWA 2013). Large coal deposits are found in the Emalahleni and Middelburg areas (Upper Olifants) and large platinum group metal (PGM) deposits are found in the Steelpoort, Polokwane and Phalaborwa areas. The WMA is home to several existing large thermal power stations, which provide energy to large portions of the country. Extensive agriculture can be found in the Loskop Dam area, the lower catchment near the confluence of the Blyde and Oilfants Rivers as well as the in the Steelpoort Valley and the upper Selati catchment (DWA 2013).

A large informal economy exists in the Middle Olifants, with many resource-poor farmers dependent upon aquatic ecosystem services, and therefore the water quality of the system is of concern.

In addition, the area downstream has many important water dependent tourist destinations, especially the Kruger National Park (DWA 2013).

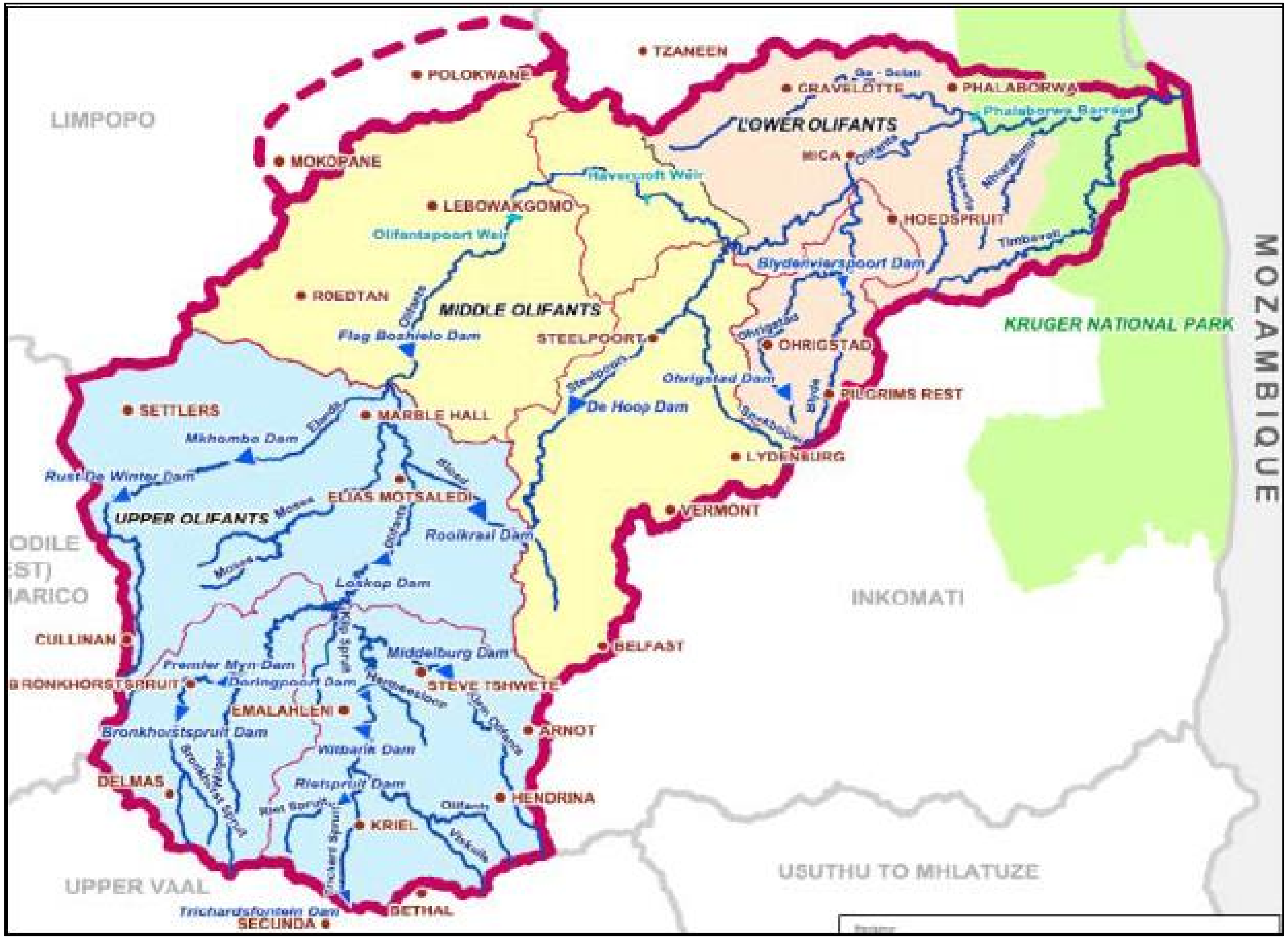

Figure 3-1. The Olifants Water Management Area (Source: DWA 2011a)

3.3.2 Land Use

Land use in the Olifants WMA is diverse and consists of irrigated and dryland cultivation, improved and unimproved grazing, mining, industry, forestry and urban and rural settlements (DWA 2013). A breakdown of land use and land cover is given in Table 3-3. Figure 3-2 is a map of land-use within the catchment based on land cover estimates derived from high-resolution satellite imagery published by the South African National Land Cover Project (CSIR 2003).

Table 3-3. Land use and land cover in the Olifants Water Management Area (Source: CSIR 2003)

Land Use	Area (ha)	%
Natural vegetation	3 474 159	63.69%
Grazing	1 689	0.03%
Plantations	64 347	1.18%
Wetlands & Water	56 422	1.03%
Degraded	552 267	10.12%
Permanent commercial cultivation	18 126	0.33%
Temporary commercial cultivation	828 495	15.19%
Subsistence cultivation	244 989	4.49%
Urban (formal residential)	110 820	2.03%
Urban (informal residential)	47 509	0.87%
Urban (smallholdings)	6 841	0.13%
Urban (commercial)	1 524	0.03%
Urban (industrial)	5 247	0.10%
Subsurface mining	26	0.00%
Surface mining	36 618	0.67%
Mine tailings	5 693	0.10%
Total	**5 454 772**	

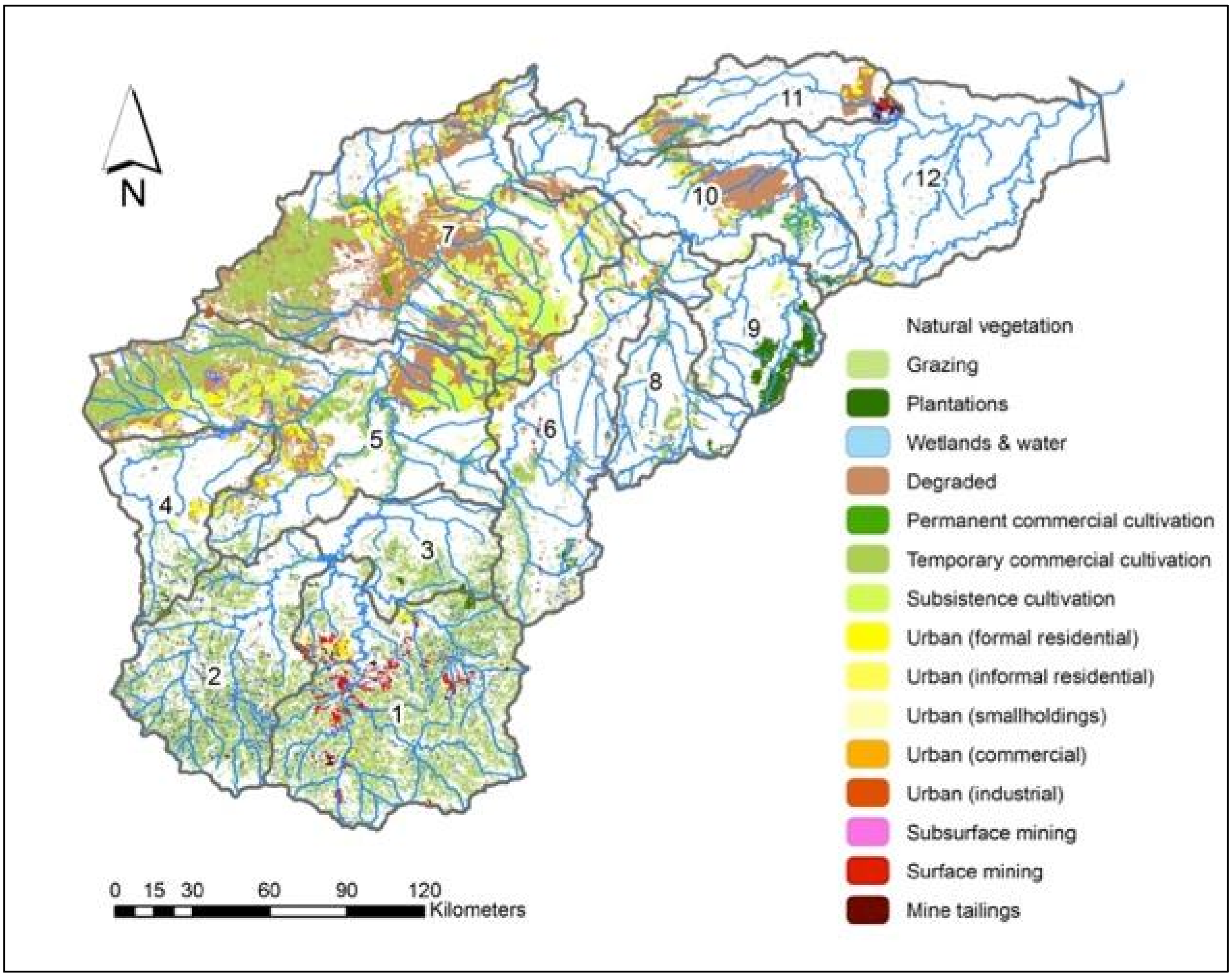

Figure 3-2. Land use map of the Olifants WMA (all land classes) (source: South African National Land-Cover database, CSIR, 2003)

3.3.3 Electricity

Eskom has 11 coal-fired power stations in South Africa and eight of these stations are found in the Olifants WMA (DWA 2013) (Table 3-4). The 8th, Kusile, is still under construction. These eight stations will produce approximately 70% of South Africa's coal-fired electricity.

Table 3-4. Installed capacity of thermal power stations in the Olifants WMA (Source: DWA 2011b)

Power Station	Installed Capacity (MW)
Arnot	2,100
Duvha	3,600
Hendrina	2,000
Kriel	3,000
Komati	1,000
Matla	3,600
Kendal	4,116
Kusile (Under construction)	4,800
Total	**24,216**

3.3.4 Agriculture

Agriculture in the Olifants WMA can be broadly divided into three farming types:

- Resource-poor farming activities (both dry land and irrigated),
- Commercial dry land, and
- Commercial irrigated farming (IWMI 2008).

Maize is the dominant dryland crop grown throughout the catchment while commercial irrigated farming is highly diversified with wheat, maize and cotton comprising the bulk of the irrigated crop. A large portion of high value crops for export, such as citrus and grapes, are grown in the catchment especially around the Groblersdal and Marble Hall areas (IWMI 2008).

The Olifants Reconciliation Strategy Report (DWA 2011a) estimated irrigation agriculture land to comprise 88,772 ha. Irrigation takes place both on irrigation schemes and as run-of-river irrigation (or diffuse irrigation). Irrigation is the largest water user in the Olifants River catchment, with the two largest schemes situated downstream of the Loskop and Blyderivierspoort Dams. Of this 39,378 ha are on irrigation schemes at high assurance of supply (80%) and 49,394 ha are diffuse irrigation at lower assurances of supply.

The total output of agriculture (dryland and irrigation) in the study area is estimated at R7.48 billion in 2010. Of this, R2.86 billion contributed to Gross Domestic Product (GDP).

3.3.5 Mining

Various mining activities span the Olifants River Basin. Three major concentrations of mining activities are of importance (DWA 2013):

- Coal mining on the Mpumalanga Highveld;
- PGM in the Middle Olifants and Steelpoort Valley; and
- Various mining activities around the Phalaborwa Industrial Complex and Gravelotte.

Mining within the Upper Olifants sub-catchment consists almost entirely of coal mining. Coal mining activities are extensive. The coal mining activities supply coal to the various power stations in the WMA, to industrial users and to the export market.

Much of the Upper Olifants falls within the Witbank Coalfield, where most of South Africa's coal is mined.

Within the Olifants WMA, there are five major coal companies (BHP Billiton, Anglo Coal, Xstrata, Exxaro and Optimum Coal) that produce the bulk of coal in South Africa. In addition there are a host of other smaller coal companies that produce coal, but information on their activities is limited. Listed companies produce 81% of coal production in South Africa (Chamber of Mines Facts and Figures 2011 and Company Annual Reports), with the balance of coal produced by smaller mining companies.

The total coal production in the Olifants WMA was 121.4 Mt in 2010, which was about 47% of the total coal produced in SA for 2010. The total output of coal mining was approximately R52.8 billion. Of this, R35.8 billion contributed to GDP.

Platinum mining dominates mining activities in the Middle Olifants zone. The Bushveld Igneous Complex (BIC) is the world's largest and most valuable layered intrusion. It holds over half the world's platinum, chromium, vanadium and refractory minerals and has ore reserves that could last for hundreds of years. These also include significant reserves of tin, fluorite and copper. Platinum group metals (as well as vanadium, chrome and iron) have been initiated in the Steelpoort/Mogoto and Mokopane areas, and is dependent upon sufficient water resources available.

The majority of platinum mining in the Olifants WMA is situated in the Steelpoort and Middle Olifants zones. The Blue Ridge Platinum Mine (operated by Aquarius) is situated 15km from Groblersdal and produces 35 000 oz. of platinum annually. There are three major platinum mining operators present (Amplats, Impala Platinum and Aquarius) in the Steelpoort zone, while other, smaller mining companies are present, information regarding their operation is however limited. The Marula Platinum Mine (operated by Impala Platinum) is situated north east of Burgersfort and produces 70 000 oz. of platinum annually.

The Olifants WUA produced approximately 1,764,000 oz. of PGM in 2010. The total output of PGM mining was approximately R15.4 billion in 2010. Of this, R7.0 billion contributed to GDP.

In the Lower Olifants, Intensive copper and phosphate mining operations exist around Phalaborwa. The mineral rich Phalaborwa complex was intruded at the same time as the Bushveld Complex.

The Phalaborwa Mining Company (operated by Rio Tinto) is South Africa's largest copper producer and in addition also produces titaniferous magnetite, nickel, uranium, gold, silver, rare-earth elements, phosphates and vermiculite. The operation encompasses a copper mine, smelter and refinery and produces approximately 80,000 tonnes of refined copper annually.

Foskor is a large producer of phosphate and zirconium as well as small quantities of copper, PGMs and other minerals.

The Cullinan Diamond mine, owned by Petra Diamonds, is situated at Cullinan, on the border of the WMA.

Samancor operates the Eastern Chrome Mine situated close to Steelpoort. The mine consists of three underground mines, two opencast mines, four surface beneficiation plants and two tailings re-treatment plants, typically producing around 2.0 Mt of saleable product per annum.

Other operations include the Consolidated Murchison Mine, which produces antimony and gold found near Mica and the mining of mica in the greater Gravelotte and Mica areas.

Xstrata Alloys operate both the Thornecliffe and Helena Chrome Mines near Steelpoort. The mines annual production capacity is 1,440kt and 600kt respectively.

Evraz Highveld Steel operates the Mapochs Mine near Roossenekal. The mine is an open-cast mining operation which produces lump iron ore and ore fines.

To the west of Phalaborwa, rocks of the Gravelotte Group and Rooiwater Complex outcrop in the vicinity of the town of Gravelotte. Quartzite, schists, basic lava and granitic rocks dominate the Gravelotte Group lithology. These formations contain important deposits of antimony and gold, with minor deposits of mercury and zinc. An extensive deposit of heavy mineral sands (illmenite, rutile and zirconium) is located near the town of Gravelotte.

These mining activities within the Olifants WUA produced a total output of approximately R11.1 billion in 2010. Of this, R5.7 billion contributed to GDP. This analysis was based on a summary of the annual reports of mining companies in the study area.

The cumulative impacts of mining are an important consideration for all water-related policy decisions in the WMA.

3.3.6 Manufacturing

Several large manufacturing facilities, associated with the mining industry, exist in the study area. Samancor operates the Tubatse Ferrochrome Plant situated in Steelpoort. Xstrata Alloys' Lion Ferrochrome Operation is also located near Steelpoort. The annual production capacity of the plant is approximately 360kt. Xstrata Alloys also operates the Lydenburg Ferrochrome plant near the town of Mashishing. The Plant has the capacity to produce 396kt of Ferrochrome per annum. Evraz Highveld Steel is one of the largest manufacturing operations within the WMA. This steelworks, which is close to eMalahleni comprises the Iron Plant, the Steel Plant, the Flat Products and Structural Products Mills and operational support infrastructure. Samancor Chrome operates two chrome-smelting operations within Irrigation Water Use Association (IWUA) being, Ferrometals near Emalahleni and Middelburg Ferrochrome near Middelburg. These activities within the Olifants WUA contributed approximately R2.4 billion to GDP in 2010. Other manufacturing activities contributed another R20.5 billion to GDP in 2010. (Source: DBSA Social Accounting Matrixes)

3.3.7 Tourism Economy

The Olifants WMA contains important natural heritage, especially in its lower reaches. These areas are water-dependent and play an important role in the tourism economy of the region. Some of these areas are closely associated with cultural heritage. Key areas include:

- The Kruger National Park and adjoining protected areas (Klaserie, Timbavati, Olifants Conservancy, Umbaba)
- The Wolkberg Wilderness Area on the northern rim of the Olifants catchment;
- The Legalametse Nature Reserve south east of the Wolkberg; and
- The Loskop Dam Nature Reserve.

Dullstroom and Lydenburg and up to the Steelpoort River and Burgersfort in the north is another important tourism area, with natural beauty and as well as being a premier fly-fishing destination.

The Kruger to Canyons Biosphere Reserve is an internationally recognised development initiative that complies with and is accredited to UNESCO's Man and the Biosphere programme. In such areas widely accepted principle of planning around a core-protected area, surrounded by areas where varying forms of conservation/utilisation take place, are applied. Also in the Olifants WMA is an area that abuts onto the western boundary of the KNP. It lies between Acornhoek and Phalaborwa and is the largest area of privately owned conservation land in the world. The inclusion of the Timbavati, Balule, Klaserie, Umbabat and other private nature and game reserves has effectively added in excess of 250,000 ha (more than 10%) to the conservation area of the KNP (DWA 2005).

The economic benefits of the tourism industry are measured in a number of economic sectors, including the accommodation, transport and trade sectors.

3.3.8 Other Economic Sectors

Other economic sectors include all economic activities in the economic sectors. These sectors are defined according to the Standard Industrial Classification (SIC) used by Statistics South Africa and the Development Bank of Southern Africa (DBSA). Social Accounting Matrixes (SAMs) for the Mpumalanga and Limpopo Provinces represent the structure of these sectors within the regional economy and is available from the DBSA:

- Building and Construction
- Trade
- Accommodation
- Transport
- Communication
- Insurance
- Real Estate
- Business Services
- General Government Services
- Community, Social and Personal Services.

These sectors together contributed approximately R8.0 billion to GDP.

4 ASSESSMENT OF ALTERNATIVES AND IDENTIFICATION OF THE PREFERRED SITE

The following section is an assessment of the environmental, social and financial (engineering) specialist reports and their selection of alternatives.

4.1 Initial Site Alternatives: Sites B, C, F & H

The initial site selection process used a 'negative mapping' approach where the existing environmental, social and infrastructure components were taken into consideration across the study area, which was a 10km radius with Kendal Power Station in the centre. From this exercise, nine sites were selected. Several of the sites were considered fatally flawed and four sites were selected for further analysis; B, C, F, H (Figure 4-1).

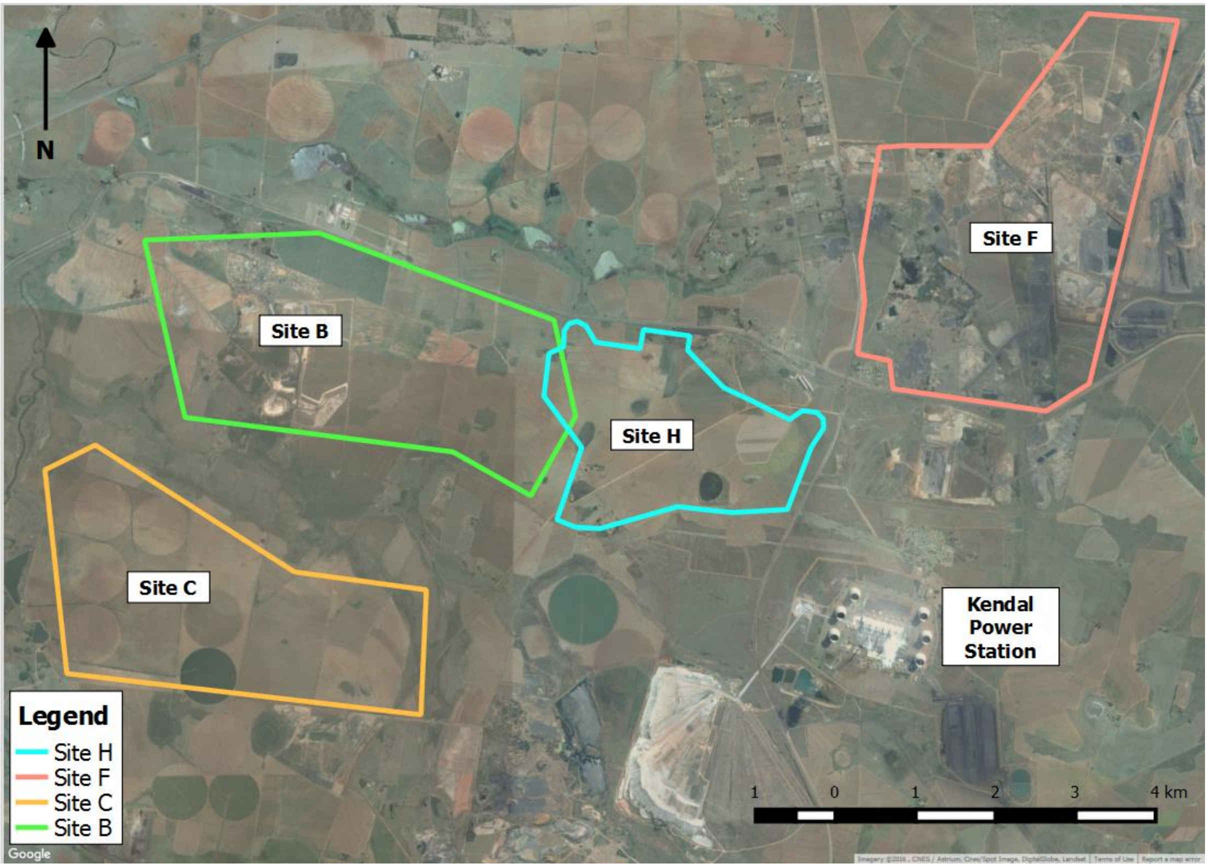

Figure 4-1. Position of the four site alternatives for the 30-yr ADF at Kendal Power Station

4.2 Environmental Assessment

4.2.1 Overall Assessment

Site H was chosen as the preferred site and the other site options are not feasible, the rest of this section is hypothetical and discusses the rationale for this by means of a multi-criteria analysis (MCA).

An MCA was done in order to determine which site is the preferred site from an environmental perspective. The MCA was based on the six specialist environmental studies, which did an analysable comparison between the sites. These specialists included wetlands, aquatic, surface water, groundwater, terrestrial ecology and visual rating (Golder 2016a, b, c, d). The summarised MCA table is given below (Table 4-1).

Table 4-1. Summarised specialist environmental multi-criteria analysis

Specialist Study	**B**	**C**	**F**	**H**
Wetlands	3	4	1	2
Aquatic	2	3	1	4
Surface water	4	4	2	1
Groundwater	4	2	3	1
Terrestrial	2	3	1	3
Visual rating	2	4	1	2
Total weighted	**17**	**20**	**9**	**13**

From the analysis it was clear that the preferred environmental site was Site F, followed by Site H, Site B and then Site C. The main reason for this result was that both sites are environmentally degraded and land use in Site F in particular is dominated by coal mining activities. The overall environmental condition of Site F is an ideal site for development from an environmental perspective and this can be seen as the preferred site for the wetlands, aquatic, terrestrial rating and visual rating specialists. Site H however, was also a preferred site from a surface water, groundwater perspective and then a second preferred site from a wetlands and visual rating perspective.

Site F was unlikely to be selected as the preferred site due to the financial costs and the engineering issues associated with the site. Site H was therefore considered the next preferred site as determined by the MCA. The selection of Site H as the preferred site would have several implications for the environment, these issues would however be relatively minor when compared to the selection of Sites B & C.

From a terrestrial ecology perspective Site H was not preferred due to the presence of disturbed and undisturbed dry mixed grassland and moist grass and sedge vegetation communities in the south-eastern portion of the site. Sections of these areas are designated as critical biodiversity areas, which is important to the Mpumalanga Biodiversity Sector Plan (MBSP). Another important factor to the terrestrial ecology assessment is the presence of the wetland pan.

The presence of the pan is an important assessment factor for the aquatic assessment. The importance of pans extends far beyond their value as biodiversity hotspots of ecological importance for biodiversity. They therefore are highly vulnerable and require to be protected where possible. Pan systems in and around towns and cities are largely under threat and thus it is vital that they are protected (Davies and Day, 1998). A variety of water birds including the Lesser Flamingo (*Phoenicopterus minor*) have been observed at the pan, during previous aquatic surveys.

From an environmental perspective, if Site H was selected as the preferred site, two major environmental components that would be at risk, would be the loss of the pan and the loss of disturbed and undisturbed dry mixed grassland and moist grass and sedge vegetation communities.

The selection of Site H would therefore require the successful mitigation (through a suitable offset mechanism) of these two environmental components.

4.2.2 Environmental Assessment Summary

The following section provides a summary of the key concerns and the main mitigation proposals of each of the environmental specialists. The summary is informed by the Environmental Impact Assessment and Statement developed by each specialist for Site H, which is the preferred alternative.

Table 4-2. Environmental assessment summary showing the key environmental and mitigation concerns for each environmental specialist

STUDY	KEY ENVIRONMNETAL CONCERNS	IMPACT ASSESSMENT RATING	KEY MITIGATION CONCERNS
Soils and Land Capability	• The loss of the soil resource due to the change in land use, erosion and removal • The loss of the utilisation potential of the soil due to compaction • Contamination of the resource due to spillage of waste materials. • Loss of soil utilisation due to the disturbance of the soil.	Moderate to high	Loss of agricultural potential.
Surface Water	• Altered flow. • Disturbance to adjacent streams. • Increased erosion. • Increased sedimentation transport into water resources. • Water quality deterioration in adjacent water resources because of sediments and spills from mechanical equipment	Low to Moderate	Can be mitigated through the following measures: • Optimise design of ADF; • Minimise area of vegetation clearing • Adherence to good stormwater management processes • Implement a water quality-monitoring programme.
Groundwater	• A change in groundwater quality. • A change in the volume of groundwater in storage or entering groundwater storage (recharge). • Change in groundwater flow regime.	Low	• Installation and testing of groundwater monitoring boreholes to accommodate the final ADF layout; and • Groundwater monitoring is recommended to form part of the mitigation and management of the proposed ADF. This monitoring must be included

STUDY	KEY ENVIRONMNETAL CONCERNS	IMPACT ASSESSMENT RATING	KEY MITIGATION CONCERNS
			in the monitoring network and will be used as a warning system for contaminant migration.
Wetlands	• Loss of wetland habitat and functionality • Increased sedimentation and erosion in wetlands • Water quality deterioration in wetlands	High	Implementation of wetland offset plan
Aquatic biodiversity	• Water quality impacts and deterioration (sedimentation and chemical contamination) from operation of the ADF; • Erosion and increased sediment transport into water resources as the ADF construction progresses; and • Loss of streams, aquatic habitats, aquatic biota, bed modification and altered flows as the ADF construction progress.	Low to Moderate	• Optimise design of ash dam to minimise size of footprint; • Minimise area of vegetation clearing; • Where areas need to be cleared of vegetation, the proposed project must aim to cap and revegetate as soon as possible to avoid run off and dust; • Where practically possible, undertake the clearing of vegetation during the dry season to minimise erosion; • Maintain sediment traps as part of the storm water management plan where necessary and especially upstream of discharge points where erosion protection measures and energy dissipaters should be in place; • Clean spills as quickly as possible; • Store and handle potentially polluting substances and waste in designated, bunded facilities; • Locate waste and hazardous substance storage facilities out of the 1:100 floodlines; • Locate sanitation facilities out of the 1: 100 year floodlines; • Maintain infrastructure for river crossings adequately to prevent spillages; and

STUDY	KEY ENVIRONMNETAL CONCERNS	IMPACT ASSESSMENT RATING	KEY MITIGATION CONCERNS
			• An aquatic biomonitoring programme should be maintained for the Wilge River and adjoining tributaries. The monitoring programme should include the following indices monitored on a quarterly basis during the wet and dry season:
Terrestrial Ecology	• Habitat loss and degradation; • Establishment and spread of alien invasive species; • Mortality and disturbance of general fauna; • Loss and disturbance of fauna of conservation importance; and • Loss and disturbance of flora of conservation importance.	Low to High	The loss of the pan in the south-eastern corner of Site H is of particular concern, as this is a recorded foraging site for Flamingo. Mitigated through wetland offset plan.

4.3 Social Assessment of alternative sites

4.3.1 Social Impact Assessment

A Social Impact Assessment (ERCS 2016) was been conducted on the potential social impacts that the site may cause, which include:

- Relocation of people (this is an extreme impact and should be avoided if at all possible);
- Impacts on livelihoods – this include breaking up of economic units, loss of land, water issues, dust and loss of labour;
- Impacts on quality of life – this includes impacts on sense of place, visual, dust, noise and health;
- Impacts related to an influx of people – this includes impacts on physical and social infrastructure, health impacts, traffic, crime, safety and security, the integration of the workforce with existing communities and access to resources;
- Economic impacts (positive) – this includes job creation, skills development and opportunities for small and medium sized enterprises; and
- Economic impacts (negative) – this includes competition for jobs and possible community unrest related to labour issues.

Other social considerations include the social benefits of assuring power generation (refer to section 6.2) and the human well-being associated with ecosystem services production (refer to section 5 and section 6.3).

According to the Social Impact Assessment, the relocation of the Triangle Community is seen as the most pressing impact. Resettlement causes significant social impacts. Being displaced and/or resettled can be a very traumatic experience for people, disrupting their sense of place, their livelihoods, their social networks and community connectedness. Resettlement is a major cause of human rights risks for companies

The Triangle community consist of 12 families (approximately 68 people) that occupy 14 units on a piece of land that is owned by Eskom. According to the residents, some of them have been living there for 60 years and have living rights on the property. The 12 families are not related to each other.

4.3.2 Heritage Impact Assessment

The aim of the heritage impact study is to identify the heritage resources and evaluate their significance. Heritage resources may include cemeteries, graves and homesteads. The final heritage report (PGS 2016) ranked the sites based on the heritage study along with the various other environmental sub-disciplines.

Based on these heritage features Site C was the most preferred site. However in all cases, mitigation would be required in the form of relocation of graves. All sites are mitigatable, and therefore the heritage assessment does not present any fatal flaws.

A combination of the studies together with recommendations from the engineering team, Site H was selected as the preferred site.

The heritage sites identified on Site H include 7 cemeteries with approximately 149 graves and a single farmstead. All seven cemeteries will be directly impacted by the development and will require the relocation of approximately 149 graves.

4.4 Economic Assessment of Alternative Sites

4.4.1 Capital and Operational Costs

The capital and operational costs of the site alternatives are primarily influenced by the size of the footprint area, the liner requirements, the distance between the power station and site and the geotechnical features of the site. In the case of Sites B, C, F and H, the size of the site and the liner requirements were identical. The geotechnical considerations and the distance from the power block had a very significant impact on both capital costs and operational costs.

Zitholele Consulting developed various capital costing models for the Kendal Power Station site options, and Jones and Wagner Consulting Engineers have developed various operational and capital costing models for Eskom in general. These models were used to estimate the total life cycle cost of the site options.

The cost estimates have indicated that Site H was by far the most preferred site. The main reasons for this were

- The extreme costs of bulk earthworks associated with creating suitable geotechnical conditions at Sites B, C and F. These earthworks result from existing or old mining coal activities at these sites, as well as topographical reasons.
- The cost of conveyor construction and operation associated with the larger distances that Sites B, C and F are located from the power block.

As a result, the unitised cost of Site H was R5.79 million/ha, which was nearly an order of magnitude lower than that of Sites B, C and F R36.29; R35.74 and R47.66 million/ha respectively. Sites B, C and F were multiple times more expensive than Site H: Site B is 6.27 times more expensive, Site C was 6.18 times more expensive and site F is 8.243 times more expensive.

As a result, Sites B, C and F were not defensible from a financial point of view. These sites, if they were to go ahead would put vast additional pressure on Eskom capital expenditure programme, by increasing capital expenditure by ratios of 59.9%, 56.2% and 72.1% respectively.

Sites B, C and F were also not defensible from a financial point of view. They would increase electricity tariffs by 0.76%, 0.74% and 0.88% respectively, much higher than the 0.12% of Site H.

The cost of unserved energy (COUE) impact was high, with all sites contributing R582 billion per year to Direct COUE and R111 billion per year Social COUE. The COUE is an indicator published by NERSA that estimates the opportunity cost of energy supply.

Table 4-3. Capital and operational costs of the 4 site options for the Kendal 30-yr ADF

Costs (R'million)	**Site B**	**Site C**	**Site F**	**Site H**
Land acquisition	R 4	R 4	R 4	R 4
Site Clearance	R 23	R 23	R 23	R 23
Bulk earthworks	R 10 490	R 9 761	R 12 918	R 0
Other earthworks	R 174	R 174	R 174	R 174
Capital construction costs	R 976	R 976	R 976	R 976
Structural concrete	R 78	R 78	R 78	R 78
Pumps & Pipework	R 87	R 87	R 87	R 87
Ring Roads	R 11	R 11	R 11	R 11
Transnet Pipeline	R 73	R 73	R 73	R 73
Road Diversion	R 4	R 4	R 4	R 4
Conveyor System (civils)	R 26	R 26	R 26	R 26
Conveyor costs (mechanical)	R 325	R 498	R 274	R 77
Conveyor Crossings	R 0	R 0	R 0	R 0
Stormwater Management on Facility	R 20	R 20	R 20	R 20
Transfer Houses	R 15	R 15	R 15	R 15
Relocation cost	R 7	R 7	R 7	R 7
Heritage Costs	R 3	R 3	R 3	R 3
Wetland rehabilitation costs	R 0	R 0	R 0	R 4
Rehabilitation costs	R 392	R 392	R 392	R 392
Opex costs (life of ADF)	**R 729**	**R 1 083**	**R 611**	**R 177**
Shifting costs	R 0	R 0	R 0	R 0
Total costs	**R 13 436**	**R 13 235**	**R 15 696**	**R 2 152**
Unitised costs (R'M/ha)	R 36,29	R 35,74	R 47,66	R 5,79
Comparison against lowest cost alternative (R/R)	6,27	6,18	8,24	1,00
Price ratio	**Site B**	**Site C**	**Site F**	**Site H**

Kendal capacity (MW)	3840	3840	3840	3840
Capacity factor (%)	80%	80%	80%	80%
KWh (Million)	26 911	26 911	26 911	26 911
Cost contribution (Cents/kWh)	0,83	0,82	0,97	0,13
Contribution to electricity prices (estimate)	0,76%	0,75%	0,88%	0,12%
COUE Benefits	**Site B**	**Site C**	**Site F**	**Site H**
Direct COUE (R/kWh)	21,63	21,63	21,63	21,63
Total COUE (R/kWh)	77,3	77,3	77,3	77,30
Social COUE (R/kWh)	4,12	4,12	4,12	4,12
Direct COUE (R million)	582 079	582 079	582 079	582 079
Total COUE (R million)	2 080 199	2 080 199	2 080 199	2 080 199
Social COUE (R million)	110 872	110 872	110 872	110 872
Capital ratios	**Site B**	**Site C**	**Site F**	**Site H**
Eskom Group planned capex	19 907	19 907	19 907	19 907
Eskom Group Generation assest value	144 548	144 548	144 548	144 548
Capital expenditure (Kendal 30yr ADF)	11 916	11 188	14 344	1 427
Capital expenditure : Eskom Group Generation assest value	8,2%	7,7%	9,9%	1,0%
Capital expenditure : Eskom Group planned capex	59,9%	56,2%	72,1%	7,2%

4.4.2 Source of Material for Bulk Earthworks

In the case of Sites B, C and F, the source of material for bulk earthworks was of concern. These sites required 60, 50 and 74 million m^3 of fill material. No information is available on where this material would be sourced and what cumulative ecological, social and economic effects would be associated with this.

What is clear is that it is highly likely that there will be impacts associated with sourcing of this fill material. In the case of Site H, no fill material was required and thus no cumulative cost would be incurred.

4.4.3 Coal Mining Activities

A major constraint in selecting a site for the 30-yr ADF is the large amount of historical and existing coal mines in the area. Utilising these areas for the 30-yr ADF is not only technically difficult, as existing and historical mining operations would have to undergo considerable bulk earthworks (backfilling of opencast pits) before the facility could be developed, but it also has the consequence of sterilising important mineral resources and mining investment opportunities. It should be noted that Sites B, C and F are earmarked for current and future mining, with mining rights already issued to the relevant mining houses on these areas.

Sites B and F have a large number of coal mining operations on or near the sites (Figure 4-2). The costs of purchasing and sterilising these operations and rights have not been quantified here; nevertheless, the presence of these operations is considered a fatal flaw.

Site C is located on coal reserves and as a result this site is also considered fatally flawed from a coal-mining point of view.

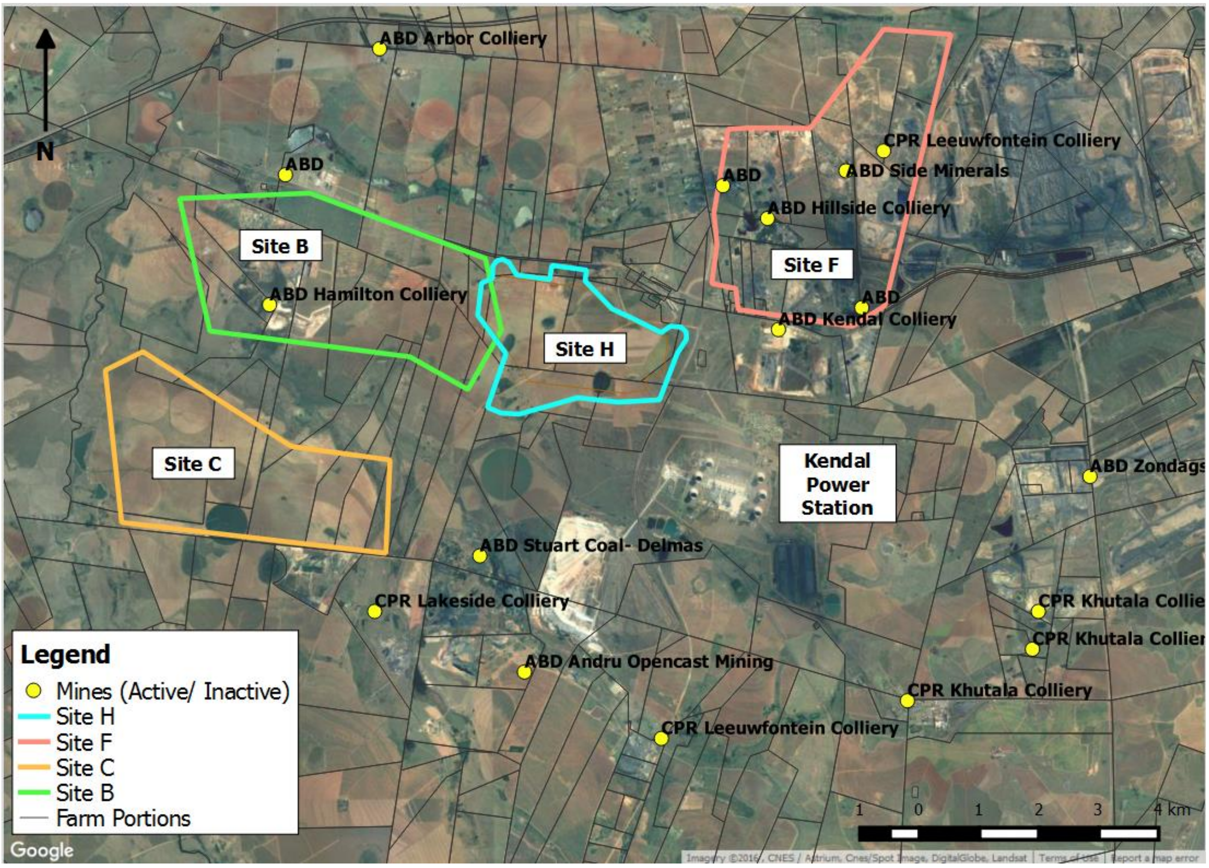

Figure 4-2. Active and inactive mining operations in the study area (source: Council for Geoscience)

4.4.4 Agriculture

All the sites have some extent of agricultural activity present.

Working from the assumption that, where land will be purchased, the value of the agricultural production will be internalised in the land value, it is assumed that the agricultural impact will be negligible as it is likely that the returns to land will be reinvested again in agriculture.

4.5 Summary: Site H is the preferred site

Site H was chosen as the preferred site, for the following reasons:

- Sites B, C and F had prohibitive engineering and operational costs associated with it which was not defensible neither from an Eskom capital expenditure perspective nor from a national electricity tariff perspective. Site H was the only site that was financially affordable.
- In the case of Sites B, C and F, the source of material for bulk earthworks was of concern. These sites required 60, 50 and 74 million m^3 of fill material. Although no information was available on where this material would be sourced and what cumulative ecological, social and economic effects would be associated with this, it was highly likely that there will be cumulative impacts associated with sourcing of this fill material. In the case of Site H, no fill material is required and thus no cumulative cost will be incurred.
- Sites B, C and F are characterised by past, present and future coal mining activities. These activities comprise strategic mineral reserves and economic activity that cannot be sterilised. Site H does not have coal mining activities present.
- Site F is underlain by dolomite and this is considered a fatal flaw as a result of the risk associated with sinkholes and groundwater pollution.
- Site B has major geological structures intersecting the site and this was considered a geotechnical fatal flaw.
- Sites B and C are located within very close proximity to the Wilge River, which increases direct and cumulative impact risks on the aquatic system.

Site H, the preferred site, will also result in several impacts.

- There will be a loss of agricultural production of maize, other annual crops and grazing. The area is characterised by moderately good arable soils.
- There are some social impacts related to agricultural habitation on a farm homestead and farm employee dwellings as well as the relocation of the Triangle Community.
- There are ecological infrastructure that will be impacted, and here the aquatic ecology is of most concern. Of greatest concern is a pan of and associated wetland area that will be impacted.

The rest of this document assesses the overall sustainability of Site H and the mitigation activities required to address the Site H impacts.

5 ECOSYSTEM SERVICES ASSESSMENT OF SITE H

5.1 What are Ecosystem Services?

Ecosystem service is the term that describes the full scope of nature's contributions to human health and welfare. The Millennium Ecosystem Assessment (MEA) provides a sound and well-established framework for the assessment of ecosystem services and the benefits to human well-being. The MEA framework defines four different categories of ecosystem services:

- **Provisioning services** are the most familiar category of benefit, often referred to as ecosystem 'goods', such as foods, fuels, fibres, biochemicals, medicine, and genetic material, that are in many cases: *directly* consumed; subject to reasonably *well-defined property rights* (even in the case of genetic or biochemical material where patent rights protect novel products drawn from ecosystems); and are *priced in the market*.
- **Cultural services** are the less familiar services such as religious, spiritual, inspirational and aesthetic well-being derived from ecosystems, recreation, and traditional and scientific knowledge that are: mainly passive or non-use values of ecological resources (*non-consumptive uses*); that have *poorly-developed markets* (with the exception of ecotourism); and *poorly-defined property rights* (most cultural services are regulated by traditional customs, rights and obligations); but are still *used directly* by people and are therefore open to valuation.
- **Regulating services** are services, such as water purification, air quality regulation, climate regulation, disease regulation, or natural hazard regulation, that affect the impact of shocks and stresses to socio-ecological systems and are: public goods (globally in the case of disease or climate regulation) meaning that they "offer non-exclusive and non-rival benefits to particular communities" (Perrings 2006); and are thus frequently undervalued in economic markets; many of these are *indirectly used* being intermediate in the provision of cultural or provisioning services.
- **Habitat or Supporting services** are an additional set of ecosystem services, such as nutrient and water cycling, soil formation and primary production, that capture the basic ecosystem functions and processes that underpin all other services and thus: are embedded in those other services (*indirectly used*); and are not evaluated separately. An additional service added by TEEB to this category is *habitat for species*. Habitats provide everything that an individual plant or animal needs to survive: food, water and shelter. Each ecosystem provides different habitats that can be essential for a species' lifecycle. Migratory species including birds, fish, mammals and insects all depend upon different ecosystems during their movements.

5.2 Ecosystem services at risk at Site H

The specialist studies performed as part the larger EIA study provides the evidence-base for this assessment.

The proposed 30-yr ADF at Kendal poses a risk to five ecosystem services. Table 5-1 below identifies these ecosystem services as:

1. Fresh water
2. Air quality
3. Water purification and waste assimilation
4. Soil fertility
5. Habitat for species.

The ecosystem services risk assessment assumes an unmitigated state. In the case of **air quality**, the normal operating procedures for ADFs include continuous dust suppression through watering and through grassing of the facility. This limits the risk to air quality to a low risk, which does not require further evaluation. Similarly, the **soil fertility** service in this case relates to agricultural production, which is assessed elsewhere in this report.

Risks to fresh water, water purification and waste assimilation and habitat for species are high likelihood (i.e. rated as "almost certain") risks and require further assessment in the economic analysis to follow in section 6 below.

Table 5-1. Assessment of ecosystem services at risk using the TEEB ecosystem services classification and the CRA methodology described in Appendix 1. The analysis was informed specialist studies.

ECOSYSTEM SERVICES	LIKELIHOOD	NOTES
Provisioning Services are ecosystem services that describe the material or energy outputs from ecosystems. They include food, water and other resources.		
Food: Ecosystems provide the conditions for growing food. Food comes principally from managed agro-ecosystems but marine and freshwater systems or forests also provide food for human consumption. Wild foods from forests are often underestimated.	No risk	Agricultural production value captured elsewhere
Raw materials: Ecosystems provide a great diversity of materials for construction and fuel including wood, biofuels and plant oils that are directly derived from wild and cultivated plant species.	No risk	No evidence available of raw material collection at Site H
Fresh water: Ecosystems play a vital role in the global hydrological cycle, as they regulate the flow and purification of water. Vegetation and forests influence the quantity of water available locally.	Almost certain	The Olifants WRCS, especially the Wilge MC and RQO inform the importance water regulation and fresh water
Medicinal resources: Ecosystems and biodiversity provide many plants used as traditional medicines as well as providing the raw materials for the pharmaceutical industry. All ecosystems are a potential source of medicinal resources.	No risk	No evidence available of medicinal resources collection at Site H
Cultural Services include the non-material benefits people obtain from contact with ecosystems. They include aesthetic, spiritual and psychological benefits.		
Recreation and mental and physical health: Walking and playing sports in green space is not only a good form of physical exercise but also lets people relax. The role that green space plays in maintaining mental and physical health is	No risk	No evidence available of recreational use of Site H

ECOSYSTEM SERVICES	LIKELIHOOD	NOTES
increasingly being recognized, despite difficulties of measurement.		
Tourism: Ecosystems and biodiversity play an important role for many kinds of tourism which in turn provides considerable economic benefits and is a vital source of income for many countries. In 2008 global earnings from tourism summed up to US$ 944 billion. Cultural and eco-tourism can also educate people about the importance of biological diversity.	No risk	No evidence available tourism activities at Site H
Aesthetic appreciation and inspiration for culture, art and design: Language, knowledge and the natural environment have been intimately related throughout human history. Biodiversity, ecosystems and natural landscapes have been the source of inspiration for much of our art, culture and increasingly for science.	No risk	No evidence available of aesthetic services at Site H
Spiritual experience and sense of place: In many parts of the world natural features such as specific forests, caves or mountains are considered sacred or have a religious meaning. Nature is a common element of all major religions and traditional knowledge, and associated customs are important for creating a sense of belonging.	No risk	No evidence available of use of Site H for spiritual experience and sense of place
Regulating Services are the services that ecosystems provide by acting as regulators e.g. regulating the quality of air and soil or by providing flood and disease control.		
Local climate and air quality: Trees provide shade whilst forests influence rainfall and water availability both locally and regionally. Trees or other plants also play an important role in regulating air quality by removing pollutants from the atmosphere.	Almost certain	Risk of air pollution, but only if ADF is not properly managed to mitigate for air-blown dust production
Carbon sequestration and storage: Ecosystems regulate the global climate by storing and sequestering greenhouse gases. As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues. In this way forest ecosystems are carbon stores. Biodiversity also plays an important role by improving the capacity of ecosystems to adapt to the effects of climate change.	No risk	Selection of Site H will not have marginal impact of carbon emissions from Kendal Power Station
Moderation of extreme events: Extreme weather events or natural hazards include floods, storms, tsunamis, avalanches and landslides. Ecosystems and living organisms create buffers against natural disasters, thereby preventing possible damage. For example, wetlands can soak up flood water whilst trees can stabilize slopes. Coral reefs and mangroves help protect coastlines from storm damage.	No risk	No evidence exists that ecological infrastructure at Site H mitigates risk of extreme events
Water purification and waste assimilation: Ecosystems such as wetlands filter both human and animal waste and act as a natural buffer to the surrounding environment. Through the biological activity of microorganisms in the soil, most waste is broken down. Thereby pathogens	Almost certain	This service is at risk as a result of loss of aquatic habitat, and pollution risks

ECOSYSTEM SERVICES	LIKELIHOOD	NOTES
(disease causing microbes) are eliminated, and the level of nutrients and pollution is reduced.		
Erosion prevention and maintenance of soil fertility: Soil erosion is a key factor in the process of land degradation and desertification. Vegetation cover provides a vital regulating service by preventing soil erosion. Soil fertility is essential for plant growth and agriculture and well-functioning ecosystems supply the soil with nutrients required to support plant growth.	Almost certain	Loss of productive land - this is captured in the agricultural economic assessment
Pollination: Insects and wind pollinate plants and trees which is essential for the development of fruits, vegetables and seeds. Animal pollination is an ecosystem service mainly provided by insects but also by some birds and bats. Some 87 out of the 115 leading global food crops depend upon animal pollination including important cash crops such as cocoa and coffee (Klein et al. 2007).	No risk	No evidence available that position of Site H will affect pollination service.
Biological control: Ecosystems are important for regulating pests and vector borne diseases that attack plants, animals and people. Ecosystems regulate pests and diseases through the activities of predators and parasites. Birds, bats, flies, wasps, frogs and fungi all act as natural controls.	No risk	No evidence available
Habitat or Supporting Services underpin almost all other services. Ecosystems provide living spaces for plants or animals; they also maintain a diversity of different breeds of plants and animals.		
Habitats for species: Habitats provide everything that an individual plant or animal needs to survive: food; water; and shelter. Each ecosystem provides different habitats that can be essential for a species' lifecycle. Migratory species including birds, fish, mammals and insects all depend upon different ecosystems during their movements.	Almost certain	Pan, refer to wetland specialist report
Maintenance of genetic diversity: Genetic diversity is the variety of genes between and within species populations. Genetic diversity distinguishes different breeds or races from each other thus providing the basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock. Some habitats have an exceptionally high number of species which makes them more genetically diverse than others and are known as 'biodiversity hotspots'.	No risk	No red data species present at Site H.

6 SOCIAL COST-BENEFIT ANALYSIS

6.1 Overview

This section provides an integrated assessment of the financial, economic, ecological and social costs and benefits of Site H as preferred site for the Kendal 30-yr ADF.

The benefits are demonstrated at the hand of the electricity crisis in South Africa.

The financial and economic costs follow the best international practices and methodology described in section 2.4 and measures the financial NPV (FNPV) and socio-economic NPV (SNPV) respectively. The ecological and social costs are measured through the ecosystem services effects on human well-being, described in section 2.4, section 4.3 and section 5.

6.2 Financial costs – Impact on Eskom

The financial costs are those costs incurred by Eskom, during the construction and operations of the ADF.

The financial costs were derived from the conceptual design specifications and estimates provide by Zitholele Consulting Engineers, as discussed and presented in section 4.4.1 above. The total cost over the life of the facility is R2 185 million. The major cost components are:

- The capital costs associated with construction and especially the liner (44.7%)
- ADF capping costs (17.9%)
- Operational costs (8.1%)
- General earthworks (8.0%).

To provide context, this cost represents a ratio of 7.2% of the planned capex of the Eskom Group for 2014/15. It also contributes 0.12% to electricity price escalation.

6.3 Combined Assessment

6.3.1 Benefits - Impact on Energy Security

In the case under study, the direct benefit of developing Site H at Kendal as the 30-year ADF is that it enables the Kendal Power Station to continue operations.

The financial benefit of this will be that Eskom will continue to sell electricity.

The economic benefit of the ADF is to provide power generation capacity to the South African power generation grid. This has significant national benefit in a CBA.

NERSA has recently approved, for Eskom, a Cost of Unserved Energy (COUE) model, which estimates the economic impact of power outages. Although this COUE-model is based on unplanned power outages, recent experience in South Africa has shown that there is often little scope for planning load shedding and therefore the COUE model is applicable in this case.

The COUE model estimates the cost of not delivering power to the grid to include a direct and a total impact on the economy. The direct impact is R21.63/kWh and the total impact is R77.30/kWh. The social COUE, i.e. the impact on household convenience and vulnerability is R4.13/kWh. Table 6-1 provides an assessment of these benefits as it relates to Kendal. The assumption is that Kendal's power production is dependent on the Site H ADF. The direct economic benefit is R691 billion per year, the total benefit is R2,470 billion per year and the household (social) benefit is R132 billion per year.

Table 6-1. Economic impact of unserved energy can be used as an indicator of the benefits provided to the economy of operating the Kendal Power Station.

	R/kWh	Impact for Kendal (R billion per year)
Direct COUE	21.63	691
Total COUE	77.3	2,470
Social COUE	4.12	132

These benefits come at financial and economic costs, which are analysed in the sections below.

6.3.2 No Impact on Mining

Site H will not sterilise any coal mining activities and will incur no additional costs as a result of this.

6.3.3 Economic cost - Impact on Agriculture

The issue of food (in) security is of great importance to the Department of Agriculture, Forestry and Fisheries (DAFF) and has been at the forefront of government policy planning since 2011. With the added impacts of the 2015/16 drought adding to food price inflation, any loss of agricultural land would require mitigation of sorts.

The footprint of the Kendal 30 year ADF is approximately of 404,7 ha of which the majority of the area is dry land agriculture. According to the Agricultural Potential Assessment conducted by ESS, there is good evidence (present land use) to believe that an economically successful agricultural development is viable for a significant proportion (79.19%) of the study area, with better than average (national average for the crop climate) yields being returned from the moderate and good (50.04%) agricultural potential sites (ESS, 2016). In order to calculate the value of the agricultural area lost and in the absence of an agricultural study, we made a few assumptions when calculating the agricultural potential of the impacted area:

1. Assumed productivity of dryland maize in the area is approximately 4 tons/ha/annum, while maize under irrigation is approximately 10 tons/ha/annum.
2. The average white maize price for 2014/2015 was R2 596/ton (South African Grain Information Service, 2016).
3. Therefore the total loss of potential income for the impacted area is approximately R3 901 951/year

Table 6-2. Approximate loss of the potential agricultural value of the Kendal 30 year ADF footprint

	Area (ha)	Assumed Productivity T/ha	Average White Maize price 2014-2015 R/ton	Yearly Income	Total Lost/Annum
Total Footprint	404,7				
Area dryland	272,5	4	R2 596	R2 829 262	
Area Pivot	80,83	10	R2 596	R2 098 066	
Percentage of Site H considered economically viable (ESS, 2016)					**79,19%**
Value of loss of agricultural potential/annum					**R3 901 951**

However, where land will be purchased, the value of the agricultural production will be internalised in the land value and it is assumed that the agricultural impact will be negligible as it is likely that the returns to land will be reinvested again in agriculture.

6.3.4 Social Cost – Socio-Economic Nexus

The Social Impact Assessment (SIA) identified several potential issues with the development of the Kendal 30 year ADF, of which the most serious was the resettlement of the Triangle Community, which reside within the footprint of the ADF. Appropriate land and services will have to be provided to this community well before the commencement of construction. Determination of the associated costs is difficult to identify without a full resettlement plan that would be done in consultation with the affected community.

For the purposes of this report, we estimated that it would cost approximately R500 000/household for successful resettlement. According to the SIA report there are 14 households to be resettled which would require an approximate budget of R7 000 000. This does not include the relocation of cemeteries.

6.3.5 Social Cost – Socio-Ecological Nexus

6.3.5.1 Value of Wetland Ecosystem Services

The wetland ecosystem services impact value of Site H is high. A wetland ecosystem services valuation was performed using data from SANBI's Working for Wetlands programme and data from the Olifants WMA Water Resources Classification Study (2012). The benefits of these ecosystem services accrue indirectly in the Olifants WMA, through water regulation, water purification and habitat services (refer to section 5 above). Based on the values from these studies it is calculated that the value of the ecosystem services delivered by the wetlands at Site H are approximately R6 million/annum. This is the value of ecosystem services lost to downstream users within the catchment. As these values are based on other studies, they are merely indicative of cost and an Ecosystem Services Assessment would need to be conducted in order to determine a more accurate value.

Table 6-3. Value of wetland in the Olifants WMA and within the footprint of the 30 Year ADF

	Ecosystem Service	**Value R**
Provisioning	Resource-poor farmers	1 169 000 000
	Resource rent to agriculture	332 000 000
	Sub-total	**1 501 000 000**
Regulating	Water flow regulation	2 733 000 000
	Water purification / waste assimilation	876 000 000
	Flood attenuation	23 000 000
	Carbon sequestration	11 000 000
	Sub-total	**R3 643 000 000**
Grand Total		**R5 144 000 000**
Total wetlands in the Olifants WMA (ha)		**126 128**
R/ha/annum		**R40 783**
Area impacted by proposed ADF (ha)		**149,3**
VALUE OF WETLANDS IMPACTED BY THE ADF		**R6 089 046**

6.3.5.2 Wetland Offset

The South African National Biodiversity Institute (SANBI) has developed guidelines for wetland offsets, which can be considered once all other avenues within the mitigation hierarchy have been exhausted. According to the SANBI Wetland Offset Guideline, wetland offsets are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse impacts on wetlands (including all impacts on water resources, including hydrological and ecological processes and function, and wetland biodiversity including ecosystems, habitats and species) (Macfarlane *et al*. 2014).

The broad wetland offset policy goals proposed by the SANBI offset guidelines are as follows:

- **Formally protecting** wetland systems in a good condition so as to contribute to **meeting national conservation targets** for the representation and persistence of different wetland and wetland vegetation types;
- **No net loss in the overall wetland functional area** by providing gains in wetland area and / or condition equal to or greater than the losses due residual impacts;

- **Providing appropriate and adequate compensation for residual impacts on key ecosystem services;** and
- **Adequately compensating** for residual impacts on **threatened or otherwise important (e.g. wetland-dependent) species** through appropriate offset activities that support and improve the survival and persistence of these species.

Wetland Consulting Services (WCS) developed a Wetland Offset Study where the required offset targets were calculated and offset target areas were identified.

Understanding the costs of the wetland offset is difficult as there are several unknowns at this stage. The Offset Guidelines provide various options for reaching the required offset targets including land tenure and level of rehabilitation. After discussions with Eskom staff, it is assumed that no land purchase would occur and the wetland targets would be secured through stewardship agreement.

Improving the present ecological state (PES) i.e. the 'health' of the wetland would be required. Understanding the costs of wetland rehabilitation is difficult without a full wetland rehabilitation plan, however several such plans have been developed for Eskom's new plant, Kusile.

Based on a 1:1 ratio, or a like for like principle, we estimated the cost of rehabilitating the 149 ha of wetland that would be directly and directly impacted by the ADF. Based on estimated cost of approximately R28 000/ha for rehabilitation, it would cost approximately **R4 200 000** to rehabilitate the wetlands for the wetland offset.

Based on a 2:1 ratio, i.e. 2 ha of wetlands to be secured for every 1 ha lost, the cost would be doubled i.e. R8 400 000.

6.3.6 Combined assessment

The combined assessment makes a strong case for extensive wetland mitigation. Table 6-4 below presents a sensitivity analysis of Site H financial and socio-economic costs using a net present cost (NPC[2]) assessment. The Financial NPC analysis refers to the project costs discounted at a specific rate of the 30-year project life cycle. The Socio-economic NPC analysis refers to the project costs as well the loss of agricultural potential and loss of ecosystem services discounted at a specific rate of the 30-year project life cycle. Three discount rates are tested i.e. 4, 6 and 8%.

The socio-economic NPC with mitigation compares is significantly lower that the socio-economic NPC without mitigation indicating that wetland mitigation need to be pursued. The difference (externality) between the financial NPC with mitigation and the socio-economic NPC with mitigation is that of the loss in food production, for which no mitigation is planned.

[2] The total Net Present Cost of a project is a summation of all costs: capital investment, non-fuel operation and maintenance costs, replacement costs, energy costs (fuel cost plus any associated costs), any other costs such as legal fees, etc

Table 6-4. Sensitivity analysis of financial net present cost (NPC) and socio-economic net present cost (SNPC) for Site H over a 30 year life cycle

Discount rate	Financial without Mitigation (NPC) (R'million)	Socio-economic without Mitigation (SNPC) (R'million)	Financial with Mitigation (NPC) (R'million)	Socio-economic with Mitigation (SNPC) (R'million)
4%	1,625	1,787	1,629	1,633
6%	1,313	1,441	1,316	1,320
8%	1,086	1,191	1,090	1,093

7 CONCLUSION

The purpose of the sustainability assessment is to guide DEA in making an informed decision on the integrated environmental, economic and social impacts and consequences that Site H may incur to society, and how this may be mitigated. The economic, environmental and social considerations are summarised below.

7.1 Economic Considerations

The economic case for the selection of Site H as a preferred option is strong as Sites B, C and F are covered by mining rights and are earmarked for current and future mining activities. If these sites had been feasible alternatives, they would have been multiple times more expensive than Site H: Site B is 6.27 times more expensive, Site C is 6.18 times more expensive and site F is 8.243 times more expensive.

As a result, Sites B, C and F are not defensible from a financial point of view. These sites, if they were to go ahead would put vast additional pressure on Eskom capital expenditure programme, by increasing capital expenditure by ratios of 59.9%, 56.2% and 72.1% respectively.

Sites B, C and F are also not defensible from an economic point of view. They would increase electricity tariffs by 0.76%, 0.74% and 0.88% respectively, much higher than the 0.12% of Site H.

7.2 Environmental and Social Considerations

However, the selection of Site H comes with considerable environmental and social consequences. Environmentally, the biggest concern is the loss of the wetlands and in particular the loss of the pan. Other concerns relate mainly to the aquatic and surface water environments, but these can be mitigated though construction and operational best practices.

Socially, the loss of the wetland ecosystem services delivered to downstream users is a concern as well as the loss of the agricultural land and the resettlement of the impacted Triangle Community.

7.3 Mitigation Considerations

From the analysis it is clear that considerable effort needs to be placed in mitigating the environmental and social attributes that will be lost. It is the opinion of the authors that in particular the following two mitigation programmes need to be developed further:

1. **The resettlement of the triangle Community**: Resettlement can causes significant social impacts. Being displaced and/or resettled can be a very traumatic experience for people, disrupting their sense of place, their livelihoods, their social networks and community connectedness. Resettlement is a major cause of human rights risks for companies. Taking these risks into consideration, Eskom is urged to develop a Resettlement Plan for the impacted community as soon as possible. While costs have been estimated in this report, a more detailed assessment needs to be completed.

2. **Wetland Offset Strategy**: The loss of ecosystem services and the loss of the pan will have a pronounced impact on the quaternary catchment and possibly even further within the catchment. While a Wetland Offset Plan has been developed, further information needs to be clarified i.e. land tenure of the offset, suitable target areas and rehabilitation planning for the offset.

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9 APPENDIX 1 - COMPARATIVE RISK ASSESSMENT

Comparative risk assessment (CRA) provides a structured way for experts to describe how a change might impact on an ecosystem service in question. It is explicit about assumptions and certainty, can quantify, and help focus other extraction of evidence.

The CRA method is both an analytical process and a methodology for prioritizing complex problems. A recent authoritative publication on this concept is titled Comparative Risk Assessment: Concepts, Problems and Applications (Schütz et al., 2006). The discussion below was adapted from this publication.

Comparative risk assessment is a multi-attribute evaluation procedure which allows for a theoretically sound and structured progression by way of manageable individual steps. For each step (such as structuring the problem, structuring and weighting the attributes, sensitivity analysis) a range of practically tested techniques exist. The strength of the CRA is that it facilitates an explicit examination of assumptions and values and thus aids in a transparent comparative risk evaluation.

This approach is therefore suitable for those comparative risk assessment processes in which a variety of evaluators, both experts and other stakeholders take part.

Risk assessment begins with the identification of hazards. Three problem areas are of significance here. Firstly, the degree of evidence required to substantiate a causal link between the causes and effects in question, secondly, the classification of an effect as adverse or undesirable, and thirdly, possible exposure effects. The evaluation of evidence is a substantial problem. Dose-response type assessments are generally applied. In the light of the importance of hazards, exposure assessments are also of considerable significance. Thus the risk characterization brings together the results of the identification of hazards, dose-response assessments, and exposure assessments.

This examination of the data is also a factual prerequisite for comparative analyses. Risk evaluation constitutes the link between the predominantly scientific / technical risk assessment and a socio-politically oriented valuation of risks. A consensus on what are tolerable risks, reached through societal debate, can be the basis for an evaluation of quantifiable risks. Many risks may be unquantifiable, and thus criteria for differentiating (on the basis of scientific expertise) between averting a substantiated danger and precautionary measures often need to be developed.

However, standards of quality for the scientific understanding of risk have yet to be developed.

A benefit of a CRA lies in the comparison of a new development fields (and by inference also complex systems), in the comparison of public risk perceptions for different cases, and in the comparison of cost and benefit effects. Risk assessment is focused on the evaluation of evidence. “This is however where scientific controversy is often found and a comparison of different evidence evaluations, for instance with the use of tried and tested guidelines and categories of evidence, could contribute considerably to the solution of the problem” (Robu

2007). Risk evaluation is generally characterised by four components: (a) the evaluation of intensity, (b) the evaluation of exposure, (c) the evaluation of the vulnerability of beneficiary populations, and (d) the comparative evaluation of the various risks.

Comparative risk assessment, as a combination of scientifically based risk assessments and value judgments, requires the cooperation of experts and societal stakeholders. A challenge to a successful CRA is that experts and general public (civil society) frequently have very different understanding and interpretation of risk. A substantial problem, from the point of view of experts is that the final results of analyses are separated from their principal constraints, methodological uncertainties, and scope, of which the public remains unaware.

Generally, the technical conception of experts is from the public's point of view, extremely narrow and encompasses only a fraction of the aspects and values that the general public – broadly represented by societal stakeholders – consider important to an appraisal of risk. Even the consideration of frequency and loss equivalent, which is derived from the insurance industry, is disputed. Both factors are related by lay people (i.e. those who are not risk experts) individually; in particular, the upper limit of potential damages is seen as an independent issue and is increasingly demanded. In addition, the concept of risk underlying risk assessments usually encompasses only a few of the dimensions of loss, often only loss of life and harm of health, and, in rare cases, loss of prosperity.

CRA thus provides an objective process for prioritizing risks, and therefore the nature and extent of ecosystem effects resulting from development, captured in a risk description for each asset.

With the assets and scenarios spatially and temporally bound, the effect of the scenario on each asset in terms of ecosystem service delivery is assessed.

For each scenario-asset combination, the ecosystem services identified in phase 1D are assessed. Table 10-1 provides a guide to ecosystem services provided by different types of aquatic ecosystems.

For each scenario-asset-service combination, the question asked is 'What is the likelihood that this ecosystem service in this significant water resource will be affected under this scenario? What would be the consequences of this scenario in this significant water resource to the delivery of this ecosystem service?'

The likelihood is the probability of the scenario having an effect on the asset. Likelihood takes into account an element of uncertainty, in that the likelihood that an ecosystem service will be affected under the scenario in question over a specified time frame is rated. Uncertainty with regards to the knowledge upon which the statements or connections between scenario-asset-service linkages are made, is also stated explicitly for each CRA. This level of certainty (e.g. high, medium or low) is a statement based on the expert's judgement of the certainty of and confidence in the risk assessment. For example, a low level of certainty indicates that evidence to bear out the assessment is weak or lacking.

Table 9-1. Qualitative and quantitative classes of likelihood of a scenario (environmental effect, or resultant change in the flow of an ecosystem service) eventuating from a management decision and of having an environmental consequence to a service from an environmental asset in the ecosystem adapted from the classification adopted by the IPCC (2007).

Likelihood rating	**Assessed probability of occurrence**	**Description**
Almost certain	> 90%	Extremely or very likely, or virtually certain. Is expected to occur.
Likely	> 66%	Will probably occur
Possible	> 50%	Might occur; more likely than not
Unlikely	< 50%	May occur
Very unlikely	< 10%	Could occur
Extremely unlikely	< 5%	May occur only in exceptional circumstances

The consequence is the change in the service from the environmental effect of the management scenario on the exposed asset. The assessment of consequences can follow, or adapt in an appropriate manner, the severity ratings in King et al. (2003) (Table 10).

Table 9-2. Qualitative measures of consequence to environmental services in an ecosystem arising from the hazards linked to a management decision.

Level of consequence		**Environmental effect**
1	Severe	Substantial permanent loss of environmental service, requiring mitigation or offset.
2	Major	Major effect on the on the asset or service, that will require several years to recover, and substantial mitigation.
3	Moderate	Serious effect on the on the asset or service, that will take a few years to recover, but with no or little mitigation.
4	Minor	Discernible effect on the asset or service, but with rapid recovery, not requiring mitigation.
5	Insignificant	A negligible effect on the asset or service.

During the CRA it is useful to identify all appropriate compensation measures (mitigation and offsets).

The level of risk is the product of likelihood and consequence in the event of an environmental effect on an asset. Figure 10-1 combines the likelihood and consequence rating to determine risk as:

- Low (L) requiring no to little response;
- Medium (M) requiring local level response;
- High (H) requiring regional level response; or
- Very High (VH) requiring national level response.

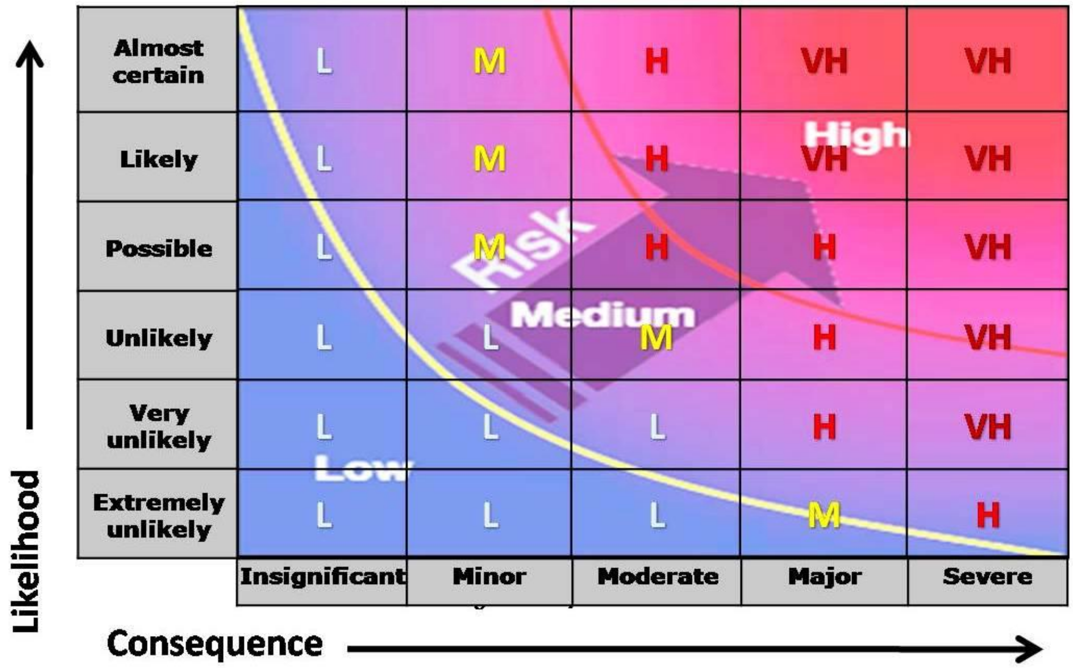

Figure 9-1. Levels of risk, assessed as the product of likelihood and consequence in the event of an environmental effect on an ecosystem asset (Adapted from Australian/New Zealand Standard on Risk Management (2004)).

The outcome of the CRA could include:

- Description of the environmental effect statement, including hazard and effect statement, scope of consequence, outcome statement and likelihood of outcome.
- Table of ecosystem services with the likelihood and consequence of environmental effect, and the level of risk (see Figure 10-1).
- Statement of the level of certainty associated to the above risk assessment, based on the availability of existing evidence and certainty of expert knowledge.