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REVISION: 02

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This report has been compiled by NGT on behalf of Zitholele and Eskom. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision-making process for the project.

DECLARATION OF INDEPENDENCE

This report has been compiled by Dr Morris Sutton for NGT. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the project.

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EXECUTIVE SUMMARY

NGT was appointed by Zitholele to make amendments to the HIA study and a PIA study conducted for site selection process for the Medupi Waste Disposal Facility which was submitted to Zitholele in February 2016. The site selection process focused on three sites, namely Site 2, Site 12 and Site 13, and it aimed at selecting the most suitable site for the handling and disposal of various waste stream that are by-products of the proposed Flue Gas Desulphurisation (FGD) technology at Medupi, which is proposed to be retrofitted in the six units currently under construction at Medupi Power Station. The aim of the FGD technology is to reduce the amount of Sulphur Dioxide (SO_2) emitted from coal fired power stations; Medupi with its six units as a coal fired powered station. From this study, (Revision 01 HIA), two potential graves sites were identified on Site 13 and Site 12 built environment ruins of no heritage significance were identified (***Annexure 1*** *– Revision 01 Heritage Impact Assessment Study Executive Summary with Conclusions and Recommendations)*.

In 2017, however, there were amendment to the project scope of works; Eskom decided on utilising the existing and licensed Ash Disposal Facility to dispose of ash and gypsum. It proposed a railway yard within the Medupi footprint for offtake of lime and handling of commercial gypsum. Within the footprint temporary storage facilities for hazardous salts and sludge have also been proposed. These new developments prompted the amendments to Revision 01 HIA and the development of the current HIA report (Revision 02). This HIA is site-specific HIA to the Medupi footprint, which also contains the site for the proposed railway yard and the existing and licensed ADF (***Annexure 3*** *– Revised Project Scope of Works*). The current study results and conclusions are also informed by the Phase II HIA study and heritage public participation process (PPP) undertaken within the Medupi PS footprint by Mbofho Consulting and Project Managers; this HIA attempted to reconstruct the environment prior to construction of Medupi and through heritage PPP with the affected community remapped the areas known to have contained graves that were accidentally disturbed or desecrated with the construction of Medupi.

Conclusions:

- It is concluded that there are no heritage and archaeological resources identified within the area proposed for the railway yard, limestone storage and associated infrastructure and the Medupi PS FGD technology construction sites as well as the AFD. The land in which the proposed construction activities have been transformed from previous construction activities at Medupi Power Station.
- There were also no heritage and archaeological resources around the existing and licensed ADF ash disposal facility – during the survey of the ADF the site were already constructed.
- The assessment of historic maps of the area Medupi PS also did not yield any burial grounds or graves as well as stone walls and historic buildings. However, the assessment of a Phase II HIA report by Mbofho Consulting and Project Manager yielded burial grounds and graves as well as areas that are known to have contained graves (e.g. *Figure 13 -15*).
- Based on the findings made by Mbofho Consulting and Project Managers one cannot rule out the subterranean burial grounds and graves since in some areas they identified areas with soil heaps that are reportedly to have been dumped on top of graves. *NGT was not part of this Phase II HIA study conducted on site; it therefore not take full responsibility or liability for any issues that were raised and addressed in this report other than to make reference to it as an important document to consider in dealing with heritage issues at Medupi PS. may be addressed by the current heritage social consultation on site.*
- It is concluded, that based on the exiting engineering drawings of the proposed FGD technology development footprint and its survey thereof that there are no archaeological or heritage resources. Like with the railway yard and the existing and licensed ADF facility the land in which the proposed FGD technology is to be constructed is already transformed through previous construction activities. *Once more NGT was not part of this Phase II HIA study conducted on site; it therefore not take full responsibility or liability for any issues that were raised and addressed in this report other than to make reference to it as an important document to consider in dealing with heritage issues at Medupi PS. may be addressed by the current heritage social consultation on site.*

Recommendations

- It is recommended that Eskom should continue with the implementation of Phase 2 HIA recommendations made by Mbofho Consulting and Project Managers which state that:
    - Eskom should consider constructing a memorial on site to memorialized the names of those whose graves were accidentally disturbed during the construction of Medupi PS six units and the associated infrastructure. All the names and surnames of those who were buried in areas that have been reconstructed as per Figure 13, 14 and 15 should be included in the memorial. This will be in addition to cleansing ceremonies and other cultural practices that have already been undertaken such as repatriation of spirits.
- A general recommendation with transcend heritage issues at Medupi PS is that, project proponents and environmental consultants alike, should always involve heritage consultants in the early stages of environmental management process. For example, from project conceptualization where a heritage screener of the development footprint can be undertaken. To project planning phase whereby archaeologist and heritage consultants form part of the project planning team. Heritage management process should not be taken as a tick box tool that fulfills compliance requirements, rather an important and integral part of the environmental management process.

TABLE OF CONTENTS

TABLE OF FIGURES 10

LIST OF TABLES 11

TERMS AND DEFINITIONS 13

1. INTRODUCTION 15

1.1.Project Description and Background 15

1.1.1. Project Aims 19

1.1.2. Legislation Triggered and Terms of Reference for the Appointment of an Archaeologist and Heritage Specialist 20

2. AFFECTED ENVIRONMENT 21

2.1. Desktop Study: Archaeological and Heritage (Built Environment & Landscape) 21

2.1.1. Prehistoric Archaeology (Stone Ages) of the Limpopo Province and study area (see Appendix A for a description and summary of the Stone Age periods) 21

2.1.2. Iron Age and History of the study area (see Appendix A for a description and summary of the Iron Age) 22

2.1.3. Built Environment and Landscape within the historic context 24

2.1.4. Previous Heritage/Archaeological Impact Assessments in the area 26

3. FINDINGS 30

3.1. Summary of Revision 01 Survey Results (Not applicable in the Current Application but Important for Future Development Around Medupi PS) 31

3.1.1. Site 2 31

3.1.2. Site 12 33

3.1.3. Site 13 (This site was not surveyed for this report, but the results of previous surveys are included here for the site selection process.) 35

4. IMPACT ASSESSMENT 39

4.1. Impact Assessment Methodology 39

4.1.1. Nature of the impact 39

4.1.2. Extent of the impact 39

4.1.4. Potential intensity of the impact 41

4.1.5. Likelihood of the impact 43

4.1.6. Cumulative Impacts 44

4.1.7. Significance Assessment 44

4.1.8. Notation of Impacts 45

4.2. Impact Assessments on Identified Heritage Resources 45

5. DISCUSSION 53

6. CONCLUSIONS 62

7. RECOMMENDATIONS 63

8. REFERENCES 64

Internet Sources 66

ANNEXURE 1: REVISION 01 HERITAGE IMPACT ASSESSMENT STUDY EXECUTIVE SUMMARY WITH STUDY CONCLUSIONS AND RECOMMENDATIONS 67

Recommendations: 70

ANNEXURE 2: GRAVE MANAGEMENT PROCEDURE PROPOSED IN REVISION 01 HERITAGE STUDY 71

ANNEXURE 3: PROPOSED NEW SCOPE OF WORK AT MEDUPI POWER STATION FOR THE CONSTRUCTION OF THE PROPOSED FGD TECHNOLOGY RETROFIT PROGRAMME, THE PROPOSED RAILWAY YARD AND THE IMPLEMENTATION OF THE EXISTING ADF AS A MULTI-WASTE STORAGE FACILITY 77

TABLE OF FIGURES

Figure 1– Location of the project area in Lephalale Local Municipality within Waterberg District Municipality, Limpopo Province, South Africa. 17
Figure 2- The proposed railway yard south-west of Medupi six units and south east of the existing and licensed ADF 17
Figure 3- Location of the proposed FGD technology construction sites (red arrows) 18
Figure 4- Existing and licensed ADF as well as the associated dams and proposed storm was management plan 19
Figure 5-View of the high density vegetation present on site 2 32
Figure 6-Another view of the vegetation present on site 2. 32
Figure 7-View of the low density vegetation present on site 12. 34
Figure 8-View of cattle on site 12. 34
Figure 9-Remains of old brick structure on site 12. 35
Figure 10-Remains of second old brick structure on site 12. 35
Figure 11-Site EMFGD 02. Potential graves on farm Eenzaamheid (Site 13). (L) Probable first grave and (R) possible second grave. Photos from van Vollenhoven, 2012. 37
Figure 12-Aerial map of the area reflecting the locations of the identified heritage resources from Revision 01 heritage study . (1) Dilapidated buildings on farm Kromdraai near the current modern farmhouse; (2) two possible graves in northwest corner of farm Eenzaamheid and (3) possible grave east of farm Eenzaamheid just off project footprint. 38
Figure 13- Markers of areas reported to have contained graves within and outside the Medupi footprint (Source: Silidi &. Matenga, 2015). 53
Figure 14- Markers of areas known to have contained graves before the construction (Source: Silidi &. Matenga, 2015). 54
Figure 15- Send heaps where two infants graves are reportedly to have been buried (Source: Silidi &. Matenga, 2015). 54
Figure 16-Signage to Medupi Ash Disposal facility (entrance point) 56
Figure 17- Available land that has been cleared for the growth of the Ash Disposal Facility (AFD). Image taken from the west facing east 56
Figure 18- The width of the facility facing Medupi from the west end of the ADF 57
Figure 19 – The western end on the AFD 57
Figure 20- Northern end of the AFD 58

Figure 21- Northern dam associated with the AFD 58

Figure 22- Current ash heap at the ADF facility 59

Figure 23- Conveyor belt system associated with the AFD 59

Figure 24- Land dedicated to the facility. Taken south of the facility facing north. This is the area where the proposed railway yard will be built 60

Figure 25- Image of the land dedicated to the facility and ash heap from Medupi power station. Taken from the south facing north-east 60

Figure 26- Two dams associated with the facility located south-west of the current ash heap 61

Figure 27- Fence line demarcating the facility with the southern property and the railway line. The area with left of the road is the proposed railway yard area. 61

Figure 28-Basic process Flow Diagram for the FGD process at Medupi Power Station 78

Figure 29-Authorised ADF area (top) with updated ADF design overlay (bottom) indicating layout of amended ADF design 85

LIST OF TABLES

Table 1-List of some of the more recent (since 2009) HIAs conducted in the area. The results of these reports vary regarding identified heritage. 27

Table 2-Criteria for assessment of the extent of the impact. 40

Table 3. Criteria for the rating of the duration of an impact. 41

Table 4-Criteria for impact rating of potential intensity of a negative impact. 42

Table 5-Criteria for the impact rating of potential intensity of a positive impact. 42

Table 6-Criteria for the rating of the likelihood of the impact occurring. 43

Table 7-Significance rating formulas. 44

Table 8-Example of Rating Scale. 45

Table 9-Impact assessment of the two built structures located on site 12. EMFGD 01. 47

Table 10-Impact Assessment of graves on Site 13. EMFGD 02. 48

Table 11-Impact Assessment of possible grave adjacent to Site 13. EMFGD 03. These are not within the development footprint but within a kilometre zone from Medupi development footprint – therefore will not be impacted. The assessment is included to bring attention to them in case the development activities move beyond the current site boundary. 51

ABBREVIATATIONS

Acronyms	Description
AIA	Archaeological Impact Assessment
ASAPA	Association of South African Professional Archaeologists
CRM	Cultural Resource Management
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
ESA	Early Stone Age
GIS	Geographic Information System
GPS	Global Positioning System
HAR	Heritage Impact Assessment
I&AP	Interested & Affected Party
Kya	Thousand years ago
LIHRA	Limpopo Provincial Heritage Resources Authority
LSA	Late Stone Age
LIA	Late Iron Age
MIA	Middle Iron Age
MSA	Middle Stone Age
Mya	Million years ago
NERSA	National Energy Regulator of South Africa
NHRA	National Heritage Resources Act
NEMA	National Environmental Management Act
PHRA	Provincial Heritage Resources Agency
PSSA	Paleontological Society of South Africa
PDAFP	Proposed Development Area Footprint
SAHRA	South African Heritage Resources Agency

TERMS AND DEFINITIONS

Archaeological resources

This includes:

- Material remains resulting from human activities which are in a state of disuse and are in or on land and which are older than 100 years including artefacts, human and hominid remains and artificial features and structures
- Rock art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation
- Wrecks, being any vessel or aircraft, or any part thereof which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation
- Features, structures and artefacts associated with military history which are older than 75 years and the site on which they are found

Cultural significance

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance.

Development

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in the change to the nature, appearance or physical nature of a place or influence its stability and future well-being, including:

- Construction, alteration, demolition, removal or change in use of a place or a structure at a place
- Carrying out any works on or over or under a place
- Subdivision or consolidation of land comprising a place, including the structures or airspace of a place

- Constructing or putting up for display signs or boards
- Any change to the natural or existing condition or topography of land
- Any removal or destruction of trees, or removal of vegetation or topsoil

Heritage resources

This means any place or object of cultural significance

1. INTRODUCTION

1.1. Project Description and Background

The current study is a Heritage Impact Assessment (HIA) for the proposed Medupi Power Station FGD-RP, the operation of the existing Medupi Power Station ADF and the proposed railway yard , Limestone storage, PCD, diesel storages, hazardous waste temporary storage (salts and sludge) (south-west of Medupi six units and south conveyor transport Medupi FGD-RP waste materials). The aim of the study was to identify archaeological and heritage resources within the affected development areas. To assess impacts on the identified archaeological and heritage resources resulting from the proposed development activities in four stages of the project: planning, construction, operational and decommissioning.

Medupi Power Station (PS) is located in Lephalale Local Municipality (LLM), within Waterberg District Municipality (WDM) in Limpopo Province, South Africa (*Figure 1*). Medupi PS is one of two South African mega power generation projects under construction, with other being Kusile Power Station in Mpumalanga Province. Medupi, like Kusile Power Station, is a coal fired power station in its completion stages. It is located on an Eskom owned property, Farm Naauw Ontkomen 509 LQ, in LLM. The power station consists of six units with a total power generation capacity of 4800 Megawatts (MW) (Eskom, 2006). The first of the six units came online on mid-2015.

Coal fired power stations are known to emit pollutants such as Sulphur Dioxide (SO_2). SO_2 is one of the most harmful gases produced through combustion of solid fossil fuel such as coal (World Health Organisation, 2014). Coal is the main solid fossil fuel that will be used in Medupi PS to generate electricity through combustion. Like with combustion of fossil fuel, there are other emissions that are produced throughout the coal life cycle such as nitrogen oxide (NO_2), ozone (O_3) and particulate matter (PM) of various sizes (World Health Organisation, 2014). To mitigate the impact of SO_2 and other pollutants in the atmosphere, Eskom is proposing to retrofit Medupi PS six units with FGD technology. The FGD technology has by-products such as gypsum, chemical salts and sludge which will need to be stored and/or disposed of at appropriately licensed facilities. The technology also requires lime as one of the agents for the functioning of the FGD technology and a railway yard is proposed for lime off-loading on site as well as offtake of commercial viable gypsum.

Electricity and access to electricity are essential to improved human quality. The South African Bill of Rights puts electricity as one of the three pillars of social service resource, others being water and sanitation (Constitution of the Republic of South Africa, 1996). However, this essential social service may come at a detrimental cost to the environment affecting biodiversity, aquatic life and cultural heritage resources, unless managed properly. This study assesses the impact of the proposed Medupi PS FGD on heritage resources, as well as the impact of the proposed existing and licensed ADF and proposed railway yard, Limestone storage, PCD, diesel storages, hazardous waste temporary storage (salts and sludge)on these resources.

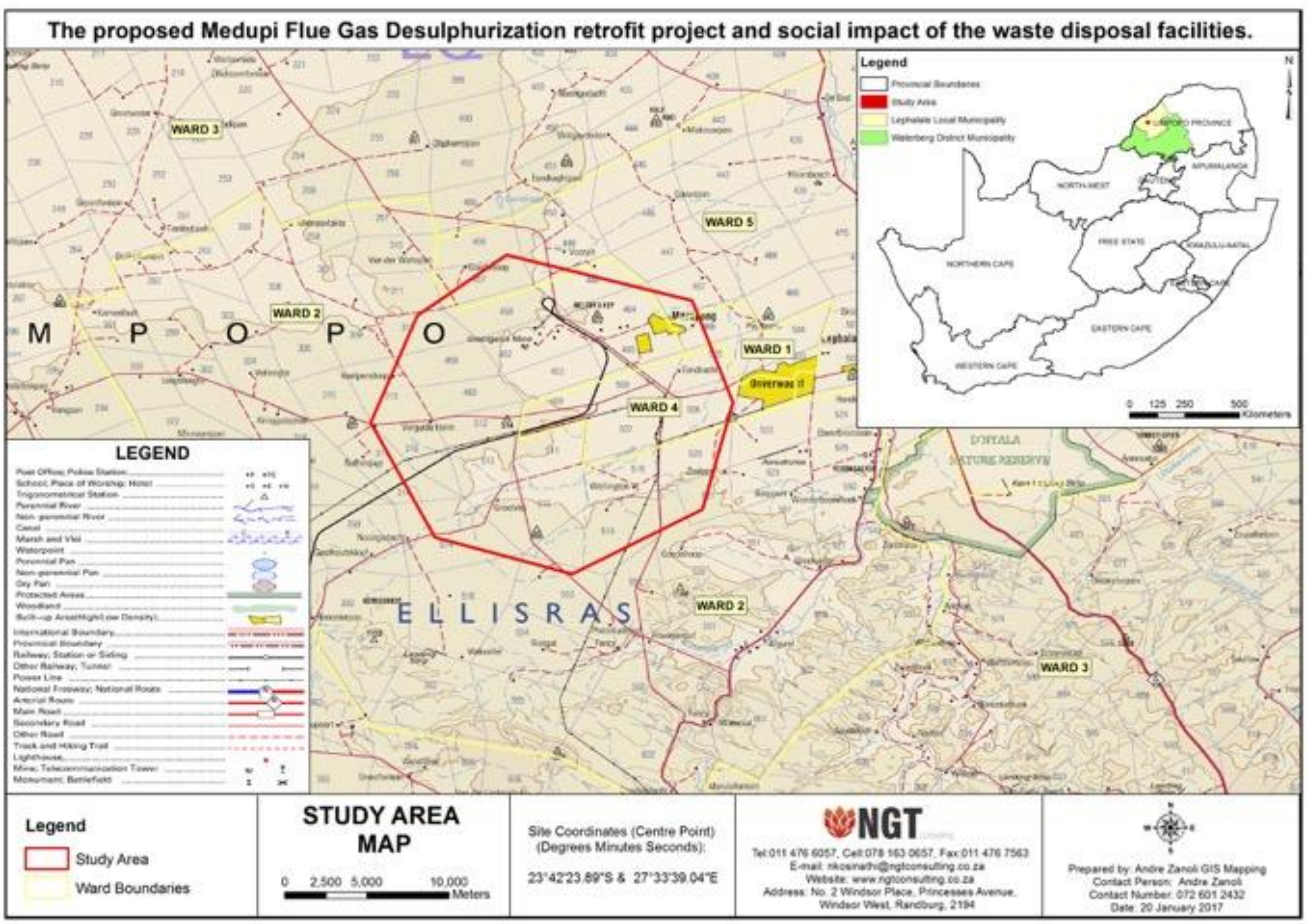

Figure 1– Location of the project area in Lephalale Local Municipality within Waterberg District Municipality, Limpopo Province, South Africa.

The following images show the location and the design of the proposed railway yard (*Figure 2*), the proposed Medupi PS FGD technology construction site (*Figure 3*) as well as the licensed ADF site (*Figure 4*).

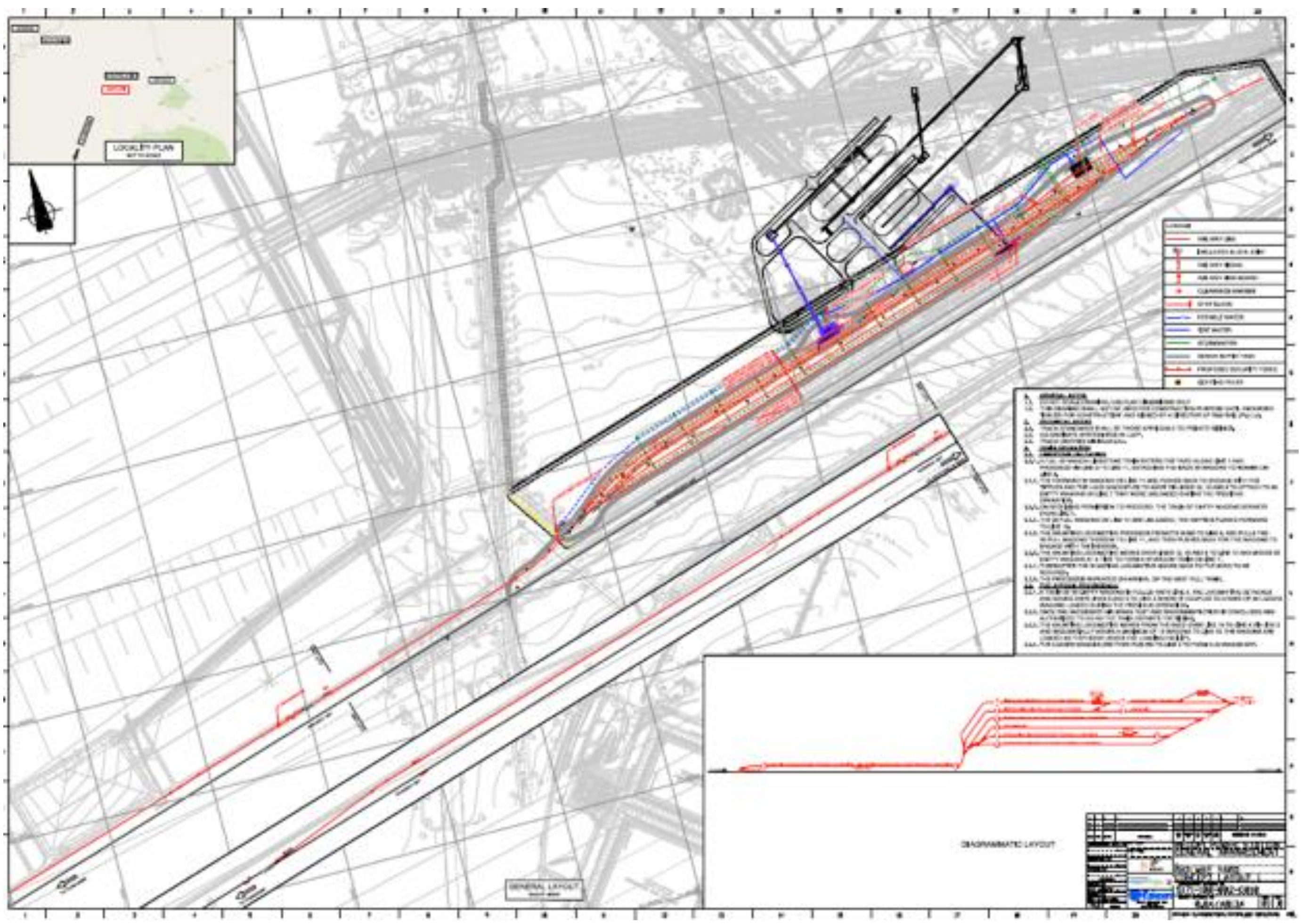

Figure 2- The proposed railway yard south-west of Medupi six units and south east of the existing and licensed ADF

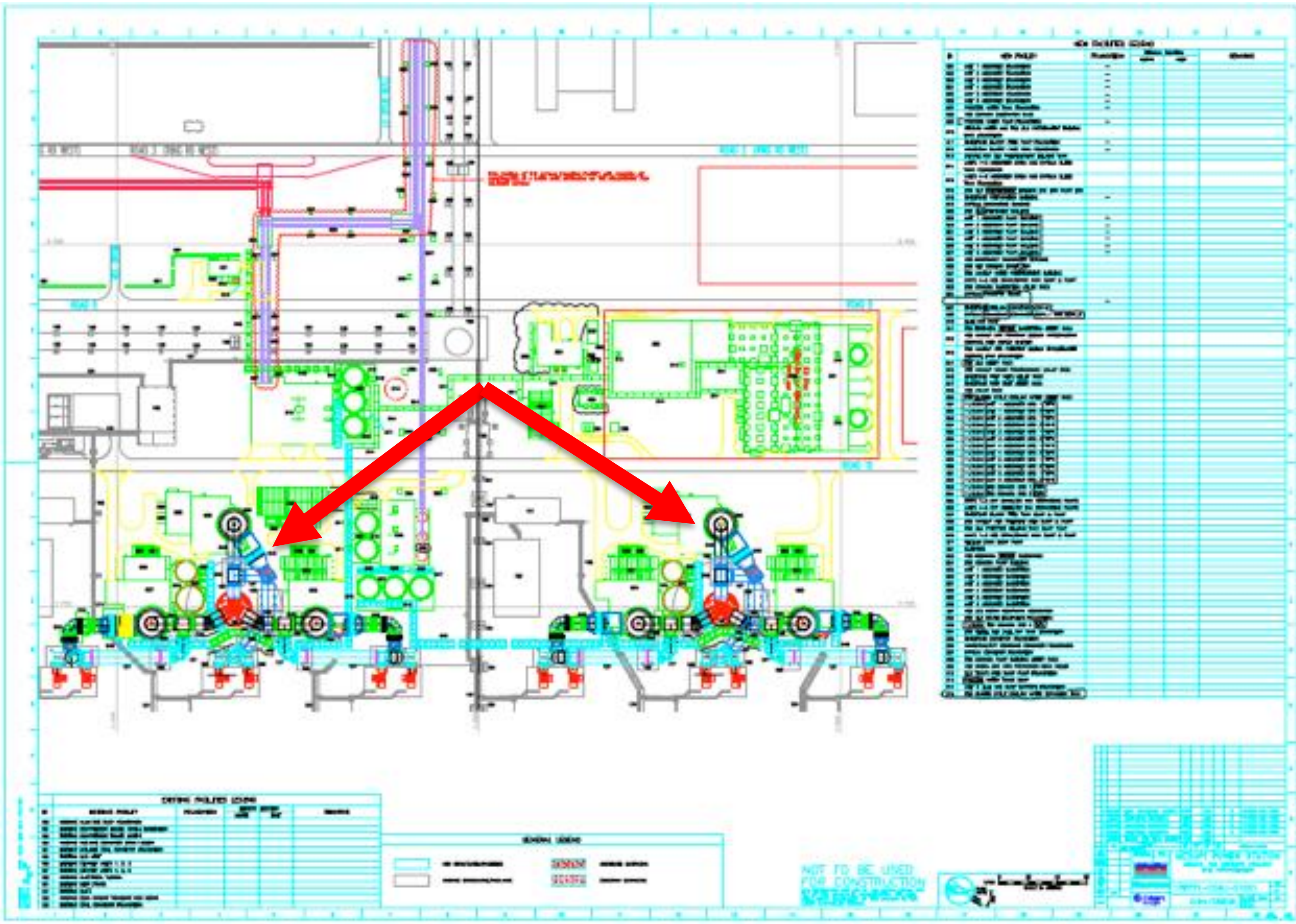

Figure 3- Location of the proposed FGD technology construction sites (red arrows)

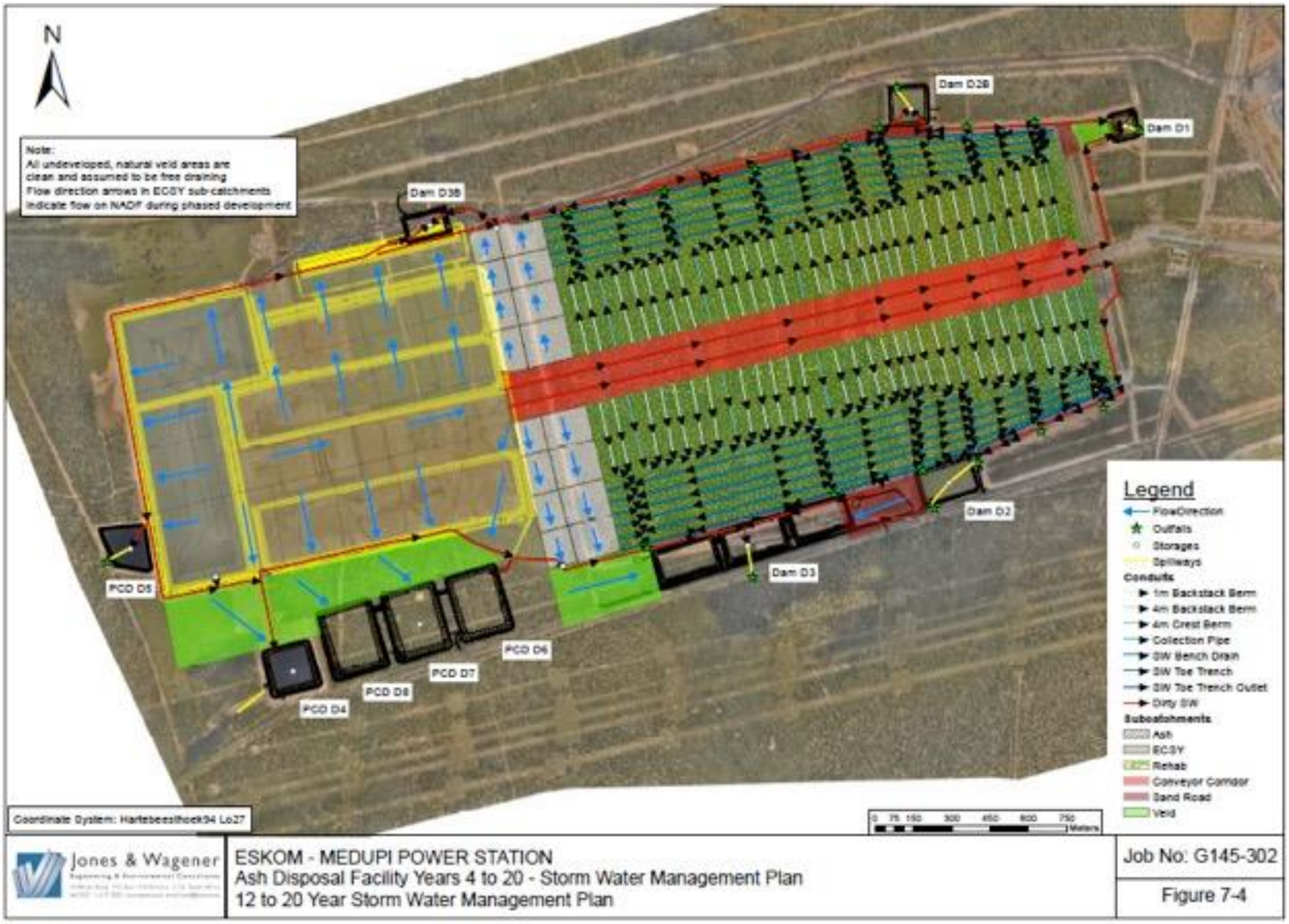

Figure 4- Existing and licensed ADF as well as the associated dams and proposed storm was management plan

1.1.1. Project Aims

- To conduct HIA (inclusive of PIA) for the proposed construction of the FGD technology to be retrofitted at Medupi, impact assessment study on heritage resources of the existing and licensed ASF and the proposed railway yard. The objective is to inform the decision making process on the current EIA and EMPr conducted for the proposed project on the status and nature of heritage resources within development footprint and how to manage and mitigate impacts on heritage resources.
- Before giving any advice on the management and mitigation of heritage resources; the first step is to identify any heritage material (Cultural, Archaeological, Built Environment and Paleontological) that may be impacted by the proposed activities on site.

- Following an impact assessment process for the various stages of the project; propose mitigation measures for those heritage resources that may be affected by the proposed activities on site. These measures will be within acceptable norms and standards for the management of South African Heritage Resources as stipulated in the NHRA, No. 25 of 1999.

1.1.2. Legislation Triggered and Terms of Reference for the Appointment of an Archaeologist and Heritage Specialist

The nature and size of the proposed project requires environmental authorization. As a result, the following legislation applies:

- The environmental application process developed in terms of the old environmental legislation, the National Environmental Act (NEMA), No. 107 of 1998 as amended and read together with the 2010 Environmental Impact Assessment (EIA) Regulations.
- Additional legislation is also relevant – the water management (and NWAA, 2014), waste management (NEMWA, 2008), the management of the natural environment l (NEMA, 1998 and NEMLAA (National Environmental Management Laws Amendment Act), 2014) and,
- The management of cultural environment triggers NEMA, No. 107 of 1998 and the National Heritage Resources Act (NHRA), No. 25 of 1999.

The environmental management process for the proposed FGD technology, the authorized existing ADF and the proposed railway involves the identification and assessment of environmental impacts through specialist studies. Eskom appointed Zitholele to manage the environmental process and associated licenses, Zitholele sub-contracted NGT as an independent Cultural Resources Management (CRM) firm to conduct a HIA study. Dr Morris Sutton (Principal Heritage Consultant) for NGT conducted the study for the FGD retrofit project and site selection process which formed part of Revision 01 report. With the amendment of project scope, which excludes the site selection process; Mr Nkosinathi Tomose from NGT conducted the field survey and amended the report to meet the current project scope. This report is referred to as Revision 02.

The appointment of NGT as an independent CRM firm is in terms of Section 38 of the National Heritage Resources Act (NHRA), No. 25 of 1999, the NEMA as well as other applicable legislations.

2. AFFECTED ENVIRONMENT

The proposed development occurs within the existing Medupi Power Station footprint and already transformed environment. Below is the background to archeology and heritage of the broader study areas.

2.1. Desktop Study: Archaeological and Heritage (Built Environment & Landscape)

South African cultural heritage extends as far back as 2.0 million years ago (m.y.a) in the form of Stone Age artefacts that represent some of the earliest tool types found. The South African archaeological record covers all the Stone Age periods, Iron Age periods and more recent historical periods. This rich cultural heritage also includes culturally significant places on the landscape that became important to the many varied groups of people that once lived here and whose descendants continue to live here.

2.1.1. Prehistoric Archaeology (Stone Ages) of the Limpopo Province and study area (see Appendix A for a description and summary of the Stone Age periods)

There have been recorded scattered finds of Stone Age sites, rock paintings and engravings in the larger region. Most of the Stone Age sites can be classified as open (surface) sites which imply that most of the artefacts occur in secondary context. There are a number of known Stone Age sites in the Limpopo Province. Southeast of the study area, but less than 150km away, is Makapansgat. This site complex includes the Makapansgat Lime Works site which has yielded fossils dated to greater than 4.0 mya. The Lime Works has also yielded hominin fossils of Australopithecus Africanus (Tobias, 1973; Reed et al., 1993). Adjacent to the Lime Works is Cave of Hearths. This site has one of the longest sequences of occupation in southern Africa, yielding Earlier Stone Age tools beyond 300k years old up to Later Stone Age artefacts. Southwest in the Waterberg Plateau area a number of MSA and LSA sites have been identified. In the Waterberg the MSA sites, though undated, appear, technologically, to reflect the early MSA. The LSA material represents the late LSA, suggesting a long period in between when there was little human presence in the Waterberg Plateau. Van der Ryst (1998) hypothesizes the LSA artefacts are the remains of hunter-gathers who followed the early Iron Age agro-pastoralists people into the area. This seems in contrast to the Mokolo River basin area that has yielded ESA stone tools as well as many MSA and LSA artefacts; though most finds are in secondary context. A good example of a primary context site is Olieboomspoort rock shelter less than 30km south of Lephalele, located in the Mokolo

River basin this rock shelter site was used for thousands of years by Stone Age people and has yielded material that spans the Stone Age sequence (Mason, 1962; Van der Ryst, 2006). Included among the large assemblage of lithics are large quantities of ochre from the MSA sequence (Mason, 1962, 1988; Mitchell, 2002). Also recovered is a wide variety of LSA tool types as well as preserved macroscopic plant material (Van der Ryst, 2006).

A large (9,000ha) survey conducted by Huffman and Van der Walt (2013) northwest of the current area identified a number of MSA sites. The scatters of artefacts were primarily located in the calcrete pans of the area. They identified the technological attributes of the stone tools to a post-Howiesons Poort industry that falls <70k years ago. However, no formal sites or sites within primary context were noted.
One Rock Art site has been noted in the area. Nelsonskop, near Lephalale contains engravings and cut markings on the rock face (van Schalkwyk, 2005).

While there exists a low probably of primary context Stone Age material being recovered, there is a higher probably of finding secondary context scatters. These are expected to be of low significance.

2.1.2. Iron Age and History of the study area (see Appendix A for a description and summary of the Iron Age)

The earliest agro-pastoralists (~2000 years ago) preferred areas with higher rainfall than that present in the study area. Thus there is only little evidence of Early Iron Age activity around Lephalale. North of the study area across the Limpopo River is one of the earliest Iron Age sites in the region, Maunatlala. This site may provide evidence of agro-pastoralist movement in reaction to climatic condition changes. As cooling temperatures and more wet conditions developed, the agro-pastoralists begin moving into the area.

The southern African Iron Age is divided by ceramics into two traditions--Urewe and Kalundu. The southern side of the Waterberg, including in the wider study area, has EIA sites that have yielded pottery representative of the Happy Rest sub-branch of the Kalundu tradition. Sites in the Sand River Valley and the Boschoffsberg Valley are EIA sites with Happy Rest material (Hall, 1981). Huffman (2007) sees these EIA sites clustering around the Waterberg and having a sub-set of Happy Rest pottery called the Diamant facies. The Diamant type site lies near the study area. Beads from these sites indicate trade with sites in the Limpopo River Valley northeast of the study area. These complex trade networks continued well into the MIA.

Further west in Limpopo along the Makgabeng Plateau there is a higher density of Iron Age evidence. The region has yielded pottery of the Eiland style that falls in the late EIA. The Eiland facies is contemporary with one of the more important Limpopo Iron Age sites, Mapungubwe. Mapungubwe, northeast of the study area in the Limpopo River Valley, was inhabited from 1220 AD to 1300 AD (Huffman, 2000). The people of Mapungubwe were ancestors of the Shona people of southern Africa. Mapungubwe is considered southern Africa's first state (Huffman, 2000). It consisted of a complex society of a much larger political scale than had been seen before in southern Africa. There were clear separations in political power, leadership and organization between the controlling royals and commoners. The people of Mapungubwe were wealthy agro-pastoralists who farmed with cattle, sheep and goats and produced large harvests that allowed them to trade and store extra food. They became advanced traders exchanging ivory and minerals, such as gold, in wide trading networks. Mapungubwe people traded with Arabia, China and India through East African harbours. But they also traded with groups south and east, including groups living in the wider study area.

By the 1200's Middle Iron Age Sotho- Tswana people followed by the precursors of Venda groups moved into the area (Eastwood et al., 2002).

In the southern Waterberg, the contemporary Eliland facies has been identified at sites such as Rhenosterkloof 3 in the Sand River valley and near Rooikrans Hill in the Boschoffsberg valley. In northern parts of the Waterberg, a variant of the Eiland facies known as the Broadhurst facies appears between 1300 AD and 1430 AD (van der Ryst, 1998).

The LIA in the Waterberg is marked by the appearance of Moor Park pottery of the Blackburn Branch and Madikwe pottery of the Moloko branch (Huffman, 2007). Huffman has argued these branches have a common Urewe origin in the EIA in East Africa and migrated separately into southern Africa. The Madikwe material has been recovered from sites in the Sand River Valley and Rooiberg Valley. The presence of Moor Park pottery indicates movements of Nguni-speakers from present day KwaZulu Natal westward (Huffman, 2007). Also associated with these groups are extensive hilltop stone wall settlements, which have been identified in northern Waterberg.

North of the study area, decorated pottery has been identified as Early Moloko by Beimond (2012). Moloko pottery diverges into three sub-branches of which one is Letibogo (ibid.). Pottery identified by Huffman and van der Walt (2013), near the study area, belong to the stylistic facies, Letsibogo, which was made by the Sotho-Tswana Bakaa cultural group. Huffman (2007) dates this period to between 1550 AD and 1750 AD. Nearby on Nelsonskop, van Schalkwyk (2005) identified remains of stone walling and attributed them to early Sotho-Tswana.

2.1.3. Built Environment and Landscape within the historic context

Throughout the middle of the 18th Century the Limpopo Province witnessed a range of settlement patterns- the occupation and reoccupation of the region by different culture groups contributed to the contemporary peopling of the present day Limpopo Province. There are various factors that contributed to this historical settlement of the region. The first has to do with the availability of natural resources. The attraction of people to natural resources available in this province date as far back as the 1st Millennium AD, to the MIA and the LIA periods (Tomose, 2013).

The first Europeans arrived in the region in the middle of the 19th Century, but the dry conditions and the intermittent presence of the tsetse fly resulted in more permanent settlements only developing toward the end of the 1800s. These early Europeans were Afrikaner Voortrekkers and passed through areas such as present day Modimolle on trading and hunting expeditions.

During historical times the availability of natural resources also played a pivotal role in the choice of settlement of people, based not only from a subsistence point of view but also driven by commerce or commercial gains resulting from the exploitation of available natural resources such as coal, iron ore and tin. The town of Thabazimbi, for example - located south of the current study area, developed from the exploitation of its rich haematite deposits (iron ore) during the early 1900s (ibid.)

A second factor contributing to historical settlement of people in the area is politically linked. For example, the Great Trek was a politically motivated movement of people. Another example is the presence of Ndebele people in the region, a result of the mfecane conflicts, which involved Zulu King Shaka's expansions and battles for control of more land and people. They can trace their roots to

Mzilikazi (ibid.). These conflicts provided an opportunity for the colonists to move into areas largely devoid of people. As they began settling in larger numbers, the conflicts spread from the African groups to include the Afrikaners. An example of this was the siege of Makapan Cave in the Makapansgat site complex. Here Ndebele Chief Makapane and his people were sieged in the Cave after retreating there during a conflict with the Voortrekkers. After Makapane's warriors had killed a hunting party of Voortrekkers led by Hermanus Potgieter near Moorddrift a much larger group of commandos sought revenge. The siege lasted almost a month and resulted in the deaths of close to 1500 of Chief Makapane's people. It was only much later that the local towns were established. Lephalale was originally named Ellisras. This name comes from a combination of the surnames of Patric Ellis and Piet Erasmus who settled in the 1930s on the farm Waterkloof 502LQ. The railway line coming through the area resulted in growth. Soon after the farm was subdivided with portions including river frontage (Lephalale 2009). Along with Ellis and Erasmus, another of the founding families of the area were the van Rooyens. Today decedents of this family still farm the area. The family currently own the Nooitgedacht farm, adjacent (South) to Site 2.

In the mid-20th century the area continued to be important due to its mineral reserves. "In 1941, the geological Survey Division of the then Department of Mining, launched an exploration programme. Iscor, the country largest steel producer, and also the biggest consumer of coking coal, actively partook in this programme. Drilling was completed in 1952. In 1957, Iscor obtained the property rights to six farms, including Grootegeluk and in 1979, a mining authorization was granted" (Lephalale 2009). Iscor maintained a presence in the area through the 1980s and was primarily responsible for the growth of the area. Ellisras was changed to Lephalale in 2002 along with several other towns as well as the provincial name from Northern to Limpopo.

2.1.3.1. Migrant Labourer and Associated Built Environment and Landscape Features

The establishment of these towns and later the mining industry between and around them required supporting efforts in terms of skilled and unskilled labourers. There was a need to establish infrastructure to support the labour pool, thus the first organized township Marapong was established on the farms Nelsonskop 464LQ and Grootestryd 465LQ. In addition, there may be other areas that include built hostels and compounds for labourer accommodation.

In summary:

- The migrant labour system, both historically and presently, is central to the labour force in the industry.
- In the past the hostel dwelling system that was meant to accommodate and confine migrant labourers within the mining premises.
- There are both marked and unmarked graves associated with migrant labourers in some of the historical mining areas.

2.1.4. Previous Heritage/Archaeological Impact Assessments in the area

A number of heritage assessment reports have been conducted in the wider area that reflects varying degrees of heritage present (*Table 4*). While these reports did not cover the current project footprint, areas around the project have been surveyed.

Table 1-List of some of the more recent (since 2009) HIAs conducted in the area. The results of these reports vary regarding identified heritage.

Author	Report Title	Year	Prepared for	Heritage Identified
Birkholtz	Proposed Development of the Grootegeluk Mine Construction Camp for the Market Coke and Co-Generation Plant Project on a Part of the Farm Enkelbult 462 LQ near Lephalale, Lephalale Local Municipality, Waterberg District, Limpopo Province	2014	Synergistics Environmental Services	Nothing found
Hutten	Proposed Development of the Steenbokpan Extension 3 Township on the Remainder and Portions 1, 2, 3 and 4 of the Farm Grootdoorn 292 LQ, Portions 20, 22 and 25 of the Farm Theunispan 293 LQ and Portion 3 of the Farm Steenbokpan 295 LQ at Steenbokpan, west of Lephalale in the Lephalale Local Municipality, Waterberg District, Limpopo Province.	2014	Flexilor Properties (Pty) Ltd	Historic Structures and Graves
Hutten	Proposed Development of a Shopping Centre on Portion 114 of the Farm Waterkloof 502 LQ, in the Town of Lephalale in the Lephalale Local Municipality, Waterberg District, Limpopo Province	2014	Tekplan Environmental	Nothing found
van Schalkwyk	Heritage Impact Assessment for the proposed continuous ash disposal facility for the Matimba Power Station, Lephalale, Limpopo Province	2014	Royal Haskoning DHV	Nothing found
van der Walt	Archaeological Assessment for the proposed Thabametsi Coal-Fired Power Station, Lephalale, Limpopo Province	2014	Savannah Environmental (Pty) Ltd	Historic Structures, Graves and Rock Art
Tomose	A Heritage Impact Assessment study for the proposed Medupi-Borutho 400kv transmission line, Limpopo Province, South Africa.	2013	Baagi Environmental Consultancy	Stone Age scatters/sites, Historic Structures, Cultural landscape and Graves
Huffman and van der Walt	Sasol Limpopo West Heritage Report	2013	SRK Consulting	Numerous MSA scatters/sites identified in the calcrete pans. Several Iron age occurrences and several historic (>60 years) structures.

Author	Report Title	Year	Prepared for	Heritage Identified
Kruger	Groothoek Coal Mine: Archaeological Impact Assessment on the farms Groothoek 504 lq and Eendracht 505 lq, Lephalale, Waterberg district municipality, Limpopo Province	2013	AGES	MSA scatters (2), Historic Structures and Graves
Pistorius	A phase 1 Heritage Impact Assessment (HIA) study for Eskom's proposed Community Network Centre in Lephalale in the Limpopo province	2013	Eskom Land Development	Nothing found
Karodia	Heritage statement for the Dalyshope Project: Phase 1 NEMA application, Lephalale, Limpopo Province	2013	Anglo American Thermal Coal	Iron Age pottery, Historic Sturctures and Graves
Karodia and Higgitt	Heritage Impact Assessment for the proposed Thabametsi Project, Lephalale, Limpopo Province	2013	Exxaro Coal (Pty) Ltd	MSA scatters, Iron Age pottery, Historic Structures and Graves
Pelser	Draft report on a Phase 1 HIA for the Peerboom Farm Opencast Coal Mine, near Lephalale and Marapong, Limpopo Province	2012	Ecopartners	Nothing found
van Vollenhoven	A report on the assessment of a possible grave site on the farm Eenzaamheid 687 lq, close to Lephalale in the Limpopo Province	2012	Basil Read	Inconclusive
Biemond	Specialist report on the analyses of excavated African ceramics for the Boikarabelo project Waterberg area, Limpopo province	2012	Digby Wells and Associates	Ceramic materials
van der Walt	Archaeological Scoping Report for the Proposal Sekoko Waterberg Colliery, Lephalale, Limpopo Province	2012	Savannah Environmental (Pty) Ltd	Nothing found
van Schalkwyk	Heritage Impact Assessment for the proposed Mixed Use Development and Solar Park on portion 1 of the farm Steenbokpan 295lq and the remainder of farm Vangpan 294lq in the Lephalale Region, Limpopo Province	2012	Interdesign Landscape Architects	Graves and Memorial Structure
Nel	Addendum to phase 1 archaeological impact assessment for the for Boikarabelo coal mine (Proposed railway link from the farm Kruishout to the farm	2011	Digby Wells	Historic Structures, Graves and Pottery

Author	Report Title	Year	Prepared for	Heritage Identified
	Buffelsjagt) Lephalale local municipality, Waterberg district, Limpopo Province			
Fourie	Res Gen SA Boikarabelo Coal Mine Project on portions of the farms rson 700 LQ, Zeekoevley 421 LQ, Vischpan 274 LQ, Kruishout 271 LQ, Kalkpan 243 LQ, Witkopje 238 LQ, and Diepspruit 386LQ, District Lephalale, Limpopo Province	2010	Digby Wells and Associates	Modern Cemeteries and Archaeological sites
van Schalkwyk	Heritage Impact Assessment for the proposed Medupi Power Station conveyor route, Lephalale Region, Limpopo Province	2010	Savannah Environmental (Pty) Ltd	Nothing found
van der Walt	Heritage walkthrough for the 132 km Medupi - Spits kop Transmission power line project, Northam, Limpopo Province	2009	PBA International	Graves and Iron Age pottery
Prins	Cultural heritage screening of the extended Medupi landfill site	2009	Strategic Environmental Focus	Nothing found
van Schalkwyk	Heritage Scoping Assessment for the proposed development of coal mining activities west of Lephalale, Limpopo Province	2009	Cabanga Concepts	Nothing found

3. FINDINGS

The finding of the current study in terms of paleontological resources within the development area have not changed from those made in terms of Revision 01 report. The Paleontological Desktop Study determined that there are no paleontological fossils or material exists within the geology of the area.

In terms of archaeology and general heritage, both Revision 01 and Revision 02 literature review yielded information about archaeological and heritage resources within Medupi PS footprint currently being assessed and the wider area. The known archaeological resources include: Stone Age occurrences, Rock Art, Iron Age occupations and historical activity. The Phase II HIA study of the Medupi PS footprint conducted by Mbofho Consulting and Project Managers has resulted to information that has been used to construct the receiving environment showing areas known to have contained graves (e.g. *Figure 13 and 14 below*). These are graves who according to the local communities were destructed with the construction of Medupi PS and the associated infrastructure. To mitigate social issues that resulted from such disturbance, a heritage PPP has been conducted in association with the Phase II HIA to find ways in which the local communities working with the appointed heritage consultants can resolve challenges resulting from graves destruction. Among others solutions that have been proposed and applied in an attempt address issues on site has been reburial of those graves that could still be identified, repatriation of spirits for those graves that were desecrated and cleansing of the affected families.

The current study did not result to the identification of any heritage resources. A survey of the existing ADF footprint and the Medupi precinct in which the FGD technology and the proposed railway yard is to be constructed was undertaken by Nkosinathi Tomose in January 2018. The proposed development area for the construction of the FGD technology and the proposed railway yard has been significantly transformed through previous construction activities. For example, the foundations for the FGD technology are within an area that was deeply excavated during the construction of the Medupi PS six units. The proposed railway yard is within an area where there has been disturbances associated with Medupi PS associated infrastructure such as storm water management systems, the existing ADF and site roads.

In terms of **Revision 01** findings:

No heritage material was identified on site 2 and only two built structures were identified on site 12 but these are not heritage features.

On site 13 two potential graves were identified and these required a verification process following a grave test application permit with SAHRA Burial Grounds and Grave (BGG) Unit.

3.1. Summary of Revision 01 Survey Results (Not applicable in the Current Application but Important for Future Development Around Medupi PS)

A physical survey of the project area took place on 31 August – 2 September and 17 and 18 November 2015 by Dr Morris Sutton.

3.1.1. Site 2

Ground visibility during the survey was poor in most areas. The undergrowth was dense to very dense with trees and shrubs covering large portions of the landscape (Figures 3 and 4). However, the survey was extensive with no areas inaccessible.

- Palaeontological
  - The geological formation pre-dates any large bodied plant or vertebrate fossils thus it is not likely any fossils exist in the area.
- Archaeological
  - No Stone Age, Rock Art or Iron Age material was identified.
- Built Environment
  - No historic built environment and landscape features where structures were identified on site such as farmstead buildings or ruins, gate posts and other landscape features such as plantation.
- Burials or Graves
  - No burials or graves were identified.
  - No heritage was identified on site 2 or along the proposed conveyer and road routes.

<u>No heritage was identified on site 2 or along the proposed conveyer and road routes.</u>

Figure 5-View of the high density vegetation present on site 2

Figure 6-Another view of the vegetation present on site 2.

3.1.2. Site 12

Ground visibility during the survey was fair to good (Figure 5). The survey was extensive. However, portions of the farm included cattle paddocks which were not surveyed (Figure 6).

- Palaeontological
    - The geological formation pre-dates any large bodied plant or vertebrate fossils thus it is not likely any fossils exist in the area.
- Archaeological
    - No Stone Age, Rock Art or Iron Age material was identified.

Built Environment

Two old brick structures were identified on the farm Kromdraai (site 12) (Figures 7 and 8). However, it was not possible to determine the actual age of the structures. Both are in an extremely dilapidated state and are not salvageable. Both are considered of low significance and have no heritage value (see below for an impact assessment of the two structures and appendix C for methodology used).

Site	EMFGD 01 Built Structures
Type	Brick (Block) building structures
Location/Coordinates	S 23^{0} 44’ 28.33” E 27^{0} 32’ 18.59”
Density	Two buildings
Approximate Age (> 60 or <60 years old) or Archaeological Time Period	< = > 60 years (date is unknown)
Applicable Section of the NHRA, No 25 of 1999:	Section 34
Site Description:	These two structures are of unknown age, but could be 60 years or older. Both structures are nearly completely collapsed with only a few sections of walls remaining. Both are simple brick (block) and mortar construction. Neither building has any unique features. The structures have no historic value.

Burials or Graves

- No burials or graves were identified.

No significant heritage was identified on site 12 or along the proposed conveyer and road routes.

Figure 7-View of the low density vegetation present on site 12.

Figure 8-View of cattle on site 12.

Figure 9-Remains of old brick structure on site 12.

Figure 10-Remains of second old brick structure on site 12.

3.1.3. Site 13 (This site was not surveyed for this report, but the results of previous surveys are included here for the site selection process.)

- Palaeontological
  - The geological formation pre-dates any large bodied plant or vertebrate fossils thus it is not likely any fossils exist in the area.

Site 13 is on the farm Eenzaamheid 512LQ. The location was previously assessed by other specialists. An initial HIA (van Schalkwyk, 2005) was conducted on the farm and no heritage material was identified. The project was granted approval. Subsequent to this, a site with two possible graves was identified on the farm. Two stones, placed two meters apart in an area where no other stones were located suggested a possible grave marker. A second study (van Vollenhoven, 2012) was commissioned and conducted to determine if the stones were, in fact, markers for graves and if the area included burials. The second study was inconclusive but made a recommendation that a "watching brief" option be followed.

A watching brief "entails that the earth-moving equipment start with the necessary work on site and an archaeologist is present on site to monitor the situation. The archaeologist would specifically be looking for any indication of possible human remains or burials" (van Vollenhoven, 2012: 17). "This option is used when the opinion is that there more likely are no graves in an area to be developed, but where the possibility that human remains may be unearthed still exists. This usually occurs when graves have been exhumed and there is a possibility that some, which are not marked above ground, may still be present. It is also applied when there are information indicating the possibility of graves, but not enough above ground evidence to support this" (van Vollenhoven, 2012: 17).

However, in 2012 several families came forward claiming graves had been destroyed during the construction of the Medupi Power Station. This compelled another study (Silidi and Matenga, 2015) which was commissioned and conducted to access the validity of the claims and to make recommendations to finding a solution with the aggrieved families. This study included the Medupi Power Station location as well as the immediate surrounding farms (including Eenzaamheid Site 13). The results of this study identified a number of graves, including a possible grave on the Eenzaamheid farm (Site 13). As part of the public participation process of the report a family name (Molisiwa) was identified in relation to the grave. The report recommends protection measures for this probable grave and the second possible grave. However, it is recommended by this current study that mitigation measures include confirmation of the graves and, if confirmed, then exhumation and relocation processes be conducted (see 7. Recommendations).

In addition, there is another potential grave identified outside of the current project footprint but could potentially be impacted by additional construction and expansion of the area. This grave is situated between the Medupi Power Station and the proposed Site 13. While it is not located along the transport route or within the site boundary, the close proximity requires attention and mitigation.

Site	EMFGD 02 Graves
Type	One probable grave and a second possible grave
Location/Coordinates	S23˚ 42' 39.4" E027˚ 30' 12.4"
Density	Two graves, Low Density
Approximate Age (> 60 or <60 years old) or Archaeological Time Period	> 60 years (date is unknown) SAHRA regulations stipulate graves with unknown dates be treated as >60 years
Applicable Section of the NHRA, No 25 of 1999:	Section 36
Site Description:	The first probable grave has still not been confirmed as an actual grave. Previous studies have been inconclusive. The second grave is less likely to be a grave but is currently treated as possible (*Figure 11*).

Figure 11-Site EMFGD 02. Potential graves on farm Eenzaamheid (Site 13). (L) Probable first grave and (R) possible second grave. Photos from van Vollenhoven, 2012.

Site	EMFGD 03 Grave
Type	One possible grave
Location/Coordinates	S23˚ 42' 26.8” E027˚ 32' 49.5”
Density	One grave, Low Density
Approximate Age (> 60 or <60 years old) or Archaeological Time Period	> 60 years (date is unknown) SAHRA regulations stipulate graves with unknown dates be treated as >60 years
Applicable Section of the NHRA, No 25 of 1999:	Section 36
Site Description:	The possible grave has still not been confirmed as an actual grave. But should be confirmed and area fenced and treated as a no-go area with a 10 meter buffer (*Figure 12*).

Figure 12-Aerial map of the area reflecting the locations of the identified heritage resources from Revision 01 heritage study. (1) Dilapidated buildings on farm Kromdraai near the current modern

farmhouse; (2) two possible graves in northwest corner of farm Eenzaamheid and (3) possible grave east of farm Eenzaamheid just off project footprint.

4. IMPACT ASSESSMENT

This chapter includes the Impact Assessment methodology used to measure the project impacts on the identified heritage resources. It also includes the Impact Assessments on the heritage resources identified in Chapter 3. The heritage sites were assessed using the Zitholele Consulting methodology (4.1).

4.1. Impact Assessment Methodology

The impacts will be ranked according to the methodology described below. Where possible, mitigation measures will be provided to manage impacts. In order to ensure uniformity, a standard impact assessment methodology will be utilised so that a wide range of impacts can be compared with each other. The impact assessment methodology makes provision for the assessment of impacts against the following criteria, as discussed below.

4.1.1. Nature of the impact

Each impact should be described in terms of the features and qualities of the impact. A detailed description of the impact will allow for contextualisation of the assessment.

4.1.2. Extent of the impact

Extent intends to assess the footprint of the impact. The larger the footprint, the higher the impact rating will be. The table below provides the descriptors and criteria for assessment.

Table 2-Criteria for assessment of the extent of the impact.

Extent Descriptor	Definition	Rating
Site	Impact footprint remains within the boundary of the site.	1
Local	Impact footprint extends beyond the boundary of the site to the adjacent surrounding areas.	2
Regional	Impact footprint includes the greater surrounds and may include an entire municipal or provincial jurisdiction.	3
National	The scale of the impact is applicable to the Republic of South Africa.	4
Global	The impact has global implications	5

4.1.3. Duration of the impact

The duration of the impact is the period of time that the impact will manifest on the receiving environment. Importantly, the concept of reversibility is reflected in the duration rating. The longer the impact endures, the less likely it is to be reversible.

Table 3. Criteria for the rating of the duration of an impact.

Duration Descriptor	Definition	Rating
Construction / Decommissioning phase only	The impact endures for only as long as the construction or the decommissioning period of the project activity. This implies that the impact is fully reversible.	1
Short term	The impact continues to manifest for a period of between 3 and 5 years beyond construction or decommissioning. The impact is still reversible.	2
Medium term	The impact continues between 6 and 15 years beyond the construction or decommissioning phase. The impact is still reversible with relevant and applicable mitigation and management actions.	3
Long term	The impact continues for a period in excess of 15 years beyond construction or decommissioning. The impact is only reversible with considerable effort in implementation of rigorous mitigation actions.	4
Permanent	The impact will continue indefinitely and is not reversible.	5

4.1.4. Potential intensity of the impact

The concept of the potential intensity of an impact is the acknowledgement at the outset of the project of the potential significance of the impact on the receiving environment. For example, SO_2 emissions have the potential to result in significant adverse human health effects, and this potential intensity must be accommodated within the significance rating. The importance of the potential intensity must be emphasised within the rating methodology to indicate that, for an adverse impact to human health, even a limited extent and duration will still yield a significant impact. Within potential intensity, the concept of irreplaceable loss is taken into account. Irreplaceable loss may relate to losses of entire faunal or floral species at an extent greater than regional, or the permanent loss of significant environmental resources. Potential intensity provides a measure for comparing significance across different specialist assessments. This is possible by aligning specialist ratings with the potential intensity rating provided here. This allows for better integration of specialist studies into the environmental impact assessment.

Table 4-Criteria for impact rating of potential intensity of a negative impact.

Potential Intensity Descriptor	**Definition of negative impact**	**Rating**
High	Any impact to human health/mortality/loss of a species.	16
Moderate-High	Significant impact to faunal or floral populations/loss of livelihoods/individual economic loss	8
Moderate	Reduction in environmental quality/loss of habitat/loss of heritage/loss of welfare amenity	4
Moderate-Low	Nuisance impact	2
Low	Negative change with no associated consequences.	1

Table 5-Criteria for the impact rating of potential intensity of a positive impact.

Potential Intensity Descriptor	**Definition of positive impact**	**Rating**
Moderate-High	Met improvement in human welfare	8
Moderate	Improved environmental quality/improved individual livelihoods.	4
Moderate-Low	Economic development	2
Low	Positive change with no other consequences.	1

It must be noted that there is no HIGH rating for positive impacts under potential intensity, as it must be understood that no positive spinoff of an activity can possibly raise a similar significance rating to a negative impact that affects human health or causes the irreplaceable loss of a species.

4.1.5. Likelihood of the impact

This is the likelihood of the impact potential intensity manifesting. This is not the likelihood of the activity occurring. If an impact is unlikely to manifest, then the likelihood rating will reduce the overall significance.

The rating for likelihood is provided in fractions in order to provide an indication of percentage probability, although it is noted that mathematical connotation cannot be implied to numbers utilised for ratings.

Table 6-Criteria for the rating of the likelihood of the impact occurring.

Likelihood Descriptor	Definition	Rating
Improbable	The possibility of the impact occurring is negligible and only under exceptional circumstances.	0.1
Unlikely	The possibility of the impact occurring is low with a less than 10% chance of occurring. The impact has not occurred before.	0.2
Probable	The impact has a 10% to 40% chance of occurring. Only likely to happen once in every 3 years or more.	0.5
Highly Probable	It is most likely that the impact will occur and there is a 41% to 75% chance of occurrence.	0.75
Definite	More than a 75% chance of occurrence. The impact will occur regularly.	1

4.1.6. Cumulative Impacts

Cumulative impacts are reflected in the in the potential intensity of the rating system. In order to assess any impact on the environment, cumulative impacts must be considered in order to determine an accurate significance. Impacts cannot be assessed in isolation. An integrated approach requires that cumulative impacts be included in the assessment of individual impacts.
The nature of the impact should be described in such a way as to detail the potential cumulative impact of the activity.

4.1.7. Significance Assessment

The significance assessment assigns numbers to rate impacts in order to provide a more quantitative description of impacts for purposes of decision making. Significance is an expression of the risk of damage to the environment, should the proposed activity be authorised.

To allow for impacts to be described in a quantitative manner in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus the total value of the impact is described as the function of significance, spatial and temporal scale as described below:

Impact Significance = (extent + duration + potential intensity) x likelihood

Table 7-Significance rating formulas.

Score	Rating	Implications for Decision-making
< 3	Low	Project can be authorised with low risk of environmental degradation
3 – 9	Moderate	Project can be authorised but with conditions and routine inspections. Mitigation measures must be implemented.
10 – 20	High	Project can be authorised but with strict conditions and high levels of compliance and enforcement. Monitoring and mitigation are essential.

21 – 26	Fatally Flawed	Project cannot be authorised

An example of how this rating scale is applied is shown below:

Table 8-Example of Rating Scale.

Nature	Extent	Duration	Potential Intensity	Likelihood	Rating
Emission of SO_2 to the environment in concentrations above the minimum emissions standards. The area is a priority hotspot in terms of air emissions and there are several industrial operations that contribute to extensive emissions of SO_2.	*Global*	<u>Long term</u>	HIGH	**Probable**	High
	5	4	16	0.5	12.5

4.1.8. Notation of Impacts

In order to make the report easier to read the following notation format is used to highlight the various components of the assessment:

- Extent- *in italics*
- Duration – in <u>underline</u>
- Potential intensity – IN CAPITALS
- Likelihood - in **bold**

Please note that the impact rating system may change slightly to accommodate ease of use. However, the basic principle of the rating system will remain the same.

4.2. Impact Assessments on Identified Heritage Resources

Table 9-Impact assessment of the two built structures located on site 12. EMFGD 01.

PRE-CONSTRUCTION PHASE

Activity	Nature of Impact	Impact type	Extent	Duration	Potential Intensity	Likelihood	Rating	Mitigation	Interpretation
Two Built Structures (Block buildings)	Direct Impact:	Existing	1	5	1	0.1	1 - LOW	No mitigation is recommended as the structures are not expected to be impacted during this phase.	Historic structures represent the history of the local inhabitants.
	Destruction of the Built Structures. Two block (brick and mortar) structures identified on Site 12 (farm Kromdraai)	Cumulative	1	5	1	0.1	1 - LOW		Air quality will remain high impact with Medupi coming on-line
		Residual	1	5	1	0.1	1 - LOW		No impact is expected during this phase so there is no potential loss of heritage.

CONSTRUCTION PHASE

Activity	Nature of Impact	Impact type	Extent	Duration	Potential Intensity	Likelihood	Rating	Mitigation	Interpretation
Two Built Structures (Block buildings)	Direct Impact:	Existing	1	5	1	0.75	5 - MOD	The buildings have been noted and recorded. No additional mitigation is recommended. While it is probable the structures will be impacted during this phase, the buildings lack any heritage value.	Historic structures represent the history of the local inhabitants.
	Destruction of the structures (two block buildings) during the this phase will result in loss of the historic built environment.	Cumulative	1	5		0.75	5 - MOD		These structures lack any historic backstory. No history is associated with the buildings and they lack any heritage signficant features.
		Residual	1	5	1	0.75	5 - MOD		As the buildings lack historic significance there is no residual loss of heritage.

OPERATIONAL PHASE

Activity	Nature of Impact	Impact type	Extent	Duration	Potential Intensity	Likelihood	Rating	Mitigation	Interpretation
Two Built Structures (Block buildings)	Direct Impact:	Existing	1	5	1	0.75	5 - MOD	The buildings have been noted and recorded. No additional mitigation is recommended. While it is probable the structures will be impacted during this phase, the buildings lack any heritage value.	Historic structures represent the history of the local inhabitants.
	Destruction of the structures (two block buildings) during the this phase will result in loss of the historic built environment.	Cumulative	1	5	1	0.75	5 - MOD		These structures lack any historic backstory. No history is associated with the buildings and they lack any heritage signficant features.
		Residual	1	5	1	0.75	5 - MOD		As the buildings lack historic significance there is no residual loss of heritage.

Activity	Nature of Impact	Impact type	Extent	Duration	Potential Intensity	Likelihood	Rating	Mitigation	Interpretation
				DECCOMMISSIONING PHASE					
Two Built Structures (Block buildings)	Direct Impact:	Existing	1	5	1	0.2	1 - LOW	No mitigation recommended as the historic value is low.	Historic structures represent the history of the local inhabitants.
	Loss of historic built environment	Cumulative	1	5		0.2	1 - LOW		These structures lack any historic backstory. No history is associated with the buildings and they lack any heritage signficant features.
		Residual	1	5	1	0.2	1 - LOW		No additional impact is expected during this phase.

Table 10-Impact Assessment of graves on Site 13. EMFGD 02.

Activity	Nature of Impact	Impact type	Extent	Duration	Potential Intensity	Likelihood	Rating	Mitigation	Interpretation
				PRE-CONSTRUCTION PHASE					
Graves (one probable grave and a second possible grave)	Direct Impact:	Existing	1	5	1	0.1	1 - LOW	No mitigation is recommended as the graves are not expected to be impacted during this phase.	Human burials are protected by law/legislation. Importantly, invasion of a burial greatly effects the family and community.
	Damage/desecration of interred human remains	Cumulative	1	5	1	0.1	1 - LOW		Potential law violations and litigation
		Residual	1	5	1	0.1	1 - LOW		No impact is expected during this phase so there is no potential loss of heritage.

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Graves (one probable grave and a second possible grave)	Direct Impact:	Existing	1	5	8	0.75	11 - HIGH	It is recommended for exhumation of the remains, relocation and reburial in a proper local cemetery. Fencing (bordering) the graves is not seen as a viable alternative.	Human graves are considered sacred. Additionally, graves are direct links to families and communities ancestral spirits.
	Damage/desecration of interred human remains	Cumulative	1	5	8	0.75	11 - HIGH		The damage would be once-off and continued activity will not increase the level of impact. However the social negative impact would increase.
		Residual	1	5	8	0.75	11 - HIGH		Loss or desecration of burials has long-term implications on a family's peace of mind and, among many groups, on angering ancestral spirits.

OPERATIONAL PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Graves (one probable grave and a second possible grave)	Direct Impact:	Existing	1	5	8	0.75	11 - HIGH	It is recommended for exhumation of the remains, relocation and reburial in a proper local cemetery. Fencing (bordering) the graves is not seen as a viable alternative.	Human graves are considered sacred. Additionally, graves are direct links to families and communities ancestral spirits.
	Damage/desecration of interred human remains	Cumulative	1	5	8	0.75	11 - HIGH		The damage would be once-off and continued activity will not increase the level of impact. However the social negative impact would increase.
		Residual	1	5	8	0.75	11 - HIGH		Loss or desecration of burials has long-term implications on a family's peace of mind and, among many groups, on angering ancestral spirits

DECCOMMISSIONING PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Graves (one probable grave and a second possible grave)	Direct Impact:	Existing	1	5	8	0.75	11 - HIGH	No additional mitigation recommended. Mitigation should take place prior to this phase.	Human graves are considered sacred. Additionally, graves are direct links to families and communities ancestral spirits.
	Damage/desecration of interred human remains	Cumulative	1	5	8	0.75	11 - HIGH		The damage would be once-off; continued activity will not increase the level of impact. However the social negative impact would increase.
		Residual	1	5	8	0.75	11 - HIGH		No additional impact is expected during this phase.

Table 11-Impact Assessment of possible grave adjacent to Site 13. EMFGD 03. ***These are not within the development footprint but within a kilometre zone from Medupi development footprint – therefore will not be impacted. The assessment is included to bring attention to them in case the development activities move beyond the current site boundary.***

PRE-CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Grave (probable)	Direct Impact:	Existing	1	5	1	0.1	1 - LOW	No mitigation is recommended as the grave is not expected to be impacted during this phase.	Human burials are protected by law/legislation. Importantly, invasion of a burial greatly effects the family and community.
	Damage/desecration of interred human remains	Cumulative	1	5	1	0.1	1 - LOW		Potential law violations and litigation
		Residual	1	5	1	0.1	1 - LOW		No impact is expected during this phase so there is no potential loss of heritage.

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Grave (probable)	Direct Impact:	Existing	1	5	8	0.75	11 - HIGH	It is recommended that this potential grave be fencd and a no-go zone of 5m established around the site.	Human graves are considered sacred. Additionally, graves are direct links to families and communities ancestral spirits.
	Damage/desecration of interred human remains	Cumulative	1	5	8	0.75	11 - HIGH		The damage would be once-off and continued activity will not increase the level of impact. However the social negative impact would increase.
		Residual	1	5	8	0.75	11 - HIGH		Loss or desecration of burials has long-term implications on a family's peace of mind and, among many groups, on angering ancestral spirits.

OPERATIONAL PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Grave (probable)	Direct Impact:	Existing	1	5	8	0.75	11 - HIGH	It is recommended that this potential grave be fencd and a no-go zone of 5m established around the site.	Human graves are considered sacred. Additionally, graves are direct links to families and communities ancestral spirits.
	Damage/desecration of interred human remains	Cumulative	1	5	8	0.75	11 - HIGH		The damage would be once-off and continued activity will not increase the level of impact. However the social negative impact would increase.
		Residual	1	5	8	0.75	11 - HIGH		Loss or desecration of burials has long-term implications on a family's peace of mind and, among many groups, on angering ancestral spirits

DECCOMMISSIONING PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Grave (probable)	Direct Impact:	Existing	1	5	8	0.75	11 - HIGH	No additional mitigation recommended. Mitigation should take place prior to this phase.	Human graves are considered sacred. Additionally, graves are direct links to families and communities ancestral spirits.
	Damage/desecration of interred human remains	Cumulative	1	5	8	0.75	11 - HIGH		The damage would be once-off; continued activity will not increase the level of impact. However the social negative impact would increase.
		Residual	1	5	8	0.75	11 - HIGH		No additional impact is expected during this phase.

5. DISCUSSION

The current study takes into account the findings, conclusions and recommendations of the heritage study conducted by NGT for Medupi Waste Disposal Facility site selection process (Revision 01). Revision 01 is important in terms of giving context for the current study, which evolved from Revision 01. It also considered the heritage study that has been undertaken by Mbofho Consulting and Project Manager in retrospect for the identification of places known to have contained burial grounds and graves within the Medupi PS precinct (*Figures 13, 14 & 15*).

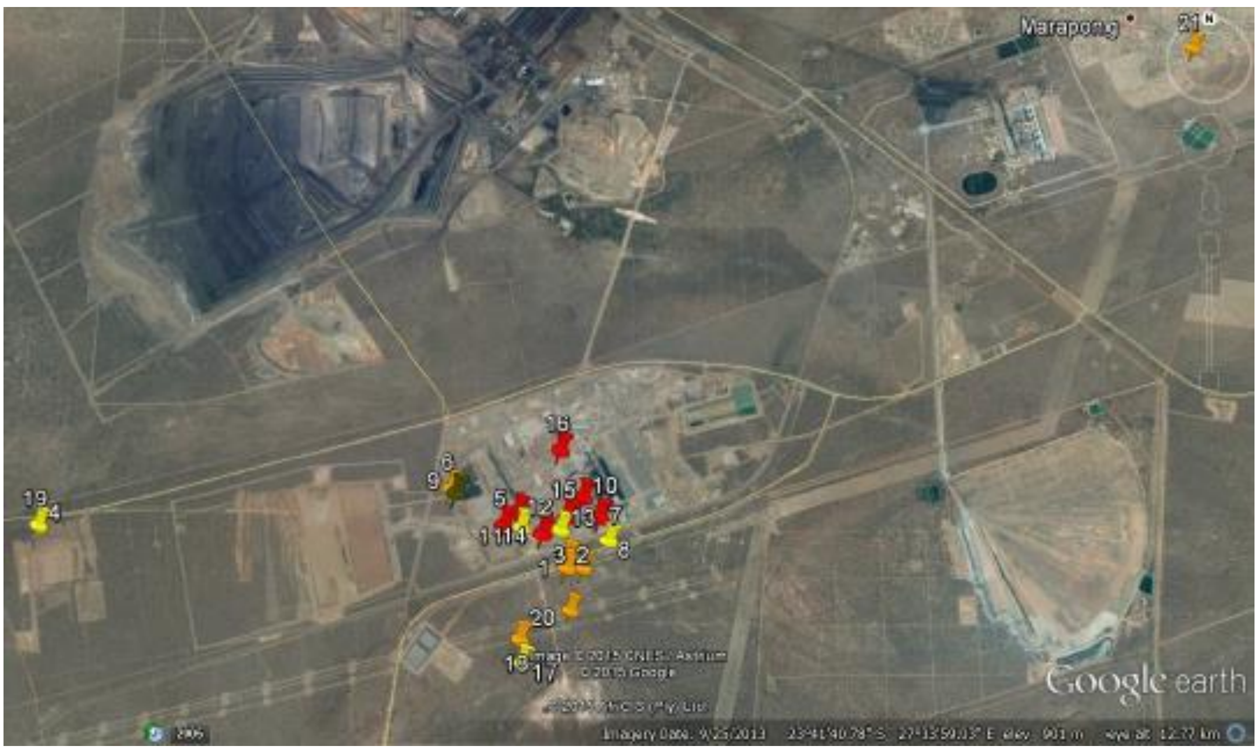

Figure 13- Markers of areas reported to have contained graves within and outside the Medupi footprint (Source: Silidi &. Matenga, 2015).

Figure 14- Markers of areas known to have contained graves before the construction (Source: Silidi &. Matenga, 2015).

Figure 15- Sand heaps where two infants graves are reportedly to have been buried (Source: Silidi &. Matenga, 2015).

In terms of the current study, it has been determined that the proposed scope of works at Medupi PS will not impact on archaeological, heritage and palaeontological resources. The survey of the proposed development footprint did not yield any archaeological or heritage resources (e.g. burial grounds and graves or historic built environment and landscape features such as old farm houses). However, potential graves were identified by Dr Sutton of NGT within a kilometer south of Medupi Power Station but outside the proposed development footprint. Although these potential graves fall outside the proposed development footprint they were assessed and it was found that they may be highly impacted should construction activities move beyond the current Medupi site boundary. Literature review for the current study has resulted to information about graves sites (and a map showing these graves) that were destructed during the construction phase of Medupi PS six units and the associated infrastructure (*Figure 10*). However, no such resources were identified during the field survey of the proposed FGD technology construction sites, the proposed railway yard and the existing and licensed ADF. The area proposed for the construction activities have been transformed during previous construction activities (e.g. *Figures 11 -22*). The ADF is an existing facility and the area around has also been transformed therefore there were no heritage resources identified. Based on these findings, the following conclusions and recommendations are made about the proposed construction of Medupi PS FGD technology, the railway yard and the implementation of the existing and licensed ADF as a multi-waste storage facility for ash and excess gypsum.

Figure 16-Signage to Medupi Ash Disposal facility (entrance point)

Figure 17- Available land that has been cleared for the growth of the Ash Disposal Facility (AFD). Image taken from the west facing east

Figure 18- The width of the facility facing Medupi from the west end of the ADF

Figure 19 – The western end on the AFD

Figure 20- Northern end of the AFD

Figure 21- Northern dam associated with the AFD

Figure 22- Current ash heap at the ADF facility

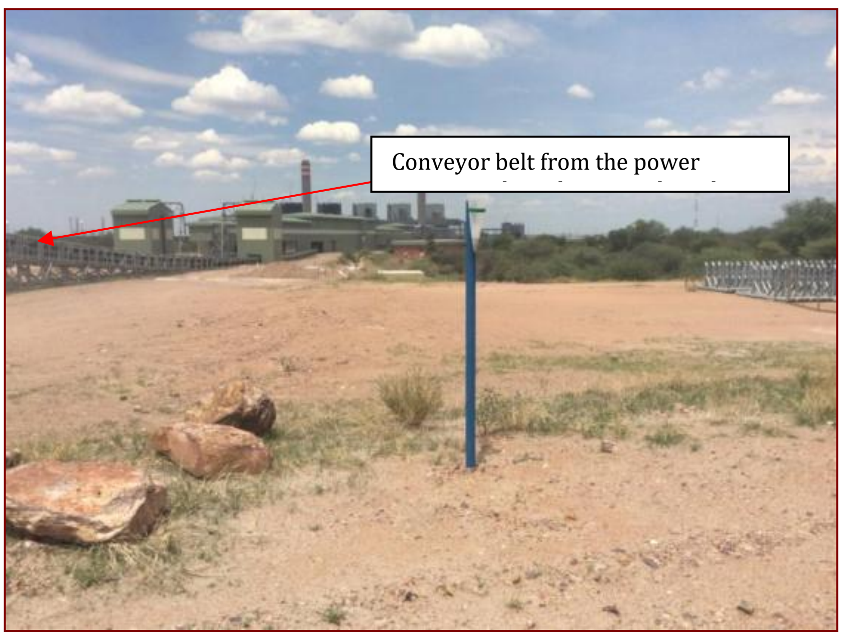

Figure 23- Conveyor belt system associated with the AFD

Figure 24- Land dedicated to the facility. Taken south of the facility facing north. This is the area where the proposed railway yard will be built

Figure 25- Image of the land dedicated to the facility and ash heap from Medupi power station. Taken from the south facing north-east

Figure 26- Two dams associated with the facility located south-west of the current ash heap

Figure 27- Fence line demarcating the facility with the southern property and the railway line. The area with left of the road is the proposed railway yard area.

6. CONCLUSIONS

- It is concluded that there are no heritage and archaeological resources identified within the area proposed for the railway yard, limestone storage and associated infrastructure and the Medupi PS FGD technology construction sites as well as the AFD. The land in which the proposed construction activities have been transformed from previous construction activities at Medupi Power Station.
- There were also no heritage and archaeological resources around the existing and licensed ADF ash disposal facility – during the survey of the ADF the site were already constructed.
- The assessment of historic maps of the area Medupi PS also did not yield any burial grounds or graves as well as stone walls and historic buildings. However, the assessment of a Phase II HIA report by Mbofho Consulting and Project Manager yielded burial grounds and graves as well as areas that are known to have contained graves (e.g. *Figure 13 -15*).
- Based on the findings made by Mbofho Consulting and Project Managers one cannot rule out the subterranean burial grounds and graves since in some areas they identified areas with soil heaps that are reportedly to have been dumped on top of graves. *NGT was not part of this Phase II HIA study conducted on site; it therefore not take full responsibility or liability for any issues that were raised and addressed in this report other than to make reference to it as an important document to consider in dealing with heritage issues at Medupi PS. may be addressed by the current heritage social consultation on site.*
- It is concluded, that based on the exiting engineering drawings of the proposed FGD technology development footprint and its survey thereof that there are no archaeological or heritage resources. Like with the railway yard and the existing and licensed ADF facility the land in which the proposed FGD technology is to be constructed is already transformed through previous construction activities. *Once more NGT was not part of this Phase II HIA study conducted on site; it therefore not take full responsibility or liability for any issues that were raised and addressed in this report other than to make reference to it as an important document to consider in dealing with heritage issues at Medupi PS. may be addressed by the current heritage social consultation on site.*
- The only potential graves were identified south of Medupi within a kilometre zone by Dr Sutton of NGT in 2016 but these are outside the current development footprint and will not be impacted even though an impact assessment measure has been undertaken of them (EMFGD).

7. RECOMMENDATIONS

- It is recommended that Eskom should continue with the implementation of Phase 2 HIA recommendations made by Mbofho Consulting and Project Managers which state that:
    - Eskom should consider constructing a memorial on site to memorialized the names of those whose graves were accidentally disturbed during the construction of Medupi PS six units and the associated infrastructure. All the names and surnames of those who were buried in areas that have been reconstructed as per Figure 13, 14 and 15 should be included in the memorial. This will be in addition to cleansing ceremonies and other cultural practices that have already been undertaken such as repatriation of spirits.
- A general recommendation with transcend heritage issues at Medupi PS is that, project proponents and environmental consultants alike, should always involve heritage consultants in the early stages of environmental management process. For example, from project conceptualization where a heritage screener of the development footprint can be undertaken. To project planning phase whereby archaeologist and heritage consultants form part of the project planning team. Heritage management process should not be taken as a tick box tool that fulfills compliance requirements, rather an important and integral part of the environmental management process.

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ANNEXURE 1: REVISION 01 HERITAGE IMPACT ASSESSMENT STUDY EXECUTIVE SUMMARY WITH STUDY CONCLUSIONS AND RECOMMENDATIONS

Eskom is the utility responsible for the generation, transmission and distribution of electricity to the South African consumer. Established in 1923 by the South African government, today it supplies approximately 95% of the country's electricity. The utility is the largest producer of electricity in Africa and is among the top seven utilities in the world in terms of generation capacity. It plays a major role in accelerating growth in the South African economy by providing reliable, high-quality electricity. Medupi Power Station, currently in the final stages of construction, is an important element of the Eskom "capacity building" initiative and is the largest construction project in the southern hemisphere. In order to reduce the emissions of sulphur dioxide into the environment and meet more stringent minimum Air Quality Emissions Limits for new power plants, Eskom will install wet limestone Flue Gas Desulphurisation technology (sulphur dioxide abatement technology) to the 6 power-generating units at the Medupi Power Station. Flue-Gas desulphurization (FGD) is a set of technologies used to remove sulphur dioxide (SO_2) from the exhaust flue gases of fossil burning power plants.

The FGD project consists of the retrofitting of FGD technology to remove sulphur dioxide from the exhaust flue gases of the Medupi Power Station operations and is expected to remove up to 95% of the SO_2. It is expected that the proposed FGD facility will have an estimated footprint of between 0.5 and 1 hectare, including associated infrastructure which may consist of: storage; handling and disposal of wastes; treatment of waste water within a Zero Liquid Discharge (ZLD) system; a conveyor belt or road route for the transportation of waste to the disposal site; services, including electricity and water supply in the form of power lines, pipelines and associated infrastructure and access and maintenance roads to the ash disposal facility (ADF).

The analysis report of the wastes generated from the FGD process resulted in the need to identify locations for disposal. The waste consists of Gypsum and Ash which are Type 3 wastes and Eskom has proposed disposing of them together in a Class C facility. The other by-products are Sludge and Salts which are Type 1 wastes and will be disposed in separate cells in a single Class A facility. To that end, a site identification process was initiated to locate an appropriate site for the Class A facility. This report forms part of the specialist studies assessing the three remaining identified locations. The three sites are located on farms within a 10km radius from the Medupi Power Station. These are Site 2 (farm

Kromdraai), Site 12 (farms Vergulde Helm and Enkeldraai) and Site 13 (Eenzaamheid). Site 13 has already been assessed and approved for waste disposal, as such it was not surveyed for this report. However, the findings from previous reports will be assessed for impacts on heritage or cultural material for this current project. All three sites are considered as part of the site selection process.

NGT was appointed by Zitholele to conduct the Heritage Impact Assessment (HIA) (inclusive of a Palaeontological Desktop Study). The heritage specialist assessment is in terms of Section 38 (1) of the National Heritage Resources Act, No. 25 of 1999 and the National Environmental Management Act (NEMA), No.107 of 1998 (as amended in 2014 & the applicable 2014 Regulations) as well as other applicable legislations. Morris Sutton, archaeologist and principal heritage consultant from NGT Consulting conducted the study. This study assesses the range of all manmade or human influenced/altered resources within the proposed locations for the selection of a waste disposal area (*Figure 1*).

The standard NGT HIA includes:

- Conducting a detailed background information search of the affected environment;
- Conducting a physical survey of the project foot print to identify, record/document and map out any heritage resources within and immediately around the development footprint;
- Field grading of the identified resources;
- Assessing impacts of the proposed development on the identified resources and making recommendations on how such impacts can be managed or mitigated.

The background information search yielded information about the existence of heritage resources in and around the project footprint, including the nearby town of Lephalale. The identified heritage resources included archaeological, rock art, burial grounds and graves and historic built environment.

The survey, conducted on 31 August – 2 September and 17 and 18 November 2015, revealed no heritage material within the project footprint or areas immediately outside the footprint.

Based on the desktop research, the physical survey and the assessment of the potential impact of the proposed project on farms Kromdraai (Site 12), Vergulde Helm and Enkeldraai (Site 2) the following conclusions and recommendations are made:

Conclusions:

The Palaeontological Desktop Study (Appendix B) determined the geological formations in the area pre-date any large bodied fossil plant or any vertebrate fossils. Micro-organisms such as algae had evolved by this time but they do not preserve in conglomerates. Sandstones are usually too coarse to preserve such small fossils. Therefore, there is an extremely small chance of finding any fossils of any kind in the three proposed areas.

The HIA desktop study identified 3 types of heritage resources that are likely to occur within the Medupi FDG retrofit waste site selection project areas. These resources include: burial grounds and graves, built environment and Iron Age and Stone Age activity/sites. Following a detailed survey of the proposed area, there were no identified resources within the project footprint. It is concluded that, from a cultural resources management point of view, that there are no objections to either of the sites and no negative perceptions regarding the selection of a waste disposal site. Neither of the two sites yielded heritage resources during the physical survey:

- Site 2- No heritage resources were identified
- Site 12- Two built structures were identified. Both are of low heritage significance and require no further mitigation.
- Site 13- One area was identified that may contain two graves. It is highly probable that the first is a grave while the second is only possibly a grave. Both of these need mitigation measures to a) determine confirmation of a grave site and, b) if confirmed, mitigate the impact by exhumation and relocation of the graves. A second area just east of the project footprint was identified as being a possible grave. This area, which is adjacent to the proposed project facility, can be fenced (bordered) with a 5m no-go zone and avoided during the construction, operational and decommissioning phases.

Recommendations:

As far as the palaeontology is concerned the proposed development can go ahead and no further impact assessment is required.

If in the extremely unlikely event that any fossils are discovered during the construction of the waste disposal site, then it is strongly recommended that a palaeontologist be called to assess their importance and rescue them if necessary.

No heritage of significant value was identified on either Site 2 or 12. On Site 13 mitigation will need to take place regarding the possible graves in the northwest corner of the site (EMFGD 02). This includes confirmation of actual graves and if confirmed these must follow the procedures for exhumation and reburial of human remains (see Discussion Chapter for detailed procedures for relocating the graves). If it is determined the site does not contain graves then no additional mitigation is necessary. It is also recommended that confirmation is made regarding the possible grave east, but adjacent, of the project footprint (EMFGD 03). If confirmed as a grave then the grave should be fenced and a 5m buffer be established to ensure the integrity of the grave during construction, operational and decommissioning phases of the project.

Following the mitigation recommendations for the graves, all three sites are viable options for the selection process. If proper mitigation is completed then, in regard to heritage, the three sites can be ranked equally for the site selection process.

It is noted, however that heritage material is, in many cases, found in sub-surface sediments thus if any heritage material is exposed during the construction/maintenance phases of this project then all work must stop and the appropriate agencies (LIHRA and SARHA) be notified. Additionally, should that heritage be in the form of graves then the South Africa Police Service must also be notified.

It is also recommended that a site specific HIA be conducted once the selection process has been completed. The site specific HIA should include a strong focus on the potential for graves. Both the site survey and a comprehensive public participation process should be conducted with an emphasis on identifying graves or burial places.

ANNEXURE 2: GRAVE MANAGEMENT PROCEDURE PROPOSED IN REVISION 01 HERITAGE STUDY

5.1 Burials/Graves

The possibility of graves being uncovered during the construction phase is of critical importance. Previous heritage studies conducted in the surrounding areas have, on occasion, failed to identify graves that were subsequently uncovered during construction. Though, not the fault of the heritage specialists, these situations create delays in the project and stress in the local communities. As often, in most areas, graves were marked by stones and those stones are sometimes moved (through natural fluvial or alluvial actions as well as by people) and thus it is not possible to discern these graves on the landscape. That was the case previously with the construction of the Medupi Power Station. Additionally, it is often not possible to identify a stone lying on the landscape as being a grave marker. That was the case with the current possible grave on Site 13.

As it is essential to anticipate the potential for graves on site, part of the report discussion includes a review of local burial customs. Currently the Lephalale area has a diverse population including many different cultural groups. Much of this diversity is the result of migrants, seeking work, entering the area over the last few decades. Migrant labourers and opportunistic entrepreneurs have both contributed to and benefited from the economic growth of the area. However, prior to a few decades ago the area was somewhat more culturally monogamous. Historically the largest population group in the area has been the Northern Sotho or, more specifically, the BaPedi. From the mid-18th century the group flourished reaching its most powerful point during the reign of Thulare from the late 18th century until 1820. During the mfecane the BaPedi were mostly driven out the area, but returned afterwards in the 1870s and slowly rebuilt. Since that time, in spite of much conflict with Afrikaners and the English, the Northern Sotho have remained in the area. Due to this long occupation, the most likely burials uncovered during the construction phase would be BaPedi or Northern Sotho people. Therefore this discussion will look at some of the customs and rituals associated with the Northern Sotho cultural group.

As with most cultural groups rituals are an important part of BaPedi group identity. Rituals operate beyond mere knowledge and human experience to integrate people. Burial rituals heal grief and enhance group membership ensuring the desired sense of belonging without being subject to scientific logic (Ktagla, 2012). In the case of death and bereavement, rituals can reinforce and help to explain the persistence of religious practices in the face of the destructive forces of dilution and distortion by external influences (ibid.)

An important understanding in Northern Sotho ritual approaches to death and grieving is that they are greatly influenced by the group's beliefs regarding death and its role in the lifecycle. Rituals surrounding death of a person among the Northern Sotho are a structured activity that involves the collective of close family and extended families (Kgatla, 2012). "Attention is drawn away from an individual activity to a collective conformity. Individualism is annulled, and in its place there is collectivism" (ibid. p.83). Importantly, Northern Sotho people see death not an end to the person's soul, but only a change in the soul's place of abode. This manifests in the relevance or importance placed on ancestors' role in the lives of the living. During a burial, rituals are performed to continue the link. Thus disturbance of a grave is not just a defilement of the decease's body, but an insult to the ancestors. This can bring about punishment to the living. Therefore it is important that the proper rituals are followed when exhuming and re-burying human remains.

The burial ceremony is usually conducted in two parts. The first takes place at the home and the second at the cemetery. A re-burial of an exposed grave on site would preclude the first part.

The cemetery burial process is also very structured. During the Iron Age period, important members of a village were buried within the central kraal. This was done to signify their position or standing within the group. In more modern times, the burial place is often an area of cultural or heritage significance. This made be in the form of landscape features, such as long-standing old trees, rock outcrops or historic structures. The selected burial site is most often an area 30-100m west of the significant feature. Thus these landscape features are often markers for BaPedi burial places.

The actual burial ceremony follows a ritualized process (Mapaya and Mugovhani, 2014):

- Normally during transport from the home to the cemetery the coffin is covered in a blanket. This is a long tradition wherein originally the body or coffin was covered in a cow hide. This should be done once the remains have been interred in a new coffin after exhumation. The praise singing would also occur at this time. Importantly, this role is conducted by the rakgadi or aunt. Traditionally, in Nguni cultures praise singing is carried out by males and in BaPedi groups males do learn praise, but in most cases it is the females who are expected to perform the rite.
- The Diphiri or young men of the village of the deceased carry out the task of digging the new grave. This is often difficult in reburials as it would be expected to be carried out by the employees of the contracted funeral directors. But, when possible, should be followed.

- During reburial the Moruti or pastor begins with a prayer and conducts the interment.
- A representative of the Chief makes comments and gives thanks from the village level.
- The Diphiri give thanks with specific reference to those present. These young men are also responsible for the conduct of those present for the burial. This includes monitoring the group and politely correcting inappropriate behavior.
- Finally, the Balapa or Elders give thanks. At this point the structured rituals are complete and the ceremony is ended. The family may desire to remain longer to reinforce the bond/link with the deceased.

Process to follow in the event of the confirmation or exposure of a grave or burial.

A number of laws come into effect when dealing with human remains. SAHRA includes legislation (NHRA No 25 of 1999) for any heritage related human remains. These include graves or burials greater than 60 years of age or persons who were victims of conflict. Human remains that are less than 60 years old are subject to provisions of the Human Tissue Act (Act 65 of 1983) and to local regulations. Laws governing the granting of permission relating to exposure or removal of graves also include a number of government agencies. Guidelines were also established, internationally, regarding the treatment of graves. The World Archaeological Congress (WAC) passed the Vermillion Accord on Human Remains in 1989. Two key points from that accord include:

- Respect for the wishes of the dead concerning disposition shall be accorded whenever possible, reasonable and lawful, when they are known or can be reasonably inferred.
- Respect for the wishes of the local community and of relatives or guardians of the dead shall be accorded whenever possible, reasonable and lawful.

A) Legislation pertaining to identification, exhumation and reburial of human remains.

1) South African Heritage Resources Agency (SAHRA)

The National Heritage Resources Act (Act No 25 of 1999) governs graveyards, burial grounds and graves older than 60 years. Graves and burial grounds are divided in six categories:

- ancestral graves;
- royal graves and graves of traditional leaders;
- graves of victims of conflict;

- graves of individuals designated by the Minister by notice in the Gazette;
- historical graves and cemeteries; and
- other human remains which are not covered in terms of the Human Tissue Act, 1983 (Act No. 65 of 1983).

Furthermore, no person may, without a permit issued by SAHRA or a provincial heritage resources authority—

- destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
- destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or
- bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) any excavation equipment, or any equipment which assists in the detection or recovery of metals.

2) SAHRA or a provincial heritage resources authority may not issue a permit for the destruction or damage of any burial ground or grave referred to in subsection (3)(a) unless it is satisfied that the applicant has made satisfactory arrangements for the exhumation and re-interment of the contents of such graves, at the cost of the applicant and in accordance with any regulations made by the responsible heritage resources authority.

- SAHRA or a provincial heritage resources authority may not issue a permit for any activity under subsection (3)(b) unless it is satisfied that the applicant has, in accordance with regulations made by the responsible heritage resources authority— (a) made a concerted effort to contact and consult communities and individuals who by tradition have an interest in such grave or burial ground; and (b) reached agreements with such communities and individuals regarding the future of such grave or burial ground.

3) Subject to the provision of any other law, any person who in the course of development or any other activity discovers the location of a grave, the existence of which was previously unknown, must immediately cease such activity and report the discovery to the responsible heritage resources authority which must, in co-operation with the South African Police Service and in accordance with regulations of

the responsible heritage resources authority— (a) carry out an investigation for the purpose of obtaining information on whether or not such grave is protected in terms of this Act or is of significance to any community; and (b) if such grave is protected or is of significance, assist any person who or community which is a direct descendant to make arrangements for the exhumation and re-interment of the contents of such grave or, in the absence of such person or community, make any such arrangements as it deems fit.

4) Permission must also be obtained from the:

- Landowner (Eskom)
- Local (Mapela?) traditional council
- Lephalale Municipality
- Waterberg District Municipality
- Limpopo Government (Office of the Premier)
- Limpopo Department of Health
- National Department of Health
- South African Police Service

5) After a permit has been granted then the exhumation and reburial process must conform to the standards set out in the Ordinance on Excavations (Ordinance no. 12 of 1980) - including the Human Tissue Act, 1983 (Act No. 65 of 1983). Human remains can only be handled by a registered undertaker or an institution declared under the Human Tissues Act (Act 65 of 1983 as amended) and must be done in the presence of both a member of SAPS and a qualified Archaeologist.

B) Steps in identification, exhumation and reburial of Human Remains

The first task is to engage local communities with the aim to collect information on graves (or other heritage resources) in the project area. This public outreach should follow the normal Public Participation process, which includes collecting data, engaging members of the community and recording all necessary information.

- If family or descendants can be located/contacted and the grave identified, then a consultation procedure is started wherein the family's consent is necessary to begin a exhumation and reburial process

- If the grave cannot be identified, then it must be treated the same as graves >60 years old and the heritage laws apply.
- Obtain the necessary approvals from various governmental entities (see 3 above).
- Obtain the necessary permit from SAHRA (see 1 above).
- Contract a certified Mortuary Practitioner (i.e. Martins Funeral Services),
- Identification and arrangement of an acceptable cemetery for reburial (i.e. Marapong Cemetery).
- The grave excavation process is conducted by the Mortuary Practitioner. This process is overseen by an Archaeologist in the presence of a member of the SAPS. Also present are any family/affected community members/traditional leaders. This process includes any rituals or rites that had been agreed upon with family/community/traditional leaders.
- Interment in a new grave in a formal cemetery.

The built environment present in the project area is of low heritage significance. Of more concern is the possible grave on site 13 and the potential for the discovery of other graves during the construction phase of the project. The migratory behavior of many laborers, including farm laborers, results in a disconnect with the landscape and can lead to a lack of knowledge of locations of burials. Additionally, the often absence of birth and death certificates within black communities in the past can make it difficult to establish burial/grave connections.

ANNEXURE 3: PROPOSED NEW SCOPE OF WORK AT MEDUPI POWER STATION FOR THE CONSTRUCTION OF THE PROPOSED FGD TECHNOLOGY RETROFIT PROGRAMME, THE PROPOSED RAILWAY YARD AND THE IMPLEMENTATION OF THE EXISTING ADF AS A MULTI-WASTE STORAGE FACILITY

1 INTRODUCTION

This project focuses on the environmental authorization process for the Medupi Power Station Flue Gas Desulphurization (FGD) Retrofit. Medupi Power Station is a coal-fired power station that forms part of the Eskom New Build Programme. Medupi Power Station is located about 15km west of the town of Lephalale in the Limpopo Province.

2 CHANGES TO AUTHORISATION AND LICENCING APPROACH IN 2017

Towards the middle of 2017 changes to the authorization and licensing approach for the Medupi FGD Retrofit Project applications were proposed in order to streamline the application processes to ensure compliance with the NEMAQA compliance requirements by the year 2021. The following changes were subsequently implemented:

- Confirmation that the assessment of an additional multiuse disposal facilities, which would be used for the disposal of ash and gypsum, and salts and sludge have been removed from this current application scope and will be undertaken as a separate authorization process.
- The application for a Waste Management License (WML) for the existing ADF was removed from the integrated Environmental Impact Assessment process hence the EIA application will not be an integrated Environmental Impact Assessment application. The proposed disposal of gypsum together with ash on the existing authorized ADF footprint will be dealt with through a separate amendment process to the existing ADF WML.

- The EIA application in terms of the National Environmental Management Act, 107 of 1998, as amended, will include application for activities associated with the construction and operation of the FGD system within the Medupi PS footprint and the railway yard and siding, including limestone and gypsum handling facilities, diesel storage facilities new access roads, Waste Water Treatment plant, facilities for temporary storage of salts and sludge.

- A Water Use License Application will focus on water uses triggered by the construction and operation of the FGD system, railway yard and limestone / gypsum handling areas, and within 500m of the approved ADF footprint.

3 DETAILED SCOPE OF WORK

The detailed scope of work for each of these applications is described in terms of the simplified process flow diagram in Figure 1 and listed in the sections below. The overall site layout encompassing the railway yard, limestone and gypsum handling areas and FGD system is provided in Appendix A to this technical memo. General layout of the existing ADF and storm water management philosophy is provided in Appendix B to this technical memo.

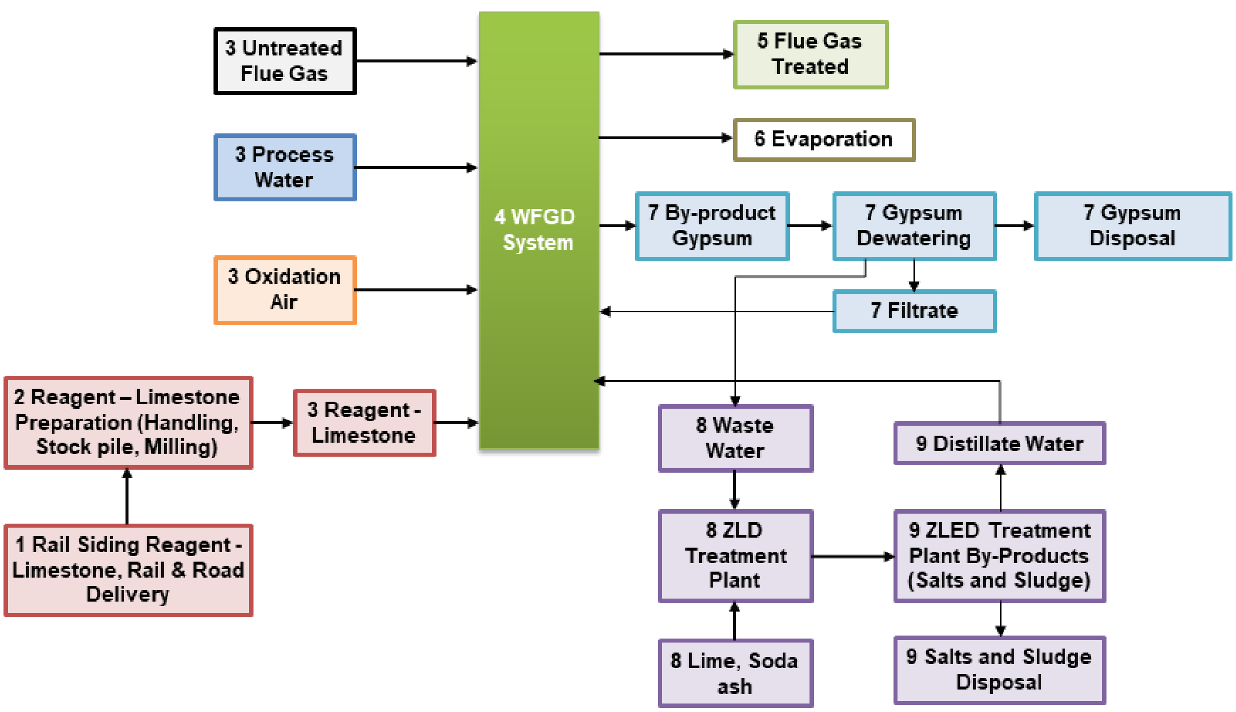

Figure 28-Basic process Flow Diagram for the FGD process at Medupi Power Station

3.1 Railway yard (Block 1 & 2)

Limestone is purchased off-site and is transported to the Medupi Power Station by rail and/or road. The limestone is offloaded at the proposed limestone storage facility, which includes a rail siding and road access, located south-west of the 6 power generation units within the Medupi Power Station footprint. The rail siding and access roads are a component of this environmental authorization (EIA) process. Infrastructure associated with the railway yard and limestone / gypsum handling area include:

- Limestone will be initially delivered by road and will be delivered to a truck offloading facility in close proximity to the Limestone Stockyard.
- Rail infrastructure proposed parallel to the existing Thabazimbi – Lephalale railway with a proposed siding take-off point situated at kilometer point 107+250m. The general arrangement of the railway yard and take-off point is provided in Appendix C.
- Linear-type yard layout configuration with six lines parallel to each other, and split into two separate yards (limestone offloading and gypsum loading) linked by means of a locomotive run-around line.
- Limestone offloading facility: Tippler Area building will include side dispensing tippler, a limestone rail, truck offloading area and separate receiving area, Tippler for “tipping” limestone onto an underground inclined conveyor, limestone transfer house and emergency limestone offloading area at the stockyard. Excavations up to 15m deep will be undertaken during construction of the Tippler facility.
- Gypsum could be routed to the Gypsum storage facility in close proximity to the railyard. Gypsum storage loading facility will include gypsum reclaim hoppers that receive gypsum from the mobile reclaim equipment and discharge to the gypsum reclaim belt conveyor, which in turn discharges to the inclined gypsum belt conveyor. The inclined gypsum belt conveyor then discharges to the bin at the loading facility that feed the rail wagons with a controlled discharge.
- Administration building and operations tower for Eskom and a Services Provider’s personnel.
- Diesel locomotive workshop, utilities rooms and ablutions. This workshop area will have approximately 600m² service space for the shunting locomotive, various offices and store rooms (180m²) attached to one end of the building.
- Two Diesel Storage Facilities (each can be approximately 3.6m in diameter and 3.0m in height) with a maximum installed storage capacity of 28 000 liters each, in two above-ground horizontal

storage tanks, and will be bunded. One of these tanks will service the shunting locomotives while the other will service the Emergency Generator, and located at the rail siding area and the FGD complex area, respectively. A covered road tanker decanting area will be located alongside the bunded area. There is a third diesel tank in the FGD common pump building, the capacity of which is significantly less than 28 000 liters.

- Security office and infrastructure: A security office will be located adjacent to the fence line at the western extent of the proposed rail yard where the proposed rail infrastructure ties in with the existing rail network. The existing service road fence will be used as the boundary fence to the rail yard.
- Conveyor infrastructure.
- Sewerage and effluent management infrastructure: The security office, locomotive workshop and administration building will be served with ablution facilities with a sewerage conservancy tank system with capacities of 3200ℓ, 8500ℓ and 8500ℓ, respectively.
- Associated infrastructure (water, storm water, and lighting): Storm water channels and structures are designed to provide a division between storm water and the dirty water from the gypsum loading facility. Dirty storm water from the gypsum loading facility will be collected into an independent concrete channel and underground pipe network that will drain to the proposed Pollution Control Dam (PCD) that will form part of the FGD infrastructure. The estimated run off contribution to the PCD is expected to be $0.05m^3/s$ for a 1:20 year return period. Eskom will provide the required power supply, while the rail yard mini substations will be constructed in accordance with Eskom's specification. PCDs will also be provided for the salts and sludge storage facility. The Medupi plant operates with two separate water networks supplying fire water and potable water. The water network required for the rail yard was designed to tie into connection points within the existing water network of the MPS.

3.2 Limestone preparation (Block 2)

An overview of the limestone handling and preparation infrastructure is presented below. The proposed limestone handling and conveyance infrastructure is shown in Appendix C. The limestone handling and conveyance will include the following infrastructure:

- Limestone stacking conveyor;
- Limestone storage area;
- Emergency limestone offloading area;
- Limestone reclaim conveyor;
- Limestone and gypsum handling substation;
- Storm Water Pollution Control Dams. The conceptual storm water management design has resulted in two separate PCDs being proposed in this area. It is also proposed that each of these PCDs is portioned to cater to maintenance activities in the future. A layout of proposed PCDs are presented in Appendix E;
- Lined channels for diversion of dirty water to Pollution Control Dams.
- Limestone is conveyed to the limestone preparation building where it is milled and combined with water to form limestone slurry for input into the FGD system. Limestone slurry is pumped to a limestone slurry feed tank from where it is pumped, via piping, on the elevated FGD utility rack to each absorber for utilization in the FGD system. Infrastructure thus includes:
- Limestone preparation building;
- Limestone slurry feed tank; and
- Piping and elevated FGD utility rack.
-

3.3 Input materials and processes (Block 3)

Input materials to the FGD process will include:

- SO2 laden flue gas received from the each generation unit. Untreated flue gas leaving the existing ID fans will be diverted to the absorber inlet, via additional ducting system;
- Process water received from process water tanks (two operational and one backup for redundancy);
- Oxidisation air; and
- Limestone slurry received from the limestone milling and preparation plant.

3.4 WFGD system (Block 4)

The site arrangement of the FGD system for the Medupi Power Station is provided in Appendix D. The FGD system includes infrastructure that is located within the previously cleared and transformed footprint of the power station. Infrastructure includes:

- An absorber unit associated with each of the 6 x generation units;

- Each absorber unit will include a flue gas duct, absorber tower, absorber pump building and absorber substation;
- Absorber drain and gypsum bleed tanks associated with each cluster of 3 absorber units, i.e. absorber units 1 – 3 and absorber units 4 – 6;
- FGD above-ground elevated utility racks containing piping to direct fluid from and to relevant systems within the absorber area.

3.5 Treated Flue Gas (Block 5) and evaporation (Block 6)

Treated flue gas is redirected from the absorbers via the flue gas ducts back to the chimneys for release with much reduced SO2 content. During the process evaporation losses are incurred.

3.6 Gypsum dewatering, re-use or disposal (Block 7)

3.6.1 Gypsum dewatering and conveyance

Gypsum will be produced from the FGD process as a by-product of the wet scrubbing process. Slurry will comprise gypsum, a mixture of salts (Magnesium Sulphate (MgSO4) and Calcium Chloride (CaCl2)), limestone, Calcium Fluoride (CaF2), and dust particles. A refinement process is carried out to separate and dewater the gypsum. Effluent is directed to the Waste Water Treatment Plant (WWTP), the overflow of the gypsum dewatering hydro cyclones goes to the waste water hydrocyclone (WWHC) feed tanks. The tanks are located in the gypsum dewatering building. From the WWHC feed tanks, the water goes through the WWHC where the underflow is directed to the reclaim tanks and the overflow to the Zero Liquid Discharge (ZLD) holding tanks. The ZLD holding tanks feed the WWTP.
Dewatered gypsum is transported via conveyor either to the existing ADF or to an offtake point where it is diverted to a storage facility from which it may be transported by rail or road to users. The gypsum storage building will be used in conjunction with the rail siding only. The storage building is a future use facility that will be built with the rail siding. There will be no facilities for gypsum recovery from the storage building to be loaded onto trucks. Road transport is used for immediate offtake for gypsum exploitation.

Use of gypsum will be subjected to quality assessments, which will be done at the storage facility. If the quality is not usable, the gypsum will be taken for disposal.

The site arrangement of the FGD system for the Medupi Power Station is provided in Appendix D and shows the infrastructure associated with the gypsum dewatering and conveyance. Infrastructure associated with the gypsum dewatering and conveyance includes:

- Gypsum bleed tanks and forwarding pumps;
- Piping and elevated FGD utility rack;
- Gypsum dewatering building containing gypsum hydrocyclones and waste water hydrocyclones ;
- Belt filter and reclaim tank;
- Gypsum conveyer belt system;
- Gypsum truck loading facility;
- Gypsum storage building and offtake via rail

3.6.2 Gypsum re-use or disposal

Initially, gypsum will be conveyed from the gypsum dewatering building via a gypsum link conveyor to a gypsum transfer house where it will be loaded onto the existing overland ash conveyor. In this conveyor system, the gypsum will be mixed with ash and will subsequently disposed together on the footprint of the existing authorized ADF. The conveyor route and transfer houses for gypsum onto the overland ash conveyor are shown in Appendix A. If there is a market for gypsum, the project has catered for an offtake point, wherein, the gypsum will be collected by trucks from overhead conveyor system. At this point, the ground will be prepared for management of any gypsum that is not contained and the trucks will be washed before leaving this area. The washing is a means to minimize the spreading of the gypsum.

In terms of the previous ash classification processes, i.e. the Minimum Requirements Documents Series, ash was considered to be hazardous and thus the 0 to 2 year area was designed and authorized according to the Department of Water and Sanitation (DWS) Minimum Requirements, resulting in a H:h liner system being installed, at the ADF. However, regulations were promulgated by the DEA in terms of NEM:WA on the 23 August 2013. In terms of the NEMWA regulations, ash and gypsum now classify as Type 3 wastes, and require to be disposed of on a Class C barrier system. This barrier will be implemented at the facility from the 4 to 19.2 year area.

An application to amend the existing ADF Waste Management License is being undertaken for disposal of gypsum and ash together on the existing footprint of the authorized ADF. Requirements to reduce impact on the wetlands in the southwest corner of the authorized ADF footprint have, furthermore, resulted in the re-design of the ADF. The proposed ADF amended design has the following attributes:

- The final layout of the ash and gypsum facility has side slopes at 1:5.
- The final layout of the ash and gypsum facility has a long fall of 1:300.
- The final height of the facility will be increased by 12 m from an original design height of 60 m, to 72 m above ground.
- The revised ADF design caters for the storage of a volume of 193 315 105 m3 which converts to a total life of 19.2 years.
- Storm water management caters for clean and contaminated storm water infrastructure, and includes berms, geocell lined trenches and pollution control dams.
- On-going rehabilitation will occur behind the advancing face as the facility develops to ensure a relatively small window of ash and gypsum being exposed to the environment.
- The proposed revised ADF design overlaid over the authorized ADF footprint is provided in Figure 2 below. Proposed PCDs are indicated in the bottom aerial image in Figure 2.

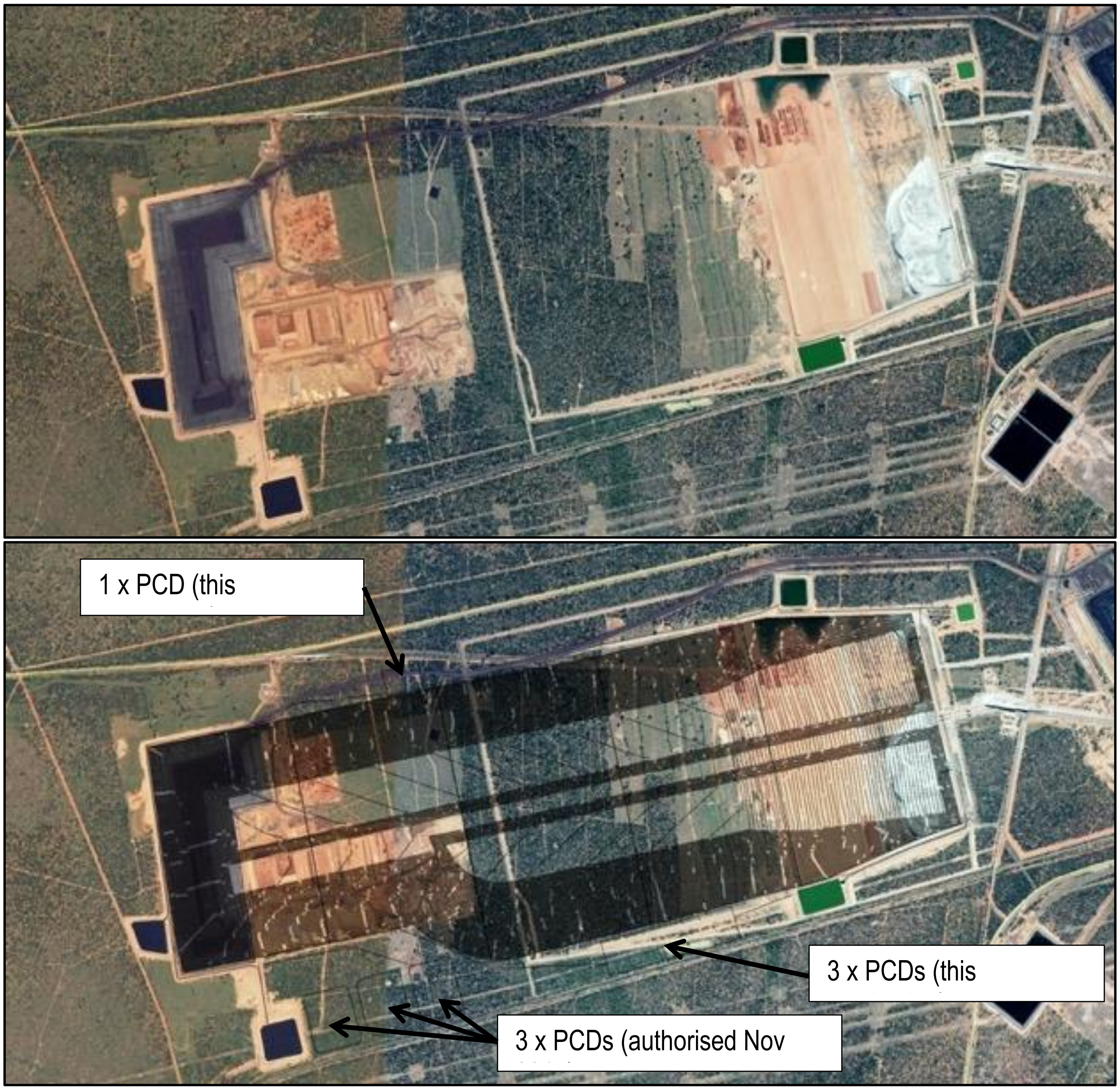

Figure 29-Authorised ADF area (top) with updated ADF design overlay (bottom) indicating layout of amended ADF design

3.7 Waste Water Treatment (Block 8)

The Medupi FGD Waste Water Treatment Plant is located directly west opposite generation units 1 to 3 at the Medupi Power Station. FGD chloride bleed stream and FGD auxiliary cooling tower blowdown stream are diverted to the ZLD holding tanks. The total organic carbon (TOC) scavenger regeneration wastewater from the filter press system / existing water treatment plant (WTP) will be directed to FGD WWTP located next to the gypsum dewatering plant.

From the ZLD holding tank the wastewater is transported via pipes on the elevated FGD utility rack to the WWTP. The pre-treatment process will include physical/chemical treatment to precipitate solids and heavy metals from the water by making use of lime and soda ash in a softening clarification process. At the WWTP lime and soda ash are added to the wastewater to convert the dissolved calcium and magnesium into salts so that the clarified water can be effectively treated in the brine concentrators and crystallizers. Due to the large amounts of lime and soda ash required it is estimated that one 18 000kg capacity truck of lime will be required every 8 hours and one 18 000kg capacity truck of soda ash will be required every 5 hours. Lime and soda ash will be stored in lime silos and soda ash silos, respectively, at the chemical storage area.

The precipitates from this pre-treatment process are settled out in clarifiers as sludge, 50% of which is sent to a filter press dewatering system. The other 50% of the sludge is returned to the clarifier. The filter press filtrate will be returned to the pre-treatment holding tank. This pre-treatment process produces approximately 488t of sludge from 85% limestone, or approximately 243t of sludge from 96% limestone, which is expected to be generated during the pre-treatment process. After chemical treatment, the precipitates are settled out in clarifiers as slurry, 50% of which is sent to a filter press dewatering system. The other 50% of the slurry is returned to the clarifier. The filter press filtrate will be returned to the pre-treatment holding tank. The overflow from the softening clarifier is sent to the brine concentrator and crystallizer processes for further salt removal. Salts are settled out and crystallized during this process. Approximately 127t of salts are expected to be generated from 85% or 96% limestone, and will require environmentally responsible management. The distillate water produced from the brine concentrator and crystallization process is returned to reclaim tanks for reuse in the process. Chemical storage is likely to exceed 955m3 to provide sufficient capacity for storage of chemicals in the FGD process.

The distillate emanating from the process will be diverted back to the FGD system for re-use in the FGD process, while dirty water run-off will be utilised in the FGD process to improve water usage.

3.8 Storage and disposal of salts and sludge (Block 9)

Sludge and salts will be temporarily stored in appropriately designed storage facilities next to the WWTP. The storage facilities will have a 7-day storage capacity. Two storage areas will be provided for, with Salts and Sludge Storage Area 1 and 2 sized to approximately 4800m2 and 16000m2 in size, respectively. The storage areas will conform to the Norms and Standards for the Storage of Waste (GN926 of 29 November 2013) and will be registered as a waste storage facility in terms of these Norms and Standards.

Salts and Sludge will, subsequent to storage, be transported (trucked) and disposed of at a registered waste disposal facility for the first 5 years of operation. The waste disposal service provider has not been confirmed yet, although disposal at Holfontein has been considered as a suitable waste disposal service provider, among others. For transportation of this waste to a disposal site, Eskom will utilize the services of a service provider who has all required authorizations and systems to manage from the temporary storage to disposal facility.

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Project Manager

DEPARTMENT: NGT HERITAGE MANAGEMENT SOLUTIONS

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Desktop Palaeontological Impact Assessment for the Proposed Medupi Power Station Flue Gas Desulphurisation Retrofit Project and the Existing Medupi Power Station Ash Disposal Facility, Lephalale, Limpopo Province, South Africa

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This report has been compiled by NGT on behalf of Zitholele and Eskom. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision-making process for the project.

DECLARATION OF INDEPENDENCE

This report has been compiled by Professor Marion Bamford for NGT. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the project.

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EXECUTIVE SUMMARY

NGT has been appointed by Zitholele to make amendments to the desktop PIA study conducted for site selection process for the Medupi Waste Disposal Facility which was submitted to Zitholele in February 2016. The site selection process focused on three sites, namely Site 2, Site 12 and Site 13, and it aimed at selecting the most suitable site for the handling and disposal of various waste streams that are a by-product of the proposed Flue Gas Desulpherisation (FGD) technology at Medupi, which is proposed to be retrofitted in the six units currently being constructed at Medupi Power Station. The aim of the FGD technology is to reduce the amount of Sulphur Dioxide (SO_2) emitted from coal fired power stations; Medupi with its six units as a coal fired powered station.

In 2017, however, there were amendment to the project scope of works; Eskom decided on utilising the existing and licensed Ash Disposal Facility to dispose of ash and gypsum. Eskom proposed a railway yard within the Medupi footprint for offtake of lime and handling of commercial gypsum. Within the footprint temporary hazardous storage facilities for salts and sludge have also been proposed. These new developments prompted the amendments to Revision 01 PIA and the development of the current PIA report (Revision 02). This HIA is site-specific HIA to the Medupi footprint which also contain the site for the proposed railway yard and the existing and licensed ADF (***Annexure 1*** – *Revised Project Scope of Works*). This study assesses the potential impact to palaeontological resources within the proposed development area.

The area to be developed lies on the Sandriviersberg and Mokalakwena Formations, (Kransberg Subgroup, Waterberg Group) which are sandstones and conglomerates 1700 to 2000 million years old and so pre-date any large bodied fossil plant and any vertebrate fossil. Micro-organisms such as algae had evolved by this time but they do not preserve in conglomerates. Sandstones are usually too coarse to preserve such small fossils.

Conclusions and Recommendations

- It is concluded that, there is an extremely small chance of finding any fossils of any kind in the three development areas.
- As far as the palaeontology is concerned the development can proceed and no further palaeontological impact assessment is required

CONTENTS

1. BACKGROUND ... 7

2. METHODS ... 12

3. A GEOLOGICAL AND PALAEONTOLOGICAL CONTEXT OF THE STUDY AREA ... 12

4. CONCLUSIONS ... 15

5. RECOMMENDATIONS ... 15

6. REFERENCES ... 16

ANNEXURE 1: PROPOSED NEW SCOPE OF WORK AT MEDUPI POWER STATION FOR THE CONSTRUCTION OF THE PROPOSED FGD TECHNOLOGY RETROFIT PROGRAMME, THE PROPOSED RAILWAY YARD AND THE IMPLEMENTATION OF THE EXISTING ADF AS A MULTI-WASTE STORAGE FACILITY ... 17

ANNEXURE 2: AREAS ASSESSED IN REVISION 01 DESTUDY PIA STUDY ... 28

LIST OF FIGURES

Figure 1 Location of the project area in Lephalale Local Municipality within Waterberg District Municipality, Limpopo Province, South Africa. ... 8

Figure 2- The proposed railway yard south-west of Medupi six units and south east of the existing and licensed ADF ... 9

Figure 3- Location of the proposed FGD technology construction sites (red arrows) ... 10

Figure 4- Existing and licensed ADF as well as the associated dams and proposed storm was management plan ... 11

Figure 5- Geological map of northwestern Limpopo showing the proposed area for the Medupi FGD waste dispoal site alternatives to the west of Lephalale (Ellisras). Arrows show approximate location of development areas 2, 12 and 13 to the west. Abbreviations of the rock types are explained in Table 1. Map enlarged from the Geological Survey 1: 1 000 000 map 1984. ... 13

Figure 6- more detailed geological map of the area taken from Snyman 1998 who based it on the unpublished MSc thesis of Botha 1984). Grootegeluk is the name of the Exxaro Mine close to Matimba and Medupi Power Stations. ... 14

Figure 7-Basic process Flow Diagram for the FGD process at Medupi Power Station ... 18

Figure 8-Authorised ADF area (top) with updated ADF design overlay (bottom) indicating layout of amended ADF design 25
Figure 9 -Map from Google Earth showing the proposed site alternatives for the waste disposal facility for the FGD retrofit project. Map supplied by NGT Consulting; Limpopo Province 28

LIST OF TABLES

Table 1- Explanation of symbols for the geological map and approximate ages with the references: Brandl et al., 2006. Barker et al., 2006; Buchanan, 2006; Cawthorn et el., 2006. 13

1. BACKGROUND

Eskom has initiated a program to reduce emissions of Sulphur Dioxide into the environment by installing Flue Gas Desulphurisation (FGD) technology on the 6 power-generating units at Medupi Power Station This FGD process will allow Eskom to ensure cleaner air and meet air quality standards. The study area is located in Medupi PS in Lephalale Local Municipality, Waterberg District, Limpopo Province (*Figure 1*).

The waste by-products (including Sludge and Salts –Type 1 wastes) will be disposed of in an approved facility. A site selection process was undertaken to recommend a site for the waste disposal (Revision 01 PIA). The current assessment if for the proposed railway yard (*Figure 2*), the area for the proposed FGD technology facility (*Figure 3*) and the existing and licensed ADF (*Figure 4*) all located within the region previously assessed for the site selection process (Revision 01 PIA – see Annexure 2 for the map of Revision 01 assessment).

In accordance with the national legislation (National Heritage Resources Act (No. 25 of 1999)) the sites to be developed must be assessed for the occurrence of any palaeontological material. If any fossils are likely to be present then their importance and rarity must be gauged and if they are important then plans must be put in place to remove the fossils (under a SAHRA permit and housed in an recognized institution), protect them and/or divert the proposed construction.

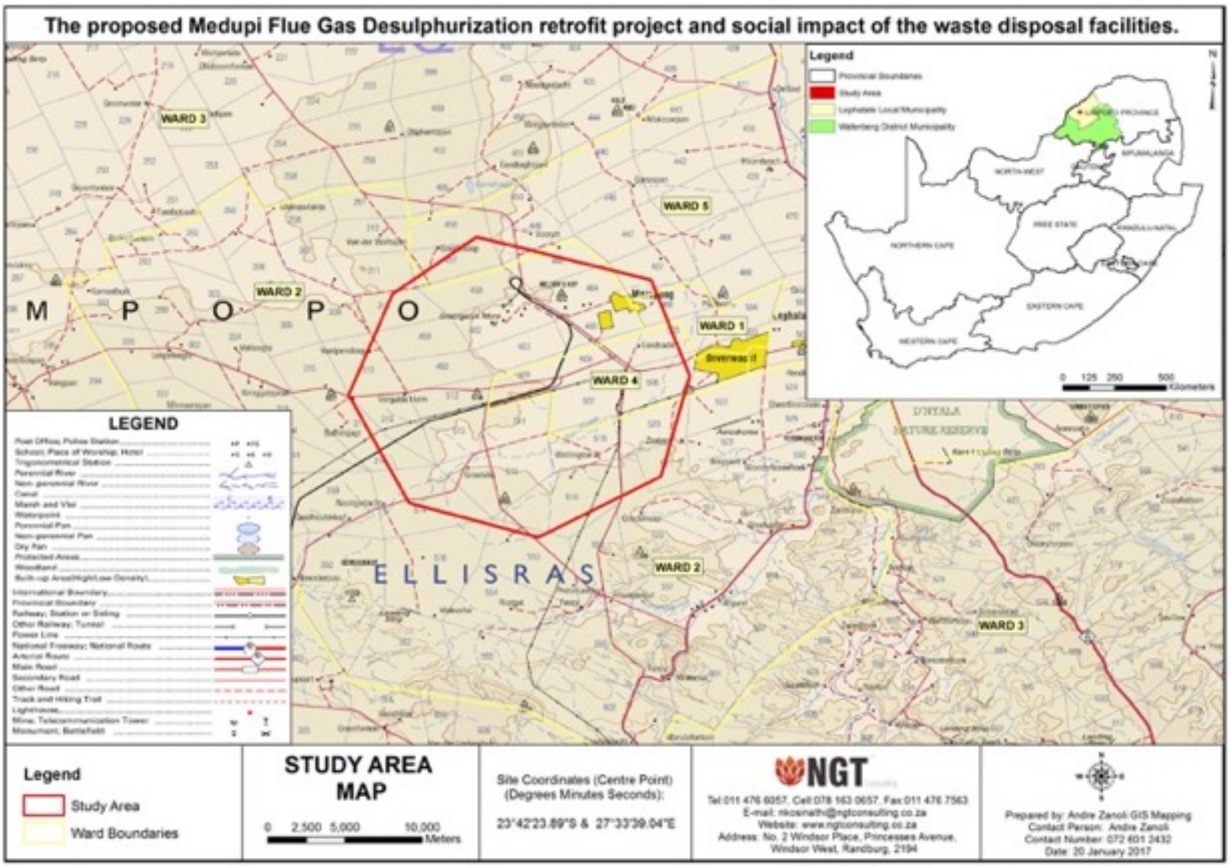

Figure 1 Location of the project area in Lephalale Local Municipality within Waterberg District Municipality, Limpopo Province, South Africa.

The following images show the location and the design of the proposed railway yard (*Figure 2*), the proposed Medupi PS FGD technology construction site (*Figure 3*) as well as the existing and licensed ADF site (*Figure 4*).

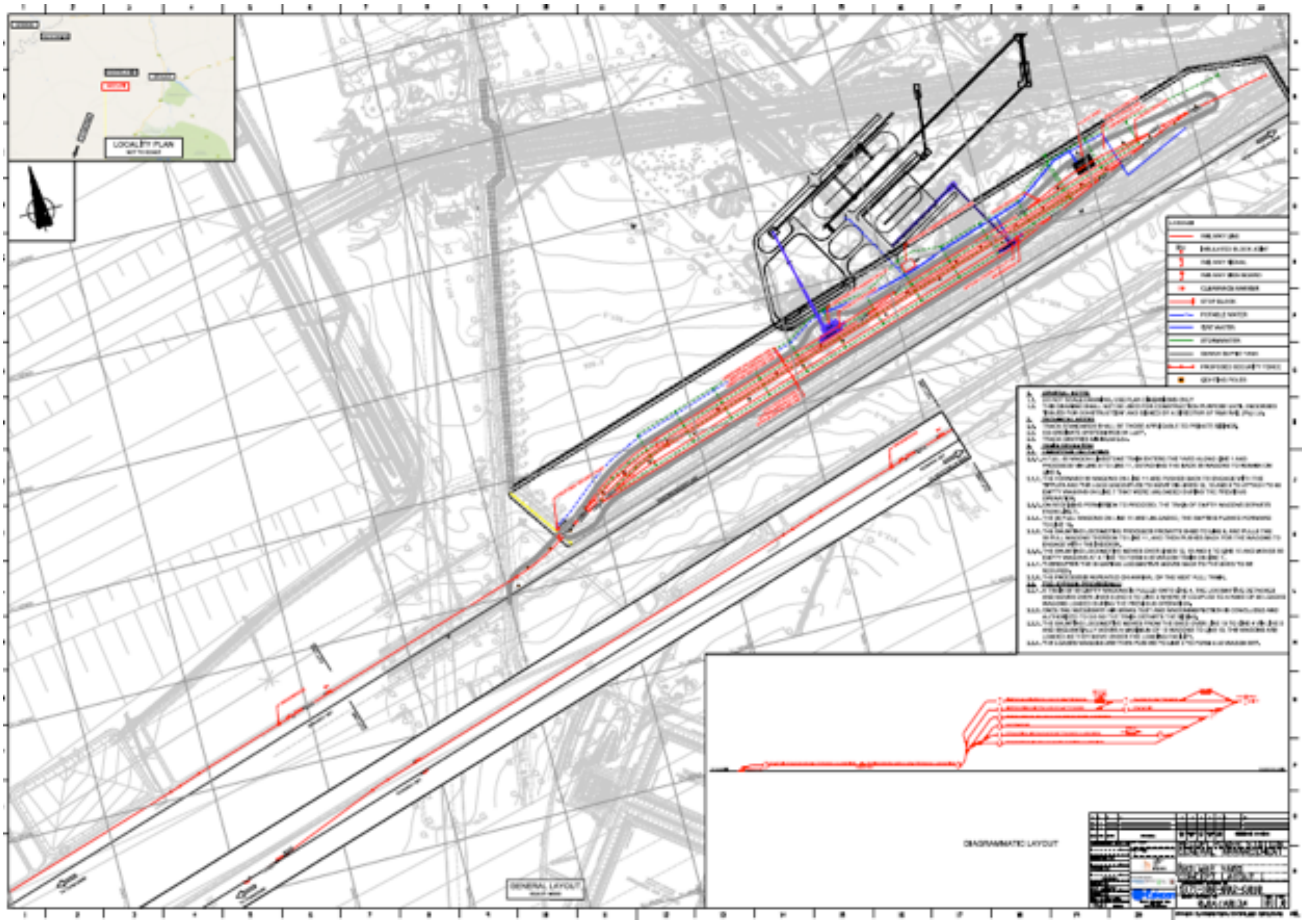

Figure 2- The proposed railway yard south-west of Medupi six units and south east of the existing and licensed ADF

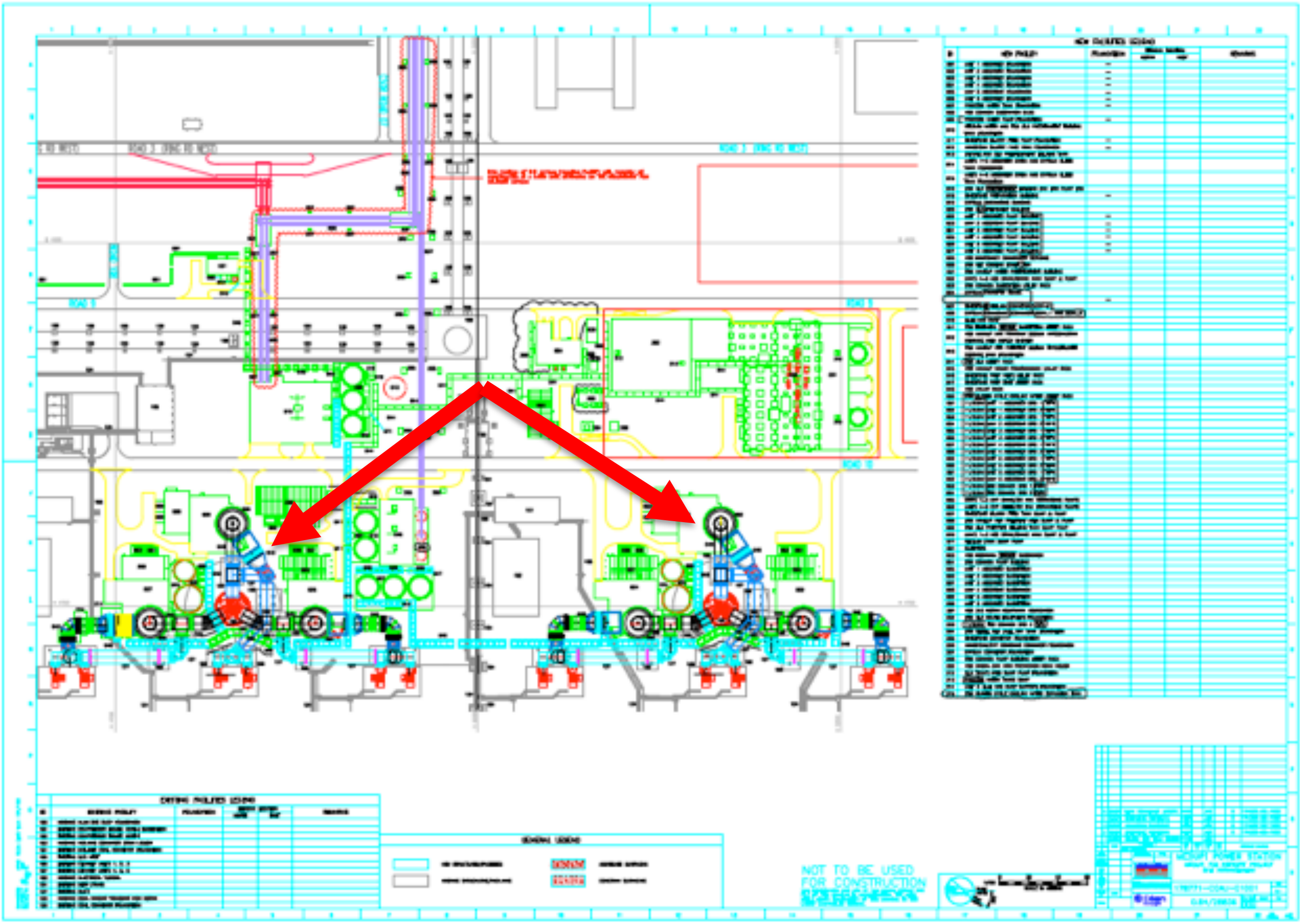

Figure 3- Location of the proposed FGD technology construction sites (red arrows)

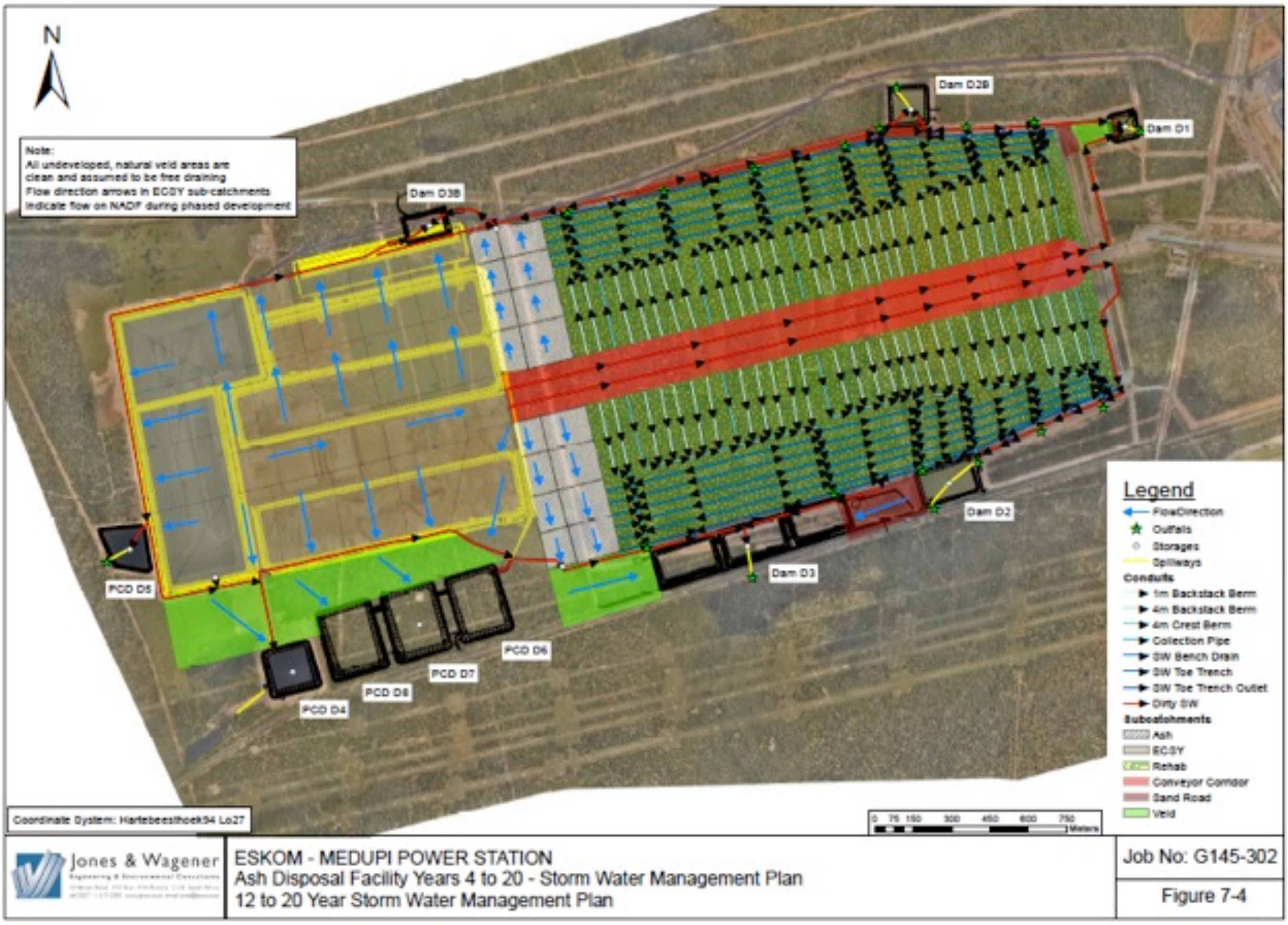

Figure 4- Existing and licensed ADF as well as the associated dams and proposed storm was management plan

2. METHODS

The published geological and palaeontological literature, unpublished records and databases were consulted to determine if there are any records of fossils from the sites and the likelihood of any fossils occurring there.

3. A GEOLOGICAL AND PALAEONTOLOGICAL CONTEXT OF THE STUDY AREA

The Ellisras Basin is important economically for coal, especially the Grootgeluk Formation and interfingering Goedgedacht Formation, which are being mined by Exxaro for export and for the Matimba Power Station. According to the maps by the Geological Survey the site lies in the undifferentiated Permian and Triassic deposits, with very old rocks to the south and east of Lephalale (Fig 2, Table 1). From more detailed studies of the coal deposits in South Africa (Snyman 1998) the Grootgeluk Mine lies on the southern edge of the Ecca deposits, adjacent to Beaufort Group sediments (*Figure 5*).

The proposed development area lie to the south of the Ellisrus Coal Basin and the Karoo sediments and are on the Sandriviersberg and Mokalakwena Formations, Kransberg Subgroup, Waterberg Group (Msm, green on the geological map, Fig 2). These rocks are sandstones and conglomerates and are 1700 – 2000 million years old and so pre-date any large bodied fossil plant and any vertebrate fossil (Cowan, 1995). Micro-organisms such as algae had evolved by this time but they do not preserve in conglomerates and sandstones are usually too coarse to preserve such small fossils. Therefore, there is an extremely small chance of finding any fossils of any kind in the four development areas.

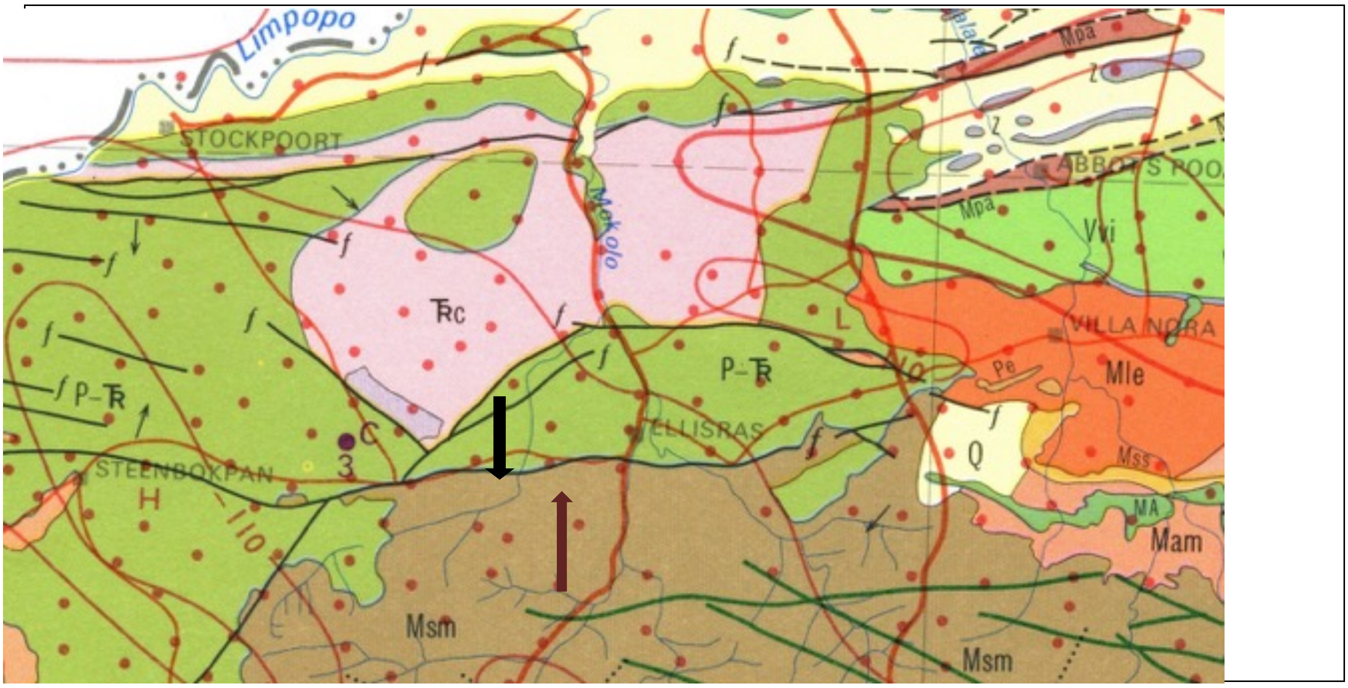

Figure 5- Geological map of northwestern Limpopo showing the proposed area for the Medupi FGD waste dispoal site alternatives to the west of Lephalale (Ellisras). Arrows show approximate location of development areas 2, 12 and 13 to the west. Abbreviations of the rock types are explained in Table 1. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 1- Explanation of symbols for the geological map and approximate ages with the references: Brandl et al., 2006. Barker et al., 2006; Buchanan, 2006; Cawthorn et el., 2006.

Symbol	**Group/Formation**	**Lithology**	**Approximate Age**
Q	Quaternary	Alluvium, sand, calcrete	Last ca 20 Ma
Trc	Clarens Formation	Sandstone, siltstone	Upper Triassic-Jurassic ca 220-180 Ma
P-Tr	Undifferentiated Permian and Triassic	Shale, sandstone, mudstone, coal	Ca 300-200 Ma
Msm	Sandriviersberg and Mokalakwena Fms, Kransberg Subgroup, Waterberg Group	Sandstones, conglomerates	1700-2000 Ma
Mam	Aasvoëlkop and Makgabeng Formations, Matlabas subgroup, Waterberg Group	Sandstones, mudstones	1700-2000 Ma
Mle	Lebowa Granite Suite	Hornblende and biotite granites	>2000 Ma

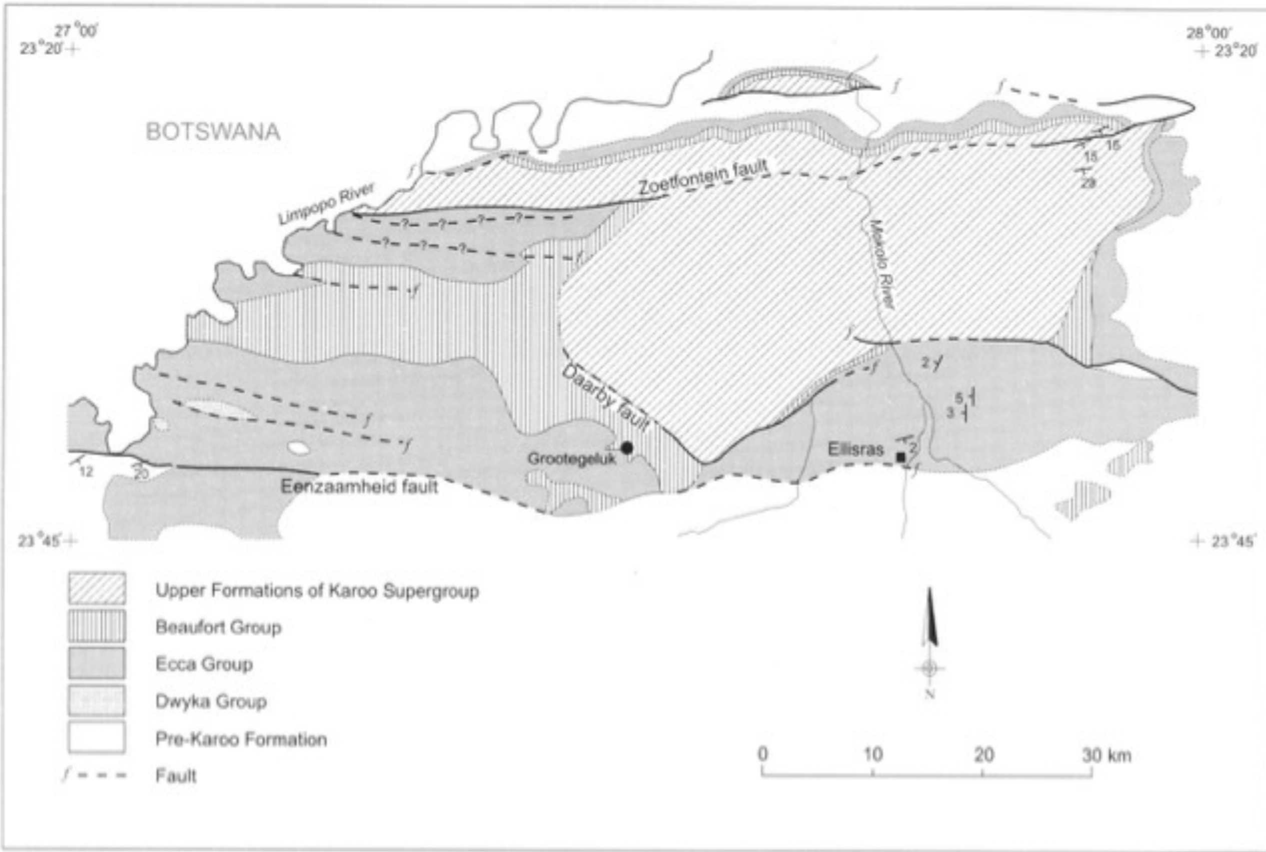

Figure 6- more detailed geological map of the area taken from Snyman 1998 who based it on the unpublished MSc thesis of Botha 1984). Grootegeluk is the name of the Exxaro Mine close to Matimba and Medupi Power Stations.

4. CONCLUSIONS

The area to be developed lies on the Sandriviersberg and Mokalakwena Formations, (Kransberg Subgroup, Waterberg Group) which are sandstones and conglomerates 1700 to 2000 million years old and so pre-date any large bodied fossil plant and any vertebrate fossil. Micro-organisms such as algae had evolved by this time but they do not preserve in conglomerates. Sandstones are usually too coarse to preserve such small fossils. Therefore, there is an extremely small chance of finding any fossils of any kind in the four development areas. As far as the palaeontology is concerned the development can proceed and no further palaeontological impact assessment is required.

5. RECOMMENDATIONS

- If in the extremely unlikely event that any fossils are discovered during the construction of the waste disposal site, then it is strongly recommended that a palaeontologist be called to assess their importance and rescue them if necessary.
- As far as the palaeontology is concerned the proposed development can go ahead and no further impact assessment is required.

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ANNEXURE 1: PROPOSED NEW SCOPE OF WORK AT MEDUPI POWER STATION FOR THE CONSTRUCTION OF THE PROPOSED FGD TECHNOLOGY RETROFIT PROGRAMME, THE PROPOSED RAILWAY YARD AND THE IMPLEMENTATION OF THE EXISTING ADF AS A MULTI-WASTE STORAGE FACILITY

1 INTRODUCTION

This project focuses on the environmental authorisation process for the Medupi Power Station Flue Gas Desulphurisation (FGD) Retrofit. Medupi Power Station is a coal-fired power station that forms part of the Eskom New Build Programme. Medupi Power Station is located about 15km west of the town of Lephalale in the Limpopo Province.

2 CHANGES TO AUTHORISATION AND LICENCING APPROACH IN 2017

Towards the middle of 2017 changes to the authorisation and licensing approach for the Medupi FGD Retrofit Project applications were proposed in order to streamline the application processes to ensure compliance with the NEMAQA compliance requirements by the year 2021. The following changes were subsequently implemented:

- Confirmation that the assessment of an additional multiuse disposal facilities, which would be used for the disposal of ash and gypsum, and salts and sludge have been removed from this current application scope and will be undertaken as a separate authorisation process.
- The application for a Waste Management Licence (WML) for the existing ADF was removed from the integrated Environmental Impact Assessment process hence the EIA application will not be an integrated Environmental Impact Assessment application. The proposed disposal of gypsum together with ash on the existing authorised ADF footprint will be dealt with through a separate amendment process to the existing ADF WML.

- The EIA application in terms of the National Environmental Management Act, 107 of 1998, as amended, will include application for activities associated with the construction and operation of the FGD system within the Medupi PS footprint and the railway yard and siding, including limestone and gypsum handling facilities, diesel storage facilities new access roads, Waste Water Treatment plant, facilities for temporary storage of salts and sludge.

- A Water Use Licence Application will focus on water uses triggered by the construction and operation of the FGD system, railway yard and limestone / gypsum handling areas, and within 500m of the approved ADF footprint.

3 DETAILED SCOPE OF WORK

The detailed scope of work for each of these applications is described in terms of the simplified process flow diagram in Figure 1 and listed in the sections below. The overall site layout encompassing the railway yard, limestone and gypsum handling areas and FGD system is provided in Appendix A to this technical memo. General layout of the existing ADF and storm water management philosophy is provided in Appendix B to this technical memo.

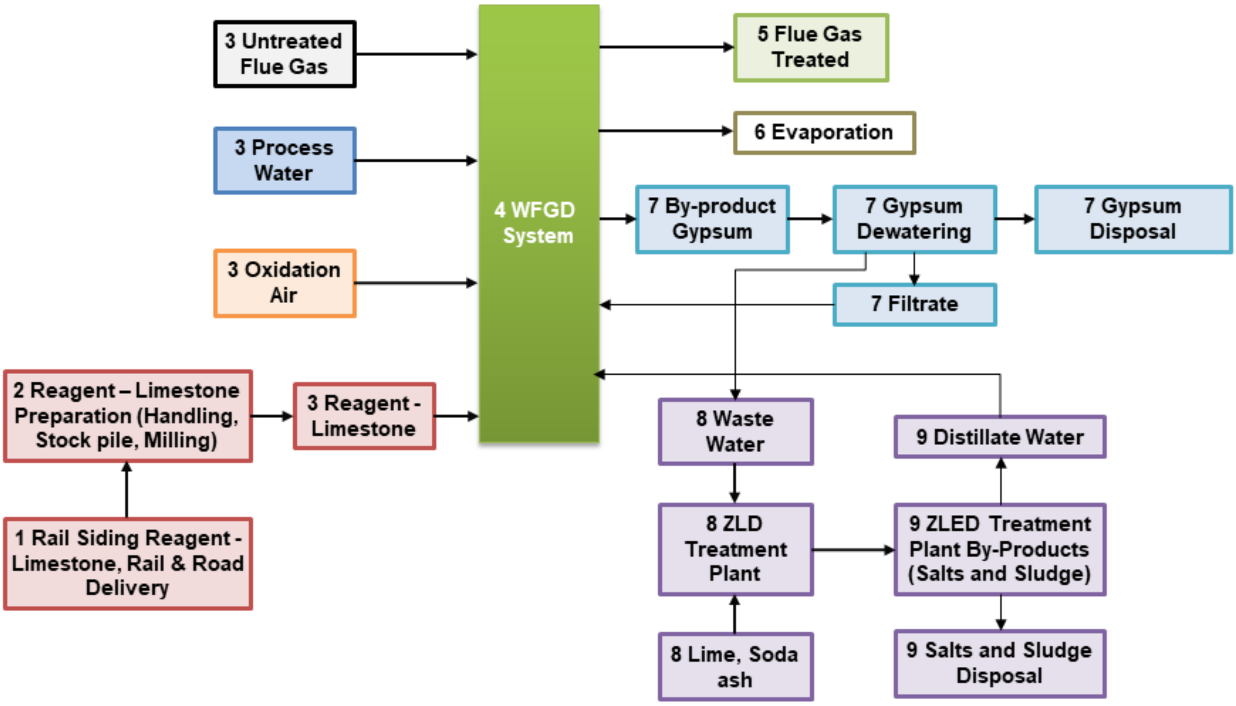

Figure 7-Basic process Flow Diagram for the FGD process at Medupi Power Station

3.1 Railway yard (Block 1 & 2)

Limestone is purchased off-site and is transported to the Medupi Power Station by rail and/or road. The limestone is offloaded at the proposed limestone storage facility, which includes a rail siding and road access, located south-west of the 6 power generation units within the Medupi Power Station footprint. The rail siding and access roads are a component of this environmental authorisation (EIA) process.

Infrastructure associated with the railway yard and limestone / gypsum handling area include:

- Limestone will be initially delivered by road and will be delivered to a truck offloading facility in close proximity to the Limestone Stockyard.
- Rail infrastructure proposed parallel to the existing Thabazimbi – Lephalale railway with a proposed siding take-off point situated at kilometre point 107+250m. The general arrangement of the railway yard and take-off point is provided in Appendix C.
- Linear-type yard layout configuration with six lines parallel to each other, and split into two separate yards (limestone offloading and gypsum loading) linked by means of a locomotive run-around line.
- Limestone offloading facility: Tippler Area building will include side dispensing tippler, a limestone rail, truck offloading area and separate receiving area, Tippler for “tipping” limestone onto an underground inclined conveyor, limestone transfer house and emergency limestone offloading area at the stockyard. Excavations up to 15m deep will be undertaken during construction of the Tippler facility.
- Gypsum could be routed to the Gypsum storage facility in close proximity to the railyard. Gypsum storage loading facility will include gypsum reclaim hoppers that receive gypsum from the mobile reclaim equipment and discharge to the gypsum reclaim belt conveyor, which in turn discharges to the inclined gypsum belt conveyor. The inclined gypsum belt conveyor then discharges to the bin at the loading facility that feed the rail wagons with a controlled discharge.
- Administration building and operations tower for Eskom and a Services Provider’s personnel.
- Diesel locomotive workshop, utilities rooms and ablutions. This workshop area will have approximately 600m^2 service space for the shunting locomotive, various offices and store rooms (180m^2) attached to one end of the building.
- Two Diesel Storage Facilities (each can be approximately 3.6m in diameter and 3.0m in height) with a maximum installed storage capacity of 28 000 litres each, in two above-ground horizontal storage tanks, and will be bunded. One of these tanks will service the shunting locomotives while the other will service the Emergency Generator, and located at the rail siding area and the FGD

complex area, respectively. A covered road tanker decanting area will be located alongside the bunded area. There is a third diesel tank in the FGD common pump building, the capacity of which is significantly less than 28 000 litres.

- Security office and infrastructure: A security office will be located adjacent to the fence line at the western extent of the proposed rail yard where the proposed rail infrastructure ties in with the existing rail network. The existing service road fence will be used as the boundary fence to the rail yard.
- Conveyor infrastructure.
- Sewerage and effluent management infrastructure: The security office, locomotive workshop and administration building will be served with ablution facilities with a sewerage conservancy tank system with capacities of 3200ℓ, 8500ℓ and 8500ℓ, respectively.
- Associated infrastructure (water, storm water, and lighting): Storm water channels and structures are designed to provide a division between storm water and the dirty water from the gypsum loading facility. Dirty storm water from the gypsum loading facility will be collected into an independent concrete channel and underground pipe network that will drain to the proposed Pollution Control Dam (PCD) that will form part of the FGD infrastructure. The estimated run off contribution to the PCD is expected to be $0.05m^3/s$ for a 1:20 year return period. Eskom will provide the required power supply, while the rail yard mini substations will be constructed in accordance with Eskom's specification. PCDs will also be provided for the salts and sludge storage facility. The Medupi plant operates with two separate water networks supplying fire water and potable water. The water network required for the rail yard was designed to tie into connection points within the existing water network of the MPS.

3.2 Limestone preparation (Block 2)

An overview of the limestone handling and preparation infrastructure is presented below. The proposed limestone handling and conveyance infrastructure is shown in Appendix C. The limestone handling and conveyance will include the following infrastructure:

- Limestone stacking conveyor;
- Limestone storage area;

- Emergency limestone offloading area;
- Limestone reclaim conveyor;
- Limestone and gypsum handling substation;
- Storm Water Pollution Control Dams. The conceptual storm water management design has resulted in two separate PCDs being proposed in this area. It is also proposed that each of these PCDs is portioned to cater to maintenance activities in the future. A layout of proposed PCDs are presented in Appendix E;
- Lined channels for diversion of dirty water to Pollution Control Dams.
- Limestone is conveyed to the limestone preparation building where it is milled and combined with water to form limestone slurry for input into the FGD system. Limestone slurry is pumped to a limestone slurry feed tank from where it is pumped, via piping, on the elevated FGD utility rack to each absorber for utilisation in the FGD system. Infrastructure thus includes:
- Limestone preparation building;
- Limestone slurry feed tank; and
- Piping and elevated FGD utility rack.
-

3.3 Input materials and processes (Block 3)

Input materials to the FGD process will include:

- SO2 laden flue gas received from the each generation unit. Untreated flue gas leaving the existing ID fans will be diverted to the absorber inlet, via additional ducting system;
- Process water received from process water tanks (two operational and one backup for redundancy);
- Oxidisation air; and
- Limestone slurry received from the limestone milling and preparation plant.

3.4 WFGD system (Block 4)

The site arrangement of the FGD system for the Medupi Power Station is provided in Appendix D. The FGD system includes infrastructure that is located within the previously cleared and transformed footprint of the power station. Infrastructure includes:

- An absorber unit associated with each of the 6 x generation units;
- Each absorber unit will include a flue gas duct, absorber tower, absorber pump building and absorber substation;

- Absorber drain and gypsum bleed tanks associated with each cluster of 3 absorber units, i.e. absorber units 1 – 3 and absorber units 4 – 6;
- FGD above-ground elevated utility racks containing piping to direct fluid from and to relevant systems within the absorber area.

3.5 Treated Flue Gas (Block 5) and evaporation (Block 6)

Treated flue gas is redirected from the absorbers via the flue gas ducts back to the chimneys for release with much reduced SO2 content. During the process evaporation losses are incurred.

3.6 Gypsum dewatering, re-use or disposal (Block 7)

3.6.1 Gypsum dewatering and conveyance

Gypsum will be produced from the FGD process as a by-product of the wet scrubbing process. Slurry will comprise gypsum, a mixture of salts (Magnesium Sulphate (MgSO4) and Calcium Chloride (CaCl2)), limestone, Calcium Fluoride (CaF2), and dust particles. A refinement process is carried out to separate and dewater the gypsum. Effluent is directed to the Waste Water Treatment Plant (WWTP), the overflow of the gypsum dewatering hydro cyclones goes to the waste water hydrocyclone (WWHC) feed tanks. The tanks are located in the gypsum dewatering building. From the WWHC feed tanks, the water goes through the WWHC where the underflow is directed to the reclaim tanks and the overflow to the Zero Liquid Discharge (ZLD) holding tanks. The ZLD holding tanks feed the WWTP.

Dewatered gypsum is transported via conveyor either to the existing ADF or to an offtake point where it is diverted to a storage facility from which it may be transported by rail or road to users. The gypsum storage building will be used in conjunction with the rail siding only. The storage building is a future use facility that will be built with the rail siding. There will be no facilities for gypsum recovery from the storage building to be loaded onto trucks. Road transport is used for immediate offtake for gypsum exploitation.

Use of gypsum will be subjected to quality assessments, which will be done at the storage facility. If the quality is not usable, the gypsum will be taken for disposal.

The site arrangement of the FGD system for the Medupi Power Station is provided in Appendix D and shows the infrastructure associated with the gypsum dewatering and conveyance. Infrastructure associated with the gypsum dewatering and conveyance includes:

- Gypsum bleed tanks and forwarding pumps;
- Piping and elevated FGD utility rack;
- Gypsum dewatering building containing gypsum hydrocyclones and waste water hydrocyclones ;
- Belt filter and reclaim tank;
- Gypsum conveyer belt system;
- Gypsum truck loading facility;
- Gypsum storage building and offtake via rail

3.6.2 Gypsum re-use or disposal

Initially, gypsum will be conveyed from the gypsum dewatering building via a gypsum link conveyor to a gypsum transfer house where it will be loaded onto the existing overland ash conveyor. In this conveyor system, the gypsum will be mixed with ash and will subsequently disposed together on the footprint of the existing authorised ADF. The conveyor route and transfer houses for gypsum onto the overland ash conveyor are shown in Appendix A. If there is a market for gypsum, the project has catered for an offtake point, wherein, the gypsum will be collected by trucks from overhead conveyor system. At this point, the ground will be prepared for management of any gypsum that is not contained and the trucks will be washed before leaving this area. The washing is a means to minimise the spreading of the gypsum.

In terms of the previous ash classification processes, i.e. the Minimum Requirements Documents Series, ash was considered to be hazardous and thus the 0 to 2 year area was designed and authorised according to the Department of Water and Sanitation (DWS) Minimum Requirements, resulting in a H:h liner system being installed, at the ADF. However, regulations were promulgated by the DEA in terms of NEM:WA on the 23 August 2013. In terms of the NEMWA regulations, ash and gypsum now classify as Type 3 wastes, and require to be disposed of on a Class C barrier system. This barrier will be implemented at the facility from the 4 to 19.2 year area.

An application to amend the existing ADF Waste Management Licence is being undertaken for disposal of gypsum and ash together on the existing footprint of the authorised ADF. Requirements to reduce impact on the wetlands in the southwest corner of the authorised ADF footprint have, furthermore, resulted in the re-design of the ADF. The proposed ADF amended design has the following attributes:

- The final layout of the ash and gypsum facility has side slopes at 1:5.
- The final layout of the ash and gypsum facility has a long fall of 1:300.
- The final height of the facility will be increased by 12 m from an original design height of 60 m, to 72 m above ground.
- The revised ADF design caters for the storage of a volume of 193 315 105 m3 which converts to a total life of 19.2 years.
- Storm water management caters for clean and contaminated storm water infrastructure, and includes berms, geocell lined trenches and pollution control dams.
- On-going rehabilitation will occur behind the advancing face as the facility develops to ensure a relatively small window of ash and gypsum being exposed to the environment.
- The proposed revised ADF design overlaid over the authorised ADF footprint is provided in Figure 2 below. Proposed PCDs are indicated in the bottom aerial image in Figure 2.

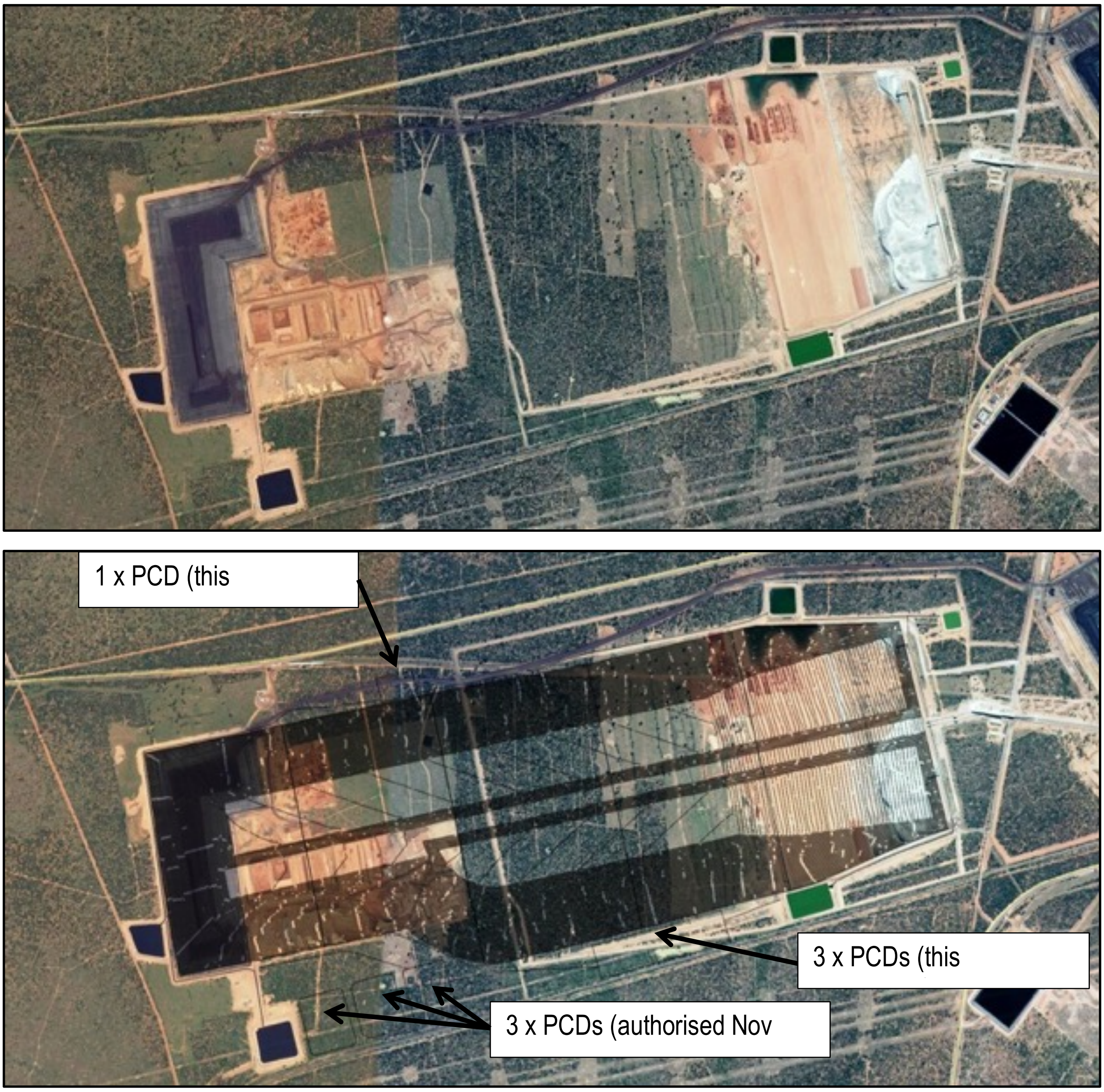

Figure 8-Authorised ADF area (top) with updated ADF design overlay (bottom) indicating layout of amended ADF design

3.7 Waste Water Treatment (Block 8)

The Medupi FGD Waste Water Treatment Plant is located directly west opposite generation units 1 to 3 at the Medupi Power Station. FGD chloride bleed stream and FGD auxiliary cooling tower blowdown stream are diverted to the ZLD holding tanks. The total organic carbon (TOC) scavenger regeneration wastewater from the filter press system / existing water treatment plant (WTP) will be directed to FGD WWTP located next to the gypsum dewatering plant.

From the ZLD holding tank the wastewater is transported via pipes on the elevated FGD utility rack to the WWTP. The pre-treatment process will include physical/chemical treatment to precipitate solids and heavy metals from the water by making use of lime and soda ash in a softening clarification process. At the WWTP lime and soda ash are added to the wastewater to convert the dissolved calcium and magnesium into salts so that the clarified water can be effectively treated in the brine concentrators and crystallisers. Due to the large amounts of lime and soda ash required it is estimated that one 18 000kg capacity truck of lime will be required every 8 hours and one 18 000kg capacity truck of soda ash will be required every 5 hours. Lime and soda ash will be stored in lime silos and soda ash silos, respectively, at the chemical storage area.

The precipitates from this pre-treatment process are settled out in clarifiers as sludge, 50% of which is sent to a filter press dewatering system. The other 50% of the sludge is returned to the clarifier. The filter press filtrate will be returned to the pre-treatment holding tank. This pre-treatment process produces approximately 488t of sludge from 85% limestone, or approximately 243t of sludge from 96% limestone, which is expected to be generated during the pre-treatment process. After chemical treatment, the precipitates are settled out in clarifiers as slurry, 50% of which is sent to a filter press dewatering system. The other 50% of the slurry is returned to the clarifier. The filter press filtrate will be returned to the pre-treatment holding tank. The overflow from the softening clarifier is sent to the brine concentrator and crystalliser processes for further salt removal. Salts are settled out and crystallised during this process. Approximately 127t of salts are expected to be generated from 85% or 96% limestone, and will require environmentally responsible management. The distillate water produced from the brine concentrator and crystallisation process is returned to reclaim tanks for reuse in the process. Chemical storage is likely to exceed 955m3 to provide sufficient capacity for storage of chemicals in the FGD process.

The distillate emanating from the process will be diverted back to the FGD system for re-use in the FGD process, while dirty water run-off will be utilised in the FGD process to improve water usage.

3.8 Storage and disposal of salts and sludge (Block 9)

Sludge and salts will be temporarily stored in appropriately designed storage facilities next to the WWTP. The storage facilities will have a 7-day storage capacity. Two storage areas will be provided for, with Salts and Sludge Storage Area 1 and 2 sized to approximately 4800m2 and 16000m2 in size, respectively. The storage areas will conform to the Norms and Standards for the Storage of Waste (GN926 of 29 November 2013) and will be registered as a waste storage facility in terms of these Norms and Standards.

Salts and Sludge will, subsequent to storage, be transported (trucked) and disposed of at a registered waste disposal facility for the first 5 years of operation. The waste disposal service provider has not been confirmed yet, although disposal at Holfontein has been considered as a suitable waste disposal service provider, among others. For transportation of this waste to a disposal site, Eskom will utilise the services of a service provider who has all required authorisations and systems to manage from the temporary storage to disposal facility.

Mathys Vosloo
Project Manager

ANNEXURE 2: AREAS ASSESSED IN REVISION 01 DESTUDY PIA STUDY

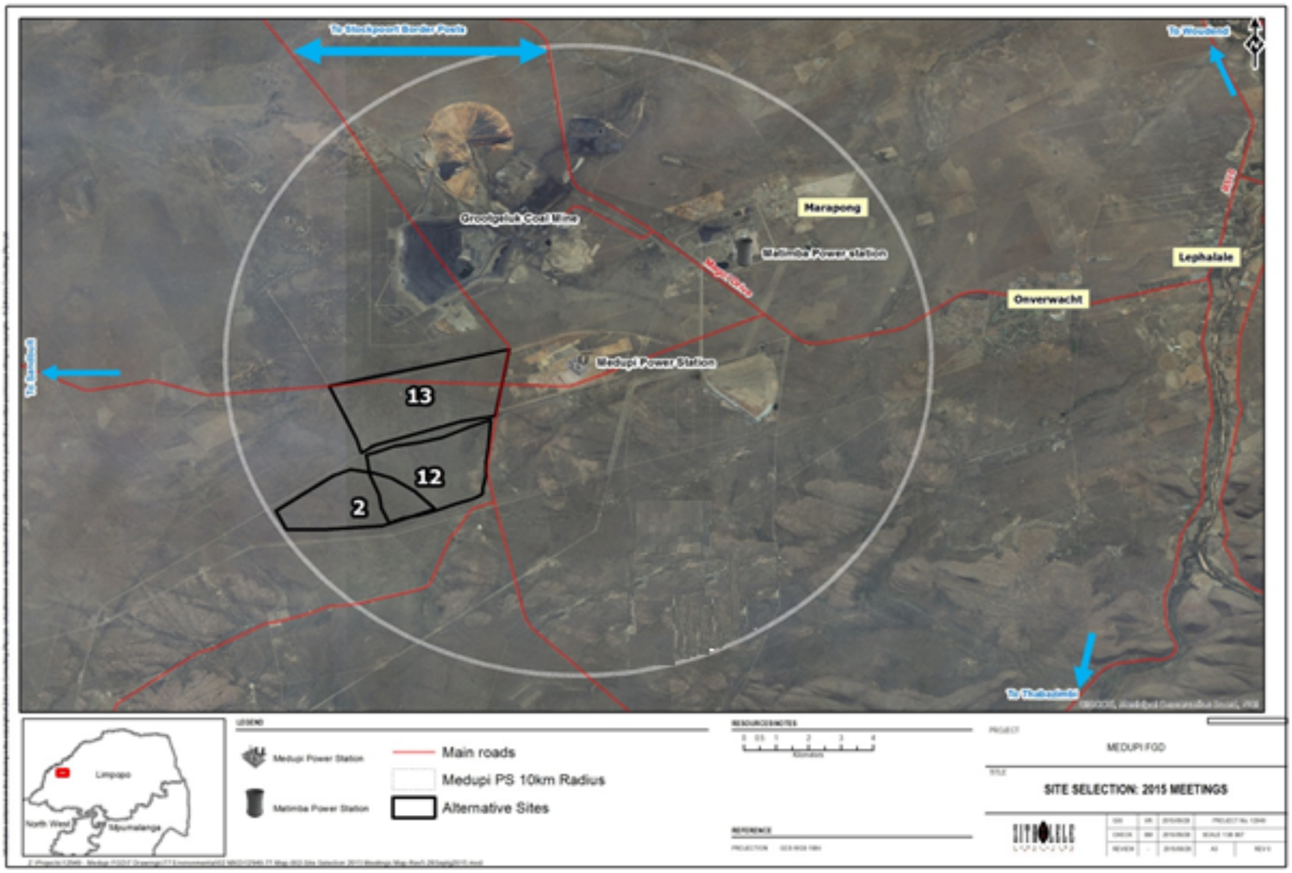

Figure 9 -Map from Google Earth showing the proposed site alternatives for the waste disposal facility for the FGD retrofit project. Map supplied by NGT Consulting; Limpopo Province

Zitholele Consulting

Medupi Flue Gas Desulphurisation

Traffic Impact Assessment

15/02/2018	3	Final Report	Yolandi Venter	Melanie Venter	Chris Manchip	
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
Hatch Goba						**Client**

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Table of Contents

1. Introduction 1

1.1 Background 1

2. Baseline Transport Assessment 3

2.1 Methodology 3
2.2 Proposed development 3
2.3 Existing Conditions 4
2.3.1 Existing road network 4
2.3.2 Traffic count summary 8

3. Construction 14

3.1 Transport route options 14
3.2 Transport of staff, materials and equipment 14
3.3 Transport of abnormal load to site 15
3.4 Management of traffic around the site during construction 16
3.5 Weigh bridge 16
3.6 Conclusion and recommendation 17

4. Operational transport 18

4.1 Limestone Transport 18
4.2 Salts and sludge transport 21
4.3 Ash and gypsum transport – Ash disposal facility 21
4.3.1 Access roads 22
4.4 Truck movement 22
4.4.1 Trucking of Limestone and Sludge & Salts 22
4.4.2 Truck types 23
4.4.3 Feeder roads to Northern Ash Disposal Facility 24

5. Traffic Impact Assessment 25

5.1 Traffic Analysis: Existing 25
5.1.1 Nelson Mandela Drive / D1675 27
5.1.2 D1675 / Afguns Rd 28
5.2 Traffic Analysis: 10-year Post Development 29
5.2.1 Nelson Mandela Drive / D1675 29
5.2.2 D1675 / Afguns Rd 31

6. Impact Assessment – IA Rating 33

7. Conclusions and Recommendations 36

Safety ● Quality ● Sustainability ● Innovation

1. Introduction

Hatch Goba was appointed by Zitholele Consulting to investigate the traffic implications arising from the construction and operation of the Medupi Power Station Flue Gas Desulfurization (FGD) integrated system. Medupi Power Station is located about 15km west of the town of Lephalale in the Limpopo Province as shown in Figure 1.1: Medupi Power Station – Locality plan, Figure 1.1.

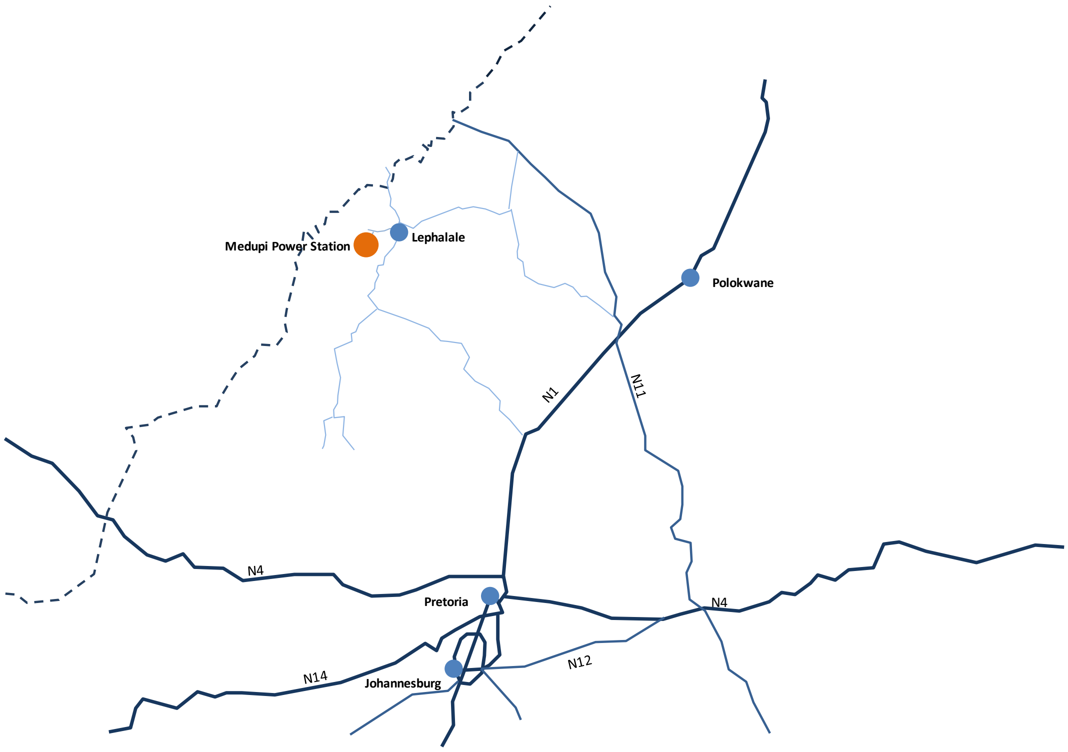

Figure 1.1: Medupi Power Station – Locality plan

1.1 Background

The Medupi Power Station Flue Gas Desulfurization (FGD) Retrofit Project consists of adding FGD systems to six 800 megawatt (MW) coal fired steam electric generating units. The six units at Medupi Power Station were designed and are being constructed to accommodate the installation of wet limestone Flue Gas Desulphurisation technology which is an SO_2 SO_2abatement technology. FGD is a set of technologies designed for removing sulphur dioxide from exhaust flue gases of fossil-fuel power plants and from the emissions of other sulphur oxide emitting processes. The FGD process requires input material and the process will generate by- products, which should be disposed of at a suitable waste disposal site. The inputs will have to be transported to the facility by means of trucks and/or rail and the by-products will have to be transported to the waste disposal facility by trucks, rail or conveyor.

The purpose of the Traffic Impact Assessment (TIA) is to quantify the impact of normal traffic, as well as the transportation of abnormal loads, on the road network during construction, operation and decommissioning of the FGD facility. The following specific study elements were undertaken as part of the TIA:

- Quantifying the impact of person and freight transport on local and external roads during construction, operation and decommissioning of the FGD facility.

- Identifying the impact on existing traffic as a result of the additional traffic generated by the facility.
- Recommending mitigation measures for accommodating the additional vehicle movements.

<u>The TIA scope of works includes the following aspects:</u>

1. Gypsum and ash will be disposed of at the existing Ash Disposal Facility (ADF), it will be conveyed to the existing ADF, therefore no additional road traffic impacts. In the immediate future, if there is a market for gypsum, the gypsum will be collected by trucks from overhead conveyor system.
2. The limestone will be trucked to site as the FGD operation ramps up and will be railed to site at a future date. Eskom have several potential sources of limestone and an assessment of traffic impacts from these sources has to be provided.
3. Salts and sludge will be transported by truck to a licensed hazardous waste facility, after being stored at a temporary waste storage facility at the station; a professional opinion is required.

Chapter 1 will discuss the scope of work and background to this study, while **chapter 2** will focus on the baseline transport assessment. **Chapter 3** will discuss the traffic implications during the construction phase and **chapter 4** will focus on the operational phase, **chapter 5** will discuss the traffic impact assessment with the impact assessment ratings explained in **chapter 6. Chapter 7** will consist out of the conclusion and recommendations from the Traffic Impact Assessment study.

2. Baseline Transport Assessment

2.1 Methodology

Phase 1 of the study included the following tasks:

- Conducting a site visit to assess the road network for the study area, including the accesses onto the external road network and key intersections onto the national/public road network.
- Confirming the transportation methods of the type 1 wastes from the power station to an existing licensed hazardous waste facility and type 3 wastes to the existing NADF.
- Obtaining and process existing traffic counts in the area and where necessary arrange to undertake additional traffic count surveys and prepare a summary thereof.
- Compiling a list of technical information to be obtained from the engineering team.

In order to complete the Traffic Impact Assessment (TIA) we had to make some assumptions with regards to some outstanding information.

2.2 Proposed development

The location of the proposed FGD plant within the existing Medupi Power Station precinct is shown in Figure 2.1. The FGD plant is situated more or less in the middle of Medupi, and access to this plant will either be from Entrance Gate 1, 2 or 4.

Figure 2.1: Location of FGD plant within Medupi Power Station

Given the nature of trips generated during construction and operations, and the different types of mitigation measures that would be considered for these activities, the traffic impact of the FGD plant discuss construction and operational traffic impact separately in **Chapter 3 and 4**.

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2.3 Existing Conditions

A desktop study of the Medupi study area was carried out prior to the site visit. The desktop study identified the most likely routes to be used for various types of vehicles for the construction of the FGD plant and during the operational phase of the plant. A site inspection was undertaken on the 28th/29th of October 2015.

2.3.1 Existing road network

The external road network is shown in Figure 2.2 below, with Figure 2.3 showing the roads surrounding Medupi Power station as well as the internal road network. The major routes in the study area are the R518 and R510 which links Lephalale to the N1 and Nelson Mandela Drive connects Lephalale with Medupi and Marapong, while the minor routes surrounding Medupi Power station are the D1675 and Afguns Road.

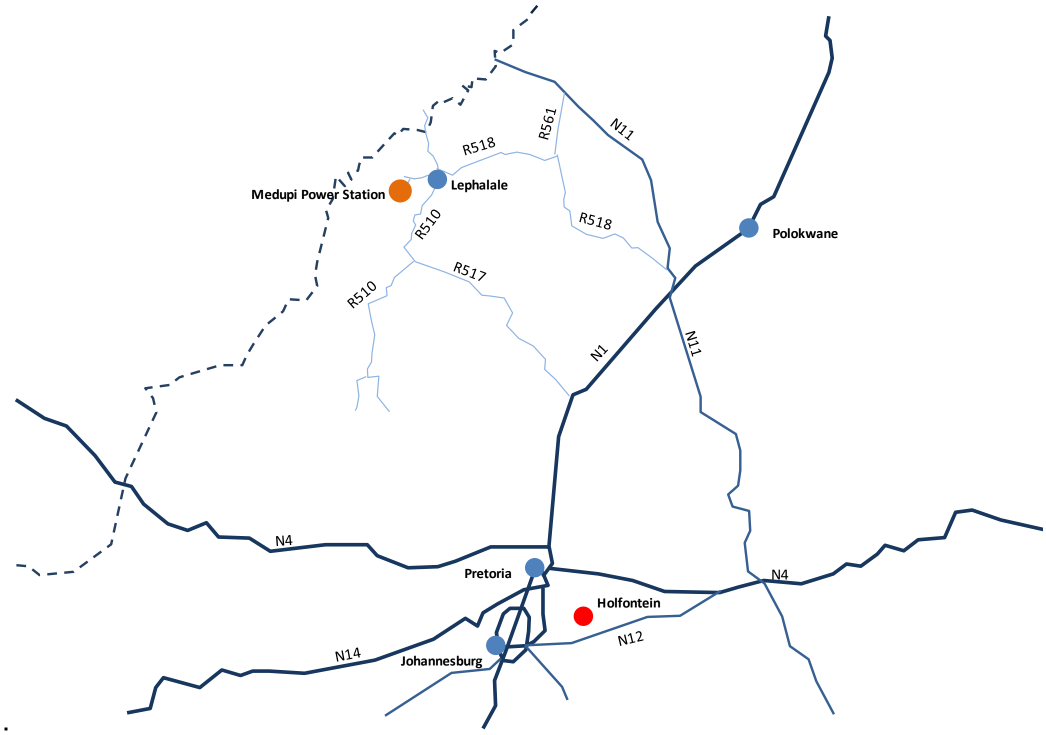


Figure 2.2: External road network - Medupi

Nelson Mandela Drive and the Afguns Road provides access to Medupi Power station, following onto the D1675 and then through Entrance Gate 1, 2 or 4. Afguns road provides access to farms in the area and connects with the R510 further south.

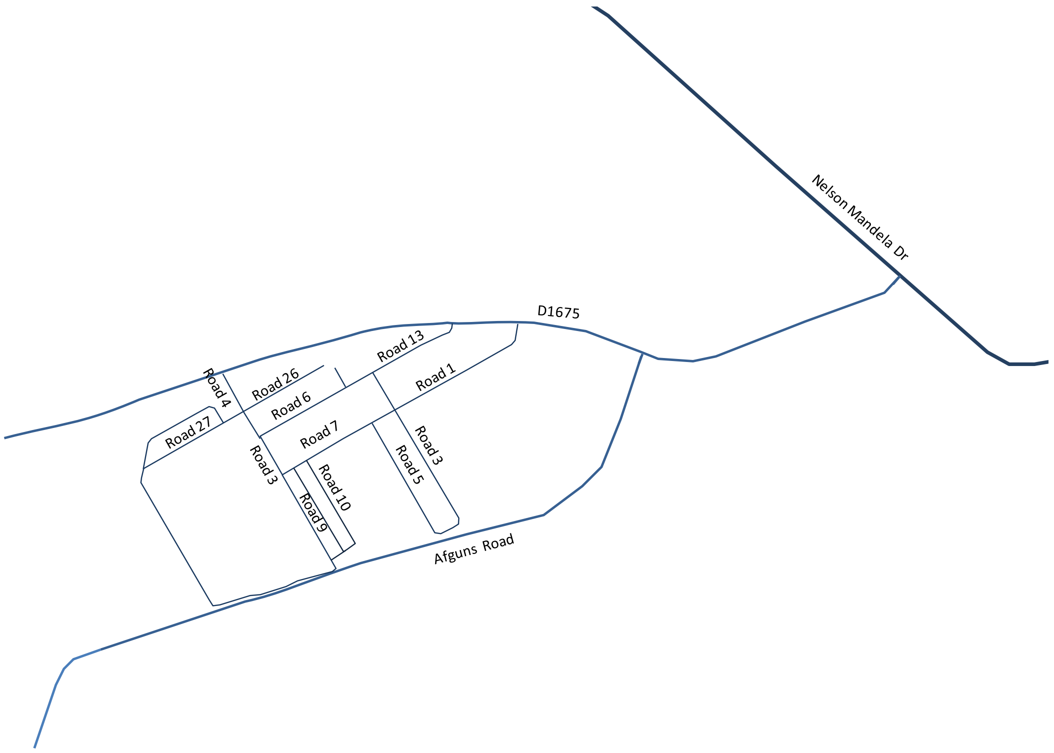


Figure 2.3: Internal road network – Medupi

Traffic counts were undertaken at the following intersections:

- Nelson Mandela Drive / D1675
- D1675 / Afguns Road
- Road 1/ Road 3
- Road 3 / Road 13
- Road 7 / Road 10
- Road 26 / Road 4

These intersections are briefly discussed below. This study will not entail a detail assessment of the internal road network and internal circulation or parking planning. It will only provide an overview of the existing road network.

The internal road network around the FGD plant has very narrow roads, which makes it difficult for heavy vehicles to travel along these roads, causing delays to light vehicle movement.

<u>Nelson Mandela Drive / D1675</u>

This is a T-junction with one lane in each direction. It is the main entrance to Medupi Power station. During the peak period a pointsman is used to direct traffic and improve the traffic flow at this intersection. This intersection is also used as a pick-up and drop-off area for passengers using public transport and employee transport.

D1675 / Afguns Road

This intersection is a T-junction with one lane in each direction. The main movement is the east-west traffic flow with minor traffic coming from the south. A pointsman is also used here to direct traffic during the peak period.

Road 1/Road 3

This intersection is close to Entrance Gate 1. It is a 4-way intersection with the western leg leading to the FGD plant. Mainly visitors and single occupant vehicles enter Medupi Power Station via Gate 1. Buses and minibus-taxis use an area west of this intersection to pick-up and drop-off passengers.

Road 3/Road 13

This intersection is a T-junction leading to Entrance Gate 2. Gate 2 is mainly used by vehicles carrying more than 1 person, especially buses and minibus-taxis. A large number of buses and minibus-taxis were observed during the peak hours.

Road 10/Road 7

The southern leg of this T-junction comes from the proposed FGD plant construction area, while the eastern leg comes from Road 1/Road 3 intersections. Heavy vehicles with large and bulky loads were observed at this intersection travelling between the power station and Road 26/Road 4 intersection.

Road 26/Road 4

This intersection leads to Entrance Gate 4. It also provides access to the current exit point for coal heavy haul route. Heavy vehicle movement was observed at this intersection.

2.3.2 Traffic count summary

Traffic counts were undertaken on the 28th and 29th of October 2015. **Figure 2.4** and **Figure 2.5** show the location of the traffic surveys, 12-hour classified vehicle counts were undertaken at seven locations. It should be noted that the traffic counts were undertaken while construction took place at Medupi, which would have generated additional traffic.

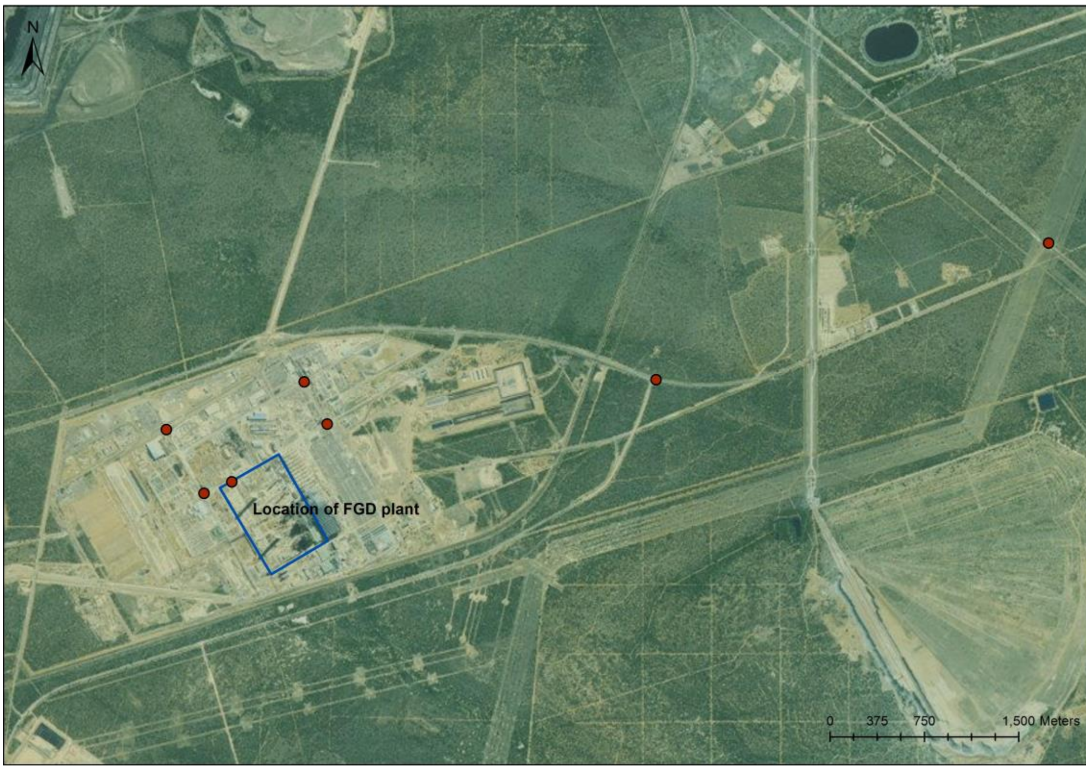


Figure 2.4: Traffic survey locations

Figure 2.5: Traffic count locations within Medupi site

The peak hour was identified as 16:00 to 17:00 for the 24-hour period. The peak hour traffic volumes are displayed in Figure 2.6 to Figure 2.11 below.

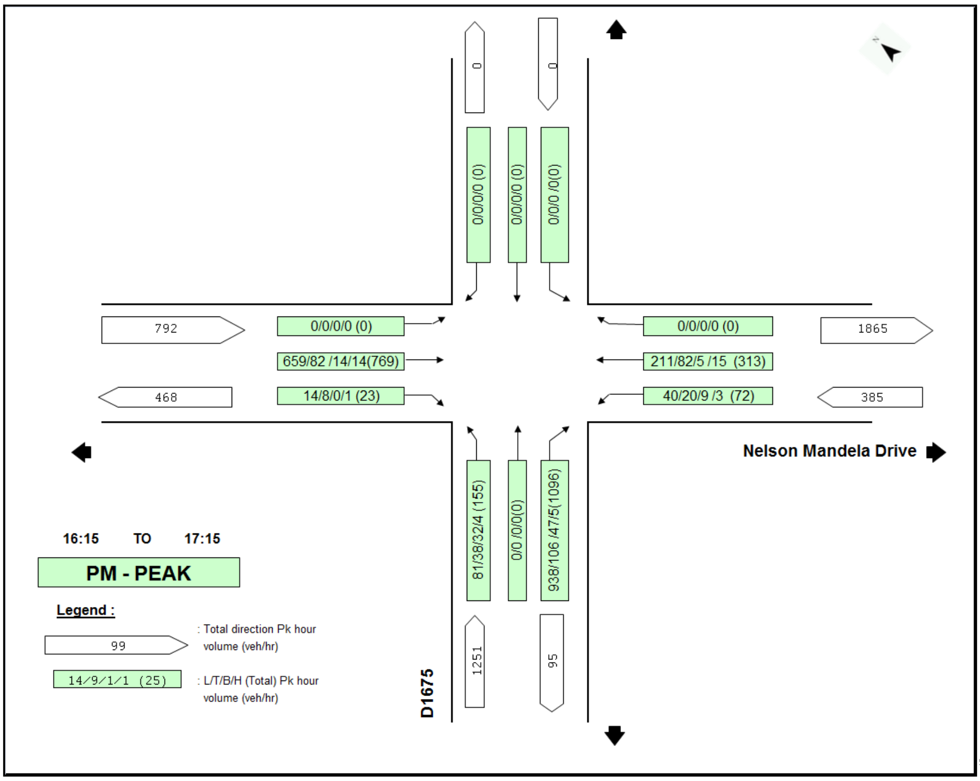


Figure 2.6: PM peak hour traffic volumes – Nelson Mandela Drive/D1675

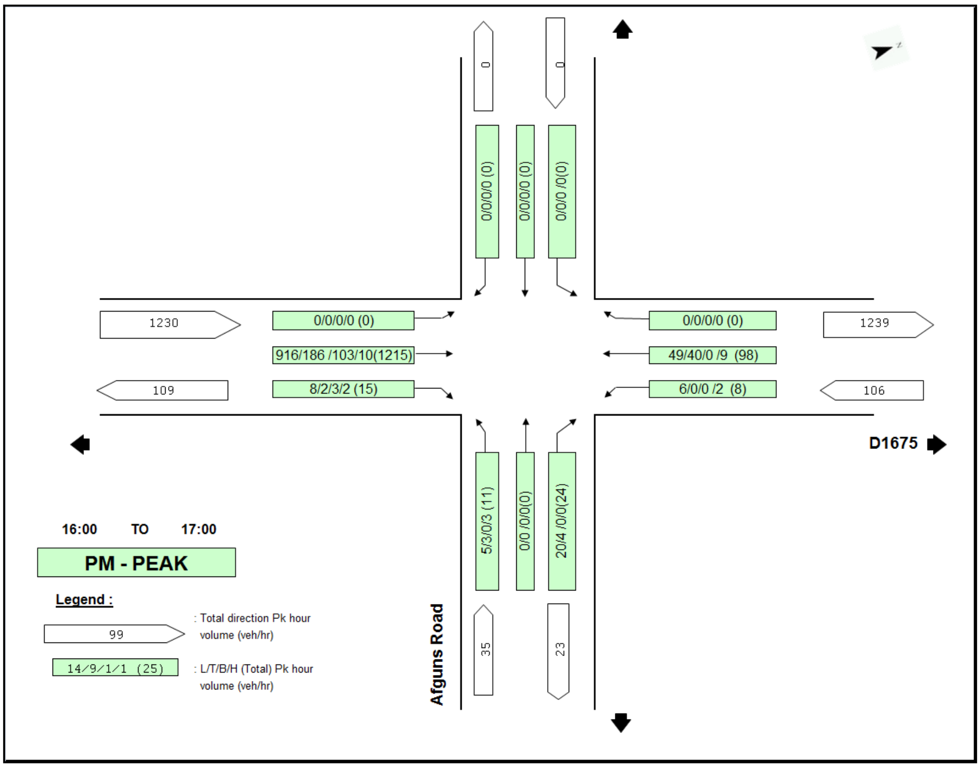


Figure 2.7: PM peak hour traffic volumes – D1675/Afguns Road

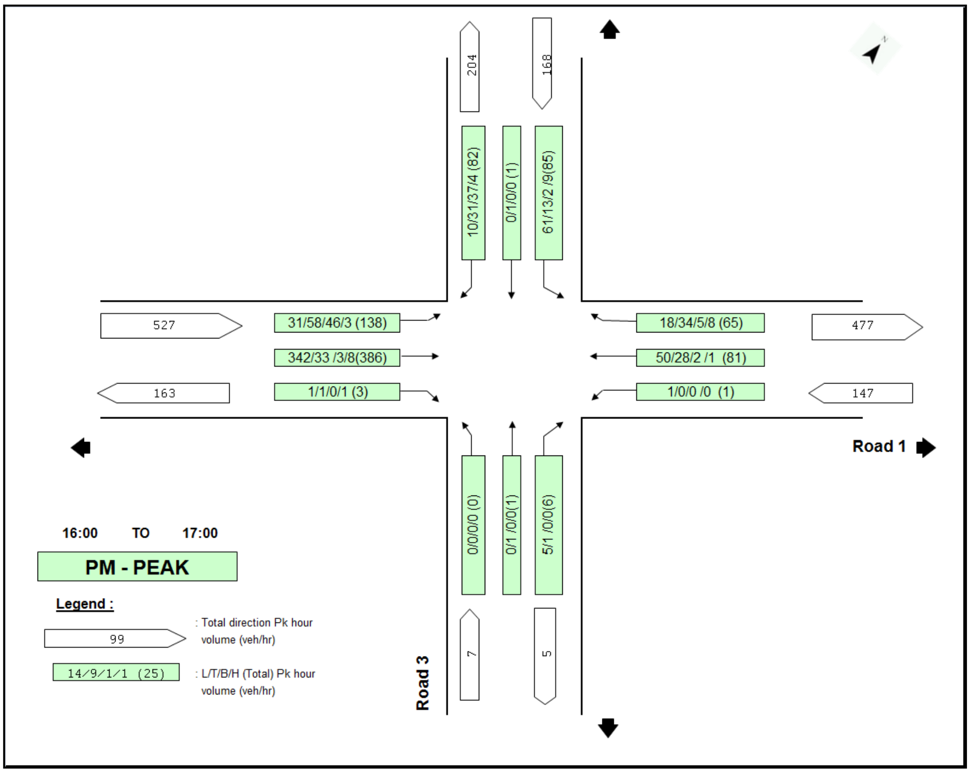


Figure 2.8: PM peak hour traffic volumes – Road 1/Road 3

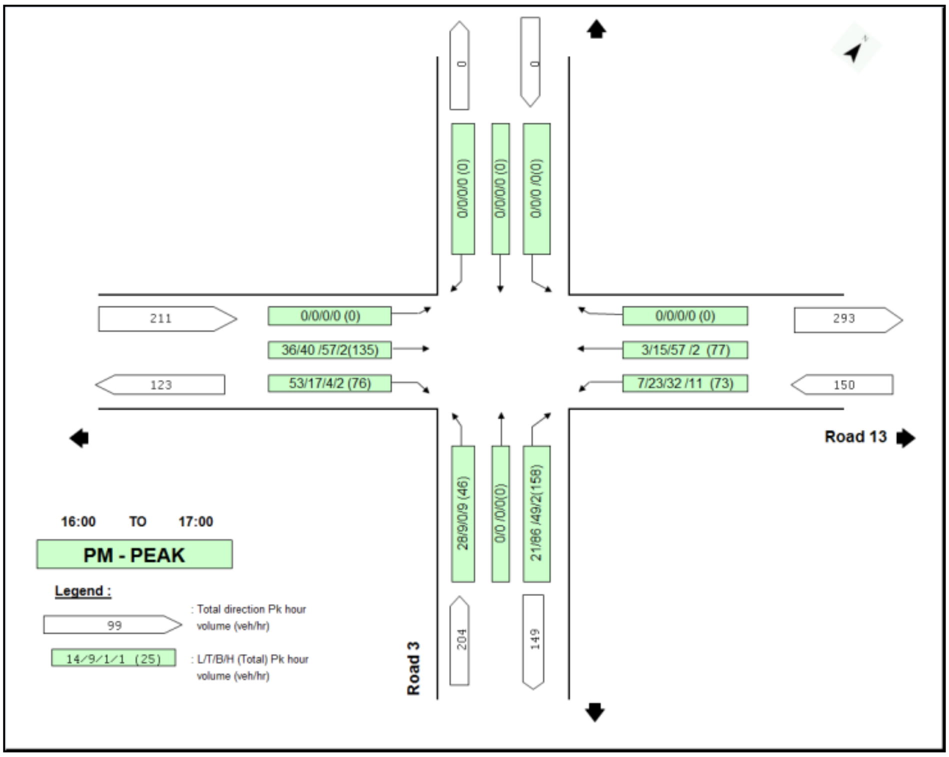


Figure 2.9: PM peak hour traffic volumes – Road 13/Road 3

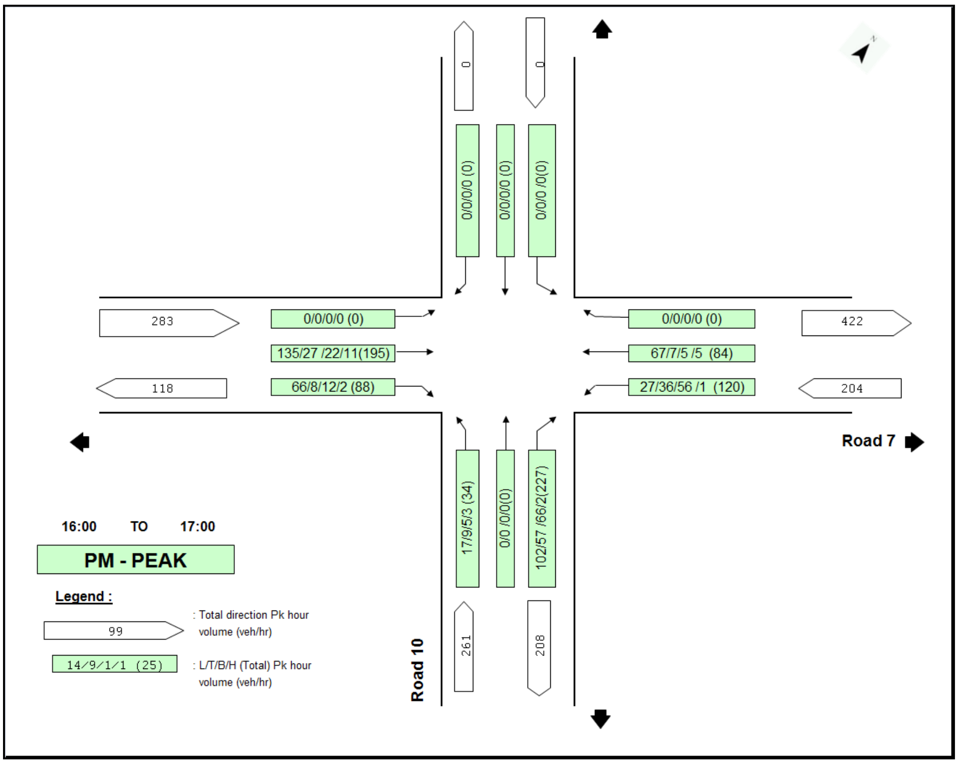


Figure 2.10: PM peak hour traffic volumes – Road 7/Road 10

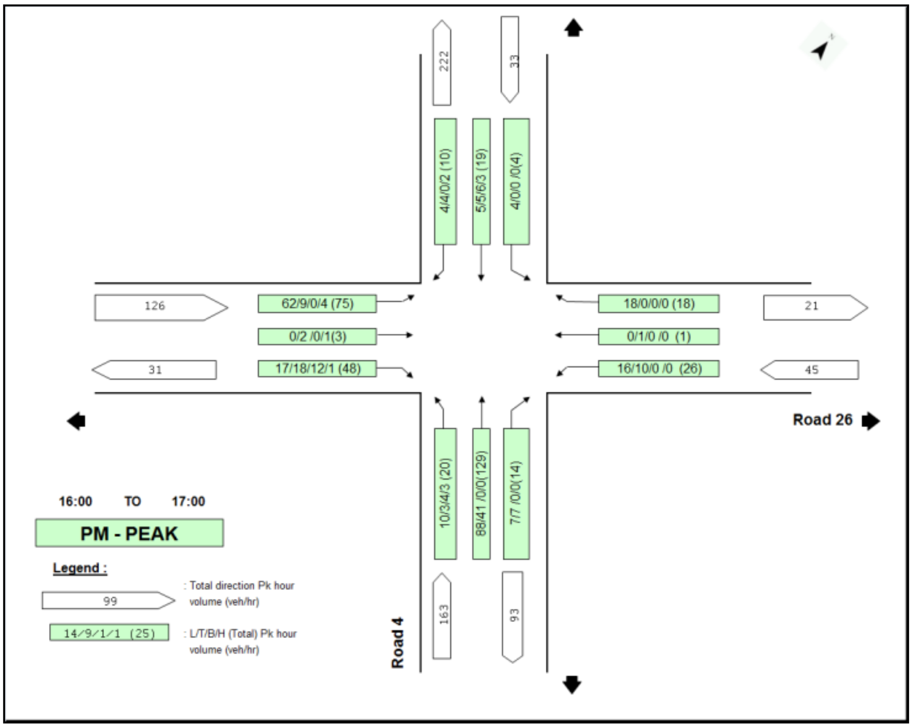


Figure 2.11: PM peak hour traffic volumes – Road 26/Road 4

Analysis of the traffic counts indicated the following:

- Nelson Mandela Drive/D1675 – There are a large number of light vehicles, minibus-taxis and buses exiting Medupi Power Station via D1675 during the pm peak period, in the morning the opposite applies.

- D1675/Afguns Road – There are only a few vehicles exiting and entering Afguns Road during the peak period, with most of the vehicles travelling east towards the Nelson Mandela Drive/D1675 intersection in the afternoon and west towards the power station in the morning.
- Road 1/Road 3 – Many buses and minibus-taxis were observed with most of them turning left or right into Road 3 or turning left from Road 3 into Road 1.
- Road 13/Road 3 – Most of the vehicles observed at this intersection are minibus-taxis or buses, this road leads to Entrance Gate 2 where all the vehicles that have one or more passengers must exit or enter.
- Road 7/Road 10 – Several heavy vehicles with large abnormal loads (construction material) were observed at this intersection.
- Road 26/Road 4 – The traffic volumes observed at this intersection are far less than the other intersections, with especially lower minibus-taxi and bus movement.

The following observations were also made during the site visit:

- Heavy pedestrian movement within the Medupi site, without any pedestrian sidewalk provision or crossings.
- Heavy vehicles travel slowly along the internal roads, causing delays for light vehicles since they can't overtake on the narrow roads.

3. Construction

The construction of the FGD plant and the waste disposal sites will include the following transport and traffic activities:

- Transport of staff, materials and equipment to site.
- Transport of abnormal load to site.
- Management of existing traffic around the site during construction.

3.1 Transport route options

The current access routes and access points to the Medupi Power Station, from a construction viewpoint, are described below.

Divided highway N1 is the main overland traffic route between the project site and major ocean ports, international airports, and Johannesburg. The most direct traffic route from Johannesburg uses the N1 to reach regional roadways R33, R517, and R510. Medupi Power Station is reached from roadway R510 by utilizing either Nelson Mandela Drive to D1675 (Magol Drive) to Medupi Power Station entrance road, or by using a new 26 km long plant entry roadway located off of R510, approximately 23 km south of Nelson Mandela Lane.

A single rail line services the Exxaro Grootegeluk coal mine and Medupi Power Station, running approximately north/south adjacent to R510 highway. This line passes through the towns of Thabazimbi, Amandelbult, and Rustenburg.

The closest South African ports to the project site are Durban (925 km, approximately a 9-hour drive via highways N3, N1, R33, R517, and R510); Port Elizabeth (1,445 km, approximately a 14-hour drive via highways N2, N10, N1, R33, R517, and R510); and Cape Town (1,768 km, approximately a 17.1/2-hour drive via highways N1, R33, R517, and R510).

3.2 Transport of staff, materials and equipment

The majority of project material will be transported to the project site via truck from Johannesburg via highways N1, R33, R517, and R510. Major equipment will be partially fabricated into truckable components in vendor fabrication shops, shipped to the project site, and fully assembled.

The following section will describe the construction roads and parking plan as developed by Eskom. Staff will be bussed to the site, checked through the permanent plant main access control facility (Entrance gate 1), and transported to their work locations. Empty busses will either exit the site or be parked until end of shift. A parking and load/unloading area for vehicles used on the site to transport personnel from/to remote site areas is located adjacent to the access control facility at the main site entrance. This area will be used only for off-shift parking for staff transport vehicles. Staff, vendors, and visitors arriving on the site via personal vehicles will enter through the main site entrance (Entrance gate 1), pass through access control and drive to a dedicated construction parking lot and office complex located on the southeast side of the plant site. This asphalt surfaced parking area will have approximately 200 parking positions. A special permit will be required to have a personal vehicle on-site and to park in this lot.

A separate site entrance and access control facility is located north of the main site entrance. It is dedicated for material delivery and heavy haul transport trucks and also includes pullover and short-term parking areas for use during security check-in and inspection prior to being allowed onsite for unloading. The construction parking lot and the roads to and from the construction parking and construction entrance are hard surfaced with asphalt to minimize maintenance and provide dust control. Parking areas will be lighted and have barriers to control parking pattern and traffic flow.

In addition to the permanent plant roads and parking facilities, construction roads and parking are required to provide access to temporary construction facilities and lay-down areas in the work areas. The temporary roads are all weather, mostly gravel surfaced, and of sufficient width and location to accommodate efficient use and traffic pattern control for the construction process. Parking at temporary construction facilities and laydown is limited to vehicles necessary for the contractors to conduct work and will be controlled by permit.

Adjacent to the construction security and induction building will be a separate bus depot for drop off and collection of pedestrians and artisans at the pedestrian entrance turnstiles. The buses will enter the construction site through a gate adjacent to these turnstiles to collect and transport the artisans to the contractor’s.

It is suggested that construction vehicles and trucks should utilise the Afguns road in order to avoid other road users on the main roads (as explained in **Section 4.1**). By utilising the Afguns – Thabazimbi road, the heavy vehicles trucks will avoid travelling through Lephalale town and avoid other busy nodes within the study area. Construction vehicles should enter via Entrance Gate 4 and use the suggested travel routes shown in Figure 3.1 below, depending on whether they are travelling to/from the FGD plant or the railyard/stockpile.

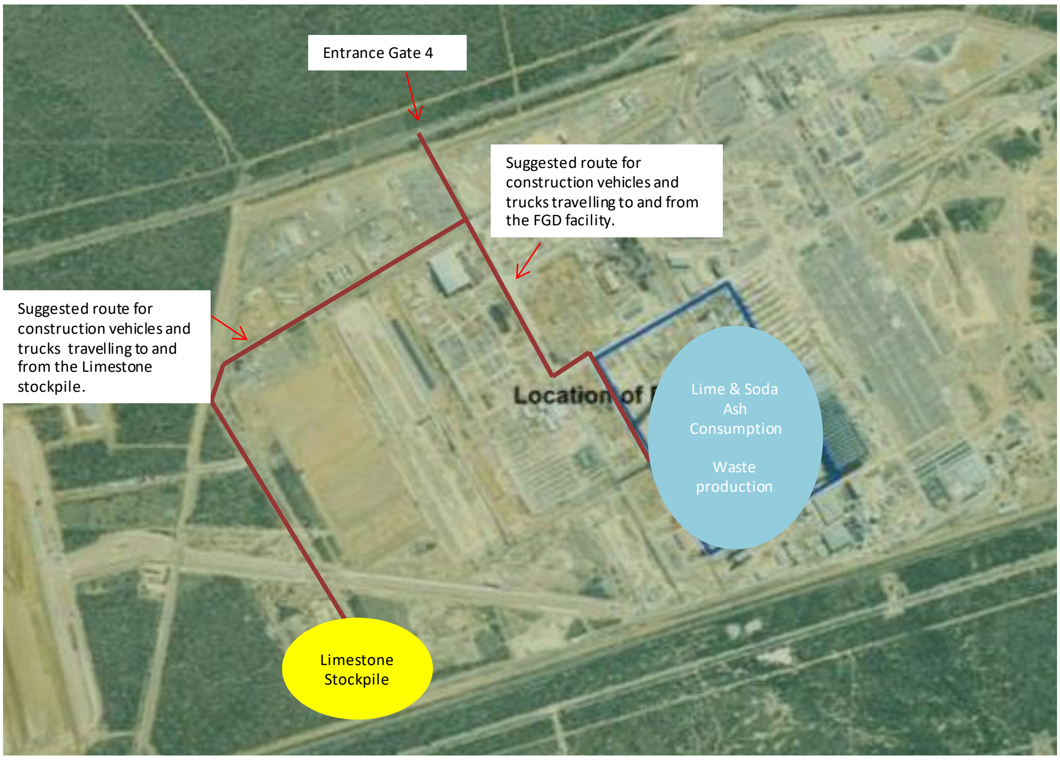


Figure 3.1: Suggested travel routes for construction vehicles

3.3 Transport of abnormal load to site

Abnormal load vehicles will use the existing road network, assisted by traffic officials and the stakeholders involved. The transportation of cargo will not be permitted when it rains or when there is mist. The truck combinations can usually travel only at a speed of 10km/h for safety reasons and a traffic official must escort these combinations in a separate vehicle at any given time. The truck company that will be used for the transport of abnormal loads to site, will have to ensure that their trucks meet the safety standards. Eskom is still in the process of developing their heavy haul/lift plans and information will be updated once that information is available.

3.4 Management of traffic around the site during construction

The permanent plant site security organization will manage the plant traffic control program within the perimeter fence on the project site. Site Security will be responsible for enforcing speed limits, assigning parking areas and enforcing parking restrictions, installing and maintaining traffic control signs, delineating emergency response and evacuation routes, adjusting traffic patterns to accommodate construction and operation activities, informing plant personnel of current traffic patterns and restrictions, and assisting emergency medical personnel with accidents.

The Field Management Personnel Staffing Plan section will be expanded during the execution phase of the project to include paragraphs describing:

- Relocation Plans
- Personnel De-Staffing Plan
- Housing Availability or Camp
- Staff Transportation - Availability/Plan
- Other Considerations

3.5 Weigh bridge

It is planned and suggested by Eskom that a weigh bridge should be built at Entrance Gate 4. The concern from a traffic and transport safety viewpoint is that it may cause queuing to back up onto the public road (D1675), which will have an impact on other road users.

The weigh bridge will allow for the weighing of delivery trucks carrying the following loads:

- Fuel Oil;
- Coal (reject or supply);
- Limestone for future Flue Gas Desulfurization plant
- Gypsum for future FGD plant;
- Any other loads that require to be verified.

The weigh bridge will have a Bi-directional weigh bridge system, consisting of two Weigh Bridges. Each system will allow for haulage traffic to be weighed in both directions. Traffic control signage and lights will be installed to ensure oncoming traffic can clearly identify the lanes and activities in the area. The weigh bridge will be able to accommodate 12 trucks per hour. The estimate is that there will between six to twelve trucks per hour delivering limestone and approximately two trucks per hour transporting salts and sludge to a hazardous waste disposal facility. In order to assess the potential of trucks queuing into the public road and the impact on other road users, we will have to undertake a traffic count at the intersection D1675 and the access road to the Entrance Gate 4 to establish the number of through traffic along this road. A detail plan showing the queuing distance available between the weigh bridge and public road together with a truck scheduling programme will be required. It is suggested that we undertake this investigation as part of this project under a variation order.

3.6 Conclusion and recommendation

It should be noted that there is some information that is not available which has an impact on the full assessment of the traffic impact during the construction period, however the following is recommended:

- The trucks delivering building material to the site should follow a similar route as recommended for the trucking of Limestone and salts and sludge in **Section 4.1** and **Section 4.2.**
- There should be a pointsman at the intersection of D1675 / Afguns Rd and Nelson Mandela Drive / D1675 during the peak hours to alleviate the traffic congestion.
- Undertake an assessment study with regards to the proposed weigh bridge design and determine whether it may cause queuing to back up onto the public road, which might have an impact on other road users.

4. Operational transport

The input materials to the FGD process are soda ash, lime or limestone. The limestone will be either brought in by rail to the plant via a rail siding from where it is collected, handled and stockpiled until used in FGD system or it could be transported to the plant with conventional bulk side-tipper trucks. The Soda ash will also be transported to the FGD plant with conventional bulk powder trucks.

Waste from the FGD process includes gypsum (which will be dewatered) and waste water. The waste water will be treated and cleaned for re-use in the plant. By- products of the waste water treatment process (salts and sludge) will be disposed at an existing licensed hazardous waste facility, after storage at a temporary storage facility in the vicinity of the waste water treatment plant. The gypsum together with the ash will be disposed of at the existing Medupi Ash disposal facility, which will be designed with the appropriate barrier system, given that ash and gypsum are both classified as the same waste type.

Figure 4.1 shows the input material that has to be transported to the FGD facility and the by-products that will be transported away from the facility to the existing licensed waste facilities.

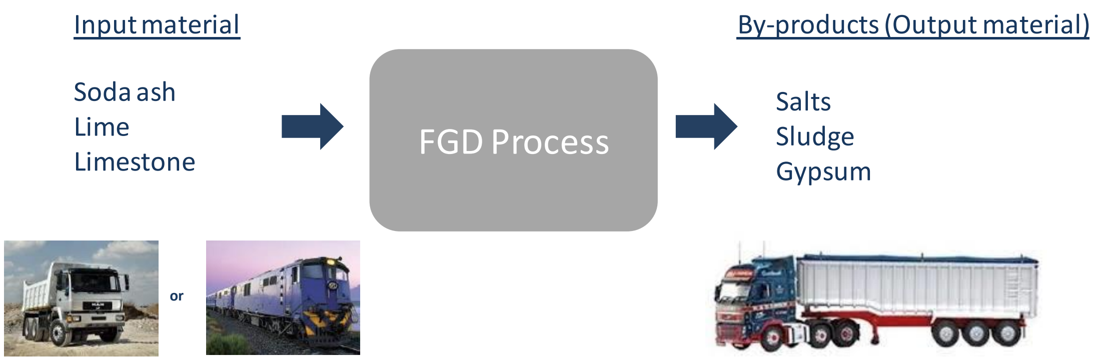


Figure 4.1: Input and output material during the FGD process

4.1 Limestone Transport

Limestone is purchased off-site and is transported to the Medupi Power Station by rail and/or road. The Limestone will be offloaded at the proposed limestone storage facility, which includes a rail siding and road access, located south-west of the six power units within the Medupi Power Station footprint. Limestone will be initially delivered by road and will be delivered to a truck offloading facility in close proximity to the Limestone Stockyard.

Some of the potential sources where limestone would be trucked from are Thabazimbi, Marble Hall and Vereeniging, as shown in Figure 4.2**,** although work still needs to be done before deciding on the limestone sources.

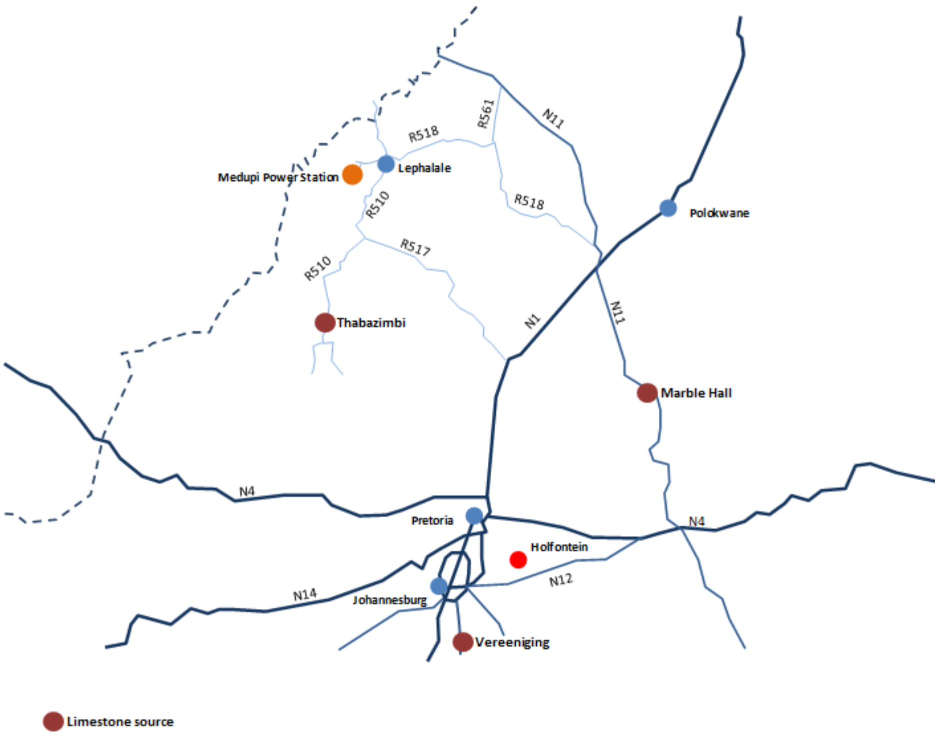


Figure 4.2: Possible limestone collection points

It is suggested that the trucks delivering limestone to the power station could utilise the Afguns road in order to avoid other road users on the main roads. By utilising the Afguns – Thabazimbi road, the trucks will avoid travelling through Lephalale town and avoid other busy nodes within the study area (see Figure 4.3). It is suggested that trucks travel from/to Medupi Power Station;

- to/from Thabazimbi via the Afguns road and the R510,
- to/from Vereeniging travel via the Afguns road, R510, R517, N1, N3 and R59 and
- to/from Marble Hall via Afguns road, R510, R517, N1 and the N11.

It is suggested that an economic study that takes into consideration travel cost, travel time, accident cost and the quality of the road surface, should be undertaken to fully understand and evaluate which of the potential limestone sources would be the best alternative to use. However, it is expected that the limestone source closest to Medupi Power Station, would have the least vehicle operating cost and impact to other road users.

The contractor would be responsible to discuss the trucking with the relevant roads agency to ensure that all legal requirements are met.

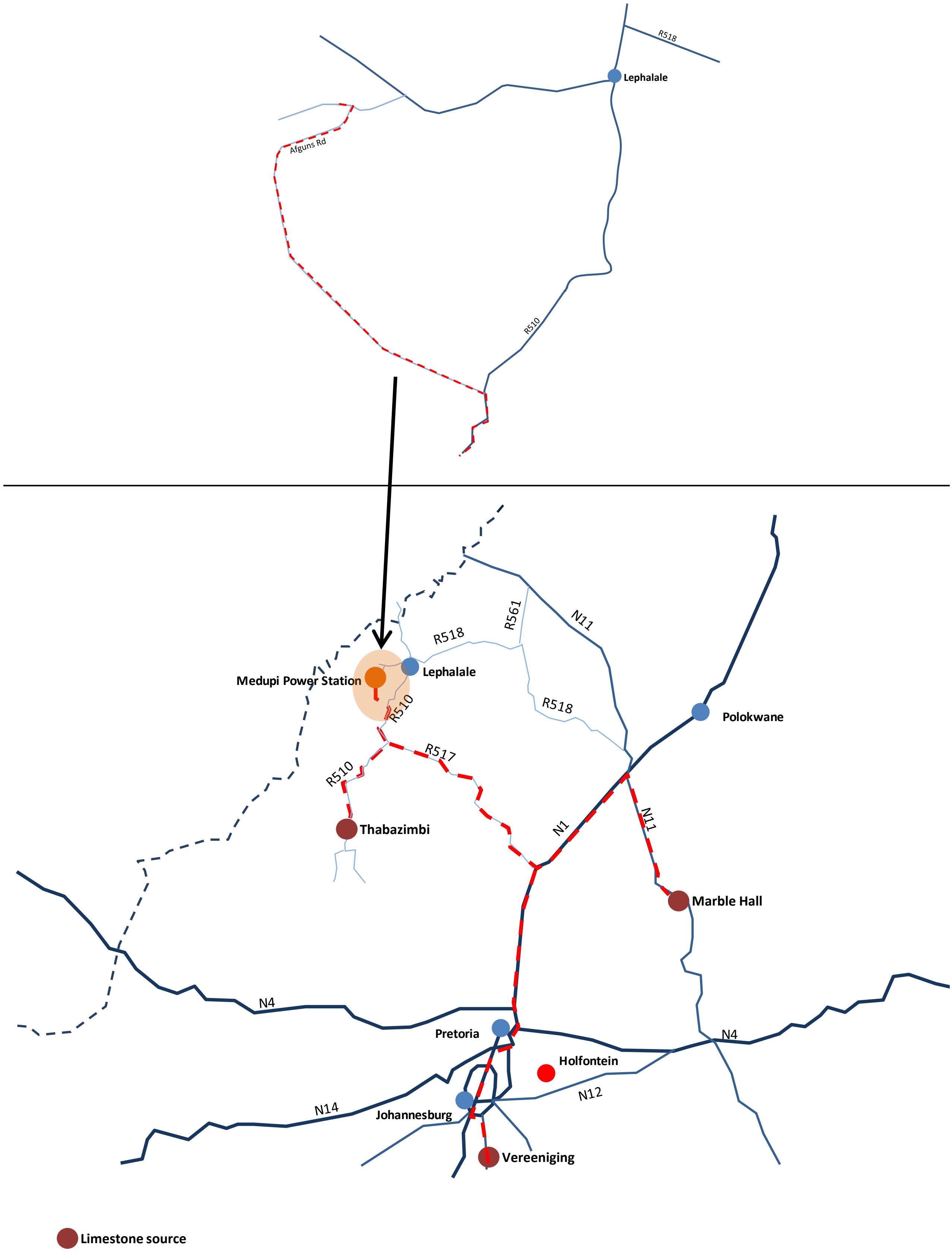


Figure 4.3:Suggested route for trucks to and from limestone sources

4.2 Salts and sludge transport

Salts and sludge will be transported to an existing licensed hazardous waste facility, there are four known options that are currently being investigated:

- Holfontein – Border of Gauteng and Free State;
- A facility in Natal;
- A facility in Western Cape;
- Vlaklaagte – within the Vaal Triangle

At the time of the assessment the selected/preferred hazardous waste facility where salts and sludge will be trucked for approximately the next five years, has not been confirmed. It is suggested that the trucks follow similar routes as described for the transport of limestone in **Section 4.1**, onto the N1 and then onto the various routes that are necessary to reach the hazardous waste facility. For transportation of the waste to a disposal site, Eskom will utilise the services of a service provider who has all required authorisations and systems to manage transportation from the temporary storage to disposal facility.

It is suggested that trucks delivering limestone should follow the yellow route to the Limestone Stockpile, while trucks transporting salts and sludge to the Hazardous Waste facility should follow the red route as shown in **Figure 4.7.** The trucks should enter via Gate 4.

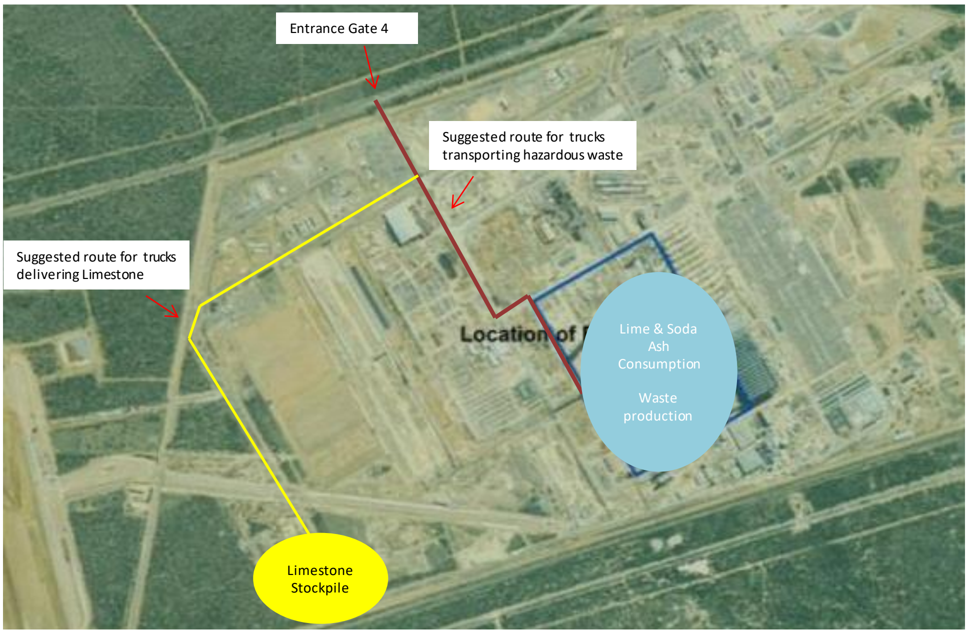


Figure 4.4: Internal travel routes for trucks

4.3 Ash and gypsum transport – Ash disposal facility

Conveyors are used to transport the ash from the power plant to the NADF. At the power plant, the ash is deposited onto an overland conveyor, while the overland conveyor transports the ash to a Transfer House (Transfer House 9) at the ash disposal facility. The transfer house will deposit the ash onto the ash dump extendable conveyor. If one or both stackers are temporarily out of commission, ash will temporarily be off loaded onto the emergency ash platforms situated close to Transfer House 9.

There is a possibility that 20% of the gypsum offtake might be removed via rail for sale, although this means that it will not be transported by conveyor to the NADF, it will only have a short-term impact on road users as it will be transported via rail in the long-term.

4.3.1 Access roads

The side entry gate will be on the eastern side of the site. Leading from the gate will be the service roads along the conveyors and the patrol road that follows the fence around the site. At certain points along the patrol road will be roads that branch off toward infrastructure such as storm water trenches or pollution control dams.

There are three service roads; one on either side of the two conveyors and one that runs between the conveyors. The service roads along the conveyors lead to the starter and erection platforms and then onto the conveyor corridor on the ash dump.

Access to the rehabilitated back stacks of the dump will be from the northern or southern end of the starter platform. On the rehabilitated back stacks, access roads are included on the northern and southern edges with crossroads every fourth shift. Access roads that run on either side of the dump also provide access to leakage detection outlets of the liner systems.

Roads will be used for access to carry out maintenance, inspections, material delivery and construction. All the access roads will be inspected for depressions, potholes and erosion. The position of all depressions shall be indicated on the inspection form. No standing water or ponding will be allowed and occurrence shall be noted.

4.4 Truck movement

4.4.1 Trucking of Limestone and Sludge & Salts

The trucks will operate for 12 hours a day, seven days a week and will be the same volume side tipper trucks that deliver coal. Table 4.1 indicates the expected daily number of truck loads required for the transport of sludge and salts to the licensed hazardous waste disposal facility per the number of units that are operational.

Table 4.1: Daily number of trucks needed for the transport of sludge and salts

Unit	No. of Units with FGD Plant Operating	Chemical Sludge Production Rate (tph)	Chemical Sludge Production Rate (tpd)	Chemical Sludge Number of Trucks per day	Chemical Salts Production Rate (tph)	Chemical Salts Production Rate (tpd)	Chemical Salts Number of Trucks per day	Daily no. of truck loads required per FGD Plant Operational
6	1	3.39	81.41	2	0.89	21.46	1	3
5	2	6.78	162.83	4	1.78	42.93	1	5
4	3	10.17	244.25	5	2.68	64.39	2	7
3	4	13.56	325.67	7	3.57	85.86	2	9
2	5	16.96	407.09	9	4.47	107.32	3	12
1	6	20.35	488.51	10	5.36	128.79	3	13

Based on the information provided in Table 4.1**,** the number of daily truck loads required for the transport of sludge and salts are 13 (if all of the units are operational). Based on a 12-hour operational day, it can be expected that a maximum number of two truckloads will be required during the peak hour, if the delivery schedule is evenly distributed through the day.

Table 4.2: Daily number of trucks needed for the transport of limestone

Unit	No. of Units Operating	Limestone consumption (tph)	Limestone consumption Rate (tpd)	Limestone Number of Trucks per day
6	1	24	576	12
5	2	48	1152	23
4	3	72	1728	35
3	4	96	2304	46
2	5	120	2880	58
1	6	144	3456	69

The information in Table 4.2 shows that a maximum number of daily trucks required for the transport of limestone to the facility are 23 for the year-2017+6 years (2023) and 69 for the year 2019 +6 years (2025). For a 12-hour operational day, it can be expected that a maximum number of six truck loads will be required during the peak hour, if evenly distributed throughout the day, and if all the limestone will be transported via road.

4.4.2 Truck types

4.4.2.1 Limestone

It is expected that conventional bulk side-tipper trucks will be used, if transport of limestone is performed by road, using trucks (Figure 4.5). They will have the following specification:

- Weight
  Tare – 11 420kg
  Payload – 35 080kg

- Specifications
  Wheels – 12R22.5/315/80R22.5 Dual Wheels
  Rims – 9.00 x 22.5 Steel Rims
  Suspension – Air Suspension

- Other
  2 x 20m3 Light Weight Bins
  3mm Domex Chasis
  Tarpaulin Top Covers
  Spare Wheel Carrier
  Catwalk

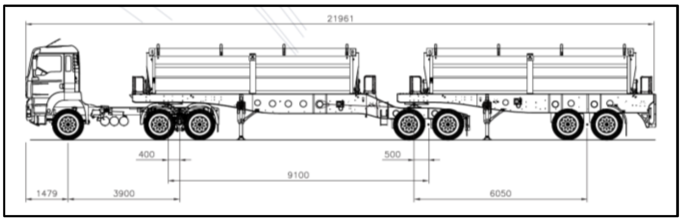


Figure 4.5: Conventional bulk side-tipper trucks

4.4.2.2 Soda Ash, Lime or Limestone

If transport of soda ash, lime or limestone is performed by road, using trucks, it is expected that conventional bulk powder trucks will be used (see Figure 4.6). They will have the following specification:

- Horse – 6m.
- Trailer – 7-11m.

Figure 4.6: Conventional bulk powder trucks

4.4.3 Feeder roads to Northern Ash Disposal Facility

Currently it is planned that gypsum and ash will be conveyed to the NADF and therefore this process will generate no additional traffic impacts. If trucked; only internal roads will be utilized to carry the gypsum and ash to the NADF. A schematic showing the likely transport routes is shown in Figure 4.7**.**

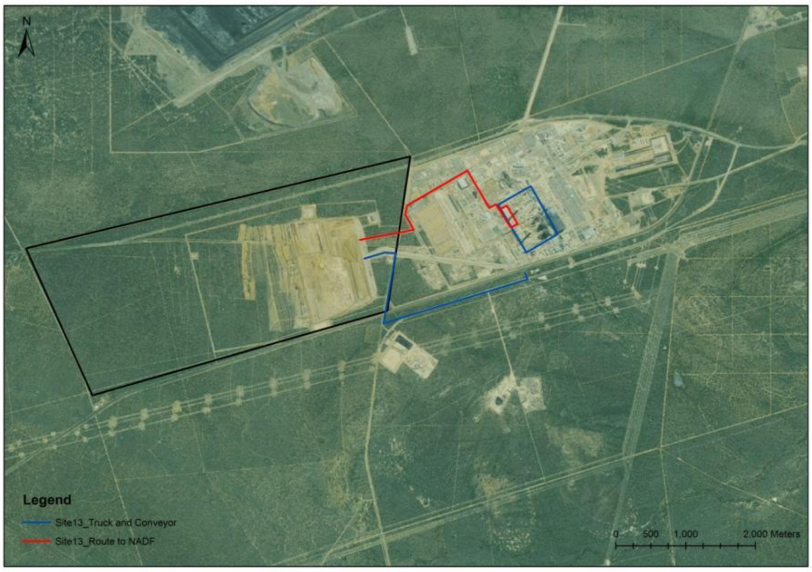


Figure 4.7: Proposed transport routes to site 13 (NADF – Northern Ash Disposal Facility)

5. Traffic Impact Assessment

The study area for the traffic impact assessment is confined to a 10km radius as specified in the scope of work document and shown in **Figure 5.1**. The 10km radius was selected based on the Medupi Power Station study area for possible waste disposal sites, before it was decided that the salts and sludge will be transported to a licensed hazardous waste disposal facility that falls outside the study area. The intersection analysis will be based on the affected intersections within the study area; however, the transport assessment will include affected areas outside the study area.

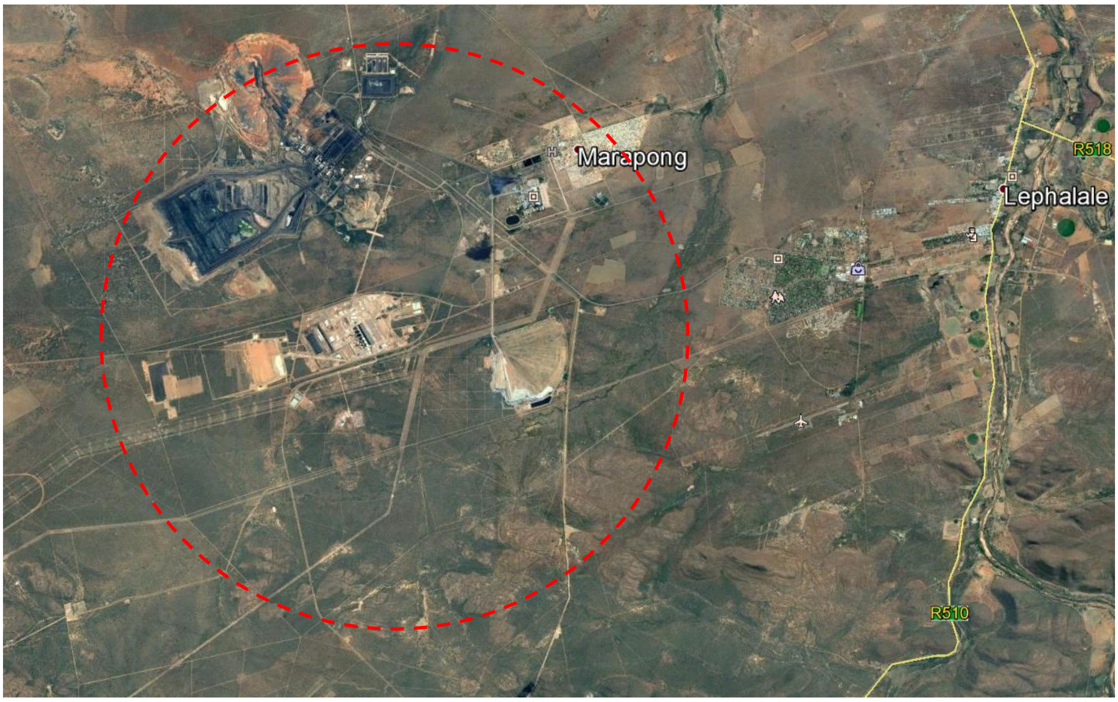


Figure 5.1: Study area – Traffic Impact Assessment

5.1 Traffic Analysis: Existing

The existing 2015 traffic count data (**Section 2.3.2**) has been used as input using SIDRA Intersection Analysis software to analyze the intersections. The peak hour was identified as 16:00 to 17:00 during the afternoon period. The peak hour analysis results are shown in **Figure 5.2** and **Figure 5.3**.

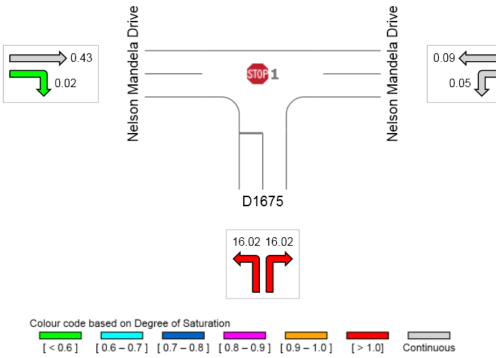
Level of Service (LOS) ratings have been used to evaluate the existing and future traffic situation. LOS tries to answer how good the present traffic situation is at a particular intersection. Thus it gives a qualitative measure of traffic in terms of delays experienced. It is represented by six levels ranging from level A to level F. Level A represents minimal delays where the driver has the freedom to drive with free flow speed and level F represents uncomfortable conditions accompanied by long delays (see **Table 5.1**).

Table 5.1: Level of Service Criteria

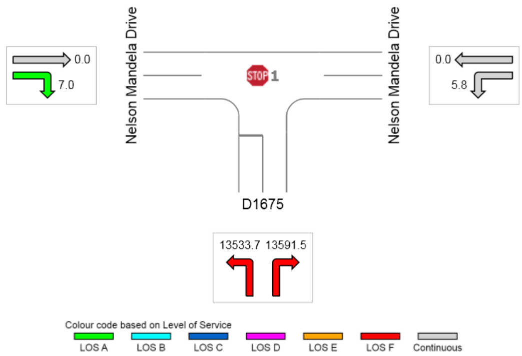
LOS	Control Delay sec/veh(signalised)	Delay sec/veh (unsignalised)
A	≤ 10	≤ 10
B	10-20	10-15
C	20-35	15-25
D	35-55	25-35
E	55-80	35-50
F	> 80	> 50

5.1.1 Nelson Mandela Drive / D1675

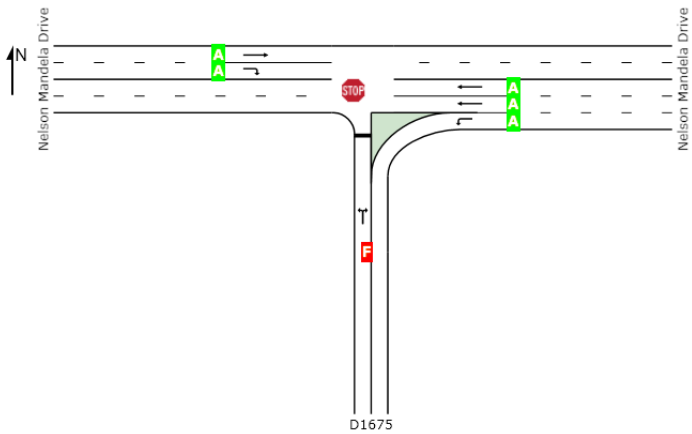
Figure 5.2 shows that this intersection currently operates at a LOS F for the northbound movement during the PM peak hour, and a LOS A for the west- and eastbound movement. This indicates that it operates well within capacity for the priority movement, but the vehicles coming from Medupi Power Station and Afguns road, wanting to turn into Nelson Mandela Drive are struggling to find a gap and long delays are experienced by motorists.



Degree of Saturation



Average Delay

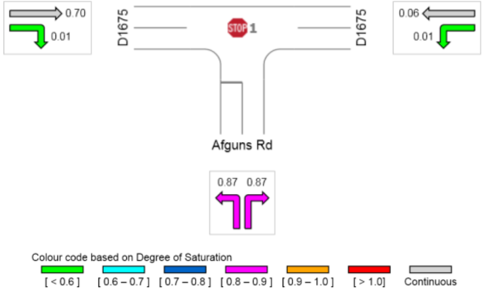


Level of Service

Figure 5.2: 2016 Existing Scenario – Nelson Mandela Dr / D1675, PM peak hour

5.1.2 *D1675 / Afguns Rd*

Figure 5.3 shows that this intersection also operates at a LOS F for the northbound movement during the PM peak hour, and a LOS A for the west- and eastbound movement. This indicates that the vehicles coming along Afguns road who want to turn into D1675 are struggling to find a gap and long delays are experienced by motorists.



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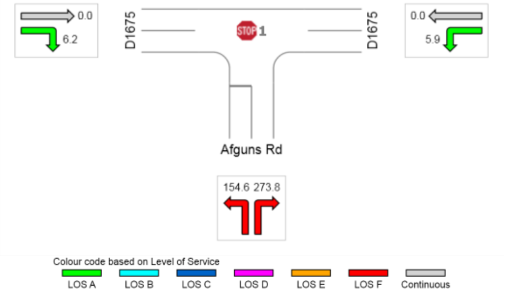
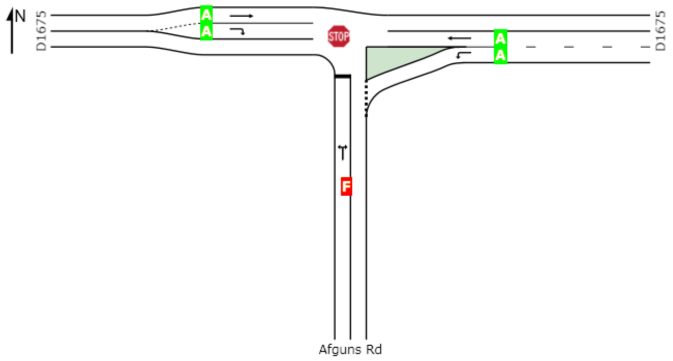


Average Delay



Level of Service

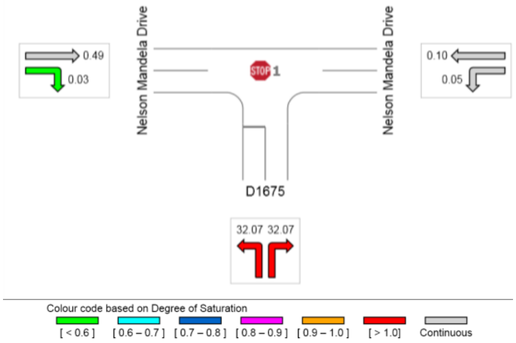
Figure 5.3: 2016 Existing Scenario – D1675 / Afguns Rd PM peak hour

5.2 Traffic Analysis: 10-year Post Development

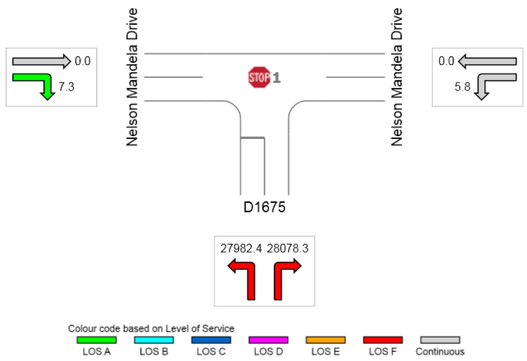
Section 5.2.1 and 5.2.2 below summarise the analysis undertaken for the 2027 scenario and include the Degree of Saturation, Average Delay and LOS results. The 10-year scenario was analyzed using 2% growth for background traffic. The development traffic was grown to the year 2027. Based on **Section 4.4** it was assumed that there will be a peak hour flow of eight trucks in both directions, two for salts and sludge and six for the limestone, for the year 2025.

5.2.1 Nelson Mandela Drive / D1675

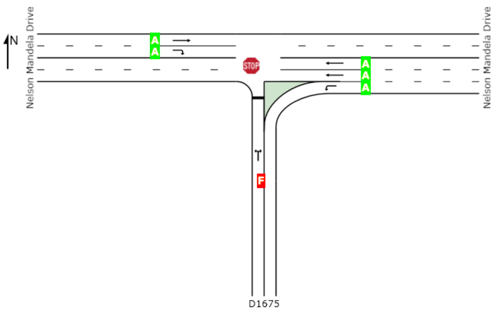
Figure 5.4 shows the anticipated performance of Nelson Mandela Drive / D1675 in 2027 after the development. The results indicate that the intersection will most probably operate at a LOS F for the northbound movement during the PM peak hour, and a LOS A for the west- and eastbound movement.



Degree of Saturation



Average Delay



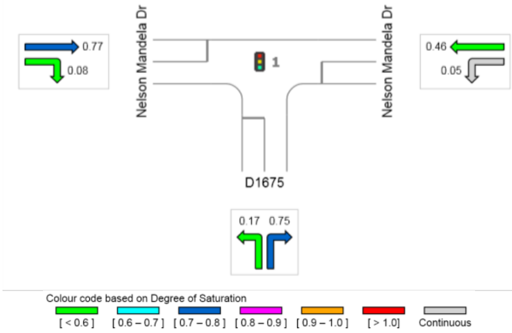
Level of Service

Figure 5.4: 2027 Future Demand – Nelson Mandela Dr / D1675 PM peak hour

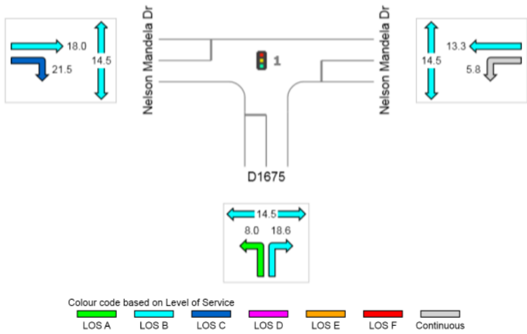
The following upgrades are suggested:

- Provide signals;
- Add a left turning slip lane along D1675 (northbound);
- The introduction of a right turning lane for the northbound right movement;
- Provision of an additional eastbound lane for the straight movement.

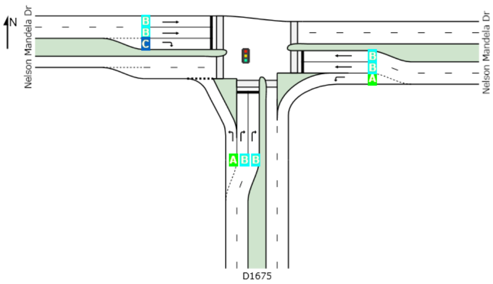
Figure 5.5 shows the anticipated performance of Nelson Mandela Dr / D1675 intersection in 2027 with the proposed changes to the road layout. The results indicate that this intersection is likely to operate at a LOS B, which is a significant improvement from a LOS F. The results indicate that the signals, additional lanes and sliplane will solve most of the congestion issues. It is recommended that the relevant road authority should fund the upgrade of this intersection, since the existing intersection is already operating at a LOS F.



Degree of Saturation



Average Delay

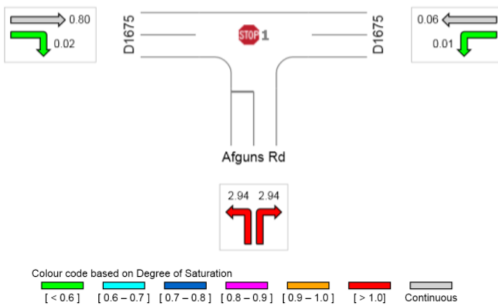


Level of Service

Figure 5.5: 2027 Future Demand & Future Layout– Nelson Mandela Dr / D1675 PM peak hour

5.2.2 *D1675 / Afguns Rd*

Figure 5.6 shows the anticipated performance of D1675 / Afguns Rd intersection in 2027, during the operational phase of the Medupi Power Station. The results indicate that this intersection is likely to operate at a LOS F for the northbound movement during the PM peak hour, and a LOS A for the west- and eastbound movement.



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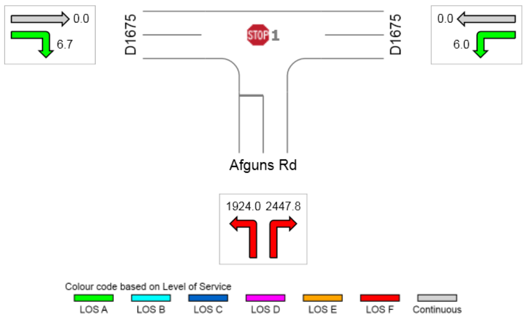
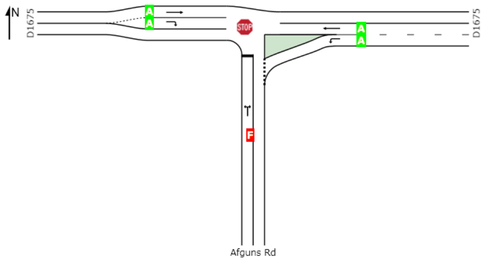


Average Delay



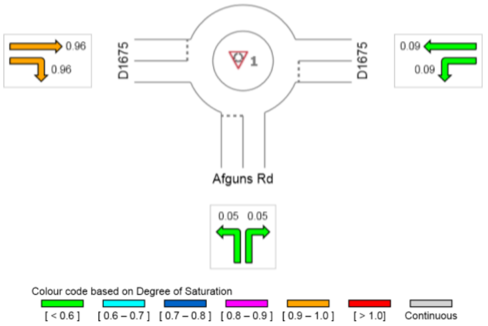
Level of Service

Figure 5.6: 2027 Future Demand – D1675 / Afguns Rd PM peak hour

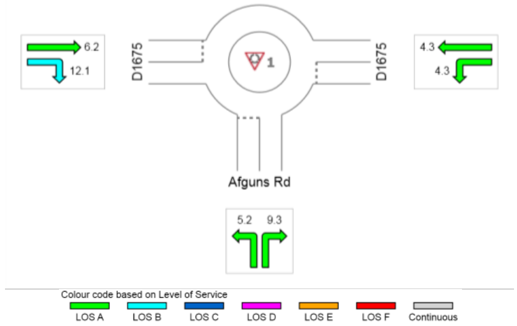
A possible solution would be to upgrade the priority control intersection to a one lane roundabout. It should be noted that a roundabout is just one of the possible upgrade scenarios and it is recommended that a detail design study should be undertaken at this intersection to determine the best upgrade option based on the traffic volumes, percentage of heavy vehicle, size of trucks, geometry and other important aspects that should be taken into consideration.

Safety ● Quality ● Sustainability ● Innovation

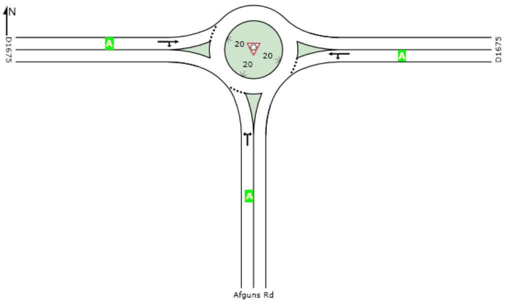
Figure 5.5 shows the anticipated performance of D1675 / Afguns Rd intersection in 2027 with the proposed changed to the road layout. The results indicate that this intersection is likely to operate at a LOS A. This is a significant improvement on the LOS and will be beneficial to the trucks travelling to and from Medupi Power Station, leading to travel time savings and vehicle operating cost saving in the long term.



Degree of Saturation



Average Delay



Level of Service

Figure 5.7: 2027 Future Demand & Future layout – D1675 / Afguns Rd PM peak hour

It is recommended that a detail design phase should be carried out as part of the traffic impact assessment for this project. During the detail design process various intersection upgrade options (roundabout, signals, sliplanes etc) will be tested and compared to ensure that the most optimum and cost-effective intersection upgrade are selected.

6. Impact Assessment – IA Rating

The following section will discuss the IA Rating for the construction, operational and de-commissioning phase for Medupi FGD process.

Table 6.1: IA Rating for Construction Phase

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Traffic Impact	Direct Impact:	Existing	3	4	4	1	11 - HIGH	Upgrade the existing road intersections as described in Chapter 5, which will improve the LOS from F (worse) to B or A (A being the best).	Current LOS at the intersections is already at a LOS F due to high traffic volumes.
	Impact of additional generated traffic due to the construction phase on existing road layout and road users. Nelson Mandela Dr / D1675 Intersection and D1675 / Afguns Rd Intersection.	Cumulative	3	1	8	1	12 - HIGH		With the additional traffic generated during the operational phase, the delay at these intersections will increase.
		Residual	3	3	1	0.1	1 - LOW		With the road upgrades at the two intersections the LOS will improve from a LOS F to B or A.

Table 6.2: IA Rating for Operational Phase

OPERATIONAL PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Traffic Impact	Direct Impact:	Existing	3	4	8	1	15 - HIGH	Upgrade the existing road intersections as described in Chapter 5, which will improve the LOS from F (worse) to B or A (A being the best).	Current LOS at the intersection is already at a LOS F due to high traffic volumes.
	Impact of additional generated traffic during operational phase of the FGD plant on the existing road layout and road users. Nelson Mandela Dr / D1675 Intersection and D1675 / Afguns Rd Intersection.	Cumulative	3	5	16	1	24 - FLAW		With the additional traffic generated during the operational phase the LOS (delay) at these intersections will be worse.
		Residual	3	3	1	0.1	1 - LOW		The road upgrades will improve the LOS from F to B or A (A being the best, no delays).
Transort of Limestone	Indirect Impact:	Existing	4	3	4	0.1	1 - LOW	It is suggested that trucks delivering limestone to Medupi Power Station should utilise the Afguns Road in order to have a minimal impact on other road users. By utilising the Afguns - Thabazimbi road, the trucks will avoid travelling through Lephalale town and avoid other busy nodes within the study area.	Truck traffic on SA roads impacts on road condition, safety, travel time and vehicle operating cost. They have a negative impact on other road users.
	Impact of the transport of Limestone from the limestone sources.	Cumulative	4	4	8	0.75	12 - HIGH		Increase in truck traffic on the various roads between Medupi and Limestone sources, could have a negative impact on the road condition, travel times and traffic volumes.
		Residual	4	3	4	0.2	2 - LOW		It is suggested that trucks delivering limestone should utilise the Afguns Rd in order to have a minimal impact on other road users.
Transport of Salts and Sludge	Indirect Impact:	Existing	4	3	4	0.1	1 - LOW	It is suggested that trucks transporting salts and sludge to the waste facilities should utilise the Afguns Road in order to have a minimal impact on other road users. By utilising the Afguns - Thabazimbi road, the trucks will avoid travelling through Lephalale town and avoid other busy nodes within the study area. It is suggested that an Economic Evaluation study should be undertaken to select the most optimum facility.	Truck traffic on SA roads impacts on road condition, safety, travel time and vehicle operating cost. They have a negative impact on other road users.
	Impact of transport of salts and sludge to one of the four potential licensed hazardous waste facilities.	Cumulative	4	4	8	0.75	12 - HIGH		Increase in truck traffic on the various roads between Medupi and Limestone sources, could have a negative impact on the road condition, travel times and traffic volumes.
		Residual	4	3	4	0.2	2 - LOW		It is suggested that trucks transporting salts and sludge should utilise the Afguns Rd in order to have a minimal impact on other road users.

Table 6.3: IA Rating for Decommissioning Phase

DECCOMMISSIONING PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Traffic Impact	Direct Impact:	Existing	2	1	1	0.5	2 - LOW	Monitoring of intersection conditions and capacity	LOS at intersections should be at an acceptable level due to the road upgrades proposed for the construction phase
	Impact of reduction in traffic volumes due to decommisioning phase.	Cumulative	2	1	1	0.5	2 - LOW		Reduction in traffic volumes.
		Residual	2	1	1	0.1	0 - LOW		With the reduction in traffic volumes and the road upgrades the LOS will improve.

From the results in **Table 6.1, 6.2** and **6.3** it is evident that with the right mitigation measures the traffic and transport impact due to the Medupi FGD Plant will be low, and thus the project can proceed.

7. Conclusions and Recommendations

This Traffic impact assessment has reviewed the traffic impact of the proposed construction and operation phase of the Medupi Flue Gas Desulphurisation power plant.

The major findings and recommendations of this report can be summarised as follows:

- The following observations were made during the site visit:
  - Heavy pedestrian movement within the Medupi site, without any pedestrian sidewalk provision or crossings. It is recommended that safe and secure sidewalks should be provided for pedestrian movement within the plant.
  - Heavy vehicles travel slowly along the internal roads, causing delays for light vehicles since they can't overtake on the narrow roads. It is suggested that an internal mobility plan should be developed for Medupi Power Station, focusing on the movement of light vehicles, heavy vehicles, public transport and pedestrians.
- Analysis of the traffic counts indicated the following:
  - Nelson Mandela Drive/D1675 – There are a large number of light vehicles, minibus-taxis and buses exiting the Medupi Power Station via D1675 during the pm peak period. In the morning there are a large number of light vehicles, minibus-taxis and buses entering Medupi Power Station.
  - D1675/Afguns Road – There are only a few vehicles exiting and entering Afguns Road during the peak period, with most of the vehicles travelling north towards the Nelson Mandela Drive/D1675 intersection.
- The following is recommended during the construction period:
  - The trucks delivering building material to the site should follow a similar route as recommended for the trucking of limestone and salts and sludge in **Section 4.1** and **Section 4.2.**
  - There should be a pointsman at the intersection of D1675 / Afguns Rd and Nelson Mandela Drive / D1675 during the peak hours to alleviate the traffic congestion and assist the northbound traffic.
  - Undertake an assessment study with regards to the proposed weigh bridge design and determine whether it may cause queuing to back up onto the public road, which will have an impact on other road users.
- From the Baseline traffic impact assessment, the following were decided upon with regards to the transport of products to and from the facility:
  - Ash and gypsum will be conveyed to the existing Northern Ash Disposal Facility and therefore this process will generate no additional traffic impacts.
  - The sludge and salts will go to an existing licensed hazardous waste facility.
- It is suggested that the trucks delivering limestone to Medupi Power Station could utilise the Afguns Road in order to have a minimal impact on other road users. By utilising the Afguns – Thabazimbi road, the trucks will avoid travelling through Lephalale town and avoid other busy nodes within the study area. It is suggested that trucks travel from Medupi Power Station to Thabazimbi via the Afguns road and the R510, to Vereeniging

via the Afguns road, R510, R517, N1, N3 and R59 and to Marble Hall via Afguns road, R510, R517, N1 and the N11. However, if the trucks will not be able to use the Afguns road, an additional traffic impact assessment should be undertaken to determine the impact of the trucks travelling through Lephalale.

- The contractor would be responsible to discuss the trucking with the relevant roads agency to ensure that all legal requirements are met.
- At the time of the assessment the final location for the disposal of salts and sludge has not been confirmed. It is suggested that the trucks follow similar routes as described for the transport of limestone in **Section 4.1**, onto the N1 and then onto the various routes that are necessary to reach the hazardous waste facility.
- 10 Year Post development traffic analyses have indicated that both intersections, Nelson Mandela Drive / D1675 and Afguns Rd / D1675 have poor levels of service for the northbound movement. The following road layout changes are proposed:
  - Nelson Mandela Dr / D1675:
    - Provide signals;
    - Add a left turning slip lane along D1675 (northbound);
    - The introduction of a right turning lane for the northbound right movement;
    - Provision of an additional eastbound lane for the straight movement.
    - It is recommended that the relevant road authority should fund the upgrade of this intersection, since the existing intersection is already operating at a LOS F.
  - Afguns Rd / D1675 – It is recommended that the priority control intersection should be upgraded, this study is only looking at conceptual design and it is recommended that a detail design study should be undertaken at this intersection to determine the best upgrade option (i.e. roundabout, increase of capacity etc. depending on the size of the trucks).
- It is recommended that a detail design phase should be carried out as part of the traffic impact assessment for this project. During the detail design process various intersection upgrade options (roundabout, signals, slip lanes etc.) will be tested and compared to ensure that the most optimum and cost-effective intersection upgrade is selected.

ZITHOLELE CONSULTING

WASTE ASSESSMENT OF ASH AND FLUE GAS DESULPHURISATION WASTES FOR THE MEDUPI POWER STATION

REPORT

Report No.: JW197/14/E173 – REV 02

Eskom SPF #: 200-150873

January 2015

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DOCUMENT APPROVAL RECORD

Report No.: JW197/14/E173 – REV 02

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Prepared	Environmental Scientist	Craig Campbell	October 2014	
Reviewed	Director	Marius van Zyl	November 2014	
Reviewed	Senior Scientist	L Potter	November 2014	
Approved	Director	John Glendinning	November 2014	

RECORD OF REVISIONS AND ISSUES REGISTER

Date	Revision	Description	Issued to	Issue Format	No. Copies
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21 Nov 2014	B	Draft for internal review	L. Potter	Electronic	NA
28 Nov 2014	00	Draft for external review	Zitholele Consulting	Electronic	NA
13 Jan 2015	01	Draft for external review	Zitholele Consulting	Electronic	NA
29 Jan 2015	02	Final report	Zitholele Consulting	Electronic	NA

EXECUTIVE SUMMARY

Eskom's Medupi Power Station will be fitted with a Flue Gas Desulphurisation (FGD) Plant to manage sulphur dioxide emissions from the Power Station. Currently the FGD Plant is being designed and authorised under the National Environmental Management Act (NEMA, Act 107 of 1998). The FGD Plant and the FGD Waste Water Treatment Plant operation will generate three waste streams that required assessment in terms of the "*National Norms and Standards for the Assessment of Waste for Landfill Disposal*" (National Norms and Standards) of the Department of Environmental Affairs (DEA) (DEA, 2013a). As it is proposed to dispose some of these wastes on the same landfill as the ash from the power station, the ash was also assessed in terms of the National Norms and Standards.

The three waste streams to be generated by the FGD Plant and the FGD Waste Water Treatment Plant operation are:

- **FGD Gypsum**: The FGD process uses finely ground limestone mixed with water to form a slurry. The slurry is sprayed into an absorber tank where it reacts with the flue gas. The calcium carbonate in the lime slurry reacts with sulphur dioxide in the flue gas and gypsum is precipitated as per the following reactions:
  - $CaCO_{3\ (aq)} + SO_{2\ (g)} \rightarrow CaSO_{3\ (aq)} + CO_2$
  - $CaSO_{3\ (aq)} + \frac{1}{2} O_{2\ (g)} \rightarrow CaSO_4.2H_2O_{\ (s)}$ (gypsum).

  In the case of the Medupi Power Station two limestone qualities are considered for usage, namely an 85% limestone and a 96% limestone.
- **FGD Waste Water Treatment Plant Sludge**: The wastewater from the absorber tank is flocculated in a clarifier. The underflow from the clarifier is fed through a filter press to recover the sludge. The sludge from the process is referred to as the FGD Waste Water Treatment Plant (WWTP) Sludge.
- **FGD Waste Water Treatment Plant Crystalliser Solids**: The crystalliser uses evaporation to cause precipitation of salts from the wastewater (brine) after flocculation and the clarifier process. The liquid from the crystalliser is of a high enough quality to be re-used in the process, resulting in a Zero Liquid Discharge (ZLD) system, but the FGD Waste Water Treatment Plant Crystalliser Solids (FGD WWTP Crystalliser Solids) require disposal.

The FGD Waste Water Treatment Plant process is illustrated in **Figure A**.

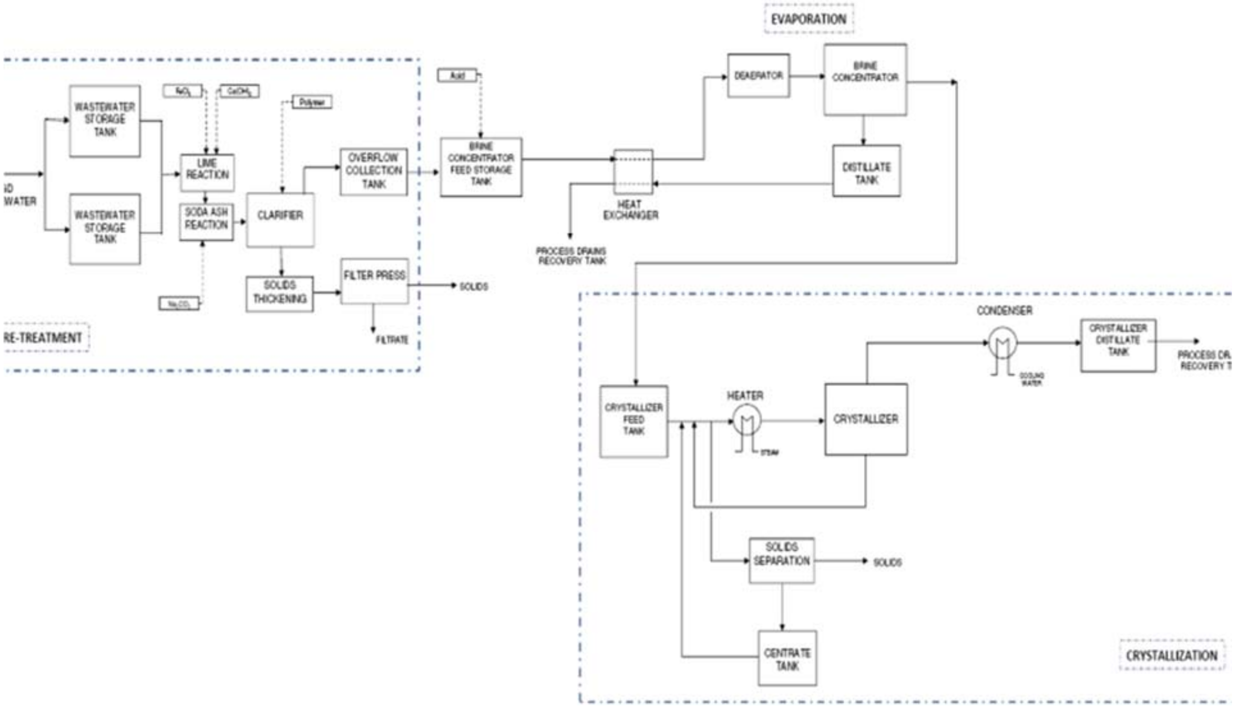

Figure A: Process Flow Diagram of the FGD Waste Water Treatment Plant

Jones & Wagener (Pty) Ltd (J&W) was requested to undertake the waste assessments for the disposal of the above wastes and the Power Station's ash in order to determine the classes of landfills required for the safe disposal of the various wastes.

The ash, FGD gypsum, FGD WWTP Sludge and FGD WWTP Crystalliser Solids were assessed for disposal according to the National Norms and Standards as per Government Notice Regulations 635 of the National Environmental Management: Waste Act, Act 59 of 2008, as amended. For this project, samples of the Matimba Power Station ash, which also contain some brine from the water treatment plant facility, was used for the assessment of the coal derived waste. For the assessment of the FGD gypsum, FGD WWTP Sludge and Crystalliser Solids information was obtained from Eskom, Black & Veatch and other sources, notable the VGD Powertech Journal published by VGD Powertech, the European Technical Association for power and heat generation, and the Electric Power Research Institute (USA) and L. Chen and co-workers/authors, who did significant research work on FGD derived gypsum in the United States of America. Reliance was also made on information obtained from work carried out by J&W and En-Chem for the Kusile Power Station. It is noted that the assessments for especially the FGD WWTP Sludge and FGD WWTP Crystalliser Solids should be regarded as provisional as such wastes are not yet generated in South Africa.

The Matimba Power Station ash was assessed as a Type 3 waste requiring disposal on a Class C landfill. The ash to be generated by the Medupi Power Station should have similar characteristics as that of the Matimba Power Station as the coal for both power stations are obtained from the same coal field. The assessment was based on chemical analyses and leach tests carried out on ash samples obtained from the Matimba Power Station.

The FGD Gypsum was assessed as a Type 3 waste and may be disposed of on a Class C landfill. The assessment was based on chemical analyses of FGD Gypsum generated elsewhere in the world, such as the USA.

The FGD WWTP sludge was classified as either a Type 1 or Type 2 waste and would require disposal in a Class A or Class B landfill for material produced using the 96% calcium carbonate limestone and the 85% calcium carbonate limestone respectively. As there is a considerable amount of uncertainty regarding the composition of the two sludges and their assessments for disposal, it is proposed that the 85% calcium carbonate limestone sludge also be disposed of in a Class A landfill as a Class A landfill provides the highest level of environmental protection.

The FGD WWTP Crystalliser Solids was assessed as a Type 1 waste due to the likely leachable TDS concentrations as a result of the high concentration of sodium chloride in the solid material, and will need to be disposed of in a Class A landfill. The 85% and 96% limestone derived FGD WWTP Sludges and FGD WWTP Crystalliser Solids are waste materials generated from the treatment of FGD wastewater and as such should have similar chemical characteristics.

The Class A landfill offers the highest level of environmental protection of any landfill barrier system used in South Africa taking this into account and given the similar chemical characteristics of the 85% and 96% limestone derived FGD WWTP Sludges and Crystalliser Solids, it is proposed that these waste materials be disposed of in a single newly designed and constructed Class A landfill at the Medupi Power Station.

Table 1: Summary of waste assessment results and

Waste	Assessment and Class of Landfill required for disposal	Percentage of waste (%)
Ash	Type 3 waste – Class C Landfill	79 or 68
FGD Gypsum	Type 3 waste – Class C Landfill	19 or 29
FGD WWTP Sludge 85% Limestone	Type 2 waste – Class A landfill*	2.4
FGD WWTP Sludge 96% Limestone	Type 1 waste – Class A landfill	1.4
FGD WWTP Crystalliser Solids	Type 1 waste – Class A landfill	0.72 or 0.62
*** The Type 2 assessment was based on theoretical values and therefore a conservative approach should be followed and the 85% Limestone FGD WWTP Sludge should be disposed of on a Class A landfill until the assessments can be confirmed on actual waste samples.**		

Based on the outcome of the assessments, it is recommended that:

- The Medupi Power Station ash and the FGD Gypsum be disposed of on a waste disposal facility of which the barrier system complies with the performance requirements of a Class C landfill.
- The 85% limestone derived FGD WWTP Sludge is provisionally assessed as a Type 2 waste but should be disposed of on a waste disposal facility of which the barrier system complies with the performance requirements of a Class A landfill due to the considerable amount of uncertainty regarding the composition of the sludge at this point in time.
- The 96% limestone derived FGD WWTP Sludge is provisionally assessed as a Type 1 waste and should be disposed of on a waste disposal facility of which the barrier system complies with the performance requirements of a Class A landfill.
- The FGD WWTP Crystalliser Solids should be disposed of on a waste disposal facility of which the barrier system complies with the performance requirements of a Class A landfill. The FGD WWTP Sludge and the FGD WWTP Crystalliser Solids may be disposed of on the same Class A landfill.

- The three FGD waste streams should be re-assessed once generated in order to confirm the theoretical assessments.
- Once the wastes are generated, leach tests should be conducted on various percentage combinations of the wastes. J&W recommends that column leach tests be conducted. The outcome of the column leach tests can then be used to motivate for the combined disposal of all three wastes or combinations thereof on a Class C landfill or other suitable class of landfill.

Marius van Zyl

Acronyms and abbreviations used in this document:

ASLP	Australian Standard Leaching Procedure
DEA	Department of Environmental Affairs
DWS	Department of Water and Sanitation
DWAF	Department of Water Affairs and Forestry
MFA	Medupi Fly Ash
ℓ	litre
landfill	Waste disposal facility
HDPE	High Density Poly-Ethylene
LC	Leach concentration in mg/ℓ
LCT	Leach concentration threshold in mg/ℓ
mg/kg	Milligram per kilogram
mg/ℓ	Milligram per litre
SPLP	Synthetic Precipitation Leaching Procedure
TC	Total concentration in mg/kg
TCLP	Toxicity Concentration Leach Procedure
TCT	Total concentration threshold in mg/kg
TDS	Total dissolved salts
µS/cm	Micro Siemens per centimetre

CONTENTS PAGE

1. INTRODUCTION 1

1.1 Background 1
1.2 Objectives of the Project 2

2. WASTE ASSESSMENT SYSTEM 4

2.1 Background 4
2.2 Waste Assessment for Disposal to Landfill 4
2.3 Containment Barrier Designs 5

3. WASTE ASSESSMENT METHODOLOGY 9

3.1 Ash Assessment 9
3.2 Flue Gas Desulphurisation Gypsum 9
3.3 FGD WWTP Sludge 10
3.4 FGD WWTP Crystalliser Solids 10

4. ASSESSMENTS 11

4.1 Ash 11
4.2 FGD Gypsum 13
4.3 FGD WWTP Sludge 16
4.4 FGD WWTP Crystalliser Solids 20

5. COMBINED DISPOSAL OF SIMILAR WASTE STREAMS 25

5.1 Ash and FGD Gypsum 25
5.2 85 and 96% FGD WWTP Sludge and Crystalliser Solids 26

6. SUMMARY 26

7. RECOMMENDATIONS 27

8. REFERENCES 28

APPENDICES

Appendix A

Calculations of total concentrations in FGD WWTP sludge and FGD WWTP Crystalliser SOLIDS

Appendix B

Laboratory Results for matimba ash

Appendix C

Literature values for Fgd Gypsum total elemental concentrations

List of Tables

Table 2-1: Organic compounds and Pesticides Total concentration limits for Type 4 Wastes 5
Table 4-1: TCs of metal ions and inorganic anions in Matimba Fly Ash 11
Table 4-2: LCs for Matimba Fly Ash (DI Water Leach) 12
Table 4-3: Predicted total concentrations of salts and inert material in the FGD Gypsum solids and assumptions regarding their solubility 14
Table 4-4: Measured LCs in SPLP and TCLP tests on FGD Gypsum 14
Table 4-5: LCs of inorganic anions used for the assessment (measured and calculated) 15
Table 4-6: Predicted total concentrations of metal ions and inorganic anions in the FGD WWTP Sludge 17
Table 4-7: Predicted concentrations of salts and inert material in the FGD WWTP Sludge and assumptions regarding their solubility 18
Table 4-8: Calculated leachable concentrations of metals ions and major ions for FGD WWTP Sludge 19
Table 4-9: Predicted total concentrations of metal ions and inorganic anions in the FGD WWTP Crystalliser Solids 22
Table 4-10: Predicted major ion concentrations in FGD WWTP Crystalliser Solids 23
Table 4-11: Predicted LCs from FGD WWTP Crystalliser Solids 24
Table 5-1: FGD Gypsum and Ash leachable pH 25
Table 6-1: Summary of waste assessment results 27

List of Figures

Figure 1-1: FGD Waste Water Treatment Plant Flow Diagram 3
Figure 2-1: Class A Landfill Barrier System (DEA, 2013b) 6
Figure 2-2: Class B Landfill Barrier System (DEA, 2013b) 7
Figure 2-3: Class C Landfill Barrier System (DEA, 2013b) 7
Figure 2-4: Class D Landfill Barrier System (DEA, 2013b) 8

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ZITHOLELE CONSULTING

WASTE ASSESSMENT OF ASH AND FLUE GAS DESULPHURISATION WASTES FOR THE MEDUPI POWER STATION

<u>REPORT NO: JW197/14/E173 – REV 02</u>

1. INTRODUCTION

1.1 Background

Eskom's Medupi Power Station, currently being constructed, will be fitted with a Flue Gas Desulphurisation (FGD) Plant to manage sulphur dioxide emissions from the Power Station. Currently the FGD Plant is being designed and authorised under the National Environmental Management Act (NEMA, Act 107 of 1998). The FGD Plant and the FGD Waste Water Treatment Plant operation will generate three waste streams that required assessment in terms of the "*National Norms and Standards for the Assessment of Waste for Landfill Disposal*" (National Norms and Standards) of the Department of Environmental Affairs (DEA) (DEA, 2013a). As it is proposed to dispose some of these wastes with the ash from the power station, the ash also needed to be assessed in terms of the National Norms and Standards.

The waste streams to be generated in the FGD Plant will be treated in a FGD Waste Water Treatment Plant – see **Figure 1-1**. The three waste streams to be generated by the FGD Plant and the FGD Waste Water Treatment Plant operation are:

- **FGD Gypsum**: The FGD process uses finely ground limestone mixed with water to form a slurry. The slurry is sprayed into an absorber tank where it reacts with the flue gas. The calcium carbonate in the lime slurry reacts with sulphur dioxide in the flue gas and gypsum is precipitated as per the following reactions:

  - $CaCO_{3\ (aq)} + SO_{2\ (g)} \rightarrow CaSO_{3\ (aq)} + CO_2$
  - $CaSO_{3\ (aq)} + \frac{1}{2} O_{2\ (g)} \rightarrow CaSO_4.2H_2O_{\ (s)}$ (gypsum).

  In the case of the Medupi Power Station two limestone qualities are considered for usage, namely an 85% limestone and a 96% limestone.

- **FGD Waste Water Treatment Plant Sludge**: The wastewater from the absorber tank is flocculated in a clarifier. The underflow from the clarifier is fed through a filter press to recover the sludge. The sludge from the process is referred to as the FGD Waste Water Treatment Plant (WWTP) Sludge.

- **FGD Waste Water Treatment Plant Crystalliser Solids**: The crystalliser uses evaporation to cause precipitation of salts from the wastewater (brine) after flocculation and the clarifier process. The liquid from the crystalliser is of a high enough quality to be re-used in the process, resulting in a Zero Liquid Discharge (ZLD) system, but the FGD Waste Water Treatment Plant Crystalliser Solids (FGD WWTP Crystalliser Solids) require disposal.

1.2 Objectives of the Project

Jones & Wagener (Pty) Ltd (J&W) was requested to undertake the waste assessments for the disposal of the FGD wastes and the power station ash in order to determine the class of landfill the wastes require disposal onto.

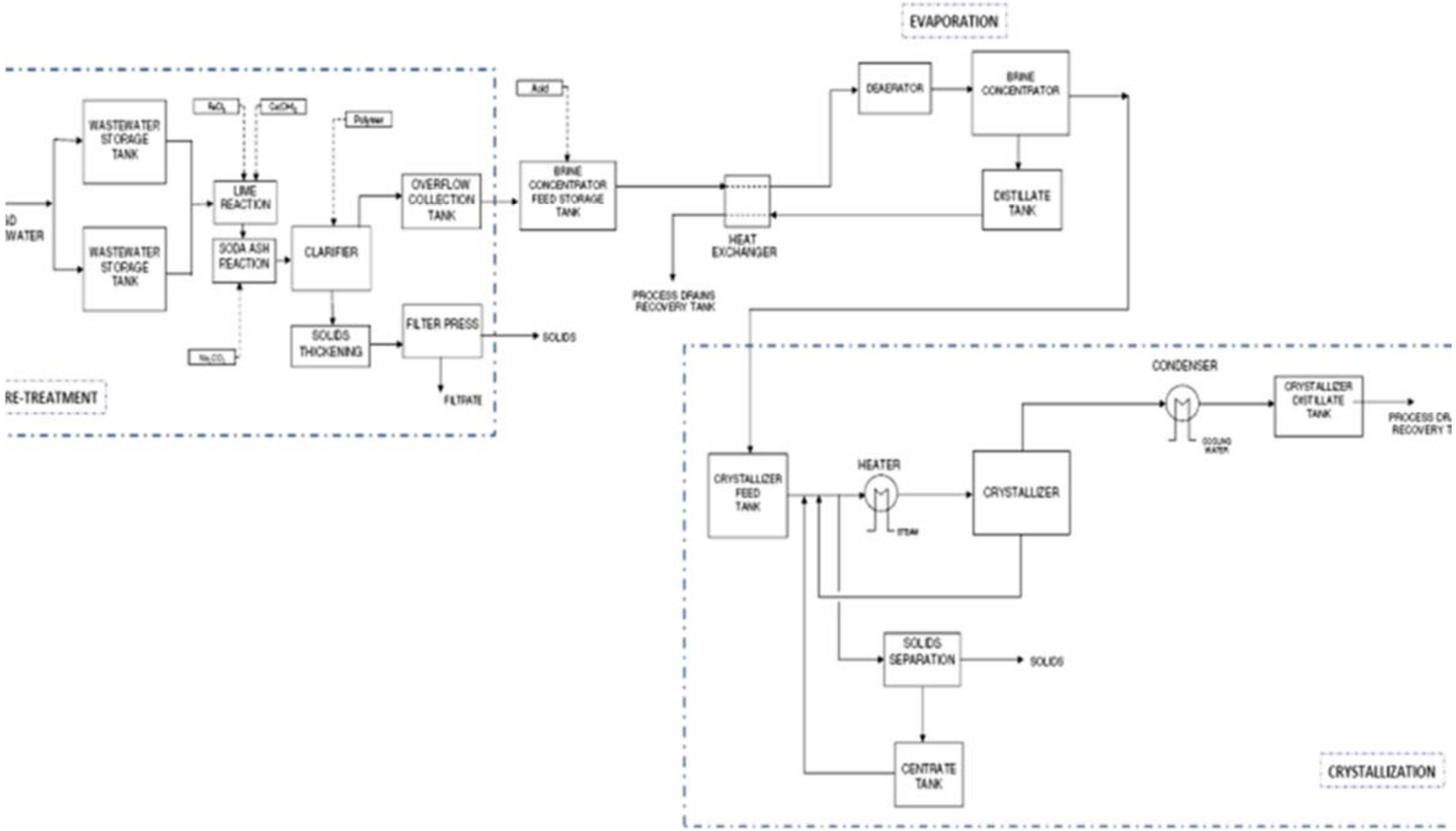

Figure 1-1: FGD Waste Water Treatment Plant Flow Diagram

2. WASTE ASSESSMENT SYSTEM

2.1 Background

The management of waste in South Africa is governed under the National Environmental Management: Waste Act, Act 59 of 2008, as amended (NEM:WA). On 23 August 2013 the "*Norms and Standards for the Assessment of Waste for Landfill Disposal*" (National Norms and Standards) were promulgated in the form of Government Notice Regulations (GNR) 635 (DEA, 2013a). These regulations are used to assess the potential impacts that a waste may have on the receiving water environment and the outcome of the assessment is used to determine the barrier (liner) system required for the waste disposal facility. The barrier systems are prescribed in GNR 636 of August 2013, the "*National Norms and Standards for Disposal of Waste to Landfill*" (DEA, 2013b)

2.2 Waste Assessment for Disposal to Landfill

The South African waste assessment system is based on the Australian State of Victoria's waste classification system for disposal, which uses total concentrations (TCs) of a range of elements in the solid waste and the Australian Standard Leaching Procedure (ASLP) to determine the leachable concentrations (LCs) of pollutants (DEA, 2013a).

The TCs can be determined by suitable and accredited methods for assessing the total concentration of the elements and/or organic compounds listed in Section 6 of the regulations.

With respect to Leachable Concentrations (LCs) a number of leach solutions can be used. For waste to be disposed with putrescible organic matter, an acetic acid leach solution is used. This leach solution is very similar to the US EPA Toxicity Characteristic Leaching Procedure (TCLP) leach solution used in the now outdated Minimum Requirements, except that the pH is 5.0, instead of pH 4.93.

In cases where non-organic wastes, such as the FGD gypsum, is to be co-disposed with other non-organic wastes, a basic 0.10 M sodium tetraborate decahydrate (borax) solution of pH 9.2 ± 0.10 should be used in addition to the acetic acid leach (DEA, 2013a). The objective of the sodium tetraborate test is to identify contaminants that are leached above the various leachable concentration thresholds (LCTs) trigger values at a high pH.

For non-putrescible inorganic waste, such as the coal derived ash, to be disposed of without any other wastes (mono- disposal scenario), reagent water (distilled water) is used as a leach reagent.

Once the total concentration and leachable concentrations have been determined they are compared to total concentration thresholds (TCTs) and leachable concentrations thresholds (LCTs) to assess the waste as either Type 0, Type 1, Type 2, Type 3 or Type 4 wastes according to the following:

- Wastes with any element or chemical substance concentration above the LCT3 or TCT2 values (LC >LCT3 or TC>TCT2) are Type 0 Wastes. Type 0 wastes require treatment/stabilisation before disposal;
- Wastes with any element or chemical substance concentration above the LCT2 but below LCT3 values, or above the TCT1 but below TCT2 values (LCT2<LC ≤ LCT3 or TCT1<TC ≤ TCT2), are Type 1 Wastes must be disposed of in a Class A landfill constructed with the most conservative barrier system.

- Wastes with any element or chemical substance concentration above the LCT1 but below the LCT2 values and all concentrations below the TCT1 values (LCT1 < LC ≤ LCT2 and TC ≤ TCT1) are Type 2 Wastes, which must be disposed of on a Class B landfill.
- Wastes with any element or chemical substance concentration above the LCT0 but below or equal to the LCT1 limits and all TC concentrations below or equal to the TCT1 limits (LCT0 < LC < LCT1 and TC < TCT1) are Type 3 Wastes and must be disposed of in a Class C landfill.
- Wastes with all element and chemical substance concentration levels for metal ions and inorganic anions below or equal to the LCT0 and TCT0 limits (LC < LCT0 and TC < TCT0), and with all chemical substance concentration levels also below the total concentration limits for organics and pesticides presented in **Table 2-1**, are Type 4 Wastes.

Table 2-1: Organic compounds and Pesticides Total concentration limits for Type 4 Wastes

Chemical Substances in Waste	Total Concentration (mg/kg)
Organics	
Total Organic Carbon	30 000 (35)
BTEX	6
PCBs	1
Mineral Oil (C10 to C40)	500
Pesticides	
Aldrin + Dieldrin	0.05
DDT+DDD+DDE	0.05
2,4-D	0.05
Chlordane	0.05
Heptachlor	0.05

- Wastes with all element or chemical substance leachable concentration levels for metal ions and inorganic anions below or equal to the LCT0 limits are considered to be Type 3 waste, irrespective of the total concentration of elements or chemical substances in the waste, provided that:
  - All chemical substance concentration levels are below the total concentration limits for organics and pesticides in **Table 2-1**;
  - The inherent physical and chemical character of the waste is stable and will not change over time; and,
  - The waste is disposed of to landfill without any other waste.
- Wastes with the TC of an element or chemical substance above the TCT2 limit, and where the concentration cannot be reduced to below the TCT2 limit, but the LC for the particular element or chemical substance is below the LCT3 limit, the waste is considered to be a Type 1 Waste.

2.3 Containment Barrier Designs

The barrier systems for waste disposal facilities were published in GNR 636 of August 2013 (DEA, 2013b). Apart from specifying the barrier systems, the GNR 636 regulations also list a number of important technical aspects which must be considered in the design of waste disposal barrier systems, such as:

- Total solute seepage (inorganic and organic) must be calculated in determining acceptable leakage rates and action leakage rates;

- Alternative elements of the barrier of proven equivalent performance may be considered in the design, such as the replacement of:-
  - granular filters or drains with geosynthetic filters or drains;
  - protective soil layers with geotextiles; or
  - clay components with geomembranes or geosynthetic clay liners;
- All drainage layers must contain drainage pipes of adequate size, spacing and strength to ensure atmospheric pressure within the drainage application for the service life of the waste disposal facility in order to prevent build-up of leachate on the barrier system.

2.3.1 Class A Landfill

The Class A landfill barrier system is presented in **Figure 2-1**. This type of landfill barrier is required for Type 1 wastes and consists of a double composite barrier system and is very similar to that of H:H landfills as specified in the *Minimum Requirements for Waste Disposal by Landfill* (2nd Ed., Department of Water Affairs and Forestry, 1998).

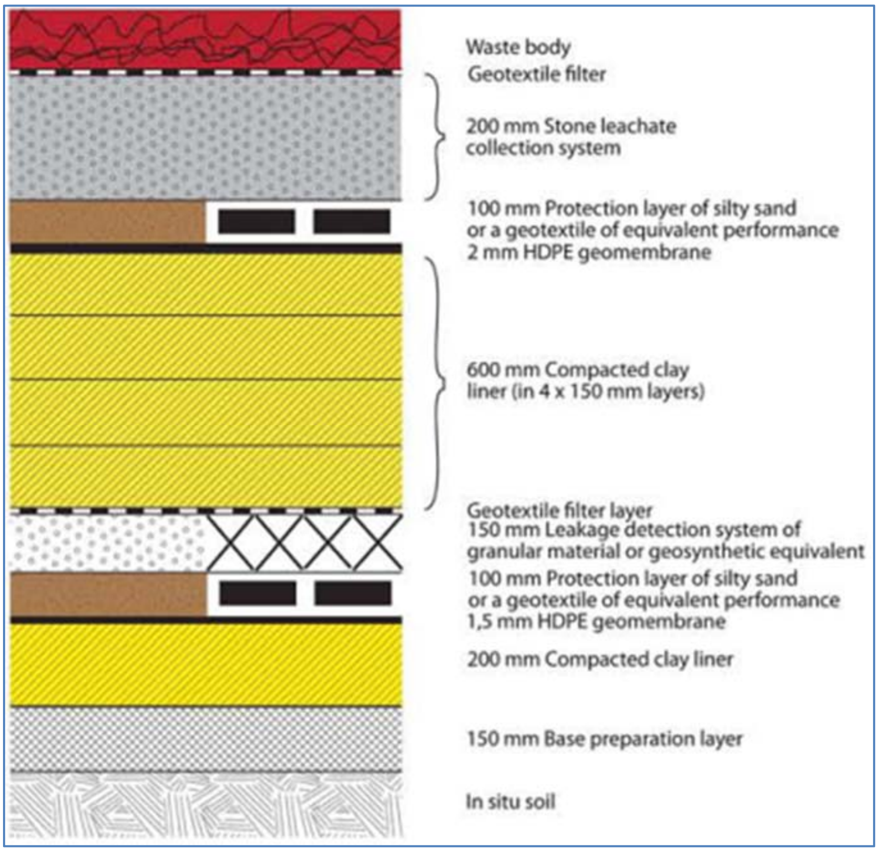

Figure 2-1: Class A Landfill Barrier System (DEA, 2013b)

2.3.2 Class B Landfill

The Class B landfill barrier system is presented in **Figure 2-2**. This type of landfill is required for Type 2 wastes and consists of a single composite barrier system of which the clay component consists of 4 x 150 mm layers.

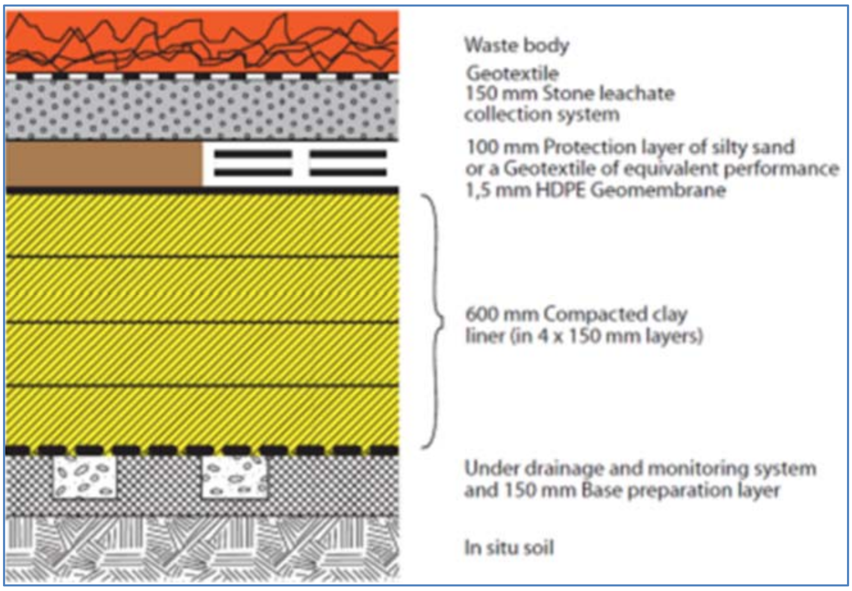

Figure 2-2: Class B Landfill Barrier System (DEA, 2013b)

2.3.3 Class C Landfill

The Class C landfill barrier system is presented in **Figure 2-3.** This type of landfill is required for the disposal Type 3 wastes to landfill and also consists of a one single composite barrier system. In this case the clay component of the barrier system is only 300 mm thick.

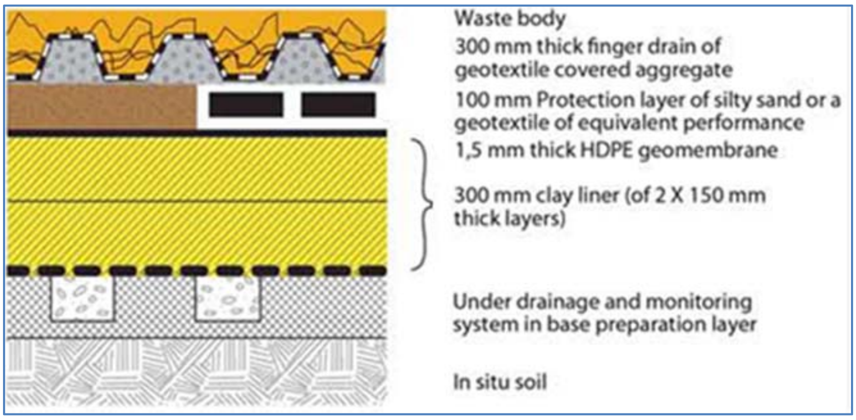

Figure 2-3: Class C Landfill Barrier System (DEA, 2013b)

2.3.4 Class D Landfill

The Class D landfill barrier system is presented in **Figure 2-4.** This type of landfill is required for the disposal of Type 4 wastes (or inert wastes) and consist of in-situ compacted material. This landfill class does not have a formal barrier system.

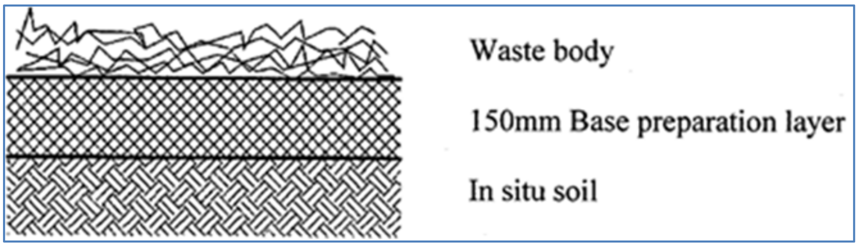

Figure 2-4: Class D Landfill Barrier System (DEA, 2013b)

3. WASTE ASSESSMENT METHODOLOGY

3.1 Ash Assessment

As the Medupi Power Station is not yet operational, ash generated from Eskom's Matimba Power Station was sampled and analysed. The Medupi Power Station will also burn coal from the Grootegeluk mine and the Matimba Power Station ash was therefore selected as a suitable analogue for testing.

Three ash samples from the Matimba Power Station's load out discharge point were collected and analysed in the following way:

- Aqua Regia digestion with analysis of relevant elements by ICP-MS to determine the total concentrations of elements in the ash. The total inorganic elemental concentrations (TCs) were compared to the total concentration threshold (TCT) limits in the norms and standards (DEA, 2013a). As the ash is a product of full combustion it was not considered necessary to determine the concentrations of organic compounds in the ash as their concentrations would be negligible.
- Deionised water leach of the samples at a 1:20 Solid:Liquid ratio as per the Australian Standards AS 4439.1 to AS 4439.3 (Standards Australia, 1997 and 1999). The total leachable concentrations of inorganic constituents were compared to the leachable concentration threshold limits (LCTs) in the Norms and Standards (DEA, 2013a). As the ash will generate an alkaline leach solution and will not turn acidic in the field neither the alkaline nor acidic leach procedures in the Australian Leach procedure are appropriate for assessment of the ash. A deionised water leach was specified instead of the TCLP or borax leachates because the waste is alkaline in nature and if other wastes are co-disposed with it such as the FGD gypsum, which is also alkaline, the waste body will not become acidic and a high pH leach will not add any value as the wastes are already alkaline.

As the ash was taken at the ash load-out point at the ash disposal facility, the ash also contained demineraliser plant effluent, which is added for dust suppression purposes.

3.2 Flue Gas Desulphurisation Gypsum

As the FGD plant is not currently operational it was not possible to undertake laboratory analysis on the actual FGD Gypsum that will be produced. Therefore the assessment was undertaken using literature values from the USA and Europe. The following data sources were used for the assessment.

Total elemental concentrations and summary data from analysis of a total of 53 FGD gypsum samples:

- Four samples of FGD Gypsum analysed and presented by Chen et al. 2012;
- The maximum values from the summary data for the analysis of 32 FGD gypsum samples presented in the Electric Power Research Institute of the USA's technical report on mixed and FGD gypsum composition (EPRI, 2011);
- The total elemental concentrations for 15 FGD gypsum samples presented by VGB (1990): Technical Scientific Report on the comparison of natural and FGD gypsum.
- One sample of FGD gypsum presented by En-Chem, 2008.
- Leachable concentrations were obtained from the following sources:
  - ♦ Synthetic precipitation leachate procedure concentrations for trace elements from the summary data for the analysis of 32 FGD gypsum

samples presented in the Electric Power Research Institute (EPRI, 2011)) USA's technical report on mixed and FGD gypsum composition. The SPLP test used a deionised water adjusted to pH 4.2 using a combination of sulphuric and nitric acids and is therefore a more conservative test than the deionised water leach test that would have been carried out under the DEA's National Norms and Standards.

- Toxicity Concentration Leach Procedure (TCLP) results for trace elements of one sample of FGD gypsum presented in En-Chem 2008. The TCLP procedure is similar to the acetic acid leach procedure in the Australian standards. Given that leaching of FGD Gypsum will result in a neutral to mildly alkaline solution this acidic leach result is considered a more conservative measure of leaching concentrations than what is required by the standard.
- The concentrations of leachable major ions were calculated based on the estimated concentrations (provided by Eskom and Black & Veatch) of gypsum and other salts in the solids. For gypsum and calcium carbonate literature solubility limits were used to predict leachable concentrations while for other salts it was assumed that 100% solubility would occur in the leach test.
- The concentration of TDS was calculated by summing the predicted leachable concentrations of major soluble components.

3.3 FGD WWTP Sludge

As with the FGD Gypsum no measured data was available for the Medupi FGD WWTP Sludge as the facility is not yet operational. In addition, no relevant sources of literature data could be found as the waste streams are not analysed by the industry as frequently as the FGD gypsum. Therefore the following approach was used for the FGD WWTP sludge:

- The total elemental concentrations of the FGD WWTP Sludge were calculated by the design engineers (Eskom and Black & Veatch, see **Appendix A**). These estimates were based on previous experience of the concentrations of total elements in the wastewater and the likely removal into the filter cake and crystalliser solids.
- The leachable concentrations of metals were calculated from the total fraction assuming full dissolution of 1 mg of solid material into 20 mℓ of water to simulate a 1:20 solid to liquid ratio used in the Australian Leach method.
- The solubility limits for calcium carbonate, gypsum and magnesium carbonate were used to predict leachable concentrations of major ions.
- The TDS concentrations were calculated using the sum of major leachable concentrations.

3.4 FGD WWTP Crystalliser Solids

As with the FGD WWTP sludge, no measured or literature data was available for the FGD WWTP crystalliser solids as the facility is not operational. Therefore the following approach was used for the FGD WWTP Crystalliser Solids:

- The TCs of elements and major ions in the FGD WWTP crystalliser solids were calculated by the design engineers (Eskom and Black & Veatch, **see Appendix A**). These estimates were based on previous experience of the concentrations of total elements in the wastewater and the likely removal into the filter cake and crystalliser solids.

- The LCs of all parameters were calculated from the total fraction assuming full dissolution of 1 mg of solid material into 20 mℓ of water to simulate a 1:20 solid to liquid ratio used in the Australian Leach method.
- The TDS concentrations were calculated using the sum of leachable concentrations.

4. ASSESSMENTS

4.1 Ash

4.1.1 Total Concentrations

The results for the total concentrations from the laboratory analysis of the three Matimba Fly Ash samples are provided in **Table 4-1** (the laboratory analytical certificates are provided in **Appendix B**).

- The TCT0 threshold concentrations were exceeded for barium and fluoride in all three samples, and mercury in one of the three samples.
- Most values were below the detection limits of the analytical method.
- There were no exceedances of the TCT1 or TCT2 thresholds in any samples.

Table 4-1: TCs of metal ions and inorganic anions in Matimba Fly Ash

Total Concentration	Total Concentration Thresholds (mg/kg)			Matimba Fly Ash Total concentrations by the Aqua Regia test (mg/kg)		
	TCT0	TCT1	TCT2	MFA-1	MFA-2	MFA-2
Metal Ions						
Arsenic	5.8	500	2 000	<4	<4	<4
Boron	150	15 000	60 000	42	38	34
Barium	62.5	6 250	25 000	388	346	356
Cadmium	7.5	260	1040	3.2	4.4	2
Cobalt	50	5 000	20 000	<10	<10	<10
Chromium (Total)	46 000	800 000	NA	54	38	33
Chromium (VI)	6.5	500	2000	<5	<5	<5
Copper	16	19 500	78 000	<10	<10	<10
Mercury	0.93	160	640	<0.4	<0.4	4.4
Manganese	1 000	25 000	100 000	357	339	312
Molybdenum	40	1 000	4 000	<10	<10	<10
Nickel	91	10 600	42 400	20	16	15
Lead	20	1 900	7 600	<4	<4	<4
Antimony	10	75	300	<4	<4	<4
Selenium	10	50	200	<4	<4	<4
Vanadium	150	2 680	10 720	27	16	<10
Zinc	240	160 000	640 000	50	42	37

Total Concentration	Total Concentration Thresholds (mg/kg)			Matimba Fly Ash Total concentrations by the Aqua Regia test (mg/kg)		
	TCT0	TCT1	TCT2	MFA-1	MFA-2	MFA-2
Inorganic anions						
Fluoride	100	10 000	40 000	296	285	346
Note – Blue shading indicates above the TC0 threshold						

4.1.2 Leachable concentrations

The results for the leachable concentrations from the laboratory analysis of three Matimba Fly Ash samples are provided in **Table 4-2**.

- The LCT0 threshold concentrations were exceeded for boron, chromium (VI) and molybdenum in all samples.
- There were no exceedances of LCT1, LCT2 or LCT3 thresholds in any samples.

Table 4-2: LCs for Matimba Fly Ash (DI Water Leach)

Elements & Chemical Substances in Waste	LCs thresholds (mg/ℓ)				Matimba Fly Ash (MFA) DI water leach (mg/ℓ)		
	LCT0	LCT1	LCT2	LCT3	MFA-1	MFA-2	MFA-3
Metal ions							
Arsenic	0.01	0.5	1	4	<0.005	<0.005	<0.005
Boron	0.5	25	50	200	0.535	0.501	0.515
Barium	0.7	35	70	280	0.062	0.08	0.067
Cadmium	0.003	0.15	0.3	1.2	<0.003	<0.003	<0.003
Cobalt	0.5	25	50	200	<0.025	<0.025	<0.025
Chromium (Total)	0.1	5	10	40	0.079	0.061	0.062
Chromium (VI)	0.05	2.5	5	20	0.073	0.061	0.060
Copper	2	100	200	800	<0.025	<0.025	<0.025
Mercury	0.006	0.3	0.6	2	<0.001	<0.001	<0.001
Manganese	0.6	25	50	200	<0.025	<0.025	<0.025
Molybdenum	0.07	3.5	7	28	0.095	0.089	0.091
Nickel	0.07	3.5	7	28	<0.025	<0.025	<0.025
Lead	0.01	0.5	1	4	<0.01	<0.01	<0.01
Antimony	0.02	1	2	8	<0.01	<0.01	<0.01
Selenium	0.01	0.5	1	4	<0.01	<0.01	<0.01
Vanadium	0.2	10	20	80	0.16	0.16	0.157
Zinc	5	250	500	2000	<0.025	<0.025	<0.025
Inorganic Anions							
TDS	1000	12 500	25 000	100 000	146	120	122
Chloride	300	15 000	30 000	120 000	<5	<5	<5
Sulfate	250	12 500	25 000	100 000	64	74	60
NO3 as N, Nitrate-N	11	550	1 100	4 400	<0.2	<0.2	<0.2

Elements & Chemical Substances in Waste	LCs thresholds (mg/ℓ)				Matimba Fly Ash (MFA) DI water leach (mg/ℓ)		
	LCT0	LCT1	LCT2	LCT3	MFA-1	MFA-2	MFA-3
F, Fluoride	1.5	75	150	600	<0.2	<0.2	<0.2
Note – Blue shading indicates above the LCT0 threshold							

4.1.3 Waste Assessment

As only TC0 and LTC0 thresholds were exceeded, it is predicted that the Medupi Ash will be a Type 3 waste requiring a Class C landfill barrier system **Figure 2-3** for disposal purposes.

The following assumptions have been made with regard to the assessment of the ash:

- The Matimba Power Station Ash has the same chemical properties as the ash that will be produced at the Medupi Power Station.
- The concentrations of any organic compounds in the ash will be negligible and therefore organic components have not been analysed.

4.2 FGD Gypsum

4.2.1 Total Concentrations

The full set of literature results for the total concentrations of trace elements in the FGD gypsum compared to the Total Concentration Thresholds (TCTs) are presented in **Appendix C**. The total concentrations of elements in the FGD gypsum at times exceeded the TCT0 concentrations but at no time were the TCT1 or TCT2 thresholds exceeded. The exceedances of the TCT0 thresholds are summarised below:

- **Arsenic**: The EPRI (2011) maximum value and Chen et al 2008 exceeded the TCT0 value.
- **Chromium (VI)**: Assuming total Chromium was equal to Chromium (VI) the total concentrations exceeded the TCT0 value for the maximum value of the EPRI dataset, one sample of the VGB dataset, and two of the values from Chen et al (2012) (Indiana and Alabama).
- **Lead**: One of the VGB samples and the En-Chem sample exceeded the TCT0 for lead.
- **Antimony**: The concentration of total antimony in the Indiana sample (Chen et al, 2012) exceeded the TCT0 for antimony.
- **Selenium**: The maximum value in the EPRI dataset, the sample from En-Chem and 2 samples from the VGB data set exceeded the TCT0 for selenium.
- **Fluoride**: Only the En-Chem dataset contained total concentration for fluoride, this value exceeded the TCT0 for fluoride.

The predicted total concentrations of salts in the gypsum (calculated by Eskom and Black & Veatch) are presented in **Table 4-3** along with the assumptions used to predict the leachable concentrations of the salts in the gypsum.

Table 4-3: Predicted total concentrations of salts and inert material in the FGD Gypsum solids and assumptions regarding their solubility

Component	Concentration (% dry weight)	Concentration mg/kg (dry weight)	Assumed solubility for prediction of leachable fraction (mg/ℓ)	Assumption
Gypsum	88.9	889 000	2 050	Literature solubility limit (CRC, 2005)
$CaCO_3$	2.8	28 000	6.6	Literature solubility limit (CRC, 2005)
$CaSO_3$	0.1	1 000	70	Total solubility 1 mg of FGD gypsum in 20 mℓ water
$MgCO_3$	0.3	3 000	150	Total solubility 1 mg of FGD gypsum in 20 mℓ water
Inert Material	7.9	79 000	0	Completely insoluble.
TDS	NA	NA	2 276.6	Sum of assumed solubility for major soluble components: gypsum, $CaCO_3$, $CaSO_3$, $MgCO_3$
Note: Values calculated by Eskom				

4.2.2 Leachable concentrations

The leachable concentrations are summarised in **Table 4-4** and **Table 4-5** for trace elements and inorganic ions respectively. The following summarises the results:

- The maximum values for boron, manganese and selenium in the EPRI dataset exceeded the LTC0s for those elements.
- The concentration of selenium in the TCLP leach test results (En-Chem, 2008) exceeded the LTC0 threshold.
- The predicted concentrations of sulphate and TDS exceed the LCT0 threshold.
- No exceedances of the LCT1, LCT2 or LCT3 thresholds were measured or predicted.

Table 4-4: Measured LCs in SPLP and TCLP tests on FGD Gypsum

Elements & Chemical Substances in Waste	Leachable Threshold (mg/L)				EPRI 2011 Maximum from SPLP (N=32) (mg/ℓ)	En-Chem 2008 TCLP (N=1) (mg/ℓ)
	LCT0	LCT1	LCT2	LCT3		
Arsenic	0.01	0.5	1	4	<0.005	<0.02
Boron	0.5	25	50	200	20.1	0.09
Barium	0.7	35	70	280	0.048	0.07
Cadmium	0.003	0.15	0.3	1.2	0.0019	<0.001
Cobalt	0.5	25	50	200	0.0106	0.25
Chromium Total	0.1	5	10	40	0.00109	<0.003
Chromium (VI)	0.05	2.5	5	20	0.00109	<0.01
Copper	2	100	200	800	0.0025	0.02
Mercury	0.006	0.3	0.6	2	-	<0.001
Manganese	0.6	25	50	200	7.52	0.04
Molybdenum	0.07	3.5	7	28	0.0289	0.007
Nickel	0.07	3.5	7	28	0.0094	0.007
Lead	0.01	0.5	1	4	0.00128	<0.01

Antimony	0.02	1	2	8	0.00142	<0.01
Selenium	0.01	0.5	1	4	0.47	0.06
Vanadium	0.2	10	20	80	0.00662	-
Zinc	5	250	500	2 000	0.0847	-
Note: Blue shading indicates above the LCT0 threshold						

Table 4-5: LCs of inorganic anions used for the assessment (measured and calculated)

Inorganic Anions	Leachable Thresholds (mg/L)				Calculated values Refer Table 4-1 (mg/ℓ)	EPRI 2011 DI water leach Measured values (mg/ℓ)	En-Chem 2008 TCLP Results Measured values (mg/ℓ)
	LCT0	LCT1	LCT2	LCT3			
TDS	1 000	12 500	25 000	100 000	2 277[1]	-	-
Chloride	300	15 000	30 000	120 000	-	76.9	5.2
Sulfate	250	12 500	25 000	100 000	1 481[1]	1 550	2 387
Fluoride	1.5	75	150	600	-	13.7	7.5
Note: 1: Refer to Table 4-3 assumptions regarding calculations. Blue shading indicates exceedance of the TCT0 threshold							

4.2.3 Waste assessment

Based on the assessment described above, the FGD gypsum is predicted to be a Class 3 waste and could therefore be disposed of in a landfill with a Class C barrier system (**Figure 2-3**).

The following assumptions have been made with regard to the assessment of the FGD gypsum:

- The ranges of values identified in the literature are representative of those that will be obtained from analysis of the Medupi Power Station FGD gypsum.
- Due to the inorganic nature of the gypsum, the concentrations of organic compounds in the gypsum would be negligible and were not assessed.
- The solubility limit for gypsum was assumed to be 2 050 mg/ℓ (CRC Handbook of Chemistry and Physics, 2005).
- The solubility limit for $CaCO_3$ was assumed to be 6.6 mg/ℓ (CRC Handbook of Chemistry and Physics, 2005)
- The calculated leachable concentration of sulphate was based on the assumed solubility limit of gypsum, complete solubility of $CaSO_3$ and total conversion of SO_3 to SO_4 in solution.
- The leachable TDS concentration was calculated by summing of the assumed solubility limits for gypsum and $CaCO_3$ and complete solubility of $CaSO_3$ and $MgCO_3$. It was assumed that trace element contribution to TDS was negligible.

4.3 FGD WWTP Sludge

Two scenarios were assessed for the FGD WWTP sludge that is using a limestone of 85% calcium carbonate and one of 96% calcium carbonate. The results of the calculations are presented in **Table 4-6** for TCs and Table 4-7 and **Table 4-8** for LCs. The predicted values from the Kusile project (En-Chem, 2008) are also presented in the tables, these values were generated using the same method that was used in this study.

4.3.1 Total concentrations

The estimated TCs, based on an 85% grade of limestone exceeded the TCT0 thresholds for barium, chromium (VI) (assuming all Chromium is in the +VI oxidation state) and mercury.

The estimated total concentrations based on a 96% grade of limestone exceeded the TCT0 thresholds for a larger range of elements than the 85% limestone grade. These elements were: barium, chromium (VI) (assuming all Chromium is in the VI oxidation state), cadmium, copper, mercury, lead, selenium and fluoride.

The TCs predicted in the Kusile project were typically lower than those predicted for the Medupi project with the exception of boron, which was predicted to be considerably higher than in the Medupi waste. TCT0 thresholds were exceeded for arsenic, boron and fluoride in the Kusile study (M-Tech, 2012).

Table 4-6: Predicted total concentrations of metal ions and inorganic anions in the FGD WWTP Sludge

Elements & Chemical Substances in Waste	Total concentration thresholds (mg/kg)			FGD WWTP Sludge – Medupi Estimates (mg/kg)		FGD WWTP Sludge – Kusile Estimates (M-Tech, 2012) (mg/kg)
	TCT0	TCT1	TCT2	96% limestone	85% limestone	
Metal Ions						
Arsenic	5.8	500	2 000	6.9	2.4	6.9
Boron	150	15 000	60 000	25	<1	405
Barium	62.5	6 250	25 000	582	282	
Cadmium	7.5	260	1040	11	5.0	0.57
Cobalt	50	5000	20 000	15	6.7	2.9
Chromium (Total)	46000	800 000	NA	46	22	6.9
Chromium (VI)[1]	6.5	500	2000	46	22	6.9
Copper	16	19 500	78 000	29	13	5.1
Mercury	0.93	160	640	3.7	1.8	0.11
Manganese	1 000	25 000	100 000	586	284	-
Molybdenum	40	1 000	4 000	<1	<1	-
Nickel	91	10 600	42 400	46	21	8.9
Lead	20	1 900	7 600	26	12	8.9
Antimony	10	75	300	<1	<1	-
Selenium	10	50	200	14	6.7	2.9
Vanadium	150	2 680	10 720	5.5	1.9	67
Zinc	240	160 000	640 000	86	40.6	6.9
Inorganic Anions						
Fluoride	100	10 000	40 000	212	74	743
Note – Data provided by Eskom, calculated values based on previous projects carried out by the design engineers. Blue shading indicates above the TCT0 threshold. [1]Chromium (VI) concentration based on assumption that all Chromium is in the +VI oxidation state						

Table 4-7: Predicted concentrations of salts and inert material in the FGD WWTP Sludge and assumptions regarding their solubility

Component	FGD WWTP Sludge 96% Grade (mg/kg dry wt)	Assumed solubility (mg/ℓ)	FGD WWTP Sludge 85% Grade (mg/kg dry wt)	Assumed solubility (mg/ℓ)	Assumption regarding solubility
Inert material	217 000	-	365 000	-	Insoluble
Gypsum	58 000	2 900	22 000	1 100	Completely soluble: 1 mg of FGD WWTP sludge in 20 mℓ water
$CaCO_3$	714 000	13	409 000	13	Based on solubility limit (CRC, 2005)
$CaSO_3$	11 000	550	4 000	200	Completely soluble: 1 mg of FGD WWTP sludge in 20 mℓ water
$Mg(OH)_2$	0	-	199 000	6.4	Based on solubility limit (CRC, 2005)

4.3.2 Leachable concentrations

The estimated total concentrations based on a 96% grade of limestone exceeded the LCT thresholds as follows:

- The LCT2 thresholds were predicted to be exceeded for cadmium and lead.
- The LCT1 thresholds were predicted to be exceeded for manganese and selenium.
- The LCT0 thresholds were predicted to be exceeded for TDS, sulphate, fluoride, arsenic barium, boron, cobalt, chromium, chromium VI, mercury, nickel and vanadium.

The estimated total concentrations based on an 85% grade of limestone exceeded the LCT thresholds as follows:

- The LCT1 concentrations were exceeded for cadmium and lead.
- The LCT0 threshold was exceeded for TDS, sulphate, fluoride, arsenic, barium, chromium, mercury, molybdenum, nickel and selenium.
- No exceedances of the LCT2 or LCT3 thresholds.

The LCT0 thresholds for arsenic, boron, cadmium, chromium, nickel, lead, selenium and vanadium were predicted to be exceeded in the Kusile study (M-Tech, 2012).

Table 4-8: Calculated leachable concentrations of metals ions and major ions for FGD WWTP Sludge

Elements & Chemical Substances in Waste	Leachable thresholds (mg/ℓ)				FGD WWTP Sludge – Medupi Estimates (mg/ℓ)		FGD WWTP Sludge – Kusile Estimates (mg/kg) (M-Tech, 2012)
	LCT0	LCT1	LCT2	LCT3	96% limestone	85% limestone	
Metal ions[1]							
Arsenic	0.01	0.5	1	4	0.35	0.12	0.34
Boron	0.5	25	50	200	1.2	<0.5	20
Barium	0.7	35	70	280	29	14	-
Cadmium	0.003	0.15	0.3	1.2	0.53	0.25	0.029
Cobalt	0.5	25	50	200	0.73	0.33	0.14
Chromium Total	0.1	5	10	40	2.3	1.1	0.34
Chromium (VI)	0.05	2.5	5	20	2.3	1.1	-
Copper	2	100	200	800	1.5	0.67	0.26
Mercury	0.006	0.3	0.6	2	0.18	0.088	0.006
Manganese	0.6	25	50	200	29	14	-
Molybdenum	0.07	3.5	7	28	<0.07	<0.07	-
Nickel	0.07	3.5	7	28	2.3	1.1	0.34
Lead	0.01	0.5	1	4	1.3	0.59	0.34
Antimony	0.02	1	2	8	<0.02	<0.02	-
Selenium	0.01	0.5	1	4	0.73	0.33	0.14
Vanadium	0.2	10	20	80	0.28	0.096	3.4
Zinc	5	250	500	2 000	4.3	2.0	0.34
Inorganic Anions							
TDS[2]	1 000	12 500	25 000	100 000	3 500	1 300	-
Sulfate[3]	250	12 500	25 000	100 000	1 600	1 800	-
Fluoride[1]	1.5	75	150	600	11	3.7	-

Notes: 1: Predicted leachable concentrations of metals/metalloids assume complete solubility of estimated total metal/metalloid concentrations presented in Table 4-6. 2: TDS concentration calculated as the sum of major soluble components summarised in Table 4-7. 3: Concentration based solubility assumptions for gypsum and $CaSO_3$ described in Table 4-7 and assuming all SO_3 converts to SO_4 in solution. Blue shaded values exceed LCT0 threshold. Purple shaded values exceed LCT1 thresholds. Orange Shaded values exceed the LCT2 thresholds

4.3.3 Waste assessment: FGD WWTP Sludge

The 96% limestone generated FGD WWTP Sludge is predicted to have exceedances of the TCT0 for a number of elements and exceedances of the LCT2 thresholds for cadmium and lead and would therefore be assessed as a Type 1 waste and would therefore require a Class A landfill barrier system for disposal (**Figure 2-1**).

The 85% limestone generated FGD WWTP sludge is predicted to have exceedances of the TCT0 and LCT1 thresholds for cadmium and lead and would therefore be assessed as a Type 2 waste requiring a Class B landfill barrier system for disposal **Figure 2-2**.

It should be noted that the predicted leachable concentrations are driving the assessment for both the 85% and 96% limestone and that those leachable concentrations are based on a highly conservative assumption that the trace element components of the FGD WWTP sludge are completely soluble. In reality trace elements that have been removed from the raw water by the treatment process are likely to be largely insoluble and the actual leachable concentrations considerably lower.

However, as the speciation of the elements in the FGD WWTP sludge is unknown, the leachable concentration of these elements cannot currently be predicted and therefore a conservative approach in the assessment should be followed. Based on this approach the 85% limestone generated FGD WWTP sludge should be disposed of on a Class A landfill until an assessment of the actual waste can be confirmed.

The following assumptions have been made regarding the assessment of the FGD WWTP Sludge:

- The Medupi Site will generate WWTP Sludge with similar chemical characteristics to the previous sites studied by Black & Veatch (see **Appendix C**).
- The designed removal efficiencies are achieved in the FGD WWTP clarifier
- All chromium is present in the +VI oxidation state.
- All metal ions in the solids are 100% soluble at the solids to liquid ratio of the test method (1 mg/ℓ solid to 20 mℓ of water). This is a highly conservative assumption as it is likely that a considerably fraction of metal constituents such as lead and cadmium will not be leachable from the solids.
- The solubility of calcium carbonate was assumed to be 6.6 mg/ℓ (CRC Handbook of Chemistry and Physics, 2005).
- The solubility of $Mg(OH)_2$ was assumed to be 64 mg/ℓ (CRC Handbook of Chemistry and Physics, 2005)
- The gypsum and $CaSO_3$ in the solids was 100% soluble when subjected to a 1:20 distilled water leach.
- All SO_3 from the $CaSO_3$ dissociates and converts to SO_4 in solution.
- The leachable TDS concentration was calculated by summing of the assumed solubility limits for $CaCO_3$ and $Mg(OH)_2$ and complete solubility of $CaSO_3$ and gypsum. It was assumed that trace element contribution to TDS was negligible.

4.4 FGD WWTP Crystalliser Solids

As with the WWTP two scenarios were assessed for the FGD WWTP Crystalliser Solids that is using a limestone of 85% calcium carbonate and one of 96% calcium carbonate, the results of the calculations are presented in **Table 4-9** for TCs and **Table 4-10** for LCs.

The predicted values from the Kusile project are also presented in the tables, these values were generated using the same method that was used in this study.

4.4.1 Total concentrations

The total concentration assessment results for the 96% and 85% limestone scenarios are the same and discussed together below:

- The TCT0 thresholds were exceeded for arsenic, boron, chromium (VI), antimony and fluoride.
- There were no predicted exceedances of TCT1 or TCT2 thresholds.

There were no predicted exceedances of total concentration thresholds in the Kusile study.

Table 4-9: Predicted total concentrations of metal ions and inorganic anions in the FGD WWTP Crystalliser Solids

Elements & Chemical Substances in Waste	Total concentration thresholds (mg/kg)			WWTP Crystalliser Solids Medupi estimates (mg/kg)		WWTP Crystalliser solids Kusile estimates (M-Tech, 2012)
	TCT0	TCT1	TCT2	96% limestone	85% limestone	
Metal Ions						
Arsenic	5.8	500	2000	10.25	11.62	0.08
Boron	150	15 000	60 000	615.24	620	51.8
Barium	62.5	6250	25000	4.1	4.65	-
Cadmium	7.5	260	1040	1.03	1.16	0.07
Cobalt	50	5 000	20 000	4.1	4.65	0.37
Chromium (Total)	46 000	800 000	NA	10.25	11.62	-
Chromium (VI)[1]	6.5	500	2000	10.25	11.62	-
Copper	16	19 500	78 000	8.2	9.3	0.66
Mercury	0.93	160	640	0.21	0.23	0.01
Manganese	1 000	25 000	100 000	1.03	1.16	-
Molybdenum	40	1 000	4 000	31.76	31.04	-
Nickel	91	10 600	42 400	10.25	11.62	0.87
Lead	20	1 900	7 600	10.25	11.62	0.87
Antimony	10	75	300	15.88	15.52	-
Selenium	10	50	200	4.1	4.65	0.37
Vanadium	150	2 680	10 720	8.2	9.31	8.62
Zinc	240	160 000	640 000	10.25	11.62	0.87
Inorganic Anions						
Fluoride	100	10 000	40 000	307.62	348.59	

Note – Data provided by Eskom, calculated values based on previous projects carried out by the design engineers. Blue shading indicates above the TC1 threshold. [1]Chromium (VI) concentration based on assumption that all Chromium is in the +VI oxidation state

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Table 4-10: Predicted major ion concentrations in FGD WWTP Crystalliser Solids

Major ion	Predicted Concentration in FGD WWTP Crystalliser Solid 96% Limestone (mg/kg dry wt)	Predicted leachable Concentration 96% Limestone (mg/ℓ)	Predicted Concentration in solid 85% Limestone (mg/kg dry wt)	Predicted leachable Concentration 85% Limestone (mg/ℓ)	Assumption regarding solubility
Calcium	29 800	1 490	27 000	1 350	Completely soluble: 1 mg of FGD WWTP crystalliser solids in 20 ml water
Magnesium	6 400	320	5 800	290	
Sodium	354 800	17 740	351 900	17 595	
Chloride	489 300	24 465	443 800	22 190	
Sulphate	119 700	5 985	177 000	8 850	
Note – Data provided by Eskom					

4.4.2 Leachable concentrations

The leachable concentration assessment results for the 96% and 85% limestone scenarios are the same and discussed together below:

- The LCT2 threshold was predicted to be exceeded for TDS.
- The LCT1 thresholds were predicted to be exceeded for arsenic, boron, lead and chloride.
- The LCT0 thresholds were predicted to be exceeded for cadmium, chromium, manganese, molybdenum, nickel, antimony, selenium, vanadium, fluoride and sulphate.

The Kusile study predicted exceedances of the LCT0 thresholds for lead, selenium and vanadium and as with the current study predicted the leachable TDS would exceed the LCT2 threshold (M-Tech, 2012).

Table 4-11: Predicted LCs from FGD WWTP Crystalliser Solids

Elements & Chemical Substances in Waste	Leachable concentration thresholds (mg/ℓ)				WWTP Crystalliser Solids – Medupi estimates (mg/ℓ)		WWTP Crystalliser Solids – Kusile estimates (mgℓ)
	LCT0	LCT1	LCT2	LCT3	95% Limestone	85% Limestone	
Metal ions[1]							
Arsenic	0.01	0.5	1	4	0.51	0.58	0
Boron	0.5	25	50	200	31	31	2.59
Barium	0.7	35	70	280	0.21	0.23	
Cadmium	0.003	0.15	0.3	1.2	0.052	0.058	0
Cobalt	0.5	25	50	200	0.21	0.23	0.02
Chromium (Total)	0.1	5	10	40	0.51	0.58	0.04
Chromium (VI)[2]	0.05	2.5	5	20	0.51	0.58	
Copper	2	100	200	800	0.41	0.47	0.03
Mercury	0.006	0.3	0.6	2	0.011	0.012	0
Manganese	0.6	25	50	200	0.052	0.058	
Molybdenum	0.07	3.5	7	28	1.6	1.6	
Nickel	0.07	3.5	7	28	0.51	0.58	0.04
Lead	0.01	0.5	1	4	0.51	0.58	0.04
Antimony	0.02	1	2	8	0.79	0.78	
Selenium	0.01	0.5	1	4	0.21	0.23	0.02
Vanadium	0.2	10	20	80	0.41	0.47	0.43
Zinc	5	250	500	2 000	0.51	0.58	0.04
Inorganic Anions							
TDS[3]	1 000	12 500	25 000	100 000	50 000	50 300	48 400
Chloride[1]	300	15 000	30 000	120 000	24 500	22 200	-
Sulphate[1]	250	12500	25 000	100 000	5 990	8 850	-
Fluoride[1]	1.5	75	150	600	15	17	-

Note: 1: Predicted leachable concentrations of these parameters assume complete solubility of estimated total concentrations presented in Table 4-9 and Table 4-10. 2: Assumes all chromium in the +VI oxidation state. 3: TDS concentration calculated by summing of predicted leachable major ion concentrations presented in Table 4-10. Blue shaded values exceed LCT0 threshold. Purple shaded values exceed LCT1 thresholds. Orange Shaded values exceed the LCT2 thresholds.

4.4.3 Waste Assessment of FGD WWTP Crystalliser Solids

The FGD WWTP Crystalliser Solids have a number of exceedances of the TCT0, LCT1 and LCT0 thresholds. In addition the LCT2 threshold is predicted to be exceeded for TDS and the waste is assessed as a Type 1 waste based on the predicted highly elevated TDS. Given that a large proportion of the crystalliser solids are likely to be highly soluble sodium chloride ions this result is logical. The predicted TDS calculated from only sodium and chloride would still exceed 40 000 mg/ℓ LCT2 threshold and the waste would remain Type 1 waste requiring a Class A landfill (**Figure 2-1**). The same result was predicted in the Kusile study (M-Tech, 2012).

The following assumptions have been made regarding the assessment of the FGD WWTP Sludge and the Crystalliser Solids:

- The Medupi Site will generate Crystalliser Solids with similar chemical characteristics to the previous sites studied by Black and Vetch (see **Appendix C**).
- The designed removal efficiencies are achieved in the Crystalliser Plant.
- All constituents of the solids are 100% soluble. This is a highly conservative assumption as it is likely that a considerably fraction of metal constituents such as lead and cadmium may not be leachable from the solids.
- All chromium is present in the +VI oxidation state.
- The TDS of the leachable fraction was calculated by summing of all the major ion components summarised in **Table 4-10**.

5. COMBINED DISPOSAL OF SIMILAR WASTE STREAMS

5.1 Ash and FGD Gypsum

The Ash and the FGD gypsum are both assessed as Type 3 wastes that can be disposed of on a disposal facility of which the performance of the barrier system complies with that of a Class C landfill. The gypsum is likely to result in near neutral to alkaline leachate (see **Table 5-1**) while the ash has an alkaline pH leachate. Neither of these wastes are likely to contain organic matter that could decompose to result in a pH change of the leachate and both wastes are likely to be stable with respect to oxidation.

Table 5-1: FGD Gypsum and Ash leachable pH

Parameter	pH
FGD Gypsum (EPRI, 2008)	
Minimum	6.6
Median	8.0
Maximum	10.1
Ash (De ionised water leach test)	
MFA - 1	8.8
MFA – 2	9.0
MFA – 3	9.1

Given that both wastes are likely to generate alkaline leachate and will be stable with respect to oxidation, the leaching characteristics of the wastes are unlikely to be significantly altered should the wastes be disposed of in the same facility and the combined waste would be suitable for disposal on a facility of which the performance of the barrier system complies with that of a Class C landfill.

5.2 85 and 96% FGD WWTP Sludge and Crystalliser Solids

The WWTP Sludge and Crystalliser Solids are both produced by treatment of the wastewater from the FGD process. The sludge is produced in the first cycle of treatment via clarification. The solids are then dewatered using a filter press and the liquid from the clarifier is transferred to the crystalliser where water is evaporated to generate a solid material (salt cake) and treated water for re-use. As such, the composition of both these waste steams is influenced by the type of coal burnt, efficiency of the fly ash removal and the type of limestone used and should have similar chemical properties.

The FGD WWTP Sludge was assessed as a Type 1 waste when using 96% limestone, and a Type 2 waste when using an 85% limestone, while the FGD WWTP Crystalliser Solids was assessed as Type 1 waste. As was stated above, the Sludge when using an 85% limestone should be disposed of on a Class B landfill, but as the assessment was based on theoretical values a conservative approach should be followed and it is recommended that the 85% FGD WWTP Sludge also be disposed of on a Class A landfill until an assessment on the actual waste can be performed.

The Class A landfill barrier system is the most conservative barrier system used in South Africa and currently offers the highest level of protection for the environment. It is normal procedure for Class A landfills in South Africa to contain a number of different wastes as it is assumed that the level of protection is sufficient to manage combined hazardous waste streams. A prime example of such a landfill is that of EnviroServ's Holfontein hazardous waste disposal facility.

Once the FGD Plant and FGD WWTP wastes are generated, assessments should be made on the actual results and a decision then made with regards to the barrier systems required for the safe disposal of these wastes. Combinations of these wastes should be blended with the ash and FGD Gypsum and assessments on these combinations carried out to verify whether or not they can be disposed of on a Class C landfill.

6. SUMMARY

The ash, FGD gypsum, FGD WWTP Sludge and FGD WWTP Crystalliser Solids were assessed for disposal according to the National Norms and Standards as per Regulation 635 of NEM:WA, 2008. The results are summarised in **Table 6-1**.

The ash and gypsum are assessed as Type 3 wastes and can be disposed of on a disposal facility of which the performance of the barrier system complies with that of a Class C landfill. These wastes would produce neutral to alkaline leachate and are chemically and biologically stable and compatible.

The 96% limestone derived FGD WWTP Sludge was assessed as a Type 1 and would require disposal in a Class A landfill. The 96% limestone derived limestone may be disposed with the FGD WWTP Crystalliser Solids on a Class A landfill, as the Crystalliser Solids was also assessed as a Type 1 waste. The 85% limestone generated FGD WWTP Sludge, which was assessed as a Type 2, but as the assessment was based purely on theoretical values, it is recommended that the 85% limestone generated FGD WWTP Sludge also be disposed of on a Class A landfill until the actual waste can be assessed and a decision then made on the way forward.

The FGD WWTP Crystalliser Solids is assessed as a Type 1 waste due to the likely leachable TDS concentrations as a result of high concentration of sodium chloride in the solid material and will need to be disposed of in a Class A landfill.

The 85% and 96% limestone derived FGD WWTP Sludge and FGD WWTP Crystalliser Solids are waste materials generated from the treatment of FGD wastewater and as such should have similar chemical characteristics. The Class A landfill offers the highest level of environmental protection of any landfill barrier system used in South Africa and taking this into account and given the similar chemical characteristics of the 85% and 96% limestone derived FGD WWTP Sludges and Crystalliser Solids, it is proposed that these waste materials be disposed of on site in a newly designed and constructed Class A landfill at the Medupi Power Station site.

Table 6-1: Summary of waste assessment results

Waste	Assessment and Class of Landfill required for disposal	Percentage of waste (%)
Ash	Type 3 waste – Class C Landfill	79 or 68
FGD Gypsum	Type 3 waste – Class C Landfill	19 or 29
FGD WWTP Sludge 85% Limestone	Type 2 waste – Class A landfill*l	2.4
FGD WWTP Sludge 96% Limestone	Type 1 waste – Class A landfill	1.4
FGD WWTP Crystalliser Solids	Type 1 waste – Class A landfill	0.72 or 0.62
*** The Type 2 assessment was based on theoretical values and therefore a conservative approach should be followed and the 85% Limestone FGD WWTP Sludge should be disposed of on a Class A landfill until the assessments can be confirmed on actual waste samples.**		

7. RECOMMENDATIONS

Based on the outcome of the assessments made, it is recommended that:

- The Medupi Power Station ash and the FGD Gypsum be disposed of on a landfill of which the barrier system complies with the performance requirements of a Class C landfill.
- The 85% limestone derived FGD WWTP Sludge, provisionally assessed as a Type 2 waste, should be disposed of on a landfill of which the barrier system complies with the performance requirements of a Class A landfill due to the considerable amount of uncertainty regarding the composition of the sludge.
- The 96% limestone derived FGD WWTP Sludge, provisionally assessed as a Type 1 waste, should be disposed of on landfill of which the barrier system complies with the performance of a Class A landfill.
- The FGD WWTP Crystalliser Solids should be disposed of on landfill of which the barrier system complies with the performance requirements of a Class A landfill. The FGD WWTP Sludge and FGD WWTP Crystalliser Solids may be disposed of on the same Class A landfill.
- The FGD process and FGD Waste Water Treatment Plant operation waste streams should be re-assessed once being generated by Medupi, in order to confirm the theoretical assessments.
- Once the wastes are generated, leach tests should be conducted on various percentage combinations of the wastes. J&W recommends that column leach tests

be conducted. The outcome of the column leach tests can then be used to motivate for the combined disposal of all four wastes or combinations thereof on a Class C landfill or other suitable landfill class.

8. REFERENCES

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Appendix A

CALCULATIONS OF TOTAL CONCENTRATIONS IN FGD WWTP SLUDGE AND FGD WWTP CRYSTALLISER SOLIDS

Project Name	Medupi Power Station	**Preparer**	**Abigail Melanie**
Calculation No.	56.6405.1204	**Date**	2014/03/14
SPF No.		**Verifier**	
Title	FGD ZLD Treatment Solids Quality Estimate	**Date**	

Purpose:

To estimate the quality of the solids generated in the the FGD WWTP.

References:

1. Medupi FGD,56.6405.1201,FGD ZLD Water Mass Balance, 20 November 2013
2. Medupi FGD,56.6405.1212,FGD ZLD Water Mass Balance, 20 November 2013
3. e-mail "AW: 131027 56.6607 Medupi FGD - Chloride Bleed Stream Flow Solids Quality", Sven Kaiser (Steinmueller), 2013/11/04 (Attached)
4. email " AW: 130816 56.6405 Medupi FGD - Chloride Bleed stream - with attachment", Stefan Binkowski (Steinmueller), 2013/08/19 (Attached)
5. Medupi FGD, 56.3202.1201, Cooling Tower Cycles of Concentration and Acid Feed Estimate, 25 October 2013

Definition of Units and Constants:

Units

1. Mass =	kg	5. 1 m^3 =	1000 L	9. 1 mass % =	10,000 ppm for solution with a specific gravity ~ 1
2. Length =	m	6. Pressure =	N/m^2		
3. Area =	m^2	7. Temperature =	deg C	10. Vol. Flow =	Lpm or m^3/hr
4. Volume =	m^3 or L	8. Density =	kg/L		

Constants

Design Conditions

	85% Limestone	**Reference**	96% Limestone	**Reference**
TSS Mass Flow in the Cooling Tower Blowdown	1 kg/hr	1	1 kg/hr	2
TSS Mass Flow in FGD Wastewater	2 773 kg/hr	1	1 170 kg/hr	2
TSS Mass Flow in the TOC Scavenger Regen Waste	0 kg/hr	1	0 kg/hr	2
$Mg(OH)_2$ formed in Mg Removal	7 972 ppm	1	0 ppm	2
$CaCO_3$ formed in Mg Removal	13 685 ppm	1	0 ppm	2
$CaCO_3$ formed in Ca Removal	2 365 ppm	1	20 134 ppm	2
Lime Inerts	1 652 ppm	1	3 ppm	2
Soda ash Inerts	86 ppm	1	107 ppm	2
SA Tank Effluent Prior to Softening Rxns	194 684 kg/hr	1	141 402 kg/hr	2
TSS Mass Flow in Clarifier Outlet	6 kg/hr	1	5 kg/hr	2
Cooling Tower Blowdown Mass Flowrate	14 515 kg/hr	1	14 515 kg/hr	2
FGD Waste Water Mass Flowrate	77 253 kg/hr	1	79 246 kg/hr	2
TOC Scavenger Regen Waste Mass Flowrate	13 769 kg/hr	1	13 769 kg/hr	2
Clarifier Outlet Mass Flowrate	115 684 kg/hr	1	102 336 kg/hr	2
TSS Mass Flow Clarifier in Solids for Disposal (Filter Cake)	8 132 kg/hr	1	4 053 kg/hr	2
Clarifier Solids for Disposal (Filter Cake) Mass Flowrate	20 330 kg/hr	1	10 132 kg/hr	2
BC after Chemical Addition and Steam Mass Flowrate	93 457 kg/hr	1	103 045 kg/hr	2
Moisture content of crystalliser filter cake	6.00%	Design Basis	6.00%	Design Basis
Moisture content of clarifier filter cake	60.00%	Design Basis	60.00%	Design Basis
Crystalliser Feed Mass Flowrate	25590.7 kg/hr	1	25 655.60	2
Sodium Added due to Caustic Addition	29.4 kg/hr	1	29.5 kg/hr	2

	Preparer		Abigail Melanie
Project Name	Medupi Power Station	Date	2014/03/14
Calculation No.	56.6405.1204	Verifier	
SPF No.		Date	
Title	FGD ZLD Treatment Solids Quality Estimate		

Maximum Concentrations in clarifier effluent

Ag	2.00 ppm	Design Basis	2.00 ppm	Design Basis
Al	50.00 ppm	Design Basis	50.00 ppm	Design Basis
As	0.50 ppm	Design Basis	0.50 ppm	Design Basis
B	30.00 ppm	Design Basis	30.00 ppm	Design Basis
Ba	0.20 ppm	Design Basis	0.20 ppm	Design Basis
Be	0.05 ppm	Design Basis	0.05 ppm	Design Basis
Cd	0.05 ppm	Design Basis	0.05 ppm	Design Basis
Co	0.20 ppm	Design Basis	0.20 ppm	Design Basis
Cr	0.50 ppm	Design Basis	0.50 ppm	Design Basis
Cu	0.40 ppm	Design Basis	0.40 ppm	Design Basis
F	15.00 ppm	Design Basis	15.00 ppm	Design Basis
Fe	1.00 ppm	Design Basis	1.00 ppm	Design Basis
Hg	0.01 ppm	Design Basis	0.01 ppm	Design Basis
Mn	0.05 ppm	Design Basis	0.05 ppm	Design Basis
Mo	2.00 ppm	Design Basis	2.00 ppm	Design Basis
Ni	0.50 ppm	Design Basis	0.50 ppm	Design Basis
Pb	0.50 ppm	Design Basis	0.50 ppm	Design Basis
Sb	1.00 ppm	Design Basis	1.00 ppm	Design Basis
Se	0.20 ppm	Design Basis	0.20 ppm	Design Basis
Sr	0.48 ppm	Design Basis	0.48 ppm	Design Basis
Ti	0.60 ppm	Design Basis	0.60 ppm	Design Basis
V	50% reduction	Design Basis	50% reduction	Design Basis
Zn	0.50 ppm	Design Basis	0.50 ppm	Design Basis
Inerts	90.36%	3	73.20%	3
$CaSO_4 \cdot 2H_2O$	6.23%	3	20.10%	3
$CaCO_3$	2.28%	3	2.84%	3
$CaSO_3 \cdot 1/2\ H_2O$	1.13%	3	3.74%	3

Clarifier Inlet Concentration

Converting from ppm to kg/hr

$$\text{Mass of Component, kg/hr} = \frac{\text{Component, ppm x Total Mass Flowrate, m}^3\text{/hr}}{1\ 000\ 000}$$

$$Mg(OH)_2 \text{ (85\% Limestone), as an example, kg/hr} = \frac{7\ 972 \quad \text{x} \quad 194\ 684}{1\ 000\ 000}$$

$Mg(OH)_2$ = 1 552 kg/hr

Preparer	**Abigail Melanie**
Date	2014/03/14
Verifier	
Date	

Project Name	Medupi Power Station
Calculation No.	56.6405.1204
SPF No.	
Title	FGD ZLD Treatment Solids Quality Estimate

Table 1: TSS Formed in Reaction Tank

	85% Limestone		96% Limestone	
	PPM	kg/hr	PPM	kg/hr
$Mg(OH)_2$ formed in Mg Removal,kg/hr	7 972	1 552	0	0
$CaCO_3$ formed in Mg Removal, kg/hr	13 685	2 664	0	0
$CaCO_3$ formed in Ca Removal, kg/hr	2 365	460	20 134	2847
Lime Inerts, kg/hr	1 652	322	3	0
Soda ash inerts, kg/hr	86	17	107	15
Total, kg/hr		**5 015**		**2 863**

	85% Limestone	96% Limestone
solids in cooling tower blowdown	1 kg/hr	1 kg/hr
+ solids in TOC regenerant	0 kg/hr	0 kg/hr
+ solids in FGD blowdown	2 773 kg/hr	1 170 kg/hr
+ solids created in softener	5 015 kg/hr	2 863 kg/hr
- solids in clarifier effluent	6 kg/hr	5 kg/hr
Precipitated solids in clarifier sludge =	7 784 kg/hr	4 029 kg/hr

Trace Metals in Clarifier

Data extracted from Reference 1 and Reference 2

Project Name	Medupi Power Station	**Preparer**	**Abigail Melanie**
Calculation No.	56.6405.1204	**Date**	2014/03/14
SPF No.		**Verifier**	
Title	FGD ZLD Treatment Solids Quality Estimate	**Date**	

Table 2: Trace Metals into the Clarifier

Heavy Metal Components	Cooling Tower Blowdown stream	TOC Scavenger Regen wastewater stream	FGD Chloride bleedstream 85% limestone, worst coal	FGD Chloride bleedstream 96% limestone, worst coal	Maximum Clarifier Effluent	Maximum Clarifier Effluent 85% Limestone	Maximum Clarifier Effluent 96% Limestone
	ppm	ppm	ppm	ppm	ppm	kg/hr	kg/hr
Ag			2.0000	2.0000	2.0000	0.2314	0.2047
Al	0.0800		50.0000	50.0000	50.0000	5.7842	5.1168
As			1.0000	1.0000	0.5000	0.0578	0.0512
B			40.0000	40.0000	30.0000	3.4705	3.0701
Ba	0.2000		30.0000	30.0000	0.2000	0.0231	0.0205
Be			2.0000	2.0000	0.0500	0.0058	0.0051
Cd	0.0200		0.6000	0.6000	0.0500	0.0058	0.0051
Co			1.0000	1.0000	0.2000	0.0231	0.0205
Cr	0.0600		3.0000	3.0000	0.5000	0.0578	0.0512
Cu	0.0200		2.0000	2.0000	0.4000	0.0463	0.0409
F	1.2800		30.0000	30.0000	15.0000	1.7353	1.5350
Fe	0.4800		40.0000	40.0000	1.0000	0.1157	0.1023
Hg			0.2000	0.2000	0.0100	0.0012	0.0010
Mn	0.0400		30.0000	30.0000	0.0500	0.0058	0.0051
Mo			2.0000	2.0000	2.0000	0.2314	0.2047
Ni	0.0200		3.0000	3.0000	0.5000	0.0578	0.0512
Pb			2.0000	2.0000	0.5000	0.0578	0.0512
Sb			1.0000	1.0000	1.0000	0.1157	0.1023
Se			1.0000	1.0000	0.2000	0.0231	0.0205
Sr	0.4800		120.0000	120.0000	0.4800	0.0555	0.0491
Ti			0.6000	0.6000	0.6000	0.0694	0.0614
V			0.8000	0.8000	0.4000	0.0463	0.0409
Zn	0.1000		5.0000	5.0000	0.5000	0.0578	0.0512

Converting from ppm to kg/hr

$$\text{Mass of Componentl, kg/hr} = \frac{\text{Component, ppm x Total Mass Flowrate,kg/hr}}{1000000}$$

$$\text{Aluminum in FGD Bleedstream (85\% Limestone), as an example, kg/hr} = \frac{50.00 \quad x \quad 77\ 253}{1000000}$$

= 3.86 kg/hr

Clarifier influent = CT Blowdown (kg/hr) + TOC Scavenger Regen (kg/hr) +FGD Chloride Bleedstream (kg/hr)

Aluminum in FGD Bleedstream (85% Limestone), as an example, kg/hr = 0.00 + 0.00 + 3.86

= 3.86 kg/hr

Clarifier effluent = the lower value of the clarifier influent or the maximum clarifier effluent except vanadium which = 1/2 influent value.

Project Name	Medupi Power Station	**Preparer**	**Abigail Melanie**
Calculation No.	56.6405.1204	**Date**	2014/03/14
SPF No.		**Verifier**	
Title	FGD ZLD Treatment Solids Quality Estimate	**Date**	

Table 3: Trace Metals exiting the Clarifier

Heavy Metal Components	Cooling Tower Blowdown stream	TOC Scavenger Regen wastewater stream	FGD Chloride bleedstream 85% limestone, worst coal	FGD Chloride bleedstream 96% limestone, worst coal	Clarifier Influent 85% Limestone	Clarifier Effluent 85% Limestone	Clarifier Influent 96% Limestone	Clarifier Effluent 96% Limestone
	kg/hr	kg/hr	kg/hr	kg/hr	kg/hr	kg/hr	kg/hr	kg/hr
Ag	0.00000	0.00000	0.15451	0.15849	0.15451	0.15451	0.15849	0.15849
Al	0.00116	0.00000	3.86266	3.96231	3.86382	3.86382	3.96347	3.96347
As	0.00000	0.00000	0.07725	0.07925	0.07725	0.05784	0.07925	0.05117
B	0.00000	0.00000	3.09013	3.16985	3.09013	3.09013	3.16985	3.07008
Ba	0.00290	0.00000	2.31759	2.37738	2.32050	0.02314	2.38029	0.02047
Be	0.00000	0.00000	0.15451	0.15849	0.15451	0.00578	0.15849	0.00512
Cd	0.00029	0.00000	0.04635	0.04755	0.04664	0.00578	0.04784	0.00512
Co	0.00000	0.00000	0.07725	0.07925	0.07725	0.02314	0.07925	0.02047
Cr	0.00087	0.00000	0.23176	0.23774	0.23263	0.05784	0.23861	0.05117
Cu	0.00029	0.00000	0.15451	0.15849	0.15480	0.04627	0.15878	0.04093
F	0.01858	0.00000	2.31759	2.37738	2.33617	1.73526	2.39596	1.53504
Fe	0.00697	0.00000	3.09013	3.16985	3.09709	0.11568	3.17681	0.10234
Hg	0.00000	0.00000	0.01545	0.01585	0.01545	0.00116	0.01585	0.00102
Mn	0.00058	0.00000	2.31759	2.37738	2.31817	0.00578	2.37796	0.00512
Mo	0.00000	0.00000	0.15451	0.15849	0.15451	0.15451	0.15849	0.15849
Ni	0.00029	0.00000	0.23176	0.23774	0.23205	0.05784	0.23803	0.05117
Pb	0.00000	0.00000	0.15451	0.15849	0.15451	0.05784	0.15849	0.05117
Sb	0.00000	0.00000	0.07725	0.07925	0.07725	0.07725	0.07925	0.07925
Se	0.00000	0.00000	0.07725	0.07925	0.07725	0.02314	0.07925	0.02047
Sr	0.00697	0.00000	9.27038	9.50954	9.27734	0.05553	9.51650	0.04912
Ti	0.00000	0.00000	0.04635	0.04755	0.04635	0.04635	0.04755	0.04755
V	0.00000	0.00000	0.06180	0.06340	0.06180	0.04627	0.06340	0.04093
Zn	0.00145	0.00000	0.38627	0.39623	0.38772	0.05784	0.39768	0.05117
Total						**9.76**		**9.58**

Determine Heavy Metals in Clarifier Solids

Heavy metals in clarifier solids = the sum of the heavy metals into the system - the heavy metals in the clarifier effluent.

Barium in clarifier solids (85% limestone) for example =	0.00	kg/h (cooling tower blowdown)
+	0.00	kg/h (TOC regeneration wastewater)
+	2.32	kg/h (FGD blowdown)
-	0.02	kg/h (Clarifier effluent)
	2.30	kg/h (Total)

Preparer	**Abigail Melanie**
Date	2014/03/14
Verifier	
Date	

Project Name	Medupi Power Station
Calculation No.	56.6405.1204
SPF No.	
Title	FGD ZLD Treatment Solids Quality Estimate

Converting from kg/hr to ppm

Concentration of dry basis component, ppm = $\dfrac{\text{Component, kg/hr} \times 10^6}{\text{Mass Flowrate of filter cake TSS, kg/hr}}$

Barium (in 85% limestone), as an example = $\dfrac{2.30 \quad \text{x} \quad 1\ 000\ 000}{8132}$

= 282.5 ppm

Concentration of wet basis component, ppm = $\dfrac{\text{Component, kg/hr} \times 10^6}{\text{Total Mass Flowrate of filter cake, kg/hr}}$

(Based on 40% solids in filter cake)

Barium (in 85% limestone), as an example = $\dfrac{2.30 \quad \text{x} \quad 1\ 000\ 000}{20330}$

= 113.00 ppm

Table 4: Clarifier filter cake trace components

Heavy Metal Components	85% Limestone			96% Limestone		
	Clarifier Solids Dry Basis kg/hr	Clarifier Solids Dry ppm	Clarifier Solids Wet ppm	Clarifier Solids Dry Basis kg/hr	Clarifier Solids Dry ppm	Clarifier Solids Wet ppm
Ag	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Al	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
As	0.019411	2.386948	0.954779	0.028078	6.928368	2.771347
B	0.000000	0.000000	0.000000	0.099764	24.617020	9.846808
Ba	2.297360	282.502096	113.000839	2.359820	582.293576	232.917431
Be	0.148722	18.288075	7.315230	0.153375	37.845918	15.138367
Cd	0.040858	5.024230	2.009692	0.042721	10.541597	4.216639
Co	0.054116	6.654584	2.661833	0.058779	14.503899	5.801560
Cr	0.174788	21.493389	8.597356	0.187441	46.251774	18.500710
Cu	0.108523	13.344865	5.337946	0.117848	29.079432	11.631773
F	0.600913	73.893120	29.557248	0.860923	212.435561	84.974224
Fe	2.981409	366.618243	146.647297	3.074477	758.637556	303.455023
Hg	0.014294	1.757680	0.703072	0.014826	3.658333	1.463333
Mn	2.312390	284.350330	113.740132	2.372848	585.508277	234.203311
Mo	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Ni	0.174208	21.421993	8.568797	0.186861	46.108508	18.443403
Pb	0.096664	11.886622	4.754649	0.107324	26.482621	10.593049
Sb	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Se	0.054116	6.654584	2.661833	0.058779	14.503899	5.801560
Sr	9.221815	1133.989363	453.595745	9.467382	2336.108743	934.443497
Ti	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
V	0.015529	1.909559	0.763823	0.022462	5.542694	2.217078
Zn	0.329875	40.564132	16.225653	0.346514	85.503547	34.201419
Total	18.64			19.56		

Project Name	Medupi Power Station	**Preparer**	**Abigail Melanie**
Calculation No.	56.6405.1204	**Date**	2014/03/14
SPF No.		**Verifier**	
Title	FGD ZLD Treatment Solids Quality Estimate	**Date**	

Determine Major Components in Clarifier Solids

Mass flow of solids in FGD solids = Mass percent X TSS Mass Flow in FGD Wastewater

$CaCO_3$ (85% Limestone) for example = 2.28% X 2773
= 63.23 kg/hr

Mass flow of precipitated solids = Sum of the precipitates from lime and soda ash addition

$CaCO_3$ (85% Limestone) for example = 2664 + 460 = 3125 kg/hr

$$\text{Percent dry solids} = \frac{\text{component solids (kg/hr) X 100}}{\text{Total dry solids (kg/hr)}}$$

$$CaCO_3 \text{ (85\% Limestone) for example} = \frac{3188 \text{ kg/hr X } 100}{7790 \text{ kg/hr}} = 41\%$$

Determine Wet basis

The wet solids are based on 60.00%

Total filter cake = Dry solids / (1-% moisture in solids)

For 85% Limestone, total filter cake = 7 790 / (1 - 60.00%)

= 19 474 kg/hr

Water in filter cake = Total filter cake - dry solids

Water in filter cake = 11684 kg/hr

Solids in % = dry solids(kg/h)/total wet solids

Wet inerts for 85% limestone = 7790 kg/h / 19474 kg/h = 40.0%

Project Name	Medupi Power Station	**Preparer**	**Abigail Melanie**
Calculation No.	56.6405.1204	**Date**	2014/03/14
SPF No.		**Verifier**	
Title	FGD ZLD Treatment Solids Quality Estimate	**Date**	

Table 5: Clarifier filter cake major components

85% Limestone

Major Components	Precipitated Solids	FGD Solids	Cooling Tower Solids	Total Solids	Total Solids	Clarifier Solids	Clarifier Solids
	Dry Basis	Dry	Dry	Dry	Dry	Wet	Wet
	kg/hr	kg/hr	kg/hr	kg/hr	%	kg/hr	%
Inerts	338	2506	1	2845	36.5	2845	14.6
$CaSO_4 \cdot 2H_2O$	0	173	0	173	2.2	173	0.9
$CaCO_3$	3125	63	0	3188	40.9	3188	16.4
$CaSO_3 \cdot 1/2\ H_2O$	0	31	0	31	0.4	31	0.2
$Mg(OH)_2$	1552	0	0	1552	19.9	1552	8.0
H_2O	0	0	0	0	0	11684	60
Total				**7790**		**19474**	

Table 6: Clarifier filter cake major components

96% Limestone

Major Components	Precipitated Solids	FGD Solids	Cooling Tower Solids	Total Solids	Total Solids	Clarifier Solids	Clarifier Solids
	Dry Basis	Dry	Dry	Dry	Dry	Wet	Wet
	kg/hr	kg/hr	kg/hr	kg/hr	%	kg/hr	%
Inerts	16	857	1	873	21.7	873	8.7
$CaSO_4 \cdot 2H_2O$	0	235	0	235	5.8	235	2.3
$CaCO_3$	2847	33	0	2880	71.4	2880	28.6
$CaSO_3 \cdot 1/2\ H_2O$	0	44	0	44	1.1	44	0.4
$Mg(OH)_2$	0	0	0	0	0.0	0	0.0
H_2O	0	0	0	0	0.0	6049	60
Total				**4032**		**10081**	

NOTE:

Water component will have high concentrations of dissolved solids including chlorides, sulfates, sodium, magnesium, and calcium.
There will be trace amounts of heavy metals in the liquid fraction.

Project Name	Medupi Power Station	**Preparer**	**Abigail Melanie**
Calculation No.	56.6405.1204	**Date**	2014/03/14
SPF No.		**Verifier**	
Title	FGD ZLD Treatment Solids Quality Estimate	**Date**	

Determining the Mass of solids formed in the Crystalliser

Converting from ppm to kg/hr

$$\text{Mass of Componentl, kg/hr} = \frac{\text{Component, ppm x Total Mass Flowrate,kg/hr}}{1\ 000\ 000}$$

$$\text{Sodium in 85\% limestone, as an example, kg/hr} = \frac{18431 \quad x \quad 93\ 457}{1\ 000\ 000}$$

= 1723 kg/hr

Sodium in crystalliser feed = Sodium content in BC inlet (kg/h) + caustic feed (kg/hr)

Sodium in crystalliser feed (85% Limestone) = 1723 + 29.4 = 1752 kg/hr

	Table 7: Crystalliser input Data					
	85% Limestone			96% Limestone		
	BC After Chem and Steam Addition	BC After Chem and Steam Addition	Crystalliser Feed	BC After Chem and Steam Addition	BC After Chem and Steam Addition	Crystalliser Feed
	ppm	kg/hr	kg/hr	ppm	kg/hr	kg/hr
Calcium	1 440	135	135	1 442	149	149
Magnesium	307	29	29	308	32	32
Sodium	18 431	1 723	1 752	16 897	1 741	1 771
Chloride	23 640	2 209	2 209	23 695	2 442	2 442
Sulfate	9 132	853	853	5 798	597	597
Total		4 949	4 978		4 961	4 990

BC Inlet concentrations and Crystalliser Feed concentration extracted from Reference 1 and Reference 2

Determine wet basis

Assume heavy metals do not impact bulk concentrations.

Based on 6.00% moisture in the crystalliser solids, the wet solids = Dry solids / (1-% moisture in solids)

Wet solids for 85% limestone = 4 978 x (1 - 6.00%)

= 5296 kg/h

Wet solids for 96% limestone = 4 990 x (1 - 6.00%)

= 5 309 kg/h

Project Name	Medupi Power Station	**Preparer**	**Abigail Melanie**
Calculation No.	56.6405.1204	**Date**	2014/03/14
SPF No.		**Verifier**	
Title	FGD ZLD Treatment Solids Quality Estimate	**Date**	

Table 8: Crystalliser product (trace metals)

Heavy Metal Components	85% Limestone			96% Limestone		
	Crystalliser	Crystalliser	Crystalliser	Crystalliser	Crystalliser	Crystalliser
	Dry Basis	Dry	Wet	Dry Basis	Dry	Wet
	kg/hr	ppm	ppm	kg/hr	ppm	ppm
Ag	0.15	31.04	29.18	0.16	31.76	29.86
Al	3.86	776.19	729.62	3.96	794.27	746.61
As	0.06	11.62	10.92	0.05	10.25	9.64
B	3.09	620.76	583.52	3.07	615.24	578.32
Ba	0.02	4.65	4.37	0.02	4.10	3.86
Be	0.01	1.16	1.09	0.01	1.03	0.96
Cd	0.01	1.16	1.09	0.01	1.03	0.96
Co	0.02	4.65	4.37	0.02	4.10	3.86
Cr	0.06	11.62	10.92	0.05	10.25	9.64
Cu	0.05	9.30	8.74	0.04	8.20	7.71
F	1.74	348.59	327.67	1.54	307.62	289.16
Fe	0.12	23.24	21.84	0.10	20.51	19.28
Hg	0.00	0.23	0.22	0.00	0.21	0.19
Mn	0.01	1.16	1.09	0.01	1.03	0.96
Mo	0.15	31.04	29.18	0.16	31.76	29.86
Ni	0.06	11.62	10.92	0.05	10.25	9.64
Pb	0.06	11.62	10.92	0.05	10.25	9.64
Sb	0.08	15.52	14.59	0.08	15.88	14.93
Se	0.02	4.65	4.37	0.02	4.10	3.86
Sr	0.06	11.15	10.49	0.05	9.84	9.25
Ti	0.05	9.31	8.75	0.05	9.53	8.96
V	0.05	9.30	8.74	0.04	8.20	7.71
Zn	0.06	11.62	10.92	0.05	10.25	9.64

Solids in % = dry solids(kg/h)/total wet solids

Wet calcium for 85% limestone = 135 kg/h / 5296 kg/h = 2.5%

Table 9: Crystalliser Product (Major Components)

Major Components	85% Limestone			96% Limestone		
	Crystalliser	Crystalliser	Crystalliser	Crystalliser	Crystalliser	Crystalliser
	Dry Basis	Dry	Wet	Dry Basis	Dry	Wet
	kg/hr	%	%	kg/hr	%	%
Calcium	134.58	2.70	2.54	148.59	2.98	2.80
Magnesium	28.69	0.58	0.54	31.74	0.64	0.60
Sodium	1 751.90	35.19	33.08	1 770.65	35.48	33.35
Chloride	2 209.32	44.38	41.72	2 441.65	48.93	45.99
Sulfate	853.45	17.14	16.12	597.45	11.97	11.25
H_2O	0.00	0.00	6.00	0.00	0.00	6.00
Total	4978	100	100	4990	100	100

Preparer	**Abigail Melanie**
Date	2014/03/14
Verifier	
Date	

Project Name	Medupi Power Station
Calculation No.	56.6405.1204
SPF No.	
Title	FGD ZLD Treatment Solids Quality Estimate

Conclusion:

	85%	96%
Clarifier Product: Trace Metals	Table 4	Table 4
Clarifier Product: Major Components	Table 5	Table 6
Crystalliser Product: Trace Metals	Table 8	Table 8
Crystalliser Product: Major Component	Table 9	Table 10

Appendix B

LABORATORY RESULTS FOR MATIMBA ASH

WATERLAB (PTY) LTD

WATERLAB

Building D, The Woods,
Persequor Techno Park,
Meiring Naudé Road,
Pretoria

Telephone: +2712 – 349 – 1066
Facsimile: +2712 – 349 – 2064
Email: accounts@waterlab.co.za

CERTIFICATE OF ANALYSES

Digestion AS 4439.3

Date received:	02/09/2014		**Date completed:**	26/09/2014
Project number:	132	**Report number:** 47779	**Order number:**	GMS/E173/140902

Client name:	Groundwater Monitoring Services (Pty) Ltd.	**Contact person:**	Steven Gumbi
Address:	PO Box 1811, Rivonia, 2128	**Email:**	steve@gwms.co.za
Telephone:	011 234 1550	**Cell:**	---

Analyses	MFY-1		MFA-2		MFA-3		TCT0 mg/kg
Sample Number	15079		15080		15081		
Digestion	Aqua Regia		Aqua Regia		Aqua Regia		
Dry Mass Used (g)	0.25		0.25		0.25		
Volume Used (mℓ)	100		100		100		
Units	mg/ℓ	mg/kg	mg/ℓ	mg/kg	mg/ℓ	mg/kg	
Al, Aluminium	57	22800	35	14000	34	13600	
As, Arsenic	<0.010	<4.00	<0.010	<4.00	<0.010	<4.00	5.8
B, Boron	0.106	42	0.095	38	0.085	34	150
Ba, Barium	0.971	388	0.864	346	0.889	356	62.5
Ca, Calcium	45	18000	43	17200	41	16400	
Cd, Cadmium	0.008	3.20	0.011	4.40	0.005	2.00	7.5
Co, Cobalt	<0.025	<10	<0.025	<10	<0.025	<10	50
$Cr_{Total,}$ Chromium Total [s]	0.134	54	0.094	38	0.082	33	46000
Cr(VI), Chromium (VI) Total [s]	---	<5	---	<5	---	<5	6.5
Cu, Copper	<0.025	<10	<0.025	<10	<0.025	<10	16
Hg, Mercury	<0.001	<0.4	<0.001	<0.4	0.011	4.4	0.93
K, Potassium	1.6	640	0.9	360	0.5	200	
Mg, Magnesium	9.00	3600	9.00	3600	8.00	3200	
Mn, Manganese	0.893	357	0.848	339	0.781	312	1000
Mo, Molybdenum	<0.025	<10	<0.025	<10	<0.025	<10	40
Na, Sodium	<2.00	<800	<2.00	<800	<2.00	<800	
Ni, Nickel	0.051	20	0.041	16	0.037	15	91
Pb, Lead	<0.010	<4.00	<0.010	<4.00	<0.010	<4.00	20
Sb, Antimony	<0.010	<4.00	<0.010	<4.00	<0.010	<4.00	10
Se, Selenium	<0.010	<4.00	<0.010	<4.00	<0.010	<4.00	10
V, Vanadium	0.067	27	0.039	16	<0.025	<10	150
Zn, Zinc	0.125	50	0.106	42	0.093	37	240
Inorganic Anions	mg/ℓ	mg/kg	mg/ℓ	mg/kg	mg/ℓ	mg/kg	
Total Dissolved Solids at 180°C	---	---	---	---	---	---	N/A
Chloride as Cl	---	---	---	---	---	---	N/A
Sulphate as SO_4	---	---	---	---	---	---	N/A
Nitrate as N	---	---	---	---	---	---	N/A
Total Fluoride [s] mg/kg	---	296	---	285	---	346	100

UTD = Unable to determine

Appendix C

LITERATURE VALUES FOR FGD GYPSUM TOTAL ELEMENTAL CONCENTRATIONS

Table 1: FGD Gypsum Total Concentration Results

Elements & Chemical Substances in Waste (all units mg/kg)	Total Concentration Thresholds (mg/kg)			FGD Gypsum	FGD Gypsum	FGD Gypsum	FGD Gypsum	FGD Gypsum	FGD Gypsum
Reference				Chen et al 2012	Chen et al 2012	Chen et al 2012	Chen et al 2012	EPRI 2011	Chen 2008
	TCT0	TCT1	TCT2	Ohio	Indiana	Alabama	Wisconsin	Max (N=32)	
Metal Ions									
Arsenic	5.8	500	2000	<1.28	1.35	<1.28	<1.28	11.1	<11
Boron	150	15000	60000	-	-	-	-	387	5.8
Barium	62.5	6250	25000	31.3	21.3	43	19.6	55.2	5.5
Cadmium	7.5	260	1040	0.158	0.472	0.549	0.079	0.369	<1
Cobalt	50	5000	20000	<0.146	0.21	<0.146	<0.146	0.716	-
Chromium Total	46000	800000	NA	1.8	7.04	7.58	3.81	14.5	<1
Chromium (VI)	6.5	500	2000	1.8	7.04	7.58	3.81	14.8	<1
Copper	16	19500	78000	3.25	<0.378	<0.378	7.02	3.17	<3
Mercury	0.93	160	640	0.376	0.198	0.589	1.33	1.41	-
Manganese	1000	25000	100000	-	-	-	-	129	1.3
Molybdenum	40	1000	4000	0.7	1.46	1.32	0.97	4	<3
Nickel	91	10600	42400	0.88	2.22	2.68	1.61	2.86	<3
Lead	20	1900	7600	<0.774	<0.774	1.33	<0.774	8.3	<5
Antimony	10	75	300	4.58	10.4	7.34	9.55	4.97	-
Selenium	10	50	200	<2.32	2.92	<2.32	8.36	32	<25
Vanadium	150	2680	10720	2.42	7.24	5.72	1.38	8.57	-
Zn, Zinc	240	160000	640000	4.7	27.4	29	11.5	23.3	4.8
Inorganic Anions									
F, Fluoride	100	10000	40000	-	-	-	-	-	-

Table 1: FGD Gypsum Total Concentration Results

Elements & Chemical Substances in Waste (all units mg/kg)	Total Concentration Thresholds (mg/kg)			FGD Gypsum	FGD Gypsum	FGD Gypsum	FGD Gypsum	FGD Gypsum	FGD Gypsum
Reference				En-Chem 2008	VGB -TW-707e	VGB -TW-707e	VGB -TW-707e	VGB -TW-707e	VGB -TW-707e
	TCT0	TCT1	TCT2		G 4/88/R	G 5/88/R	G 6/88R	9/88/R	G 10/88/R
Metal Ions									
Arsenic	5.8	500	2000	2	1.15	1.34	0.48	0.72	1.96
Boron	150	15000	60000	-	-	-	-	-	-
Barium	62.5	6250	25000	17	0.32	0.15	0.05	0.04	0.16
Cadmium	7.5	260	1040	<0.1	0.29	0.03	0.06	<0.02	0.21
Cobalt	50	5000	20000	8.2	1.36	0.4	0.25	0.22	2.2
Chromium Total	46000	800000	NA	7.8	4.61	3.88	1.02	9.72	1.18
Chromium (VI)	6.5	500	2000	<1	4.61	3.88	1.02	9.72	1.18
Copper	16	19500	78000	2.8	8.56	5.44	1.25	1.2	5.83
Mercury	0.93	160	640	<1	1.32	0.66	0.03	0.87	1.02
Manganese	1000	25000	100000	7.1	-	36.3	3.67	9.74	196
Molybdenum	40	1000	4000	0.79	-	-	-	-	-
Nickel	91	10600	42400	6.8	5.2	0.85	0.55	0.55	12.9
Lead	20	1900	7600	93	22	8.96	0.49	<2.5	2.04
Antimony	10	75	300	<1	-	-	-	-	-
Selenium	10	50	200	22	8.9	1.03	2.69	2	13.3
Vanadium	150	2680	10720	-	7.7	3.48	1.22	2.67	5.09
Zn, Zinc	240	160000	640000	-	53.2	22.8	<3	<3	22
Inorganic Anions									
F, Fluoride	100	10000	40000	355	-	-	-	-	-

Table 1: FGD Gypsum Total Concentration Results

Elements & Chemical Substances in Waste (all units mg/kg)	Total Concentration Thresholds (mg/kg)			FGD Gypsum	FGD Gypsum	FGD Gypsum	FGD Gypsum	FGD Gypsum	FGD Gypsum
Reference				VGB -TW-707e	VGB -TW-707e	VGB -TW-707e	VGB -TW-707e	VGB -TW-707e	VGB -TW-707e
	TCT0	TCT1	TCT2	G 11/88/R	G 12/88/R	G13/88/R	G 14/88/R	G 22/88/R	G 23/88/R
Metal Ions									
Arsenic	5.8	500	2000	0.67	1.04	1.13	0.21	2.7	0.49
Boron	150	15000	60000	-	-	-	-	-	-
Barium	62.5	6250	25000	<0.05	0.09	<0.1	<0.1	<0.1	0.65
Cadmium	7.5	260	1040	0.02	0.03	0.02	0.02	0.02	0.01
Cobalt	50	5000	20000	0.2	0.27	0.24	0.06	0.17	0.09
Chromium Total	46000	800000	NA	1.68	3.32	4.3	3.16	2.31	2.18
Chromium (VI)	6.5	500	2000	1.68	3.32	4.3	3.16	2.31	2.18
Copper	16	19500	78000	1.3	1.9	1.65	2.38	2.3	2.37
Mercury	0.93	160	640	0.3	0.96	0.1	0.23	0.6	0.33
Manganese	1000	25000	100000	9.17	106	15.8	28.9	8.3	29
Molybdenum	40	1000	4000	-	-	-	-	-	-
Nickel	91	10600	42400	0.3	1.02	1.2	1.27	1.1	1.36
Lead	20	1900	7600	3.98	<2.5	3.1	1.19	12.2	0.27
Antimony	10	75	300	-	-	-	-	-	-
Selenium	10	50	200	0.88	6.2	15.7	1.61	1.1	2.27
Vanadium	150	2680	10720	1.49	4.23	2.9	3.57	3.3	2.62
Zn, Zinc	240	160000	640000	<3	7	3	3	1.7	4.6
Inorganic Anions									
F, Fluoride	100	10000	40000	-	-	-	-	-	-

Table 1: FGD Gypsum Total Concentration Results

Elements & Chemical Substances in Waste (all units mg/kg)	Total Concentration Thresholds (mg/kg)			FGD Gypsum	FGD Gypsum	FGD Gypsum	FGD Gypsum
Reference				VGB -TW-707e	VGB -TW-707e	VGB -TW-707e	VGB -TW-707e
	TCT0	TCT1	TCT2	G 24/88/R	G 25/88/R/B1	G 26/88/R/B2	G 27/88/R/B3
Metal Ions							
Arsenic	5.8	500	2000	0.42	2.04	2.2	2.6
Boron	150	15000	60000	-	-	-	-
Barium	62.5	6250	25000	0.03	0.24	0.42	0.1
Cadmium	7.5	260	1040	0.003	0.14	0.15	<0.02
Cobalt	50	5000	20000	0.04	0.49	0.53	0.49
Chromium Total	46000	800000	NA	1.8	3.64	2.75	4.8
Chromium (VI)	6.5	500	2000	1.8	3.64	2.75	4.8
Copper	16	19500	78000	3.99	4.65	2.38	1.1
Mercury	0.93	160	640	0.27	0.76	0.66	0.9
Manganese	1000	25000	100000	2.04	64.9	52.7	41.7
Molybdenum	40	1000	4000	-	-	-	-
Nickel	91	10600	42400	0.6	1.63	3.12	3.2
Lead	20	1900	7600	<2.5	<3	11.1	6.41
Antimony	10	75	300	-	-	-	-
Selenium	10	50	200	DL	DL	2.3	0.7
Vanadium	150	2680	10720	4	3.55	3.92	5.4
Zn, Zinc	240	160000	640000	DL	DL	43	24.3
Inorganic Anions							
F, Fluoride	100	10000	40000	-	-	-	-

Att: Theuns Blom 11 May 2018
Eskom : Medupi Project

RE: Medupi WFGD: WASTE STREAM HANDLING

Good day Theuns

Based on the theoretical assessments carried out by Jones & Wagner, the waste streams that will be generated by Eskom's Medupi Power Station will be permitted to be disposed at Holfontein's H:H Landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed. DWAF, 1998) which is equivalent to a Class A landfill designed in accordance with section 3(1) and (2) of the National Norms and Standards for Disposal of Waste to Landfill (GN R636).

The wastes streams, once generated by Eskom's Medupi Power Station, shall be re-assessed in order to confirm the theoretical assessments carried out by Jones & Wagner.

Table 1: Summary of waste assessment results and

Waste	Assessment and Class of Landfill required for disposal	Percentage of waste (%)
Ash	Type 3 waste – Class C Landfill	79 or 68
FGD Gypsum	Type 3 waste – Class C Landfill	19 or 29
FGD WWTP Sludge 85% Limestone	Type 2 waste – Class A landfill*	2.4
FGD WWTP Sludge 96% Limestone	Type 1 waste – Class A landfill	1.4
FGD WWTP Crystalliser Solids	Type 1 waste – Class A landfill	0.72 or 0.62
*** The Type 2 assessment was based on theoretical values and therefore a conservative approach should be followed and the 85% Limestone FGD WWTP Sludge should be disposed of on a Class A landfill until the assessments can be confirmed on actual waste samples.**		

Kind regards

LUCY MULLER
Sales Manager

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Reg No 2008/021152/07

DEPARTMENT: WATER AFFAIRS AND FORESTRY

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16/2/7/C212/Y121/1

PERMIT NUMBER:	16/2/7/C212/Y121/P3 (Amendment to Permit number B33/2/321/121/P3 issued on 25 April 1996)
CLASS:	H:H
WASTE DISPOSAL SITE:	HOLFONTEIN
LOCATION:	PORTIONS 23 AND 24 OF THE FARM HOLFONTEIN 71 IR AND PORTION 8 OF THE FARM MODDERFONTEIN 236 IR, DISTRICT OF BENONI
PERMIT HOLDER:	DISPOSE TECH, A DIVISION OF ENVIROSERV WASTE MANAGEMENT (PTY) LTD
ADDRESS:	PO BOX 13420, NORTHMEAD 1511

PERMIT IN TERMS OF SECTION 20 OF THE ENVIRONMENT CONSERVATION ACT, 1989 (ACT 73 OF 1989)

By virtue of the powers delegated to me by the Minister of Water Affairs and Forestry (hereinafter referred to as "the Minister"), I, Cornelius Ruiters, in my capacity as Manager: Water Use in the Department of Water Affairs and Forestry (hereinafter referred to as "the Department"), hereby, in terms of section 20(1) of the Environment Conservation Act, 1989 (Act 73 of 1989), authorise the abovementioned Permit Holder to further develop and operate the Holfontein H:H Landfill Site, subject to the conditions specified herein

PERMIT CONDITIONS

In this Permit, "Manager" means the Manager: Waste Discharge and Disposal of the Department, who may be contacted at the address below:

Director General
Department of Water Affairs and Forestry
Private Bag X313
PRETORIA
0001

ATTENTION: Manager: Waste Discharge and Disposal

1. LOCATION

1.1 This Permit authorises the further development and operation of a waste disposal site on Portions 23 and 24 of the farm Holfontein 71 IR and Portion 8 of the farm Modderfontein 236 IR, District of Benoni, (hereinafter referred to as "the Site") according to the following reports numbered –

(a) *Environmental Impact Control Report for Holfontein Hazardous Waste Disposal Site- Updated for 2003* (report number JW20/03/6923) by Jones & Wagener dated May 2003;
(b) *Projection of a Health Buffer Zone for the Holfontein Landfill Site* (report number EMS/01/EWM-04) by Environmental Management Services CC dated 23 February 2001;
(c) *Holfontein Operations Manual* by J Nicholson dated August 2003;
(d) *Scoping Report, Holfontein Leachate Treatment Plant* by Environmental and Chemical Consultants and Environmental Risk Management dated 25 April 2002;
(e) *Addendum to Scoping Report for the Holfontein Leachate Treatment Plant* by Environmental and Chemical Consultants and Environmental Risk Management dated 27 September 2002;
(f) Emergency Response Plan (report number DTWI-17/gau/holf);
(g) *Holfontein H:H Landfill – Design and Operational Manual for Encapsulation in Large Volume Silos* (report number JW165/02/6444-7) by Jones and Wagener dated November 2002

(unless specifically stated otherwise, hereinafter referred to as "the Reports"), submitted by the Permit Holder.

1.2 Portion 8 of the farm Modderfontein 236 IR may not be used for the disposal of waste and may only be used for the purposes of a bufferzone as required in this permit.

1.3 The boundaries of the Site must be as indicated by the co-ordinates on Drawing number 6444-02-019 dated 11 July 2003 of the Report referred to in condition 1.1 (c).

2. PERMISSIBLE WASTE

2.1. Any portion of the Site which has been constructed or developed according to condition 3 of this Permit, may be used for the disposal of all waste types which are classified according to the latest edition of the "Minimum Requirement" series of documents as published by the Department (hereinafter referred to as the "Minimum Requirements"), as waste suitable for disposal at a H:H disposal facility, excluding those waste types listed in Annexure I

2.2 Pharmaceuticals (narcotics) confiscated by the South African Police Service may be disposed of according to Annexure III after written approval by the Manager for a specific batch

2.3 The classification, acceptance and disposal criteria as listed in the latest edition of the Minimum Requirements must be conformed to

3. CONSTRUCTION

3.1 The Site or any portion thereof may only be used for the disposal of permissible waste or leachate if the Site or any portion have been constructed and developed according to condition 3 of this Permit

3.2 The construction of further developments within the Site, may only be undertaken by the Permit Holder after specified engineering plans have been submitted to the Manager and approved in writing by the Manager.

3.3 The construction of further developments within the Site must be carried out under the supervision of a Professional Civil Engineer, registered under the Engineering Profession of South Africa Act, 1990 (Act 114 of 1990) as proposed by the Permit Holder and approved by the Manager.

3.4 Should a portion of the Site be further developed, according to plans for which approval has been obtained under condition 3.2 and in accordance with condition 3.3, the Permit Holder must notify the Manager of the estimated date of completion of the development. The completed development shall be inspected by a Registered Professional Civil Engineer from the Department and by the person referred to in condition 3.3. Should the Manager be satisfied with the development after the inspection is completed and has granted written permission thereto, the Permit Holder may use that portion of the Site for the disposal of waste

3.5. The Site must be constructed in accordance with recognised civil engineering practice, with special consideration to stability

3.6. The slope of the outer walls of the waste disposal cells on the Site shall not be steeper than 1 vertical to 3 horizontal length units, unless an equivalent engineered alternative has been approved by the Manager

3.7. The slope of the sides of the Site must be constructed and maintained in such a manner that the occurrence of erosion is prevented

3.8 The maximum height of the Site must not exceed 35 metres above ground level

3.9. Stormwater diversion works constructed in compliance with condition 5.1 must be of such a capacity as to accommodate all stormwater runoff which could be expected as a result of the estimated maximum precipitation during a period of 24 hours with an average frequency of once in fifty years (hereinafter referred to as the "estimated maximum precipitation").

3.10 Containment works constructed in compliance with condition 5.1.2 must be of such a capacity as to maintain a freeboard of half a metre and to accommodate all stormwater runoff which could be expected as a result of the estimated maximum precipitation

3.11. Containment works constructed in compliance with conditions 5.1 for contaminated stormwater must be lined according to the relevant Minimum Requirements and in compliance with condition 3.2.

3.12 Leachate containment works constructed in compliance with condition 5.2 must be of such a capacity as to contain all expected leachate as a result of disposal operations and the estimated maximum precipitation and must maintain a freeboard of half a metre and must be lined according to the specifications contained in the Minimum Requirements for Hazardous lagoons.

3.13. Plans for the leachate treatment plant and associated containment structures as referred to in the Report listed in condition 1.1(d) and (e) must be submitted within six months from the date of this Permit to the Manager for his approval

3.14. The leachate treatment works must be constructed in accordance with the approved plans, and must be in operation by 31 December 2004

3.15. The Permit Holder must compile annual written reports on the construction of all works within the Site. These reports must contain an assessment by the person referred to in condition 3.3, of all works constructed on the Site in comparison with the specified engineering drawings as submitted to and approved by the Manager and must also contain the detailed results of all quality control tests performed on the construction. All reports must contain a photographic record of the construction up to the written report date

4. GENERAL IMPACT MANAGEMENT AND OPERATION

4.1 Disposal of Waste

4.1.1 The Permit Holder must ensure that the disposal of permissible waste and the operation of the Site is done in accordance with –

(a) the latest edition of the *Minimum Requirements* as published by the Department of Water Affairs and Forestry;
(b) the conditions of this Permit;
(c) the Reports or subsequent approved versions there-of;
(d) the approved Operational Plan;
(e) any written Operational Procedures or amendments of the Operational Plan submitted by the Permit Holder and approved by the Manager; and
(f) any other written direction issued by the Manager to the Permit Holder

4.2 Co-disposal

4.2.1 The Permit Holder must ensure that the co-disposal of solid and liquid waste is done in such a manner that the hydraulic head of leachate on the liner of the Site is less than 200 mm per annum as specified in the Minimum Requirements

4.2.2 The co-disposal ratio shall be managed according to the methodology specified in Appendix 10.1 of the Minimum Requirements for Waste Disposal by Landfill (second edition, 1998) or subsequent versions thereof.

4.2.3 The Permit Holder shall develop and maintain a calibrated liquid management model to ensure compliance to condition 4.2.2.

4.2.4 The Permit Holder shall submit the results of the liquid management model to the Manager on a monthly basis.

4.2.5 The Permit Holder may not exceed the co-disposal ratio of the liquid management model, which ensures compliance to conditions 4.2.1 and 4.2.2 without written approval by the Manager.

4.3 Bufferzone

4.3.1 The Permit Holder must take all reasonable steps, such as suitable zoning, written agreements with adjacent landowners, buying out land and/or obtaining a servitude, to establish and maintain a "bufferzone", between the Site and the nearest residential and/or light industrial area not closer to the Site than:

(a) 400 metres to the north
(b) 700 metres to the South
(c) 350 metres to the east, and
(d) 500 metres to the west

during the operative life of the Site.

4.3.2 The Permit Holder must submit written proof to the Manager of the steps taken according to condition 4.3.1, within one year from the date of this Permit.

4.3.3 Heavy industries or industries which may create nuisance conditions may be permitted within the bufferzone in terms of the appropriate legislation.

4.3.4 Should the operation of the Site change in such a manner that the approved bufferzone referred to in condition 4.3.1 may be influenced, the Permit Holder may be directed by the Manager to review the air dispersion modeling as contained in the report referred to in condition 1.1 (b) to confirm whether the approved bufferzone is adequate.

4.4 General Operational Measures

4.4.1. Municipal waste disposed of on Site shall be compacted and covered on a daily basis with a minimum of 150 millimetres of soil or other material as approved by the Manager.

4.4.2 Where applicable, the Permit Holder must operate the Site in such a manner that the height of the embankment or perimeter wall is at all times maintained at a higher elevation than the level of the operating floor

4.4.3 Waste disposed of on the Site is not allowed to burn.

4.4.4. Waste disposed of on the Site may not be reclaimed.

4.4.5. Containers in which waste is accepted on Site may be reclaimed after a management plan has been approved by the Manager.

4.4.6. The Permit Holder must take all reasonable steps to ensure that the Site is operated in such a manner that nuisance conditions or health hazards, or the potential creation of nuisance conditions or health hazards, are prevented.

4.4.7 The Permit Holder must make provision for adequate sanitation facilities on the Site.

4.4.8. The Permit Holder must implement, maintain and at all times apply sufficient dust control measures to prevent wind-blown dust from causing nuisance conditions or health hazards.

4.4.9. The Permit Holder must implement, maintain and at all times apply sufficient odour control measures to prevent odours from causing nuisance conditions or health hazards.

4.4.10 The measured concentration of flammable gas, amended for Standard Temperature and Pressure, in the atmosphere inside buildings on the Site must not exceed 0.5% by volume in air. Should the levels above 0.5% be detected, the Permit Holder must submit a contingency plan regarding occupational safety to the Manager, which must be implemented on the Site, after written approval by the Manager.

4.4.11. The Permit Holder must implement adequate measures to the satisfaction of the Manager, to ventilate methane gas generated in the waste disposal area and to prevent lateral migration of methane gas in order to prevent the build-up of dangerous concentrations within the Site.

4.4.12. The Permit Holder must implement, maintain and at all times apply sufficient noise control measures to prevent noise from causing nuisance conditions or health hazards.

4.5. Access Control

4.5.1. Weatherproof, durable and legible notices in at least three official languages applicable in the area, must be displayed at each entrance to the Site. These notices must prohibit unauthorised entry and state the hours of operation, the name, address and telephone number of the Permit Holder and the person responsible for the operation of the Site.

4.5.2 Notices prohibiting unauthorised persons from entering the Site, as well as an internationally accepted sign indicating the risks involved in unauthorised entry must be displayed at 50 metre intervals along the boundary fence of the Site.

4.5.3. The Site must be fenced to a minimum height of 1,8 metres, with gates of the same height at all entrances, to reasonably prevent unauthorised entry.

4.5.4 All leachate containment works must be fenced to a minimum height of 1,8 metres, with gates of the same height at all entrances, to reasonably prevent unauthorised entry.

4.5.5 The Permit Holder must take all reasonable steps to maintain service roads within his jurisdiction in a condition which ensures unimpeded access to the Site for vehicles transporting waste.

4.5.6. The Permit Holder must ensure that all entrance gates are manned during the hours of operation and locked outside the hours of operation.

4.5.7 The Permit Holder must ensure effective access control.

4.5.8. The Permit Holder must take all reasonable steps to prevent the disposal of waste on the Site for which the Site has not been approved.

5. STORMWATER AND LEACHATE MANAGEMENT

5.1. Runoff Management

5.1.1. All runoff water (stormwater) arising as a result of precipitation on land adjacent to the Site, must be reasonably prevented from coming into contact with any substance, whether such substance is a solid, liquid, vapour or gas, or a combination thereof, which is produced, stored, dumped or spilled on the premises, including leachate and must be diverted and drained around the Site by means of works constructed by the Permit Holder in accordance with condition 3.9.

5.1.2 Runoff water (stormwater) arising as a result of precipitation on the Site, must be prevented where possible from coming into contact with any substance, as enumerated in condition 5.1.1 and must be diverted and drained from the Site and working face of the Site, by means of works constructed by the Permit Holder in accordance with condition 3 and must be contained in works constructed by the Permit Holder in accordance with condition 3.

5.1.3 Runoff water, as referred to in condition 5.1.2, may not be discharged to the Ericsons Dam unless it complies with the quality requirements specified in Annexure III, or with such quality requirements as may from time to time be determined by the Manager, but must be diverted to and contained in works constructed by the Permit Holder in accordance with condition 3.10.

5.1.4. Uncontaminated runoff water as referred to in condition 5.1.1, must be diverted away from the Site and discharged into the Ericsons Dam.

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5.1.5 In the event that runoff water referred to in condition 5.1.1 becomes contaminated with leachate or as a result of the operational activities on the Site and/or the premises of the Permit Holder, it must be regarded as leachate and must be dealt with according to condition 5.2

5.1.6. Runoff water arising from operational actions, for example the washing of vehicle exteriors, or which are suspected to be contaminated must be regarded as contaminated and must be dealt with according to condition 5.1.7

5.1.7 Contaminated runoff must be contained in the works constructed according to condition 3.10.

5.1.8. A management plan for contaminated runoff must be submitted to the Manager for approval within 60 days from the date of this permit

5.1.9. Until the management plan referred to in condition 5.1.8 has been approved, contaminated runoff referred to in condition 5.1.7 must be:

(a) evaporated in dams and/or be evaporated by spraying over those portions of the Site which comply with the requirements set in terms of condition 3.1; or
(b) used for the suppression of dust; or
(c) discharged into any convenient sewer only if accepted in writing by the authority in control of the sewer.

5.1.10. Uncontaminated runoff water must under no circumstances be used to dilute waste water resulting from any activities on the Site or actions relating to the operation of the Site, contaminated stormwater or leachate emanating from the Site, but must be dealt with according to condition 5.1.7.

5.2. Leachate Management

5.2.1. All leachate produced by the Site must be collected in containment works constructed according to condition 3.11 from where it must be treated in the leachate treatment plant constructed according to conditions 3.12 and 3.13

5.2.2. The capacity of the leachate treatment plant must be reviewed annually and a report submitted to the Manager, starting within one year from the commissioning of the leachate treatment plant according to condition 3.12. Should the capacity not be adequate, the Permit Holder may be instructed by the Manager to increase the capacity

5.2.3. Leachate which has been treated in works constructed in accordance with conditions 3.12 and 3.13 may not be discharged into the environment

6. MONITORING

6.1. AIR QUALITY AND GAS MONITORING

6.1.1 Air quality and gas monitoring during the normal operative lifetime of the Site

6.1.1.1 The Permit Holder shall conduct air quality monitoring according to sections 4.3.1 and 4.3.2 of the Report referred to in condition 1.1.(a) or subsequent versions thereof, submitted by the Permit Holder and approved by the Manager

6.1.1.2 The air quality monitoring programme must be reviewed annually and updated as necessary as the site development takes place.

6.1.2 **Post-closure air quality and gas monitoring**

6.1.2.1. Air quality and gas monitoring, as described in the monitoring programme referred to in condition 6.1.1, must continue after closure of the Site and must be maintained for a period of 30 years, or for such period and/or frequency as may be determined by the Manager

6.2 WATER QUALITY MONITORING

6.2.1 **Location of points and specifications for water quality monitoring network**

6.2.1.1 Monitoring of groundwater, surface water and leachate must be conducted at the locations specified in conditions 6.2.2 and 6.2.3 and at any other location or locations that may from time to time be specified by the Manager.

6.2.1.2 The water quality monitoring network shall be reviewed annually and updated as necessary as site development takes place

6.2.2 **Groundwater quality monitoring network**

6.2.2.1 A monitoring borehole network for the Site must be maintained by the Permit Holder according to Table 4.2.3(a) of the Report referred to in condition 1.1(a) or subsequent approved versions thereof, to the satisfaction of the Manager so that unobstructed sampling, as required in terms of the Permit, can be undertaken

6.2.2.2 Monitoring boreholes must be equipped with lockable caps. The Department reserves the right to take water samples at any time and to analyse those samples, or to have them taken and analysed.

6.2.3 Surface water quality and leachate monitoring network

6.2.3.1 Surface water and leachate monitoring network for the Site must be maintained by the Permit Holder according to Table 4.1.2(a) of the Report referred to in condition 1.1 (a) or subsequent approved versions thereof

6.2.3.2 Monitoring of treated leachate shall be conducted at locations which shall be approved by the Manager

6.2.4 Background monitoring

6.2.4.1 Samples from the borehole where the groundwater in the borehole is at an expected higher hydraulic pressure level than the hydraulic pressure level of the ground water under the Site, shall be considered as background monitoring

6.2.4.2 Background groundwater monitoring must be conducted during each monitoring occasion according to Table 4.2.4(a) of the report referred to in condition 1.1.(a) or subsequent approved versions thereof.

6.2.5 Detection monitoring

6.2.5.1. Monitoring for surface water, groundwater and leachate quality must be conducted for the variables listed in Table 4.2.3.(b) and at the frequency listed in Tables 4.1.2(a) and 4.2.4(a) of the Report referred to in condition 1.1 (a) or subsequent approved versions thereof.

6.2.6 Investigative monitoring

6.2.6.1 If, in the opinion of the Manager, a water quality variable at any monitoring point listed under the detection monitoring programme, as referred to in condition 6.2.5, shows an increasing trend, the Permit Holder shall initiate a monthly monitoring programme for the water quality variables listed in Annexure IV.

6.2.7 Post-closure water monitoring

6.2.7.1 Groundwater, surface water and leachate monitoring by the Permit Holder, in accordance with conditions 6.2.4 and 6.2.5 must continue after closure of the Site and must be maintained for a period of 30 years, or for such period and/or frequency as may be determined by the Manager

6.3. LEAK AND FAILURE DETECTION MONITORING

6.3.1 The leachate detection system must be monitored on a daily basis for the occurrence of leakages and a higher frequency of monitoring, as approved by the Manager, must be initiated should a leak be suspected and/or identified

6.3.2 Inspection of liners, where liners are accessible, must be performed monthly by the Permit Holder and bi-annually by an external contractor and reported annually to the Manager.

6.3.3 Liners must be repaired when possible, or replaced when necessary, when inspection tests show deterioration or leaking and these corrective actions shall be performed to the satisfaction of the Manager.

6.3.4 Pipes exposed to leachate shall be subjected to annual pressure cleaning where possible

6.3.5 Should a leak or failure be suspected or detected during monitoring or tests performed in accordance with conditions 6.3.1 to 6.3.3, or at any other time, it must be regarded as an incident according to condition 12.1 and addressed accordingly

7. FURTHER INVESTIGATIONS

7.1. If, in the opinion of the Manager, groundwater, surface water and/or air pollution have occurred or may possibly occur, the Permit Holder must conduct, and/or appoint specialists to conduct the necessary investigations and implement additional monitoring and remediation measures to the satisfaction of the Manager

8. AUDITS

8.1 Internal audits

8.1.1 Inspections must be conducted weekly by the Permit Holder as described in the Report referred to in condition 1.1.(c) and the findings of these inspections must be available to the external auditor specified in condition 8.2.

8.1.2 Internal auditing must be conducted quarterly by the Permit Holder and on each audit occasion an official report must be compiled by the relevant auditor to report the findings of these audits, which must be available to the external auditor according to condition 12.2.1 and the Department on request

8.2 External audits

8.2.1 The Permit Holder must appoint an independent external auditor to audit the Site bi-annually and this auditor must compile an audit report documenting the findings of the audit within 60 days from the date of the audit, which must be submitted by the Permit Holder according to condition 12.2.2

8.2.2 The audit report must specifically state whether conditions of this Permit are adhered to and must include whether monitoring required in terms of condition 6 of this permit has been carried out and whether reasonable interpretation of the data has been undertaken in accordance with condition 12.3.1 of this permit.

8.2.3 The audit report must contain recommendations regarding non-compliance or potential non-compliance and must recommend target dates for the implementation of critical recommendations by the Permit Holder

8.2.4 Based on the audit report, the Permit Holder must prepare a programme detailing target dates for implementation of all the recommendations made, which must be submitted to the Manager and to the external auditor within 30 days after submission of the audit report in accordance with condition 12.2.2

8.3 Departmental audits and inspection

8.3.1 The Department reserves the right to audit and/or inspect the Site at any time and at such a frequency as the Manager may decide, or to have the Site audited or inspected

8.3.2 The Permit Holder must make any records or documentation available to the Manager upon request, as well as any other information the Manager may require.

8.3.3 The findings of these audits or inspections shall be made available to the Permit Holder and the Monitoring Committee within 30 days of the end of the audit or inspection. Information from the audits must be treated in accordance with the Promotion of Access to Information Act, 2000 (Act 2 of 2000).

9. MONITORING COMMITTEE

9.1 The Permit Holder must take all reasonable steps to maintain and ensure the continued functioning of the Holfontein Monitoring Committee (in this Permit referred to as the "Monitoring Committee") for the normal operative lifetime of the Site and for a period of at least two years after the closure of the Site, or such longer period as may be determined by the Manager

9.2 The Monitoring Committee shall be representative of relevant interested and affected persons and may consist of at least the following persons:

- (a) Permit Holder and/or his appointed consultant(s) or advisor(s);
- (b) representative(s) of the Health, Environment and/or Waste Departments of the relevant local authority;
- (c) representative(s) of this Department;
- (d) representative(s) of the Provincial Government responsible for waste management and environmental functions; and
- (e) at least 3 (three) persons/parties, or their representatives elected by the local residents

9.3 The Monitoring Committee shall meet at least once every three months and not later than 30 days after the external audit report specified in condition 8.2 has been submitted according to condition 12.2.2.

9.4 The Permit Holder must keep minutes of all meetings of the Monitoring Committee and distribute these minutes to all members of the Monitoring Committee within 30 days after the meeting

10. ANALYSIS OF SAMPLES

10.1 The Permit Holder must ensure that all samples taken in accordance with condition 6, are-

10.1.1 analysed by a laboratory accredited by the South African National Accreditation System (SANAS); and

10.1.2 according to the methods prescribed in terms of Government Notice 991 of 18 May 1984, or another method of analysis for which written approval has been obtained from the Manager.

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11. RECORDING

11.1 The Permit Holder must keep records of all water monitoring data in the format depicted in Annexure VI, as well as from air quality and gas monitoring conducted in accordance with condition 6.

11.2 The Permit Holder must keep records of the following for all waste deposited on the Site and must update all the information referred to in Annexure V on an annual basis:

(a) date and time of arrival of the waste at the Site;
(b) generator (source of the waste);
(c) mass or volume of the specific wastes;
(d) type, classification and composition of the waste, with a separate list of hazardous components where the composition is not evident from the name of the waste;
(e) any specified pre-treatment procedures and/or method of disposal to which the waste was subjected before its disposal was permitted on the Site; and
(f) the location of encapsulated waste within the Site.

11.3 Safe disposal certificates must be issued in the name of the generator.

11.4 Records must be kept of all tests and inspections conducted in accordance with condition 6.3.

12. REPORTING

12.1 Reporting of incidents

12.1.1 The Permit Holder must, within 24 hours, notify the Manager of the occurrence or detection of any incident on the Site, or incidental to the operation of the Site, which has the potential to cause, or has caused water pollution, pollution of the environment, health risks or nuisance conditions.

12.1.2 The Permit Holder must, within 14 days, or a shorter period of time, if specified by the Department, from the occurrence or detection of any incident referred to in condition 12.1.1, submit an action plan to the satisfaction of the Manager, which shall include a detailed time schedule of measures taken to-

(a) correct the impact resulting from the incident;
(b) prevent the incident from causing any further impacts; and
(c) prevent a recurrence of a similar incident.

12.1.3 In the event that measures have not been implemented within 21 days to address impacts caused by the incident referred to in condition 12.1.1, or measures which have been implemented are inadequate, the Department may implement the necessary measures at the cost and risk of the Permit Holder

12.1.4 The Permit Holder must keep an incident report and complaints register, which must be made available to both external and Departmental auditors for the purpose of their audits

12.2 Audit reports

12.2.1 All internal audit reports referred to in condition 8.1 must be made available to the external auditor referred to in condition 8.2.

12.2.2 Each external audit report referred to in condition 8.2 must be submitted to the Manager and the Monitoring Committee within 14 days from the date on which the external auditor finalised the audit report

12.3 Other reports

12.3.1 The information required in terms of condition 6 must be reported to the Manager, in the format specified in condition 11.1 where applicable, within a period of 30 days or less following the completion of analysis of the samples. The information must also be compiled into a trend report, which must contain a graphical presentation of all results obtained previously at any specific point, as well as an interpretation and discussion of the results of each monitoring occasion.

12.3.2 Should the results of analysis required in terms of condition 6 show that a significant risk exist, the information should be reported to the Manager within a period of 7 days following the analysis of the samples

12.3.3 The information required in terms of condition 11.2, must be submitted to the Manager within a period of one year from the date of issuing of this Permit and annually thereafter

12.3.4 The Report referred to in condition 1.1 (a) must be reviewed annually and be updated to reflect development on Site and must be submitted to the Manager for approval. Monitoring as specified in condition 6 must be conducted according to the updated approved Report

12.3.5 The Report referred to in condition 1.1.(c) must be reviewed annually and updated if necessary. The updated report must be submitted to the Manager for approval.

12.3.6 The Permit Holder must submit a written report to the Manager regarding any deviations from plans and/or operation procedures described in this

Permit and must obtain written permission from the Manager before such deviations may be implemented.

13. REHABILITATION AND CLOSURE OF THE SITE

13.1 The Permit Holder must rehabilitate the Site, or any portion thereof, in accordance with a rehabilitation plan, which must be submitted to the Manager for approval at least one year prior to the intended closure of the Site.

13.2 The Permit Holder must, at least 120 days prior to the intended closure of the Site, or any portion thereof, notify the Manager by registered mail of such intention and submit any final rehabilitation plans or amendments for his approval.

13.3 Immediately following the cessation of operations with the intention to close the Site, or any portion thereof, the surface of the Site must be capped with an interim capping as approved by the Manager and the Site must be maintained in such a way that-

(a) the formation of pools due to rain is prevented;
(b) free surface runoff of rainwater is ensured;
(c) contamination of stormwater is prevented;
(d) no objects or material which may hamper the rehabilitation of the Site are present; and
(e) little or no erosion occurs,

until the approved rehabilitation plan referred to in condition 13.1 is completely implemented.

13.4 The Permit Holder shall be responsible for the Site, or its impacts on the environment, after operations on the Site have ceased.

14. GENERAL

14.1 This Permit is not transferable.

14.2 The Permit must not be construed as exempting the Permit Holder from compliance with the provisions of the National Environmental Management Act, 1998 (Act 107 of 1998), Health Act, 1977 (Act 63 of 1977), the National Water Act, 1998 (Act 36 of 1998), the Occupational Health and Safety Act, 1993 (Act 85 of 1993), other sections of the Environment Conservation Act, 1989 (Act 73 of 1989) or any other applicable act, ordinance, regulation or by-law.

14.3 All reports and results that should be submitted to the Manager in terms of this Permit should also be submitted to the Gauteng Provincial Department for the Environment

14.4 The Permit Holder must provide the Manager with any information which he may require to enable him to fulfil the objective of the Environment Conservation Act, 1989 (Act 73 of 1989) for waste disposal purposes

14.5 The Permit Holder must make adequate financial provision for the closure and rehabilitation of the Site and proof of this must be submitted to the Manager on an annual basis.

14.6 The Permit Holder must inform the Manager of any agreements or contracts which are entered into and which might affect any aspect of the Permit.

14.7 Should transgression of any condition of this Permit not be rectified to the satisfaction of the Manager, this could result in the Permit being terminated by the Minister.

14.8 This Permit replaces all previous Permits issued in terms of section 20(1) of the Environment Conservation Act, 1989 (Act 73 of 1989) for the operation of this Site

MANAGER: WATER USE
p.p. MINISTER OF WATER AFFAIRS AND FORESTRY

DATE: 05/02/2004

ANNEXURE I

PERMISSIBLE WASTE:
WASTE WHICH MAY BE ACCEPTED ON THE SITE BUT NOT DISPOSED OF ON SITE PRIOR TO TREATMENT:

CONDITION 2.1.

1. Waste where specific control has been established in terms of the Nuclear Energy Act, 1993 (Act 131 of 1993).

2. Waste types controlled in terms of the Minerals Act, 1991 (Act 50 of 1991) and the Electricity Act, 1987 (Act 41 of 1987), unless written permission has been obtained from the Manager: Waste Discharge and Disposal

3 Waste with the following hazardous characteristics, unless the waste has been treated to remove those characteristics:

3.1.1 flammable wastes, with a closed cup flash point less than 61°C,
3.1.2. waste for which the pH of the waste or the pH of a 1:1 w/w extract with water are below pH 6 or above pH 12;
3.1.3 explosive waste, i.e. class 1 or containing a substance that can react with water, air or other waste as defined in SABS 0228: 1995;
3.1.4. compressed gasses, i.e. Class 2 as defined in SABS 0228: 1995;
3.1.5 radioactive with a specific activity of greater than 74 Bq/g, i.e. Class 7 as defined in SABS 0228: 1995, and as regulated in terms of the Nuclear Energy Act (Act 131 of 1993) and the Hazardous Substances Act (Act 15 of 1973).

4. Any healthcare risk waste unless it has been treated with a treatment technology supported by the Department to render the healthcare risk waste unrecognisable and sterile.

5 Scheduled pharmaceutical products must be disposed according to the Minimum Requirements and the requirements of Section 27 of the Regulations made in terms of the Medicines and Related Substances Control Act, 1965 (Act 101 of 1965) as amended 2003

6 Asbestos waste unless it has been packed in special plastic bags in accordance with the Asbestos Regulations No 440 in the Government Gazette Number 23108 dated 10 February 2000

ANNEXURE II

DISPOSAL OF PHARMACEUTICAL WASTE CONFISCATED BY THE SOUTH AFRICAN POLICE SERVICE

CONDITION 2.2

1. The Permit Holder shall ensure that the packets and containers shall be broken, punctured or opened to ensure that the contents will come into contact with other waste and leachate when co-disposed on the Site

2. The waste shall be disposed of into trenches of at least 4 metres deep, cut by mechanical means, and filled with leachate which has been treated with at least 100 kilograms of caustic soda. The waste shall be properly mixed into the alkaline leachate to effectively destroy the waste.

3. Trenches should be filled with other waste and compacted immediately after disposal.

4. The Permit Holder shall ensure that the handling and disposal of the waste will be done under the supervision of the South African Police Service

5. All workers coming into contact with the waste during transport and disposal shall be equipped with suitable protective clothing.

6. Detailed records shall be kept of the quantity and types of waste, date received and date disposed and reported to the Manager: Waste Discharge and Disposal after the disposal has been completed.

7. Detailed records shall be kept of the position and placement of the pharmaceutical waste within the waste body. This information shall be submitted to the Manager: Waste Discharge and Disposal within six weeks of the date of this permit amendment

ANNEXURE III

WATER QUALITY REQUIREMENTS TO WHICH UNCONTAMINATED RUNOFF WATER MUST COMPLY BEFORE DISCHARGE INTO THE ERICSON DAM:

CONDITION 5.1 3

Determinant	Value
pH	6.5-8.5
Electrical conductivity (mS/m)	< 70
Chemical oxygen demand (COD in mg/l)	<35
Manganese (Mn in mg/l)	< 0.5
Sulphate (SO_4 in mg/l)	< 300
Chloride (Cl in mg/l)	< 150
Aluminium (Al in mg/l)	< 0.3
Ammonia (mg/l N)	< 1.5
Iron (Fe in mg/l)	< 0.5
Magnesium (Mg in mg/l)	< 30
Nitrate (NO_3 as ml/l N)	< 3
Phosphate (PO_4 in mg/l)	< 0.4
Sodium (Na in mg/l)	< 100
Fluoride (F in mg/l)	< 0.7

ANNEXURE IV

WATER QUALITY VARIABLES REQUIRED FOR INVESTIGATIVE MONITORING

CONDITION 6.2.6

Alkalinity (as mg $CaCO_3$/l)	pH
Free & saline ammonia as N (NH_4-N)	Soluble orto-phosphate (PO_4 - P)
Calcium (Ca)	Potassium (K)
Chemical oxygen demand (COD)	Sodium (Na)
Chloride (Cl)	Sulphate (SO_4)
Chromium (hexavalent) (Cr^{6+})	Chromium (Total) (Cr)
Total free cyanide (CN)	Arsenic (As)
Dissolved organic carbon (DOC)	Boron (B)
E. coli (counts per 100ml)	Cadmium (Cd)
Electrical conductivity (EC)	Lead (Pb)
Fluoride (F)	Mercury (Hg)
Iron (Fe)	Total phenol
Manganese (Mn)	Poly Aromatic Hydrocarbons (PAH)
Magnesium (Mg)	Poly Chlorinated Hydrocarbons (PCH)
Nitrate (as N) (NO_3-N)	Uranium (U)
Total organic carbon (TOC)	Vanadium (V)

ANNEXURE V

INFORMATION WHICH SHALL BE SUBMITTED ON AN ANNUAL BASIS:

CONDITIONS 11.2

** = Indicate with an X. Please print legibly.*

NAME OF SITE: DATE OF REPORT: ______ (y/m/d)

1. Registered owner(s) of property on which disposal site is situated:

Name		Telephone	
Postal Address		Fax	
		Postal Code	

2. Operator in control of disposal site:

Name				Telephone			
Identity number				After hours			
Educational	std 6		std 8		matric		Other (specify)
Qualifications (*)	diploma		higher diploma		degree		

3. Latest estimated lifetime of the disposal site: ______ yr

4. Indicate the type of waste and approximate quantities of waste disposed of during the year:

[illegible] waste [illegible]	Frequency (per annum) [illegible]	Compacted (C)	Uncompacted (U)
Non-hazardous waste [illegible]			
Household			
Garden refuse			
Building rubble			
Industrial (not hazardous) - (specify)			
TOTAL			
Hazardous wastes [illegible]			
Flammable solids			
Flammable liquids			
Oxidising agents			
Toxic wastes			
Corrosive wastes			
Hospital and infectious wastes (specify)			
TOTAL			

5. (a) Indicate the method of disposal of waste (*).

Landbuilding		Landfilling	

(b) Indicate the present dimensions of the site (metre)

Height/depth		
Length		
Breadth		

6. Indicate the applicable waste types and quantities salvaged during the year (*)

Salvaging undertaken?		Yes	No		
Type	(t)	Quantity (m³)	Type	(t)	Quantity (m³)
Paper/wood fibre			Rubber		
Plastics			Textiles		
Glass			Iron		
Copper			Aluminium		
Zinc			Lead		
Phospho-gypsum			Fly-ash		
Waste for composting			Food residues		
Flammable gases			Other		
Other			Other		
Other			Other		

7. Indicate the types, sources and approximate quantities of available covering material (*).

Type		Sources	Quantity
Soil			
Sand			
Ash			
Gravel			
Clay			
Building rubble			
Other (specify)			

I, the undersigned, declare that the information stated above is to my knowledge a true reflection of the status at the HOLFONTEIN landfill site.

Signature: __________

Name: __________

Capacity: __________

Place: __________ Date __________

ANNEXURE VI

FORM TO BE USED FOR CHEMICAL INFORMATION: CONDITIONS 6 AND 11.1

Name of Site:			
Borehole/observation point name/number:			
Sampling date:		Method: Bailer	
Sampling Time:		Pump	
Time taken to purge:	min	Depth of Sample:	m
Date of analysis:		Laboratory:	

General chemistry

Constituent	Unit	Value	Constituent	Unit	Value
pH	(-log[H⁺])		Al	(mg/l)	
EC	(mS/m)		As (III)	(mg/l)	
TDS	(mg/l)		B	(mg/l)	
Ca	(mg/l)		Cd	(mg/l)	
Mg	(mg/l)		free CN	(mg/l)	
Na	(mg/l)		Cr (Total)	(mg/l)	
K	(mg/l)		Cr (VI)	(mg/l)	
Alkalinity	(mg $CaCO_3$/l)		Cu	(mg/l)	
Cl	(mg/l)		Fe	(mg/l)	
SO4	(mg/l)		Mn	(mg/l)	
NO3-N	(mg/l)		Pb	(mg/l)	
F	(mg/l)		Zn	(mg/l)	
COD	(mg/l)		Co	(mg/l)	
NH4-N	(mg/l)		Hg	(mg/l)	
Organic N	(mg/l)		Li	(mg/l)	
Phenol	(mg/l)		Ni	(mg/l)	
PO4	(mg/l)		Se	(mg/l)	
E. Coli	counts/100ml		U	(mg/l)	
DOC	mg/l		V	(mg/l)	
TOX	µg/l				
TOC	mg/l				
PAH	µg/l				
PCH	µg/l				
VCH	(mg/l)				

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E. 3) No answer
E. 2) Busy
E. 4) No facsimile connection

FAX

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DEPARTMENT: WATER AFFAIRS AND FORESTRY

P-A (012) 323 [illegible]
E-A [illegible]@dwaf.gov.za

PERMIT NUMBER: 16/2/7/C212/M121/P3 (Amendment to Permit Number [illegible] issued on 26 April 1996)

CLASS: H:H

WASTE DISPOSAL SITE: HOLFONTEIN

LOCATION: PORTIONS 23 AND 24 OF THE FARM HOLFONTEIN 71 IR AND PORTION 8 OF THE FARM MODDERFONTEIN 236 IR, DISTRICT OF BENONI

PERMIT HOLDER: DISPOSE TECH, A DIVISION OF ENVIROSERV WASTE MANAGEMENT (PTY) LTD

ADDRESS: PO BOX 13420, NORTHMEAD 1511

PERMIT IN TERMS OF SECTION 20 OF THE ENVIRONMENT CONSERVATION ACT, 1989 (ACT 73 OF 1989)

By virtue of the powers delegated to me by the Minister of Water Affairs and Forestry (hereinafter referred to as "the Minister"), I, Cornelius Ruiters, in my capacity as Manager: Water Use in the Department of Water Affairs and Forestry (hereinafter referred to as "the Department"), hereby in terms of section 20(1) of the Environment Conservation Act, 1989 (Act 73 of 1989), authorise the abovementioned Permit Holder to further develop and operate the Holfontein H:H Landfill Site, subject to the conditions specified herein.

Zitholele Consulting
Reg. No. 2000/000392/07

PO Box 6002 Halfway House 1685, South Africa
Building 1, Maxwell Office Park, Magwa Crescent West
c/o Allandale Road & Maxwell Drive, Waterfall City, Midrand
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ZITHOLELE CONSULTING

REPORT ON

Environmental Management Programme for the Medupi FGD Retrofit Project

Report No : 12949-46-Rep-002

Submitted to :

Eskom Holdings SOC Limited
PO Box 1091
Johannesburg
2000

23 May 2018 12949

TABLE OF CONTENTS

SECTION **PAGE**

1 INTRODUCTION 1
1.1 Project background 1
1.2 Existing authorisations, licences and approvals 1
1.3 Details of the proponent 3
1.4 Details of the EAP 3
2 PURPOSE AND OBJECTIVES OF THE EMPR 5
2.1 Purpose of the EMPr 5
2.2 Applicable documentation 6
2.3 Structure of the EMPr 7
3 ENVIRONMENTAL GUIDELINES, LEGISLATION AND STANDARDS 8
4 DESCRIPTION OF THE ACTIVITIES 9
4.1 Rail Yard (Block 1 & 2) 9
4.2 Limestone preparation (Block 2) 11
4.3 Input materials and processes (Block 3) 12
4.4 Wet Flue Gas Desulphurisation (WFGD) system (Block 4) 12
4.5 Treated Flue Gas (Block 5) and evaporation (Block 6) 12
4.6 Gypsum dewatering, re-use or disposal (Block 7) 13
4.7 Waste Water Treatment (Block 8) 14
4.8 Storage and disposal of salts and sludge (Block 9) 14
5 ENVIRONMENTAL MANAGEMENT PROGRAMME 16
5.1 Roles and Responsibilities 16
5.2 Environmental Specifications 16
6 MONITORING AND COMPLIANCE 34
6.1 Compliance monitoring and reporting of construction and operation activities 34
6.2 Soils 34
6.3 Groundwater 37
6.4 Biodiversity (Terrestrial Ecology) and Wetlands 37
6.5 Noise 38
6.6 Heritage, archaeology and palaeontology 39
7 ENVIRONMENTAL AWARENESS PLAN 40

LIST OF FIGURES

Figure 4-1: Basic process Flow Diagram for the FGD process at Medupi Power Station . 10

LIST OF TABLES

Table 1-1: Existing authorisations, approvals and licences issued for the Medupi Power Station 2

Table 1-2: Details of the Environmental Assessment Practitioner 3

Table 3-1: Applicable legislation, programmes and guidelines........ 8

Table 5-1: Project Initiation and General Management 17

Table 5-2: Management of Surface Water Resources 18

Table 5-3: Management of Groundwater Resources 19

Table 5-4: Management of impacts on Biodiversity and Wetlands 20

Table 5-5: Management of Air Quality impacts 22

Table 5-6: Management of Ambient Noise Levels 23

Table 5-7: Management of Soil and Land Capability Impacts 24

Table 5-8: Management of Heritage, Archaeological and Palaeontological Resources ... 26

Table 5-9: Management of Social Impacts........ 27

Table 5-10: Management of impacts on Traffic and Roads........ 28

Table 5-11: Site management - Site establishment and laydown areas 29

Table 5-12: Site Management - On-site workshops and handling of hazardous materials 30

Table 5-13: Site management - Waste management activities 31

Table 5-14: Site management - Sanitation........ 32

Table 5-15: Site Management - Fire prevention........ 33

Table 6-1: Construction Phase – Soil Utilization Plan 35

Table 6-2: Operational Phase – Soil Conservation Plan 35

Table 6-3: Decommissioning Phase – Soil Conservation Plan........ 36

LIST OF ACRONYMS

AEL	Air Emissions Licence
ADF	Ash Disposal Facility
$CaCl_2$	Calcium Chloride
CaF_2	Calcium Fluoride
EAP	Environmental Assessment Practitioner
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
EMS	Environmental Management System
FGD	Flue Gas Desulphurisation
IDP	Integrated Development Plan
IEM	Integrated Environmental Management
IAIA	International Association for Impact Assessments
IEC	International Electrotechnical Commission
$MgSO_4$	Magnesium Sulphate
MPS	Medupi Power Station
MW	megawatt
PCD	Pollution Control Dam
ROD	Record of Decision
SLM	Sound Level Meter
SACNASP	South African Council for Natural Scientific Professionals
SDF	Spatial Development Framework
SO_2	Sulphur Dioxide
SO_3	Sulphur Trioxide
TOC	Total Organic Carbon
WML	Waste Management License
WWHC	waste water hydrocyclone
WWTP	Waste Water Treatment Plant
WTP	Water Treatment Plant
WULA	Water Use License Application
ZLD	Zero Liquid Discharge

1 INTRODUCTION

1.1 Project background

Medupi Power Station is a greenfield coal-fired power station that forms part of the Eskom New Build Programme and is located about 15km west of the town of Lephalale in the Limpopo Province.

The Medupi Power Station (MPS) has an installed generation capacity of 6 x 800 megawatt (MW) units and utilises a supercritical boiler and turbine technology designed to operate at higher temperatures and pressures, which allows for better efficiency of the power station. The result is an improvement of approximately 2 percentage points on the plant efficiency which equates to a reduced coal consumption of approximately 1 million tons per annum.

In coal-fired power stations electricity is generated through combustion of coal. Coal is composed, primarily, of carbon along with variable quantities of other elements, chiefly hydrogen, sulphur, oxygen, and nitrogen. When coal is burned, the sulphur combines with oxygen to form oxides of sulphur (SO_x), which include Sulphur Dioxide (SO_2) and Sulphur Trioxide (SO_3) (Eskom Holdings SOC Limited, 2017). Stringent air quality regulations have been implemented worldwide to combat the emissions of SO_x. Since the major emission of SO_x is by coal-fired power stations, removing sulphur from the flue gas is a common technique for reducing these emissions (US EPA, 2016).

In response to the Eskom Air Quality Strategy, requirements of the MPS's Air Emissions Licence (AEL) and funder requirements, the MPS units have been designed, and constructed, with provisions incorporated into the space and equipment designed to accommodate the installation of the wet limestone Flue Gas Desulphurisation (FGD) system. Each of the six generating units of the Power Station operates independently, while common facilities for all 6 generation units are provided for electricity, water, coal supply and coal combustion waste disposal.

1.2 Existing authorisations, licences and approvals

The MPS received the station's AEL in 2012. The AEL contains conditions that require the SO_2 emissions from the Power Station be reduced by more than 90%. This is one of the key reasons for the initiation of the FGD retrofit project. All existing authorisations, approvals and licences received for the Medupi Power Station are summarised in **Table 1-1** below.

Table 1-1: Existing authorisations, approvals and licences issued for the Medupi Power Station

Authorisations / Permits / Licenses	Authority	Reference	Applicable legislation/ code of practice
Medupi Power Station Record of Decision (ROD)	DEA	12/12/20/695	ECA (73 of 1989); GNR 1182 & 1183
Afguns Road ROD	DEA	12/12/20/1179	NEMA (107 of 1998); EIA Regulations 2006; GNR385, 386 &387
Raw Water Dam & Pipelines ROD	DEA	12/12/20/1139	NEMA (107 of 1998); EIA Regulations 2006; GNR385, 386
Raw Water Dam & Pipelines ROD Amendment	DEA	12/12/20/1139	NEMA (107 of 1998); Environmental Authorisation
Environmental Authorisation Raw water Dam & Pipeline	DEA	12/12/20/2069	NEMA (107 of 1998); Environmental Authorisation; EIA Regulations 2010; GN R. 544
Telecommunications Mast ROD	DEA	12/12/20/1228	NEMA (107 of 1998); EIA Regulations 2006; GNR385, 386
Environmental Authorisation for the Coal Stockyard on Ash Dump site	DEA	14/12/16/3/3/1/531	NEMA (107 of 1998) as amended
Ash Dump Waste License	DEA	12/9/11/L50/5/R1	NEM:WA (59 0f 2008)
Environmental Authorisation for the Pollution Control Dams and associated infrastructure	DEA	14/12/16/3/3/2/666	NEMA (107 of 1998)Listing Notice 1 and 2 (GNR 544 -item 12 and 545 item 3, 15)
Coal stockyard (coal supply conveyor alignment)	DEA	12/12/20/695	NEMA (107 of 1998) as amended
Amended Medupi Atmospheric Emission License	LEDET	12/4/12L-W2/A3	NEM:AQA (39 of 2004)
Integrated Water Use License for the Medupi Power Station, August 2017	DWS	01/A1042/ABCEFGI/5213	NWA (36 of 1998)
Water Use License for additional dams and C&I	DWS	07/A42H/IG/6425	NWA (36 of 1998)
Eskom ash dumps designs: Medupi ash dump 1-2 year, Excess Coal Stockyard, temporary coal storage area and temporary effluent containment paddock	DWS	Letter 348-859600	NWA (36 of 1998)
Kroomdraai borrow pit permit	DMR	114/2009	MPRDA as amended
Grootvlei borrow pit permit	DMR	113/2009	MPRDA as amended
Tree removal permit (Eenzamheid)- Ash Site	DAFF	200 - 163625	National Forest Act (84 of 1998) as amended
Tree removal permit (Eenzamheid)- Haul Road	DAFF	200 - 163626	National Forest Act (84 of 1998) as amended
Tree removal permit (Turvlakte, Naauw Ontkomen, Hangklip, Kroomdraii, Kuipersbuilt and Grootvallei) - Medupi Power Station	DAFF	200 - 163627	National Forest Act (84 of 1998) as amended

1.3 Details of the proponent

Eskom Holdings SOC Limited (referred to hereafter as Eskom) is the largest South African utility that generates, transmits and distributes electricity. Eskom supplies approximately 95% of the country's electricity, as well as about 45% of the electricity used in Africa. The utility is the largest producer of electricity in Africa. Eskom plays a major role in accelerating growth in the South African economy by providing a high-quality and reliable supply of electricity.

1.4 Details of the EAP

Eskom appointed Zitholele Consulting (Pty) Ltd. to undertake the regulatory Environmental Authorisation (EA), variation application for existing Waste Management License (WML) for the Ash Disposal Facility, and Water Use License Application (WULA) processes for the proposed Medupi FGD Retrofit Project. These processes are being undertaken independently as separate processes.

Zitholele Consulting (Pty) Ltd. is an empowerment company formed to provide specialist consulting services primarily to the public sector in the fields of Water Engineering, Integrated Water Resource Management, Environmental and Waste Services, Communication (public participation and awareness creation) and Livelihoods and Economic Development. Zitholele Consulting (Pty) Ltd has no vested interest in the proposed project and hereby declares its independence as required in terms of the EIA Regulations. Table 1-2 provides the details of the Environmental Assessment Practitioner (EAP).

Table 1-2: Details of the Environmental Assessment Practitioner

Details of the Environmental Assessment Practitioner	
Name and Surname	Mathys Vosloo
Highest Qualification	Phd Zoology
Professional Registration	*Pr.Sci.Nat.* (400136/12)
Company Represented	Zitholele Consulting (Pty) Ltd.
Physical Address	Building 1, Maxwell Office Park, Magwa Crescent West, Waterfall City, Midrand
Postal Address	P O Box 6002, Halfway House, 1685
Contact Number	011 207 2079
Facsimile	086 674 6121
E-mail	mathysv@zitholele.co.za

1.4.1 Expertise of Environmental Assessment Practitioner

Dr Mathys Vosloo graduated from the Nelson Mandela Metropolitan University with a PhD in Zoology in 2012, after successfully completing a MSc in Zoology and BSc (Hons) in Zoology. Dr Vosloo is a member of the International Association for Impact Assessments (IAIA) and is a registered professional natural scientist (Pr. Sci. Nat.) in the field of Ecological Science with the South African Council for Natural Scientific Professionals (SACNASP) since 2012.

Dr Vosloo has been involved in electricity generation, transmission and distribution projects and their potential impacts on the environment for a large part of his career. Dr Vosloo has gained extensive experience in managing integrated environmental authorisation processes and has successfully managed large projects through the phases of EIA in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) and National Environmental Management Waste Act, 2008 (Act No. 59 of 2008). Dr Vosloo has also been involved in Water Use Licensing as a component of integrated authorisation processes.

Dr Vosloo has a comprehensive understanding of the relevant environmental legislation and works intimately with specialist consultants to ensure that potential impacts are accurately identified, assessed and mitigated. With his experience in similar projects, Dr. Vosloo is ideally positioned to manage this environmental authorisation process with integrity and independence, while advising the client toward alternatives that have less potential for environmental impact.

2 PURPOSE AND OBJECTIVES OF THE EMPR

The preparation of an Environmental Management Programme (EMPr) is recognised as a tool in Integrated Environmental Management (IEM) to mitigate or minimise negative impacts and enhances positive impacts of a proposed development on the receiving environment. Typically an EMPr document is aligned to the project life cycle addressing each project phase i.e. the Planning / Pre-Construction, Construction, Operation and Decommissioning phases.

An EMPr provides a link between the impacts predicted and mitigation measures recommended within the Environmental Impact Assessment Report, and the implementation activities of a project to ensure that these activities are managed and mitigated to prevent unnecessary harm resulting from impacts to the receiving environment.

An EMPr, in the context of the Environmental Impact Assessment (EIA) Regulations (2010) under which this application was made, takes a project from a high level consideration of issues down to a detailed workable action plan that can be implemented in a cohesive and controlled manner.

2.1 Purpose of the EMPr

Construction and operation of the MPS is being undertaken subject to an existing EMPr (September 2010) authorised in terms of the Record of Decision for the MPS, as well as addenda to this EMPr resulting from the authorisation of additional construction activities such as the addendum to the MPS EMPr for the proposed pollution control dams and associated infrastructure at the MPS ash dump and coal stockyard (Savannah Environmental, 2013).

This EMPr addresses the construction and operation of additional infrastructure associated with the operation of the MPS within the power station's operational footprint and therefore serves as an addendum to the existing EMPr for the MPS.

The purpose of the EMPr is to ensure continued improvement of environmental performance, reducing negative impacts and enhancing positive effects during the construction and operation of the proposed infrastructure. An effective EMPr is concerned with both the immediate outcome as well as the long-term impacts of the project.

The objectives of this EMPr can be articulated as follows:

- To outline mitigation measures, and environmental specifications which are required to be implemented for the construction, operation and maintenance phase of the FGD system in order to improve overall environmental performance and compliance during these phases.
- To identify measures that will optimise beneficial impacts during the project phases.
- To ensure that the proposed activities associated with the FGD system does not result in undue or reasonably avoidable adverse environmental impacts, and ensure that any potential environmental benefits are enhanced.

- To ensure that all environmental management conditions and requirements as stipulated in the resultant Environmental Authorisation (EA) are implemented throughout the project life-cycle.
- To ensure that all relevant legislation (including national, provincial and local) is complied with during the project life-cycle of the proposed project.
- To identify entities who will be responsible for the implementation of the measures and outline functions and responsibilities.
- To specify a monitoring programme / mechanisms for monitoring compliance to the approved EMPr and EA, and preventing long-term or permanent environmental degradation. The monitoring programmes in this EMPr will be subject to the approval of the Department of Environmental Affairs (DEA) and aligned with the conditions of the EA once authorised. Once approved, the monitoring requirements must be captured in the power stations Environmental Management System (EMS).
- To facilitate appropriate and proactive responses to unforeseen events or changes in project implementation that was not considered in the EIA process.

2.2 Applicable documentation

The development of the Medupi Power Station (MPS) has resulted in a suite of environmental documentation governing the management and mitigation of all potential and real impacts identified for activities taking place during the planning, construction, operation and decommissioning of the power station. Since the proposed FGD system, rail yard and associated infrastructure will occur within the footprint of the MPS and will form part of the operation of the power station, the following environmental documentation is also applicable to the proposed FGD Retrofit project, and must be read in conjunction with this EMPr:

- Final Environmental Scoping Report for the proposed new Coal-Fired Power Station in the Lephalale Area, Limpopo Province (Bohlweki Environmental, November 2005).
- Final Environmental Impact Assessment Report for the proposed new Coal-Fired Power Station in the Lephalale Area, Limpopo Province (Bohlweki Environmental, May 2006).
- Scoping and Impact reports related to all additional authorisations.
- All Environmental Authorisations, licences and permits that have been issued or granted to the MPS, as per Table 1-1.
- Generation Primary Energy Division Primary Energy (water); Medupi power station technical report.
- Eskom's operational specifications (refer to Appendix C).
- The Medupi Power Station EMS, as amended, which include :
  - Medupi Environmental Policy (200-73979)
  - Procedure for the identification and assessment of environmental aspects and impacts (200-73975)
  - Environmental legal and other requirements (200-73977)
  - Medupi EMS scope and manual (200-73971)
  - Environmental training, awareness and competence (200-73973)

- Identification and application of environmental operational controls (200-73969) and the individual operational controls emanating from this procedure
- Health, Safety and Environmental Communications procedure (200-38432)
- Environmental Performance Monitoring and Measurement Procedure (200-73970)
- Handling of HSE non-conformities and corrective and preventative action (200-38426)
- Health, Safety and Environmental incident management procedure (200-10506)
- Health, Safety and Environmental audit procedure (200-38428)
- Management Review procedure (200-73968)

This EMPr has been compiled in accordance with Section 33 of the EIA Regulations of June 2010, as amended, in terms of the National Environmental Management Act 107 of 1998. It must further be noted that the stipulations of Appendix 6 of the EIA Regulations of 2014, as amended, in terms of the National Environmental Management Act 107 of 1998, have also been considered to ensure that the EMPr complies with the intention of the latest regulations.

The EMP is a dynamic document and may be updated as and when required throughout the life-cycle of the proposed FGD retrofit project. This EMPr will furthermore be updated to reflect any authority decisions or requirements communicated during the EMPr approval stage, or as a result of any substantive amendments to the EMPr requiring authority approval thereafter.

In the event that a conflict of interpretation arise between this EMPr and EA to be issued for the FGD retrofit project or any other existing authorisation of approved EMPr, the stipulations in the EA or approved document shall prevail over that of this EMPr, unless otherwise agreed by the Department of Environmental Affairs (DEA) in writing. Similarly, any provisions in current legislation overrule any provisions or interpretations within this EMPr. Any determinations on a conflict must be amended accordingly to ensure consistent and appropriate implementation.

2.3 Structure of the EMPr

This EMPr is specific to the FGD plant, but will serve as an addendum to the Medupi Power Station EMP Revision 2 (September 2010), has been developed as a set of environmental specifications which are appropriately contextualised to provide clear guidance in terms of the implementation of these specifications for this proposed project.

This addendum to the approved EMP for MPS must be read in conjunction with the EIA Report for the Medupi FGD Retrofit Project (February 2018), as well as relevant sections and appendices of the Medupi Power Station EMP Revision 2 (September 2010).

This EMPr has therefore been compiled to address site-specific and project-specific requirements of the proposed project within the MPS development footprint, while general specifications for the management of construction and operational activities as stipulated in the Medupi Power Station EMP Revision 2 (September 2010), relevant addenda and MPS EMS have not been repeated.

3 ENVIRONMENTAL GUIDELINES, LEGISLATION AND STANDARDS

Acts, standards or guidelines relevant to the planning, construction, operation and decommissioning of the Medupi FGD, rail yard and associated infrastructure were identified within the EIA process undertaken and is summarised in Table 3-1 below.

Table 3-1: Applicable legislation, programmes and guidelines

Act, Policies, Programmes and Guidelines
National Environmental Management Act, 1998 (Act No. 107 of 1998)
Environmental Impact Assessment Regulations, 2010 (GN R 543 – 545)
National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)
National Environmental Management Waste Act, 2008 (Act No. 59 of 2008)
National Water Act, 1998 (Act No. 36 of 1998)
National Heritage Resources Act, 1999 (Act No. 25 of 1999)
Hazardous Substance Act, 1973 (Act No. 15 of 1973)
National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)
National Environmental Management Protected Areas Act, 2003 (Act. 57 of 2003)
Water Services Act, 1997 (Act 108 of 1997).
Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)
National Forests Act (No 84 of 1998) and regulations
Infrastructure Development Act, 2014 (Act No. 23 of 2014)
National Road Traffic Act (Act No. 85 of 1993) (NRTA) and National Road Traffic Regulations, 2000 (GN R225, 17 March 2000) (NRTR)
National Key Points Act, 1980 (Act 102 of 1980)
Fencing Act (No 31 of 1963)
Occupational Health and Safety Act, 1993 (Act No. 85 of 1993)
Hazardous Substances Act (No 15 of 1973) and regulations
National Development Plan 2030 (NDP)
NEM:WA: National Waste Management Strategy (GN 344 of 4 May 2012)
Limpopo Environmental Management Act, 2003 (Act No. 7 of 2003)
Lephalale Local Municipality Final Integrated Development Plan (IDP) 2017/2018
Lephalale Local Municipality Draft Spatial Development Framework (SDF) – May 2017
Lephalale Local Municipality By-laws
White Paper on Environmental Management Policy for South Africa (1998)
National Biodiversity Strategy and Action Plan (NBSAP)
National Aquatic Ecosystem Health Monitoring Program (NAEHMP) & River Health Program (RHP)
National Freshwater Ecosystem Priority Areas (NFEPA)
National Water Resource Strategy (NWRS) 2
Limpopo Conservation Plan version 2, 2013

It must however be noted that the proposed FGD infrastructure, including the rail yard and all associated infrastructure and structures, fall completely within the footprint of the MPS. As such, the Eskom Medupi Power Station legal register, which is to be updated on a regular basis, shall be referred to and will be applicable to all phases of the proposed Medupi FGD Retrofit project to ensure compliance.

4 DESCRIPTION OF THE ACTIVITIES

The activities and infrastructure associated with the construction and operation of the Medupi FGD Retrofit project are summarised into a basic process flow diagram and is presented in Figure 4-1 below. Brief descriptions of the infrastructure and activities associated with this process are discussed in the following sections.

4.1 Rail Yard (Block 1 & 2)

Limestone is purchased off-site and is transported to the MPS by rail and/or road. The limestone will be offloaded at the proposed limestone storage facility, which includes a rail siding and road access, located south-west of the 6 power generation units within the MPS footprint. Infrastructure associated with the railway yard and limestone / gypsum handling area include:

- Limestone will be initially delivered by road and will be delivered to a truck offloading facility in close proximity to the Limestone Stockyard.
- Rail infrastructure proposed parallel to the existing Thabazimbi – Lephalale railway with a proposed siding take-off point situated at kilometre point 107+250m. The runoff line will leave the mainline approximately 1.8km west of the entry point to the railway yard/siding.
- Linear-type yard layout configuration with six lines parallel to each other and split into two separate yards (limestone offloading and gypsum loading) linked by means of a locomotive run-around line.
- Limestone offloading facility: Tippler Area building will include side dispensing tippler, a limestone rail, truck offloading area and separate receiving area, Tippler for “tipping” limestone onto an underground inclined conveyor, limestone transfer house and emergency limestone offloading area at the stockyard. Excavations up to 15m deep will be undertaken during construction of the Tippler facility.
- Gypsum will be routed to the Gypsum storage facility in close proximity to the railyard, while the other by-products from the FGD process, i.e. salts and sludge, will be temporarily stored in close proximity to the WWTP within the FGD infrastructure footprint. Gypsum storage loading facility will include gypsum reclaim hoppers that receive gypsum from the mobile reclaim equipment and discharge to the gypsum reclaim belt conveyor, which in turn discharges to the inclined gypsum belt conveyor. The inclined gypsum belt conveyor then discharges to the bin at the loading facility that feed the rail wagons with a controlled discharge.
- Administration building and operations tower for Eskom and a Services Provider’s personnel.
- Diesel locomotive workshop, utilities rooms and ablutions. This workshop area will have approximately 600m² service space for the shunting locomotive, various offices and store rooms (180m²) attached to one end of the building.

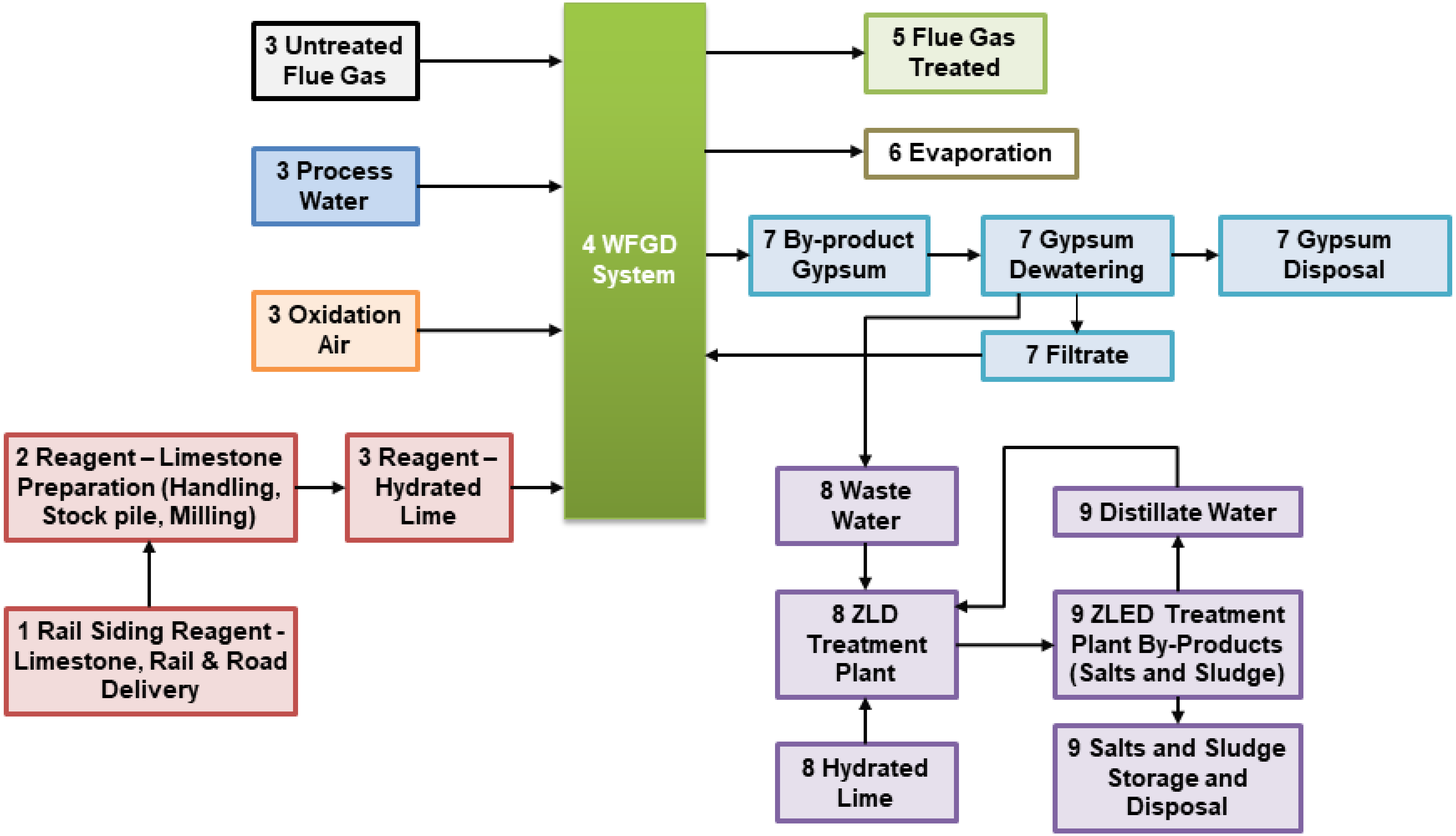

Figure 4-1: Basic process Flow Diagram for the FGD process at Medupi Power Station

- Two Diesel Storage Facilities (each can be approximately 3.6m in diameter and 3.0m in height) with a maximum installed storage capacity of 28 000 litres each, in two above-ground horizontal storage tanks, and will be bunded. One of these tanks will service the shunting locomotives while the other will service the Emergency Generator, and located at the rail siding area and the FGD complex area, respectively. A covered road tanker decanting area will be located alongside the bunded area. There is a third diesel tank in the FGD common pump building, the capacity of which is significantly less than the other two tanks.
- Security office and infrastructure: A security office will be located adjacent to the fence line at the western extent of the proposed rail yard where the proposed rail infrastructure ties in with the existing rail network. The existing service road fence will be used as the boundary fence to the rail yard.
- Conveyor infrastructure to transport limestone to the FGD system, and gypsum from the MPS to the rail yard or waste disposal facility.
- Sewerage and effluent management infrastructure: The security office, locomotive workshop and administration building will be served with ablution facilities with a sewerage conservancy tank system with capacities of 3200ℓ, 8500ℓ and 8500ℓ, respectively.
- Associated infrastructure (water, storm water, and lighting): Storm water channels and structures are designed to provide a division between storm water and the dirty water from the gypsum loading facility. Dirty storm water from the gypsum loading facility will be collected into an independent concrete channel and underground pipe network that will drain to the proposed Pollution Control Dam (PCD) that will form part of the FGD infrastructure. The estimated run off contribution to the PCD is expected to be 0.05m^3/s for a 1:20 year return period. Eskom will provide the required power supply, while the rail yard mini substations will be constructed in accordance with Eskom's specification. PCDs will also be provided for the salts and sludge storage facility. The Medupi plant operates with two separate water networks supplying fire water and potable water. The water network required for the rail yard was designed to tie into connection points within the existing water network of the MPS.

4.2 Limestone preparation (Block 2)

The limestone handling and conveyance will include the following infrastructure:

- Limestone stacking conveyor;
- Limestone storage area;
- Emergency limestone offloading area;
- Limestone reclaim conveyor;
- Limestone and gypsum handling substation;
- Storm Water Pollution Control Dams. The conceptual storm water management design has resulted in two separate PCDs being proposed in this area. It is also proposed that each of these PCDs is portioned to cater for maintenance activities in the future.

- Lined channels for diversion of dirty water to the Pollution Control Dams.

Limestone is conveyed to the limestone preparation building where it is heated and milled to produce pulvorised lime, or Quicklime. Quicklime is then combined with water to form hydrated lime, or Slaked Lime, in slurry form for input into the FGD system. The Slaked lime slurry is pumped to a lime slurry feed tank from where it is pumped, via piping, on the elevated FGD utility rack to each absorber for utilisation in the FGD system. Infrastructure thus includes a limestone preparation building, lime slurry feed tank, and piping on an elevated FGD utility rack.

4.3 Input materials and processes (Block 3)

Input materials to the FGD process will include:

- SO_2 laden flue gas received from the each generation unit. Untreated flue gas leaving the existing ID fans will be diverted to the absorber inlet, via additional ducting system;
- Process water received from process water tanks (two operational and one backup for redundancy);
- Oxidisation air; and
- Lime slurry (Slaked lime) received from the limestone milling and preparation plant.

4.4 Wet Flue Gas Desulphurisation (WFGD) system (Block 4)

The FGD system includes infrastructure that is located within the previously cleared and transformed footprint of the power station. Infrastructure includes:

- An absorber unit associated with each of the 6 x generation units;
- Each absorber unit will include a flue gas duct, absorber tower, absorber pump building and absorber substation;
- Absorber drain and gypsum bleed tanks associated with each cluster of 3 absorber units, i.e. absorber units 1 – 3 and absorber units 4 – 6;
- FGD above-ground elevated utility racks containing piping to direct fluid from and to relevant systems within the absorber area.

4.5 Treated Flue Gas (Block 5) and evaporation (Block 6)

Treated flue gas is redirected from the absorbers via the flue gas ducts back to the chimneys for release with much reduced SO_2 content. During the process evaporation losses are incurred.

4.6 Gypsum dewatering, re-use or disposal (Block 7)

4.6.1 Gypsum dewatering and conveyance

Gypsum will be produced from the FGD process as a by-product of the wet scrubbing process. Slurry will comprise gypsum, a mixture of salts (Magnesium Sulphate ($MgSO_4$) and Calcium Chloride ($CaCl_2$)), limestone, Calcium Fluoride (CaF_2), and dust particles. A refinement process is carried out to separate and dewater the gypsum. Effluent is directed to the Waste Water Treatment Plant (WWTP), the overflow of the gypsum dewatering hydro cyclones goes to the waste water hydrocyclone (WWHC) feed tanks. The tanks are located in the gypsum dewatering building. From the WWHC feed tanks, the water goes through the WWHC where the underflow is directed to the reclaim tanks and the overflow to the Zero Liquid Discharge (ZLD) holding tanks. The ZLD holding tanks feed the WWTP.

Dewatered gypsum is transported via conveyor either to the existing Ash Disposal Facility (ADF) or to an offtake point where it is diverted to a storage facility from which it may be transported by rail or road to users. The gypsum storage building will be used in conjunction with the rail siding only. The storage building is a future use facility that will be built with the rail siding. There will be no facilities for gypsum recovery from the storage building to be loaded onto trucks. Road transport is used for immediate offtake for gypsum exploitation.

Use of gypsum will be subjected to quality assessments, which will be done at the storage facility. If the quality is not usable, the gypsum will be taken for disposal. Infrastructure associated with the gypsum dewatering and conveyance includes:

- Gypsum bleed tanks and forwarding pumps;
- Piping and elevated FGD utility rack;
- Gypsum dewatering building containing gypsum hydrocyclones and waste water hydrocyclones ;
- Belt filter and reclaim tank;
- Gypsum conveyer belt system;
- Gypsum truck loading facility; and
- Gypsum storage building and offtake via rail.

4.6.2 Gypsum re-use or disposal

Initially, gypsum will be conveyed from the gypsum dewatering building via a gypsum link conveyor to a gypsum transfer house where it will be loaded onto the existing overland ash conveyor. In this conveyor system, the gypsum will be mixed with ash and subsequently disposed together on the footprint of the existing authorised ADF. If there is a market for gypsum in the immediate execution of the project, the project has catered for an offtake point, wherein, the gypsum will be collected by trucks from overhead conveyor system. At this point, the ground will be prepared for management of any gypsum that is not contained and the trucks will be washed before leaving this area. The washing is a means to minimise the spreading of the gypsum.

4.7 Waste Water Treatment (Block 8)

The Medupi FGD WWTP is located directly west opposite generation units 1 to 3 at the Medupi Power Station. FGD chloride bleed stream and FGD auxiliary cooling tower blowdown stream are diverted to the ZLD holding tanks. The Total Organic Carbon (TOC) scavenger regeneration wastewater from the filter press system / existing Water Treatment Plant (WTP) will be directed to FGD WWTP located next to the gypsum dewatering plant.

From the ZLD holding tank the wastewater is transported via pipes on the elevated FGD utility rack to the WWTP. The pre-treatment process will include physical/chemical treatment to precipitate solids and heavy metals from the water by making use of slaked lime in a softening clarification process. Quicklime is delivered by bulk tankers and transferred into a quicklime silo, from where it is slaked with water in a detention-type slaker. At the WWTP slaked lime is added to the wastewater to convert the dissolved calcium and magnesium into salts so that the clarified water can be effectively treated in the brine concentrators and crystallisers.

The precipitates from this pre-treatment process are settled out in clarifiers as sludge, 50% of which is sent to a filter press dewatering system. The other 50% of the sludge is returned to the clarifier. The filter press filtrate will be returned to the pre-treatment holding tank. This pre-treatment process produces approximately 160t of sludge per day from 90% limestone.

After chemical treatment, the precipitates are settled out in clarifiers as slurry, 50% of which is sent to a filter press dewatering system. The other 50% of the slurry is returned to the clarifier. The filter press filtrate will be returned to the pre-treatment holding tank. The overflow from the softening clarifier is sent to the brine concentrator and crystalliser processes for further salt removal. Salts are settled out and crystallised during this process. Approximately 80t per day of salts are expected to be generated from 90% lime, and will require environmentally responsible management. The distillate water produced from the brine concentrator and crystallisation process is returned to reclaim tanks for reuse in the process. Chemical storage is likely to exceed 955m^3 to provide sufficient capacity for storage of chemicals in the FGD process.

The distillate emanating from the process will be diverted back to the FGD system for re-use in the FGD process, while dirty water run-off will be utilised in the FGD process to improve water usage.

4.8 Storage and disposal of salts and sludge (Block 9)

Sludge and salts will be temporarily stored in appropriately designed storage facilities next to the WWTP. The storage facilities will have a 7-day storage capacity. Two storage areas will be provided for, with Salts and Sludge Storage Area 1 and 2 sized to approximately 4800m^2 and 16000m^2 in size, respectively. The storage areas will conform to the Norms and Standards for the Storage of Waste (GN926 of 29 November 2013) and will be registered as a waste storage facility in terms of these Norms and Standards.

Salts and Sludge will, subsequent to storage, be transported (trucked) and disposed of at a registered waste disposal facility for the first 5 years of operation. The designated service provider must comply with all relevant legislative requirements, norms and standards. For transportation of this waste to a disposal site, Eskom will utilise the services of a service provider who has all required authorisations and systems to manage from the temporary storage to disposal facility.

5 ENVIRONMENTAL MANAGEMENT PROGRAMME

This EMPr (addendum to the approved EMP for MPS) must be read in conjunction with the EIA Report for the Medupi FGD Retrofit Project (February 2018), as well as relevant sections and appendices of the Medupi Power Station EMP Revision 2 (September 2010), relevant EMPr addenda, and MPS EMS.

The roles and responsibilities in this EMPr must align with the roles and responsibilities stipulated in the approved EMPr and EMS for the MPS.

5.1 Roles and Responsibilities

Specific roles and responsibilities for key stakeholders during the life cycle of a project have been detailed in the approved Medupi Power Station EMP Revision 2 (September 2010) and relevant addenda to this EMPr. Since this EMPr will serve as an addendum to the approved Medupi Power Station EMP Revision 2 (September 2010), key stakeholders associated with the construction and operation of the proposed Medupi FGD Retrofit Project will be subject to the roles and responsibilities as stipulated in approved EMP for the MPS. The key stakeholders as stipulated in the approved EMP for the MPS and relevant addenda to the EMP include:

- Power Station Manager (PSM) / General Manager (GM), the proponent
- Project Director (PD), during planning and construction phases
- Senior Construction Manager (SCM)
- Contracts Manager/FIDIC Engineer (CM)
- Construction and Operations Environmental Manager (EM)
- Construction and Operations Senior Environmental Advisor (EA)
- Construction and Operations Environmental Officer (EO)
- Construction and Operations Environmental Control Officer (ECO)
- Contractor (C), including sub-contractors
- Environmental Monitoring Committee (EMC)
- Eskom Head Office (HO)

5.2 Environmental Specifications

Environmental specifications proposed for the construction and operation of the FGD complex and rail yard development, within the existing MPS footprint, are summarised in table format in the following sections. These environmental specifications reflect site-specific management and mitigation measures proposed by specialists in relation to impacts identified during the impact assessment phase of the EIA.

Environmental specifications for the general management of the development site during project initiation and site management during construction and operations are provided in the following tables.

Table 5-1: Project Initiation and General Management

Environmental Specification		Section			Legend	
PROJECT INITIATION AND GENERAL MANAGEMENT		5.2.1				
Objective:		**Expected outcome:**				
1	Ensure necessary legal obligations and contractual conditions have been met prior to the commencement of construction	Achieve compliance with EMPs, EA and all relevant legislation, while maintaining good communication with communities and stakeholders				
2	Ensure staff are aware of their responsibilities and are informed about environmental sensitivities and the consequences of non-conformance					
3	Ensure effective communication with all affected stakeholders					
Management and Mitigation Measures		**Phase**	**Responsibility**	**Resources**	**Reporting / Indicator**	**Monitoring frequency**
1	Ensure compliance and alignment with this document as an addendum to the station's EMP, authorisations and licences.	All	PD, PD, SCM, CM, EM, EA, EO	Approved EMPrs, EAs and licenses	Signed agreement statement in contracts	Monthly
2	All persons involved shall attend a compulsory environmental induction and awareness session on an annual basis.	PC	EM	Environmental training material	Signed attendance register	Annual
3	Eskom must appoint a suitably qualified Independent Environmental Control Officer (ECO) who would act on behalf of the applicant, monitor project compliance with the conditions of environmental authorisation, environmental legislation and the recommendations of the approved EMPr.	PC	PD, EM, EA	Signed appointment letter and/or contract with a company that provides this service	Appointment letter / Contract	Once off
4	The ECO shall remain employed until all rehabilitation measures are completed and the site is handed over to Eskom by the contractor for operation.	PC	PD, PD, EM	-	Appointment letter / Contract-	Duration of construction
5	Ensure compliance with conditions of the EA for Medupi FGD Retrofit Project elements.	All	GM, PD, SCM, CM, EM, EA, EO	EA, EMPrs	Inspection and audit reports	Daily
6	All relevant permits, certificates and permissions must be obtained prior to any activities commencing on site and are strictly enforced / adhered to.	PC	PD, C	Site walkdown	Permits issued	Once off
7	The Contractor shall submit written Method Statements for acceptance to the CM, EM and ECO for the activities identified by the CM, EM and/or the ECO.	PC	C, CM, EM, ECO	Method statements	Letter of acceptance from CM	Once off
8	A Complaints Register must be maintained on Site. The Register shall contain contact details of complainants, the nature of the complaint, details on the complaint itself, as well as the date and time that the complaint was made and resolved.	PC	C, EM, ECO	Complaints register	Compliance monitoring report	Monthly
Monitoring		-	-	-	-	-
1	Compliance monitoring and reporting as per section 6.1.					

Legend

Phase			
PC	: Pre-construction	O	: Operational
C	: Construction	D	: Decommisioning
Responsible Party			
PSM	: Power Station Manager	GM	: General Manager
PD	: Project Director	SCM	: Senior Construction Manager
CM	: Contracts Manager	ECO	: Environmental Control Officer
EM	: Environmental Manager	C	: Contractor
EA	: Senior Environmental Advisor	EMC	: Environmental Monitoring Committee
EO	: Environmental Officer	HO	: Eskom Head Office

Table 5-2: Management of Surface Water Resources

Environmental Specification		**Section**			**Legend**	
MANAGEMENT OF SURFACE WATER RESOURCES		**5.2.2**			Phase PC : Pre-construction; O : Operational C : Construction; D : Decommisioning Responsible Party PSM : Power Station Manager; GM : General Manager PD : Project Director; SCM : Senior Construction Manager CM : Contracts Manager; ECO : Environmental Control Officer EM : Environmental Manager; C : Contractor EA : Senior Environmental Advisor; EMC : Environmental Monitoring Committee EO : Environmental Officer; HO : Eskom Head Office	
Objective:		**Expected outcome:**				
1	Prevent pollution of natural surface water features (Water quality)	No measurable impact on water resources observed or reported				
2	Minimise reduction of the surface water runoff footprint					
3	Prevent unnatural flooding of nearby watercourses					
Management and Mitigation Measures		**Phase**	**Responsibility**	**Resources**	**Reporting / Indicator**	**Monitoring frequency**
1	Removal of topsoil should be done systematically, only clearing the necessary areas at a time.	C	C, EO, EM	EMPr, site layout plan	Compliance monitoring reports	Monthly ECO audits
2	Clean and dirty surface water channels must be constructed and maintained to ensure separation of clean and dirty water.	C, O	C, EM, PD	EA, EMPr, Design drawings	Compliance monitoring reports	Monthly ECO audits
3	Ensure optimal operation and maintenance of Storm Water Management System during all phases by regularly removing sediment and any other obstructive material from dams and channels	All	EM, EA	EA, EMPr, Design drawings	Compliance monitoring reports	Monthly ECO audits
4	Water accumulated in the containment facility during the wet season should be used as a priority in the process water circuit to ensure that the capacity requirements are not compromised during periods of heavy and/or extended rainfall.	C, O, D	SCM, CM, EM, EO, C	Water level data	Water Accounting Framework daily report	Daily site checks / site diary
5	Update storm water management plan (SWMP) and the existing water balance be undertaken, if required, to comply with GN704.	All	Engineering	Existing SWMP, water balance	Updated SWMP, water balance	As required
6	Appropriate erosion control and protection measures must be employed during the rainy seasons to minimise and prevent erosion from occurring at the construction works.	C, O, D	C, PD, EO, EM	EMPr, Detail design drawings	Compliance monitoring reports	Rainy season
7	Propose amendments to the approved EMPr where mitigation measures are proven to be ineffective.	C, O, D	EM, EA, EO, ECO, EMC	Compliance monitoring reports	Non-conformances reported	As required
Monitoring Measures:						
1	Ongoing monitoring of the surface water must continue or be commissioned for all constituents as stipulated in the Environmental Authorisation and permits, e.g. WUL. The existing monitoring programme must be extended to cover additional facilities to be constructed for the FGD plant and associated infrastructure in line with the integrated WUL limits once issued.	C, O, D	EO, EA, HO	EMPr, EA, relevant permits and licences	Surface Water Monitoring Reports and data	Weekly/monthly/quarterly as per WUL requirements
2	Proposed monitoring must be incorporated into the existing surface water monitoring programme for the MPS	C, O, D	EO, EA, EM	EMPr, existing MPS EMPr	Monitoring and Measurement procedure updated	As per existing programme
3	Compliance monitoring and reporting as per section 6.1.					

Table 5-3: Management of Groundwater Resources

Environmental Specification		**Section**			**Legend**	
MANAGEMENT OF GROUNDWATER RESOURCES		**5.2.3**			Phase PC : Pre-construction O : Operational C : Construction D : Decommissioning Responsible Party PSM : Power Station Manager GM : General Manager PD : Project Director SCM : Senior Construction Manager CM : Contracts Manager ECO : Environmental Control Officer EM : Environmental Manager C : Contractor EA : Senior Environmental Advisor EMC : Environmental Monitoring Committee EO : Environmental Officer HO : Eskom Head Office	
Objective:		**Expected outcome:**				
1	Prevent or minimise groundwater pollution	No measurable impact on groundwater resources observed or reported				
2	Compliance of groundwater quality and quantity reserve					
Management and Mitigation Measures		**Phase**	**Responsibility**	**Resources**	**Reporting / Indicator**	**Monitoring frequency**
1	During transportation of hazardous waste, the trucking contractor should adhere to all environmental acts, regulations and standards.	C, O	C	EMPr, Method Statements	Complaints received spillages from trucks	Monthly
2	Method Statements, Works Instructions and or Operational Controls for transportation of hazardous waste must be in place, to minimize the risk of contamination to the environment and groundwater should a spillage occur.	C, O	C	EMPr, Method Statements, SWPs	Spillage Incident Reports or non-conformity reports	Monthly
3	Any spillages that occur must be logged and reported immediately in line with the EMS requirements in a quantitative manner.	C, O	C, EM, EO	EMPr, Method Statements, SWPs	Spillage Incident Reports	Monthly
4	If the groundwater is contaminated as a result of activities associated with the construction, commissioning and operation of FGD plant and infrastructure, immediate treatment and clean-up must be undertaken according to applicable legislation and Eskom EMS or Contractor processes.	All	C, EM, EO	Groundwater treatment system	Compliance monitoring reports	Monthly
5	Eskom to ensure that groundwater monitoring boreholes are maintained in a good state to ensure continued monitoring can be conducted as per the approved monitoring plan.	All	EM, EA, EO	EMPr, Monitoring Reports	Groundwater Monitoring Reports	Monthly and/or quarterly
6	Aquifer testing of new monitoring boreholes to determine hydraulic parameters and update initial groundwater conceptual model. This must be aligned with the requirement in the existing WUL to update the groundwater model on an annual basis.	All	EM, EA, EO	Existing Groundwater Conceptual Model	Updated Groundwater Conceptual Model	Once off
7	The newly-drilled monitoring boreholes should be incorporated into the existing monitoring programme. The monitoring tasks should be conducted to be consistent with the existing WUL Licence no.: 01/A1042/ABCEFGI/5213, and any subsequent WULs issued for the power station.	All	EM, EA, EO	Groundwater Monitoring Programme, EMPr, MPS EMS	Groundwater Monitoring Reports	Monthly
8	Development of a numerical groundwater flow & transport model (or update of existing models) and Impact Assessment. This model to include Medupi Power station (MPS) and the Medupi FGD Project. In the event such a model has already been undertake, the existing model must be updated accordingly.	All	EM, EA, EO, C	Groundwater Monitoring Reports, MPS EMS	Numerical groundwater flow & transport model	As required
9	Update mitigation and management measures for the Medupi FGD Project on numerical model outcome and predictions.	All	EM, EO	Numerical groundwater flow & transport model	Updated mitigation measures	As required
Monitoring Measures:						
1	Monitoring of exiting monitoring boreholes groundwater levels and quality. Monitoring should be conducted to be consistent with the existing WUL (Licence no.: 01/A42J/4055) as well as with any	All	EO, EA, HO	EMPr, EA, relevant permits	Surface Water Monitoring Reports and data	Monthly

	amendments following the integrated WUL application;			and licences		
2	Compliance monitoring and reporting as per section 6.1.					

Table 5-4: Management of impacts on Biodiversity and Wetlands

Environmental Specification		**Section**			**Legend**	
MANAGEMENT OF IMPACTS ON BIODIVERSITY AND WETLANDS		**5.2.4**			Phase PC : Pre-construction; O : Operational C : Construction; D : Decommisioning Responsible Party PSM : Power Station Manager; GM : General Manager PD : Project Director; SCM : Senior Construction Manager CM : Contracts Manager; ECO : Environmental Control Officer EM : Environmental Manager; C : Contractor EA : Senior Environmental Advisor; EMC : Environmental Monitoring Committee EO : Environmental Officer; HO : Eskom Head Office	
Objective:		**Expected outcome:**				
1	Minimise impacts on wetlands habitat and functionality	No significant measurable impact on biodiversity or wetland resources observed or reported				
2	Minimise loss of protected sensitive or Conservation Important biodiversity					
3	Minimise or prevent spillages of hazardous substances					
4	Control alien invasive species within the development site					
Management and Mitigation Measures		**Phase**	**Responsibility**	**Resources**	**Reporting / Indicator**	**Monitoring frequency**
1	All clearing of vegetation needs to occur only within the required construction and/or operation footprint of the proposed FGD / railway yard area. If at all possible vegetation clearing in the western corner of the railway yard area must be minimised to the required construction footprint only.	C, O, D	C, EO, EM	EMPr, EA, MPS EMS	Site diary and Internal audit reports	Daily
2	Once the area footprint required for construction is known all other remaining natural areas must be designated as no-go areas and access minimised/prevented where possible.	C, O, D	C, EO, EM	EMPr, EA, MPS EMS	Site diary and Internal audit reports	Daily
3	Any bulbous or protected plant species that can be transplanted must be removed and transplanted to a similar habitat nearby. This must be done during the relevant growth season to maximise search and rescue of these species.	C, O, D	EO, EM, Vegetation specialist	EMPr, EA, Biodiversity Specialist Report	Rehabilitation Strategy and implementation Plan	As required but prior to vegetation clearance commencing within the growing season.
4	Alien species must be monitored and controlled under the MPS Alien Control Programme. Furthermore, a pre- and post-construction alien and invasive control, monitoring and eradication programme must be implemented along with an on-going programme to ensure persistence of indigenous species;	All phases	EO, EM, C, PSM	EMPr, EA, Biodiversity Specialist Report, MPS EMS	Records of aliens removed	Daily, as required
5	Alien invasive plant species in and around the road reserve must be removed in terms of Conservation of Agricultural Resources Act (CARA), and follow-up actions for at least 5 years need to take place;	All phases	EO, EM, C, PSM	EMPr, EA, Biodiversity Specialist Report, MPS EMS	Records of aliens removed	Daily, as required
6	Construction crew must be made aware of the alien species that occur on site, specifically Category 1 species. Where alien species have been identified for removal, the provisions of the Alien and invasive Species Management Plan and relevant legal requirements must be followed.	C, O, D	EO, EM, Vegetation specialist	EMPr, EA, Biodiversity Specialist Report, MPS EMS	Signed attendance register for training	Monthly, or as required
7	Document and tag all Protected Trees within the development footprint. Where removal and/or relocation of such trees are requires, it must be undertaken in compliance with conditions of the relevant tree permits.	C, O, D	EO, EM, Vegetation specialist	EMPr, EA, Biodiversity Specialist Report, MPS EMS	Species relocation plan	As required

8	Obtain permits from the Department of Agriculture, Forestry and Fisheries (DAFF) for the relocation and/or destruction of sensitive or protected tree species.	C, O, D	EO, EM, Vegetation specialist	EMPr, EA, Permit application forms	Permit applications approved and available on site	Once off
9	Any other plant species that may be identified as Conservation Important (CI) must either be translocated (if possible) or specific mitigation specified in the permits must be compiled with.	C, O, D	EO, EM, Vegetation specialist	EMPr, EA, Biodiversity Specialist Report, MPS EMS	Species relocation plan	As required
10	In order to reduce the impact on CI faunal species on site, clearing must be undertaken in winter, where possible. If this is not possible, a search and rescue programme must be implemented to identify and relocate all CI species prior to clear of any vegetation. The search and rescue (or walkdown) be conducted in conjunction with a suitable specialist, preferably one with expertise in arachnids, to intensively search the site preferably in the height of the rainy season (December) to detect and relocate any baboon or trapdoor spiders or scorpions frogs, tortoises. If any of these species are encountered during development the specialist with should advise upon and oversee relocation.	C, O, D	EO, EM, Faunal specialist/ Ecologist	EMPr, EA, Biodiversity Specialist Report, MPS EMS	Species relocation plan	Height of the rainy season
11	In the event that CI bird species nests, especially raptor nests, are encountered, its location should be marked. The local conservation office must be consulted should permits be required.	C, O, D	EO, EM, AviFauna specialist	EMPr, EA, Biodiversity Specialist Report, MPS EMS	Recorded raptor nests, Internal audit reports	As required
12	Game within the within the Railyard area must be captured and relocated to either Swartwater or Grootvallei Conservation Area or sold.	C, O, D	EO, EM	EMPr, EA, Biodiversity Specialist Report, MPS EMS	EO's site diary, Internal audit reports	Daily
13	Minimise faunal mortality through active search and rescue prior to clearing and relocate less mobile fauna. Maintain existing tortoise road signs and insert new ones where necessary. Continue to enforce speed regulation controls such as speed humps and limits.	All phases	EO, EM, Faunal specialist/ Ecologist	EMPr, EA, Biodiversity Specialist Report, MPS EMS	EO's site diary, Internal audit reports	Daily
14	Keep lighting to a minimum during construction but most significantly during operation to limit the impact of increased sensory disturbance to fauna. Lights should be angled downwards and hooded to lower light pollution. Restrict unnecessary access to the remaining patches of natural vegetation.	All phases	PD, C, EO, EM	EMPr, EA, MPS EMS	Internal and external audit reports	Daily
15	<u>All wetlands areas must be avoided by the development activities, including a suitable buffer zone to avoid impacts on these water courses.</u>	<u>C, O, D</u>	<u>C, EO, EM</u>	<u>EMPr, EA</u>	<u>EO's site diary, Internal audit reports</u>	<u>Daily</u>
16	<u>Harvest of hill wash material must be prohibited within 100m of the delineated edge of all identified depressions and semi-arid ephemeral wash wetlands and within 500m radial buffer of the identified bullfrog breeding site.</u>	<u>C, O, D</u>	<u>C, EO, EM</u>	<u>EMPr, EA</u>	<u>EO's site diary, Internal audit reports</u>	<u>Daily</u>
17	<u>Rehabilitation work must be done during low rainfall seasons and soil compaction should be prevented as far as possible.</u>	<u>O, D</u>	<u>C, EO, EM</u>	<u>EMPr, EA</u>	<u>EO's site diary, Internal audit reports</u>	<u>Daily</u>
18	<u>All re-vegetation must be done with local indigenous plant species as specified by the Provincial Co-ordinator and/or Wetland Ecologist.</u>	<u>O, D</u>	<u>C, EO, EM</u>	<u>EMPr, EA</u>	<u>EO's site diary, Internal audit reports</u>	<u>Daily</u>

19	Erosion and Storm Water Management Plan must be revised to allow for heavy rainfall events, if not in contradiction to operation requirements, legislation or construction standards.	C, O, D	PD, EO, EA, HO, PSM, C	EMPr, EA, MPS EMS	Updated erosion and SWMP	As required
20	Prevent or contain spills through installation of effective engineered infrastructure in line with the approved engineering designs.	C, O, D	PD, EO, EA, PSM	EMPr, EA, MPS EMS, Approved designs	Reported contained spills, EO's site diary	Once off
Monitoring Measures:						
1	Existing biodiversity and wetlands monitoring programmes in terms of the approved Medupi EMPr, EA and EMS must be updated to include the areas affected by the proposed FGD Retrofit Project.	C, O, D	EO, EA, HO, PD	EMPr, EA, MPS EMS	EO's site diary, Internal audit reports	As per existing monitoring requirements
2	Manganese levels in stockpiles and the environment must be monitored through regular water quality testing at pans immediately south of the FGD and compared to current baseline levels.	C, O, D	EO, EA, HO, C	EMPr, EA, MPS EMS	EO's site diary, Internal audit reports	Quarterly
3	Compliance monitoring and reporting as per section 6.1.					

Table 5-5: Management of Air Quality impacts

Environmental Specification		**Section**	**Legend**
MANAGEMENT OF AIR QUALITY IMPACTS		**5.2.5**	Phase PC : Pre-construction; O : Operational C : Construction; D : Decommissioning Responsible Party PSM : Power Station Manager; GM : General Manager PD : Project Director; SCM : Senior Construction Manager CM : Contracts Manager; ECO : Environmental Control Officer EM : Environmental Manager; C : Contractor EA : Senior Environmental Advisor; EMC : Environmental Monitoring Committee EO : Environmental Officer; HO : Eskom Head Office
Objective:		**Expected outcome:**	
1	Reduce SO_2 to within NAAQS	Significantly reduced SO_2 concentrations resulting in an increase in quality of life for local residents. No exceedances of the NAAQS for NO_2, PM_{10} and $PM_{2.5}$.	
2	Enhance positive impacts resulting from reduction of SO_2 concentrations		

	Management and Mitigation Measures	**Phase**	**Responsibility**	**Resources**	**Reporting / Indicator**	**Monitoring frequency**
1	As the proposed operation of the FGD will significantly reduce SO_2 impacts from the MPS, it is recommended that the FGD Retrofit Project be implemented.	O	PSM, PD, EM, HO	EA to be granted for FGD	Air quality monitoring results and reports	Once off
2	Dust control measures, such as watering, chemical stabilisation and the reduction of surface wind speed through the use of windbreaks and source enclosures must be put in place during construction activities.	C, O, D	C, PD, EM, EO	Dust suppression system	Dust fallout results within applicable standards	Monthly
3	All temporary construction, access or gravel roads used during construction and operation must be sprayed down with a water truck on a regular basis, as necessary, to manage traffic generated dust.	C, O, CL	C, PD	Water bowser	Inspections	Weekly
4	All topsoil stockpiles and cleared areas should be re-vegetated, covered or kept moist to prevent dust generation.	C, O, CL	C, PD	Water bowser	Inspections	Weekly
Monitoring Measures:						
1	Monitoring of dust-fall rates (via dust bucket network) and ambient air quality must be updated to include the proposed study area.	C, O, D	EM, EA, PSM, Air quality specialist	Air quality management programme	Air quality audit reports	Monthly
2	Air Quality monitoring in terms of the existing Air Quality monitoring programme must continue for the life of the MPS.	C, O, D	EM, EA, PSM, Air quality specialist	Air quality measurement	Air quality audit reports	Monthly

				equipment		
3	Compliance monitoring and reporting as per section 6.1.					

Table 5-6: Management of Ambient Noise Levels

Environmental Specification		**Section**			**Legend**	
MANAGEMENT OF AMBIENT NOISE LEVELS		**5.2.6**			Phase PC : Pre-construction O : Operational C : Construction D : Decommisioning Responsible Party PSM : Power Station Manager GM : General Manager PD : Project Director SCM : Senior Construction Manager CM : Contracts Manager ECO : Environmental Control Officer EM : Environmental Manager C : Contractor EA : Senior Environmental Advisor EMC : Environmental Monitoring Committee EO : Environmental Officer HO : Eskom Head Office	
Objective:		**Expected outcome:**				
1	Ensure that noise is managed in such a manner that no complaints are received	Noise levels maintained within acceptable range.				
2	Reduce noise generated by activities associated with the construction of the overland ash conveyor and ash disposal facility					
Management and Mitigation Measures		**Phase**	**Responsibility**	**Resources**	**Reporting / Indicator**	**Monitoring frequency**
1	The management of ambient noise within the MPS through the existing EMS, EA, EMPr and relevant legislation must be expanded to include the management of noise within the FGD, and rail yard areas.	All	EM, EA, EO, HO	EMPR, MPS EMS	Noise monitoring records	Once off
2	Minimizing individual vehicle engine, transmission and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.	All	C, EM, EO	Equipment maintenance program	Inspection checklists, Environmental audit reports	Monthly
3	Minimize slopes by managing and planning road gradients to avoid the need for excessive acceleration/deceleration.	All	PD, EM, EO, PSM	Approved designs		Once off
4	Maintain road surface regularly to avoid corrugations, potholes etc.	All	PD, EM, EO, PSM	Road maintenance plant	Compliance monitoring report	Monthly
5	Avoid unnecessary idling times.	All	PD, EM, EO	Vehicles and plant	EO's site diary, Internal audit reports	Daily
6	Minimizing the need for trucks/equipment to reverse. This will reduce the frequency at which disturbing but necessary reverse warnings will occur. Alternatives to the traditional reverse 'beeper' alarm such as a 'self-adjusting' or 'smart' alarm should be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm is so that it is 5 to 10 dB above the noise level in the vicinity of the moving equipment.	All	C, EM, EO	Vehicles and plant	Compliance monitoring report	Monthly
7	To minimise noise generation, vendors can be required to guarantee optimised equipment design noise levels.	All	C, EM, EO	-	Inspection checklists	As required
Monitoring Measures:						
1	The monitoring of ambient noise within the MPS through the existing EMS, EA, EMPr and relevant legislation must be expanded to include the monitoring of noise levels within the FGD, and rail yard areas.	All	EM, EO, EA, HO	EMPr, EA, MPS EMS	Noise monitoring reports, Compliance monitoring reports	As stipulated per EMS, EMPr
2	Compliance monitoring and reporting as per section 6.1.					

Table 5-7: Management of Soil and Land Capability Impacts

Environmental Specification		Section	Legend
MANAGEMENT OF SOIL AND LAND CAPABILITY IMPACTS		5.2.7	Phase PC : Pre-construction; O : Operational C : Construction; D : Decommissioning Responsible Party PSM : Power Station Manager; GM : General Manager PD : Project Director; SCM : Senior Construction Manager CM : Contracts Manager; ECO : Environmental Control Officer EM : Environmental Manager; C : Contractor EA : Senior Environmental Advisor; EMC : Environmental Monitoring Committee EO : Environmental Officer; HO : Eskom Head Office
Objective:		**Expected outcome:**	
1	Prevent or reduce loss of utilisable soil resources	Stockpiling and storage of soils in the manner to maintain soil integrity and seedbed viability until rehabilitation phase.	

	Management and Mitigation Measures	Phase	Responsibility	Resources	Reporting / Indicator	Monitoring frequency
1	Limit the area of impact to as small a footprint as possible.	C, O, D	C, EO, EM	EMPr, EA, MPS EMS	EO's daily site diary	Daily
2	Avoid or reduce impact on sensitive soil groups such as wetlands and soils sensitive to erosion and/or compaction, where possible.	C, O, D	C, EO, EM	EMPr, EA, MPS EMS	EO's daily site diary, Internal audit reports	Daily
3	Extend the existing MPS EMS management and monitoring procedure to include monitoring and auditing of all soil resources within the study site.	C, O, D	EM, EA, EO, HO	EMPr, EA, MPS EMS	Internal and external audit reports	Weekly and Monthly
4	Undertake concurrent rehabilitation of all affected areas that are not under construction or required for operational activities.	C, O, D	C, PD, EM, EO	Manual labour & plant	EO's daily site diary, Internal audit reports	Weekly
5	Undertaken soil stripping during the less windy months when the soils are less susceptible to erosion, where possible.	C, O, D	C, PD, EM, EO	TLB and tucks	EO's daily site diary, Internal audit reports	Weekly
6	Clad berms and all soil stockpiles with vegetation or large rock fragments, while minimising the height of storage facilities to 15m and soil berms to 1,5m wherever possible.	C, O, D	C, PD, EM, EO	TLB and tucks	EO's daily site diary, Internal audit reports	Weekly
7	Restrict movement of vehicles over unprotected or sensitive areas in order to reduce compaction.	C, O, D	C, PD, EM, EO	Demarcating material or fencing	No signs of vehicle traffic in demarcated areas	Monthly
8	Avoid or reduce contamination of soil resources through proper maintenance of all vehicles on site and regular cleaning and maintenance of all haulage ways, conveyancing routes and service roads, drains and storm water control facilities.	C, O, D	C, PD, EM, EO	-	No spillages on soils reported in EO's site diary and audit reports	Daily
9	Ensure soil replacement and preparation of a seed bed to facilitate and accelerate the re-vegetation program and to limit potential erosion on all areas that become available for rehabilitation.	C, O, D	C, PD, EM, EO	Viable soils and manual labour or TLB	Internal and external audit reports	Monthly
10	Undertake soil amelioration (rehabilitated and stockpiled) to enhance the growth capability of the soils and sustain the soils ability to retain oxygen and nutrients, thus sustaining vegetative material during the storage stage.	C, O, D	C, PD, EM, EO	-	Approved method statements	As required
11	Implement soil conservation plan proposed for the FGD Retrofit Project	C, O, D	EM, EA, EO, HO	Soil Conservation Plans in EMPr, MPS EMS	Compliance monitoring reports	As required
Monitoring Measures:						

1	Preliminary soil quality monitoring should be carried out during rehabilitation to accurately determine the fertilizer and pH requirements that will be needed. Additional soil sampling should also be carried out annually after rehabilitation has been completed and until the levels of nutrients, specifically magnesium, phosphorus and potassium, are at the required levels for sustainable growth. Nutrient levels to be advised by a relevant specialist for the specific vegetation type.	C, O, D	EM, EO, EA, Soil specialist	EMPr, EA, MPS EMS	Soil quality monitoring report and data	As required during rehabilitation
2	The interval between sampling can be increased once the desired nutritional status has been achieved. An annual environmental audit should be undertaken, but if growth problems develop, ad hoc, sampling should be carried out to determine the problem.	C, O, D	EM, EO, EA, Soil specialist	Soil sampling equipment	Soil monitoring reports, External audit report	Annual
3	Monitoring should always be carried out at the same time of the year.	C, O, D	EM, EO, EA, Soil specialist	Soil sampling equipment	Soil monitoring reports, External audit report	Annual
4	Soils should be sampled and analysed for the parameters: pH (H_2O), Phosphorus (Bray I), Electrical conductivity, Calcium (mg/kg), Cation exchange capacity, Sodium (mg/kg), Magnesium (mg/kg), Potassium (mg/kg), Zinc (mg/kg), Clay, sand and Silt, and Organic matter content (C %).	C, O, D	EM, EO, EA, Soil specialist	Soil sampling equipment	Soil monitoring reports, External audit report	Annual
5	Compliance monitoring and reporting as per section 6.1.					

Table 5-8: Management of Heritage, Archaeological and Palaeontological Resources

Environmental Specification	Section	Legend
MANAGEMENT OF HERITAGE, ARCHAEOLOGICAL AND PALAEONTOLOGICAL RESOURCES	**5.2.8**	Phase: PC : Pre-construction; C : Construction; O : Operational; D : Decommissioning Responsible Party: PSM : Power Station Manager; PD : Project Director; CM : Contracts Manager; EM : Environmental Manager; EA : Senior Environmental Advisor; EO : Environmental Officer; GM : General Manager; SCM : Senior Construction Manager; ECO : Environmental Control Officer; C : Contractor; EMC : Environmental Monitoring Committee; HO : Eskom Head Office
Objective:	**Expected outcome:**	
1 Prevent or minimise impact on potential heritage, archaeological and palaeontological finds	Protection of heritage, archaeological or palaeontological resources	

	Management and Mitigation Measures	Phase	Responsibility	Resources	Reporting / Indicator	Monitoring frequency
	The Heritage and Palaeontological Impact Assessments did not identify any heritage, archaeological or palaeontological resources within the proposed development footprint for the FGD infrastructure, rail yard and associated infrastructure. Therefore no impacts exist that may have a detrimental impact on any heritage, archaeological or palaeontological resources. Given the low likelihood that fossil finds would be uncovered the following good practice measures should be implemented as part of due diligence.					
1	Conduct basic awareness training on heritage, archaeological and palaeontological finds and fossils to staff and contractors during construction.	PC	EM, EO	FEIR, EMPr, Heritage specialist report	Training programme, attendance register	Once off, or as required
2	In the extremely unlikely event that any fossils are discovered during the construction of the waste disposal site, a palaeontologist must be called to assess their importance and implement necessary mitigation if necessary.	C	C, EO, EM, Palaeontologist	Uncovered material	Palaeontological assessment report	As and if required
3	Should any remains be found on site that is potentially human remains, the South African Police Service must be informed. Construction activities must cease and a buffer of at least 20 m must be implemented.	C, O	C, EO, EM, SAPS	-	Inspections	As and if required
	Monitoring Measures:					
1	Ongoing monitoring of all excavations must be undertaken in the event that archaeological or palaeontological finds are uncovered.	C, O	EO, EM	Heritage specialist report	Potential finds documented in EO's site diary	Daily
2	Compliance monitoring and reporting as per section 6.1.					

Table 5-9: Management of Social Impacts

Environmental Specification		Section			Legend	
MANAGEMENT OF SOCIAL IMPACTS		**5.2.9**			Phase PC : Pre-construction; O : Operational C : Construction; D : Decommissioning Responsible Party PSM : Power Station Manager; GM : General Manager PD : Project Director; SCM : Senior Construction Manager CM : Contracts Manager; ECO : Environmental Control Officer EM : Environmental Manager; C : Contractor EA : Senior Environmental Advisor; EMC : Environmental Monitoring Committee EO : Environmental Officer; HO : Eskom Head Office	
Objective:		**Expected outcome:**				
1	Minimise social impacts on the receiving communities	Significantly enhance positive social impacts through implementation of the FGD system and indirect socio-economic benefits to the region.				
2	Manage and minimise complaints from the public or landowners					
3	Prevent and manage claims or litigation during all phases of development					
4	Ensure effective transparent communication with stakeholders and I&APs					
Management and Mitigation Measures		**Phase**	**Responsibility**	**Resources**	**Reporting / Indicator**	**Monitoring frequency**
1	Construction activities must be restricted to within the existing Medupi footprint in order to minimise land use impacts on surrounding properties.	C, O	PD, C, EM	Approved engineering designs	Construction quality assurance	Monthly
2	All measures and recommendation proposed by the traffic specialist to reduce traffic impacts on motorists and commuters must be implemented to reduce social impacts associated with increased traffic volumes.	C, O, D	PD, C, EM, PSM	Approved engineering designs	Construction quality assurance	Monthly
3	Eskom must improve project public participation and communication strategies in order to strengthen multi-stakeholder engagement and participation in the planning and implementation of the FGD retrofit project.	PC, C, O	EM, EO, EMC, PSM	EMPr, EA, MPS EMS	No complaints received from public	Monthly
4	Eskom must prioritize the tender for construction of the FGD and retrofitting the FGD within time and budget to ensure compliance with AEL timeframes for SO_2 reduction targets.	All	PSM, PD, EM, HO	EA, Tender adjudication	Appointment of contractor	Once off
5	Eskom to continue to develop and implement initiatives to contribute towards educating and developing necessary skills for the locals to take advantage of opportunities associated with the FGD construction and operation.	All	PSM, EM, HO	-	Reporting on employment opportunities created	Annual
6	Recommendation: Eskom to advertise the types of available jobs, the required education and skillset to take up employment opportunities in order to potentially reduce influx of migrant labour.	C	PSM, EM, HO	List of skills required	Advertisement placed	Annual
7	Recommendation: The EMC should strengthen its multi-stakeholder engagement strategy or adopt new forms of communication that resonate with the interests of I & APs in the region. This should be done in a manner that does not polarise relations between existing stakeholders. One way of addressing this issue is to develop a sub-committee for the EMC.	All	EM, EO, EMC, PSM	EMPr, EA, MPS EMS	Minutes of EMC meetings	Quarterly
8	Recommendation: Eskom should consider appointing an independent company/specialist that specialises in the management of Social Risks to advise on the facilitation between the various project stakeholders such as the appointed contractors, the EMC, the Environmental Control Officer (ECO), the affected community and community organisations such as NGOs, local labourers, local Small Medium Enterprises (SMMEs) as well as big industries.	All	EM, EMC, PSM, ECO	EMPr, EA, MPS EMS, minutes of EMC meetings	Report on consultation with stakeholders	Monthly
Monitoring Measures:						
1	Compliance monitoring and reporting as per section 6.1.					

Table 5-10: Management of impacts on Traffic and Roads

Environmental Specification		Section	Legend
TRAFFIC AND ROADS		5.2.10	Phase PC : Pre-construction; O : Operational C : Construction; D : Decommisioning Responsible Party PSM : Power Station Manager; GM : General Manager PD : Project Director; SCM : Senior Construction Manager CM : Contracts Manager; ECO : Environmental Control Officer EM : Environmental Manager; C : Contractor EA : Senior Environmental Advisor; EMC : Environmental Monitoring Committee EO : Environmental Officer; HO : Eskom Head Office
Objective:		**Expected outcome:**	
1	Minimise impacts on the traffic patterns in the area	Reduced or low impacts on local traffic patterns resulting from construction and operational traffic to and from MPS.	
2	Minimise damage to existing access roads		
3	Ensure monitor and maintenance of new roads.		

	Management and Mitigation Measures	Phase	Responsibility	Resources	Reporting / Indicator	Monitoring frequency
1	Management of traffic within and around the MPS must be aligned with the stipulations of the approved MPS EMP Revision 2 (September 2010) and relevant addenda to this EMP, authorisations and licences.	All	PSM, EM, EO	Traffic Impact Assessments, EMPr, EA and MPS EMS	Traffic complaints received, EMC minutes	As required
2	Proposed upgrade of the Nelson Mandela Drive / D1675 intersection to provide signals, addition of a left turning slip lane along D1675 (northbound), introduction of a right turning lane for the northbound right movement, and provision of an additional eastbound lane for the straight movement. This is subject to approval and engagement with the relevant roads authority.	All	PSM, EM, EO, Local Municipality	Approved design drawings	Compliance monitoring reports	Monthly
3	Proposed upgrade of the D1675 / Afguns Rd intersection to include to the upgrading of the priority control intersection to a one lane roundabout.	All	PSM, EM, EO, Local Municipality	Approved design drawings	Compliance monitoring reports	Monthly
4	Vehicles delivering limestone to MPS and transporting salts and sludge from the MPS to an offsite service provider must utilise the Afguns Road in order to have a minimal impact on other road users.	All	C, EM, EO, PSM	-	Traffic complaints received, EMC minutes	Monthly
5	A points man must be deployed as required at the intersection of D1675 / Afguns Rd and Nelson Mandela Drive / D1675 during the peak hours to alleviate the traffic congestion and assist the northbound traffic.	All	C, EM, EO, PSM	Qualified points man	Traffic complaints received, EMC minutes	Monthly
Monitoring Measures:						
1	Compliance monitoring and reporting as per section 6.1.					

Table 5-11: Site management - Site establishment and laydown areas

Environmental Specification		Section	Component	Legend
SITE MANAGEMENT DURING CONSTRUCTION AND OPERATION OF THE FGD		5.2.11	Site establishment and laydown areas	Phase PC : Pre-construction; O : Operational C : Construction; D : Decommissioning Responsible Party PSM : Power Station Manager; GM : General Manager PD : Project Director; SCM : Senior Construction Manager CM : Contracts Manager; ECO : Environmental Control Officer EM : Environmental Manager; C : Contractor EA : Senior Environmental Advisor; EMC : Environmental Monitoring Committee EO : Environmental Officer; HO : Eskom Head Office
Objective:		**Expected outcome:**		
1	Ensure proper demarcation of the project area prior to construction.	Construction site established without resulting in adverse impacts on the surrounding environment.		
2	Minimise impact on natural and No-Go areas.			
3	Maintain a safe and clean construction site			

	Management and Mitigation Measures	Phase	Responsibility	Resources	Reporting / Indicator	Monitoring frequency
1	A demarcated area at or close to the site must be provided for the storage of machinery, plant and trucks as necessary.	All	C, PD, EO, EM	EMPr, ECO recommendations	Compliance monitoring reports	Monthly
2	A Site Layout Master Plan illustrating the location and layout of the proposed site camp and working areas must be produced. This plan must be approved by the PD.	PC	C, EM, PD	Method statements, detail design drawings	Site Layout plan	Once off
3	A photographic record of the area earmarked for the site camp must be produced prior to site establishment. This will serve as a benchmark against which rehabilitation will be measured and shall be kept in the site environmental file.	PC	ECO, EO, PD	Camera, Site Layout Plan	Pre-construction audit report	Once off
4	Where necessary, the No-Go areas shall be demarcated with hazard tape, fencing or equivalent, and enforced.	PC, C, D	C, EO, EM, PD	Site Layout Plan, demarcation material	Photographic evidence of demarcated areas	Monthly
5	Construction activities are limited to the development area as demarcated within the site identified for the construction of the FGD infrastructure and rail yard.	PC, C, O	C, PD, EO, EM	Site Layout Plan	Compliance monitoring reports	Monthly
7	The contractor's camp shall be fenced, with access control, and the contractor shall maintain in good order all fencing for the duration of the construction activities.	C, O	C, EO, PD	Site Layout Plan	Compliance monitoring reports	Monthly
8	Site establishment shall take place in an orderly manner and all amenities shall be installed at Camp sites before the main workforce move onto site.	PC	C, EO, PD	Site Layout Plan	Pre-construction audit report	Once off
9	The Contractor will ensure that delivery drivers are informed of all procedures and restrictions required by this EMPr. Such drivers will be supervised during off-loading, by a person knowledgeable of the requirements.	C, O, D	C, EO, PD	EMPr	Delivery supervision	As required
10	Materials will be appropriately secured to ensure safe passage between destinations.	C, O, D	C, EO, PD	Appropriate covering	Delivery supervision	As required
11	The Contractor will be responsible for any clean-up resulting from the failure by his employees or suppliers to properly secure transported materials.	C, O, D	C, EO, PD	-	Delivery supervision	As required
12	All material lay-down areas and stockpiles will be subject to the Project Manager's approval.	C, O, D	PD, C, EO	Site Layout Master Plan	Compliance monitoring reports	Monthly
14	Locate all topsoil stockpiles outside delineated wetland and 32m buffer zone. Install sediment barriers along the lower edge of the soil stockpile. Prevent down wash or erosion of topsoil into wetlands or water courses.	C, O, D	C, EO, PD, EM	Site Layout Master Plan	Compliance monitoring reports	Monthly
Monitoring Measures:		-	-	-	-	-
1	Compliance monitoring and reporting as per section 6.1.					

Table 5-12: Site Management - On-site workshops and handling of hazardous materials

Environmental Specification	Section	Component
SITE MANAGEMENT DURING CONSTRUCTION AND OPERATION OF THE FGD	5.2.12	On-site workshops and Handling of Hazardous Materials

Legend

Phase			
PC	: Pre-construction	O	: Operational
C	: Construction	D	: Decommissioning
Responsible Party			
PSM	: Power Station Manager	GM	: General Manager
PD	: Project Director	SCM	: Senior Construction Manager
CM	: Contracts Manager	ECO	: Environmental Control Officer
EM	: Environmental Manager	C	: Contractor
EA	: Senior Environmental Advisor	EMC	: Environmental Monitoring Committee
EO	: Environmental Officer	HO	: Eskom Head Office

Objective:		Expected outcome:
1	Maintain a safe and clean construction site	On-site workshops and storage of hazardous materials managed without resulting in adverse impacts on the receiving environment.
2	Ensure safe storage and usage of hazardous materials	
3	Ensure implemented mitigation measures reduce any adverse impacts on the environment resulting from on-site workshop areas	

	Management and Mitigation Measures	Phase	Responsibility	Resources	Reporting / Indicator	Monitoring frequency
1	If at all possible, no workshop should be erected within the site development footprint or Contractor's site camp.	PC	C, EO, PD	Site layout master plan	Compliance monitoring reports	Once off
2	If the establishment of a workshop on site is unavoidable, the workshop location must be approved and indicated in the site layout master plan.	PC	C, EO, PD	Site layout master plan	Pre-construction Compliance monitoring	Once off
3	Workshop areas shall be monitored for oil and fuel spills and such spills shall be cleaned and remediated to the satisfaction of the ECO.	C, O	EO, PD, ECO	Site layout master plan	Compliance monitoring reports	Monthly
4	Where possible and practical all maintenance of vehicles and equipment shall take place in the workshop area.	C, O	C, EO, PD	Site layout master plan	Compliance monitoring reports	Monthly
5	Only emergency repairs shall be allowed outside the workshop area on site and a drip tray shall be used to prevent oil spills.	C, O	C, EO, PD	Drip trays	Compliance monitoring reports	Monthly
6	All hazardous materials shall be clearly marked with symbolic safety/hazard warning signs, documented in a register, and stored according to best practice guidelines.	C, O, CL	C, EO, PD	MSDS, materials register	Compliance monitoring reports	Monthly
7	All hazardous substances shall be stored in suitable containers and storage areas shall be bunded. This includes all carbon substances like fuel and oil as well as herbicides and battery acid.	C, O, CL	C, EO, PD	Method statements	Compliance monitoring reports	Monthly
8	Locate temporary waste and hazardous substance storage facilities out of the 1:100 flood line.	C, O, CL	C, EO, PD	Method statements	Compliance monitoring reports	Monthly
9	All potentially hazardous raw and waste materials are to be handled by the Contractor's trained staff and stored on site in accordance with manufacturer's instructions and approved method statements.	C, O, CL	C, EO, PD	Method statements	Compliance monitoring reports	Monthly
10	Fire extinguishers should be available at conspicuous places and should also be serviced as required.	All phases	C, EO, PD	Clearly visible fire extinguishers	Compliance monitoring report	Monthly
11	The relevant Material Safety Data Sheets (MSDS) shall be available on site. Procedures detailed in the MSDS shall be followed in the event of an emergency situation.	C, O, CL	C, EO, PD	MSDS	Compliance monitoring reports	Monthly
12	The Contractor shall be in possession of an emergency spill kit that must be complete and available at all times on site.	All phases	C, EO, PD	Readily available spill kit	Compliance monitoring report	Monthly
13	The location of a fuel storage area for construction activities during the construction phase shall be approved by the PD and ECO, and shall comply with all relevant	All phases	C, EO, PD	Relevant approvals, Site layout Master	Compliance monitoring report	Monthly

	legislation and standards.			Plan		
14	All liquid fuels and oils shall be stored in tanks with lids and that these are kept firmly locked at all times. The design and construction of the storage tanks shall be in accordance with a recognised code and as approved by the PD.	C, O, CL	C, EO, PD	MSDS	Compliance monitoring reports	Monthly
Monitoring Measures:		-	-	-	-	-
1	Compliance monitoring and reporting as per section 6.1.					

Table 5-13: Site management - Waste management activities

Environmental Specification		**Section**	**Component**		**Legend**	
SITE MANAGEMENT DURING CONSTRUCTION AND OPERATION OF THE FGD		**5.2.13**	Waste management		Phase PC : Pre-construction; O : Operational C : Construction; D : Decommisioning Responsible Party PSM : Power Station Manager; GM : General Manager PD : Project Director; SCM : Senior Construction Manager CM : Contracts Manager; ECO : Environmental Control Officer EM : Environmental Manager; C : Contractor EA : Senior Environmental Advisor; EMC : Environmental Monitoring Committee EO : Environmental Officer; HO : Eskom Head Office	
Objective:		**Expected outcome:**				
1	Ensure proposed waste management activities are aligned with legislation	No spillages or pollution from the handling or storage of waste during construction.				
2	Maintain a tidy and clean construction site					
3	Minimise potential pollution from waste					
Management and Mitigation Measures		**Phase**	**Responsibility**	**Resources**	**Reporting / Indicator**	**Monitoring frequency**
1	A certificate of disposal shall be obtained by the Contractor and kept on site. All waste and construction material generated during construction and operation of the facility must be removed and disposed of at a licensed waste disposal facility.	All	C, EO, PD	Appointment of waste service provider	Compliance monitoring reports	Monthly
2	In the case where a registered waste site is not available close to the construction site, the Contractor will be responsible to provide a method statement and/or Waste Management Licence with regard to waste management. This method statement must be approved by the ECO.	All	C, EO, PD	Waste engineer to draft method statement	Approved method statement	Monthly
3	Waste management activities shall be undertaken strictly according to the approved method statement or WML.	C, O	C, EO, PD, EM	Waste engineer to draft method statements	Approved method statements	Once off
4	The Contractor camp shall have the necessary ablution facilities with chemical toilets in the ratio of 1 toilet per 15 staff members.	C, O	C, EO, PD	Sufficient number of chemical toilets	Adequate ablution facilities	Monthly
5	The Contractor will supply waste collection bins where such is not available and all solid waste collected shall either be recycled or disposed of at a registered waste disposal facility.	C, O	C, EO, PD	Waste collection bins	Only temporary waste storage	Monthly
6	Under no circumstances may solid waste be burned on site unless a suitable incinerator is available.	All	C, EO, PD	-	-	Daily
7	The washing of concrete trucks on site is prohibited. Any spilled concrete shall be cleaned up immediately.	C, O	C, EO, PD	Spill kits and clean up material	Incident report	Weekly
8	The Contractor must provide Authorities with proof of confirmation of service provision from waste service providers for the removal of wastes.	C, O	C, EO, PD	Certificafte of disposal of waste	Compliance monitoring reports	Monthly
9	Wherever possible, materials such as steel off-cuts, wire, etc will be recycled. To this end, containers for glass, paper, metals, plastics, organic waste and hazardous wastes	All phases	C, EO, PD	Recycling containers	Proof of recycling service provider agreement.	Weekly

	(e.g. oil rags, paint containers, thinners) will be provided in sufficient quantity on the site.					
10	Waste will be removed during off-peak traffic periods, where possible, to minimise impacts on local traffic patterns.	All phases	C, EO, PD	-	-	Weekly
Monitoring Measures:		-	-	-	-	-
1	Compliance monitoring and reporting as per section 6.1.					

Table 5-14: Site management - Sanitation

Environmental Specification		**Section**	**Component**		**Legend**	
SITE MANAGEMENT DURING CONSTRUCTION AND OPERATION OF THE FGD		**5.2.14**	Sanitation		Phase PC : Pre-construction; O : Operational C : Construction; D : Decommisioning Responsible Party PSM : Power Station Manager; GM : General Manager PD : Project Director; SCM : Senior Construction Manager CM : Contracts Manager; ECO : Environmental Control Officer EM : Environmental Manager; C : Contractor EA : Senior Environmental Advisor; EMC : Environmental Monitoring Committee EO : Environmental Officer; HO : Eskom Head Office	
Objective:		**Expected outcome:**				
1	Maintain a safe and clean construction site	No spillages or pollution from the handling or storage of sewerage or waste water during construction.				
2	Ensure implemented mitigation measures reduce any adverse impacts on the environment resulting from construction site activities					
Management and Mitigation Measures		**Phase**	**Responsibility**	**Resources**	**Reporting / Indicator**	**Monitoring frequency**
1	Where existing ablution facilities and associated infrastructure are available the Contractor shall make use of such facilities.	All	C, EO, PD	Existing ablution facilities	Compliance monitoring reports	Monthly
2	The Contractor shall inform all site staff to make use of supplied ablution facilities and under no circumstances shall indiscriminate excretion and urinating be allowed other than in supplied facilities.	All	C, EO, PD	Appropriate ablution facilities	Compliance monitoring reports	Monthly
3	Locate temporary sanitation facilities out of the 1: 100 year flood line.	All	C, EO, PD	Appropriate ablution facilities	Compliance monitoring reports	Monthly
4	The Contractor will ensure that no spillage occurs when the toilets are cleaned or emptied and that a licensed provider removes the contents from the site.	All	C, EO, PD	Appropriate ablution facilities	Agreement with service provider	Monthly
5	Disposal of such waste is only acceptable at a licensed waste disposal facility. Disposal certificates shall be obtained from the service provider and included in the site file.	All	C, EO, PD	Honeysucker trucks	Disposal cert. in site file	Monthly
6	Portable ablution facilities to be provided at a maximum ration of 1:15 people with separate facilities for men and women.	All	C, EO, PD	Appropriate ablution facilities	Compliance monitoring reports	Monthly
7	Locate ablution facilities at least 100 m away from the edge of wetland areas outside the direct development footprint.	All	C, EO, PD	EMPr, specialist studies	Compliance monitoring reports	Monthly
8	No washing of machinery or equipment within wetlands areas adjacent to the development sites should be allowed.	All	C, EO, PD	-	Compliance monitoring reports	Monthly
Monitoring Measures:						
1	Compliance monitoring and reporting as per section 6.1.					

Table 5-15: Site Management - Fire prevention

Environmental Specification		Section	Component
SITE MANAGEMENT DURING CONSTRUCTION AND OPERATION OF THE FGD		5.2.15	Fire prevention
Objective:		**Expected outcome:**	
1	Ensure effective fire prevention measures are in place	No fires recorded on site.	
2	Prevent occurrences of veld fires		

Legend

Phase

PC	: Pre-construction	O	: Operational
C	: Construction	D	: Decommissioning

Responsible Party

PSM	: Power Station Manager	GM	: General Manager
PD	: Project Director	SCM	: Senior Construction Manager
CM	: Contracts Manager	ECO	: Environmental Control Officer
EM	: Environmental Manager	C	: Contractor
EA	: Senior Environmental Advisor	EMC	: Environmental Monitoring Committee
EO	: Environmental Officer	HO	: Eskom Head Office

Management and Mitigation Measures		Phase	Responsibility	Resources	Reporting / Indicator	Monitoring frequency
1	The Contractor will document a fire reduction management plan. The plan will identify fire hazards and appropriate management measures to reduce the identified risks.	PC	C, PD	-	Fire Reduction Management Plan	Once off
2	The Contractor shall have fire-fighting equipment available on all vehicles working on site.	All	C, PD	Firefighting equipment in good working order	Firefighting equipment on all contractor vehicles.	Daily
3	All fire control mechanisms (fire-fighting equipment) will be routinely inspected by a qualified investigator for efficacy thereof and be approved by local fire services. Such mechanisms will be present and accessible at all times.	All	C, EO, PD	Appointment of qualified investigator	Inspection reports	Monthly
4	The contractor shall designate or appoint a suitable and qualified fire officer for full time duty on site.	All	C, EO, PD	Designated fire officer	Fire drills and roll call register	Twice a year
5	All staff on site will be made aware of general fire prevention and control methods, and name of responsible person to alert to the presence of a fire.	All	C, EO, PD	Toolbox talks, fire awareness training	Signed attendance registers	As required
Monitoring Measures:						
1	Compliance monitoring and reporting as per section 6.1.					

6 MONITORING AND COMPLIANCE

These proposed monitoring and maintenance measures are provided in the sections below.

6.1 Compliance monitoring and reporting of construction and operation activities

Independent monitoring by an ECO must be undertaken on a monthly basis with feedback on contractor and Eskom compliance presented at the contractor's construction management meetings. The ECO will report to the PD, SCM and EM on the compliance with the construction and operational activities during the preceding period in terms of the approved EMPr, EA, MPS EMS.

The Station Environmental Manager or designated person must provide feedback to the Environmental Monitoring Committee on a quarterly basis on the performance of the contractor, Eskom and findings and outcomes of all required monitoring as stipulated in the MPS EMS and approved EMPrs. Where necessary, Eskom shall task the relevant specialists to present monitoring data and findings to the EMC.

6.2 Soils

The soils and land capability specialist proposed a soil conservation plan for the construction, operational and decommissioning phases of the proposed development. These soil conservation plans aims to maintain the integrity of the topsoil removed during construction.

Making provision for retention of utilisable material for the decommissioning and/or during rehabilitation will not only save significant costs at closure, but will ensure that additional impacts to the environment do not occur.

The proposed soil conservation plans for the construction, operational and decommissioning phases of the development is provided in Table 6-1, Table 6-2 and Table 6-3 below.

Table 6-1: Construction Phase – Soil Utilization Plan

Phase	Step	Factors to Consider	Comments
Construction	Delineation of areas to be stripped		Stripping will only occur where soils are to be disturbed by activities that are described in the design report, and where a clearly defined end rehabilitation use for the stripped soil has been identified.
	Reference to biodiversity action plan		It is recommened that all vegetation is stripped and stored as part of the utilizable soil. However, the requirements for moving and preserving fauna and flora according to the biodiversity action plan should be consulted.
	Stripping and Handling of soils	Handling	Where possible, soils should be handled in dry weather conditions so as to cause as little compaction as possible. Utilizable soil (Topsoil and upper portion of subsoil B2/1) must be removed and stockpiled separately from the lower "B" horizon, with the ferricrete layer being seperated from the soft/decomposed rock, and wet based soils seperated from the dry soils if they are to be impacted.
		Stripping	The "Utilizable" soil will be stripped to a depth of 750mm or until hard rock/ferricrete is encountered. These soils will be stockpiled together with any vegetation cover present (only large vegetation to be removed prior to stripping). The total stripped depth should be 750mm, wherever possible.
	Delineation of Stockpiling areas	Location	Stockpiling areas will be identified in close proximity to the source of the soil to limit handling and to promote reuse of soils in the correct areas. All stockpiles will be founded on stabilized and well engineered "pads"
		Designation of Areas	Soils stockpiles will be demarcated, and clearly marked to identify both the soil type and the intended area of rehabilitation.

Table 6-2: Operational Phase – Soil Conservation Plan

Phase	Step	Factors to Consider	Comments
Operation	Stockpile management	Vegetation establishment and erosion control	Enhanced growth of vegetation on the Soil Stockpiles and berms will be promoted (e.g. by means of watering and/or fertilisation), or a system of rock cladding will be employed. The purpose of this exercise will be to protect the soils and combat erosion by water and wind.
		Storm Water Control	Stockpiles will be established/engineered with storm water diversion berms in place to prevent run off erosion.
		Stockpile Height and Slope Stability	Soil stockpile and berm heights will be restricted where possible to <1.5m so as to avoid compaction and damage to the soil seed pool. Where stockpiles higher than 1.5m cannot be avoided, these will be benched to a maximum height of 15m. Each bench should ideally be 1.5m high and 2m wide. For storage periods greater than 3 years, vegetative (vetiver hedges and native grass species - refer to Appendix 1) or rock cover will be essential, and should be encouraged using fertilization and induced seeding with water and/or the placement of waste rock. The stockpile side slopes should be stabilized at a slope of 1 in 6. This will promote vegetation growth and reduce run-off related erosion.
		Waste	Only inert waste rock material will be placed on the soil stockpiles if the vegetative growth is impractical or not viable (due to lack of water for irrigation etc.). This will aid in protecting the stockpiles from wind and water erosion until the natural vegetative cover can take effect.
		Vehicles	Equipment, human and animal movement on the soil stockpiles will be limited to avoid topsoil compaction and subsequent damage to the soils and seedbank.

Table 6-3: Decommissioning Phase – Soil Conservation Plan

Phase	Step	Factors to Consider	Comments
Decommissioning & Closure	Rehabilitation of Disturbed land & Restoration of Soil Utilization	Placement of Soils	Stockpiled soil will be used to rehabilitate disturbed sites either ongoing as disturbed areas become available for rehabilitation and/or at closure. The utilizable soil (500mm to 750mm) removed during the construction phase, must be redistributed in a manner that achieves an approximate uniform stable thickness consistent with the approved post development end land use (Conservation land capability and/or Low intensity grazing), and will attain a free draining surface profile. A minimum layer of 300mm of soil will be replaced.
		Fertilization	A representative sampling of the stripped and stockpiled soils will be analysed to determine the nutrient status and chemistry of the utilizable materials. As a minimum the following elements will be tested for: EC, CEC, pH, Ca, Mg, K, Na, P, Zn, Clay% and Organic Carbon. These elements provide the basis for determining the fertility of soil. based on the analysis, fertilisers will be applied if necessary.
		Erosion Control	Erosion control measures will be implemented to ensure that the soil is not washed away and that erosion gulleys do not develop prior to vegetation establishment.
	Pollution of Soils	In-situ Remediation	If soil (whether stockpiled or in its undisturbed natural state) is polluted, the first management priority is to treat the pollution by means of in situ bioremediation. The acceptability of this option must be verified by an appropriate soils expert and by the local water authority on a case by case basis, before it is implemented.
		Off site disposal of soils.	If in situ treatment is not possible or acceptable then the polluted soil must be classified according to the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (Local Dept of Water Affairs) and disposed of at an appropriate, permitted, off-site waste facility.

The specialist furthermore proposed the following monitoring and maintenance recommendations:

- During the rehabilitation exercise, preliminary soil quality monitoring should be carried out to accurately determine the fertilizer and pH requirements that will be needed.
- Soils should be sampled and analysed for the following parameters:

pH (H_2O)	Phosphorus (Bray I)	
Electrical conductivity	Calcium mg/kg	
Cation exchange capacity	Sodium mg/kg;	
Magnesium mg/kg;	Potassium mg/kg	Zinc mg/kg;
Clay, sand and Silt	Organic matter content (C %)	

The following maintenance is recommended:

- The area must be fenced, and all animals kept off the area until the vegetation is self-sustaining;
- Newly seeded/planted areas must be protected against compaction and erosion (Vetiver hedges etc.);
- Traffic should be limited were possible while the vegetation is establishing itself;
- Plants should be watered and weeded as required on a regular and managed basis were possible and practical;
- Check for pests and diseases at least once every two weeks and treat if necessary;
- Replace unhealthy or dead plant material;
- Fertilise, hydro seeded and grassed areas soon after germination, and
- Repair any damage caused by erosion.

6.3 Groundwater

The following recommendations regarding monitoring were made by the groundwater specialist and include:

- Monthly monitoring of exiting monitoring boreholes groundwater levels and quality. Monitoring should be conducted to be consistent with the existing WUL (Licence no.: 01/A42J/4055);
- Aquifer testing of new monitoring boreholes to determine hydraulic parameters and update initial groundwater conceptual model. The groundwater conceptual model with aquifer parameters provides the basic input into a groundwater numerical model;
- The newly-drilled monitoring boreholes should be incorporated into the existing monitoring programme. The following monitoring tasks should be conducted to be consistent with the existing WUL (Licence no.: 01/A42J/4055);
  - Bi-annually groundwater monitoring of existing groundwater user's boreholes in the area surrounding the existing licensed disposal facility (In radius of ~ 3.0 km).
  - Update of conceptual groundwater model;
  - Development of a numerical groundwater flow & transport model (or update of existing models) and Impact Assessment. This model to include Medupi Power station (MPS) and the existing licensed disposal facility;
  - Use model predictions to predict the pollution plume from the existing licensed disposal facility and Medupi Power station;
  - Update mitigation and management measures for the existing licensed disposal facility on numerical model outcome and predictions; and
  - Reporting based on the important hydrogeological aspects identified in this report – in support of the EIA, WML and WUL.

6.4 Biodiversity (Terrestrial Ecology) and Wetlands

The following recommendations regarding monitoring were made by the specialist and include:

- Biodiversity and wetland monitoring must be undertaken in line with the existing monitoring protocol of the MPS.
- Regular surface and ground water quality monitoring is required to be continued at the identified sampling sites.
- Sediment analysis of depressions and the ephemeral washes must be conducted yearly and compared with the current results for the site. This will then indicate whether heavy metal concentrations are increasing during the Operation Phase of MPS and its ADF.
- Annual monitoring of the aquatic invertebrate assemblage should be conducted at the various remaining sediment sampling sites.
- Amphibian assemblages should be monitored at key sediment sampling sites as well as the newly created pans once a year by means of acoustic, visual encounter transects.

- Measures should be implemented to minimise erosion on site, and potential sedimentation and contamination of the downstream ephemeral watercourse and associated dams;
- It is advised that water quality at local boreholes (if present) be monitored before and during construction of the site. The exact duration, frequency and positioning of the sampling points should be determined from the geohydrological studies commissioned for the site.

6.5 Noise

In the event that noise related complaints are received, short term (24-hour) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

The following procedure should be adopted for all noise surveys:

- Any surveys should be designed and conducted by a trained specialist.
- Sampling should be carried out using a Type 1 Sound Level Meter (SLM) that meets all appropriate International Electrotechnical Commission (IEC) standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.
- Samples of at least 24 hours in duration and sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic climate should be taken.
- The following acoustic indices should be recoded and reported:

  L_{Aeq} (T)

  L_{AIeq} (T)

  Statistical noise level LA90

  L_{Amin} and L_{Amax}

  Octave band or 3rd octave band frequency spectra.
- The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
- A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic climate of each site.

6.6 Heritage, archaeology and palaeontology

If in the extremely unlikely event that any fossils are discovered during the construction of the waste disposal site, then it is strongly recommended that a palaeontologist be called to assess their importance and rescue them if necessary.

7 ENVIRONMENTAL AWARENESS PLAN

The EO or EM shall be appropriately trained in environmental management and shall possess the skills necessary to impart environmental management skills to all personnel involved in the construction, rehabilitation and operation of the ADF, as applicable.

The PD and EM shall ensure, on behalf of Eskom and the Contractor, that the employees (including construction workers, engineers, and long-term employees) are adequately trained on the stipulations of the EMPr. Further, the EO and EM shall arrange for all employees to attend an induction presentation on environmental awareness.

Where possible, training must be conducted in the language of the employees. The induction and training shall, as a minimum, include the following:

- The importance of conformance with all the specifications of the EMPr and other environmental policies and procedures;
- The significant environmental impacts, actual or potential, of their work activities;
- The environmental benefits of improved personal performance;
- Their roles and responsibilities in achieving conformance with the EMPr and other environmental policies and procedures;
- The potential consequences of departure from specified operating procedures; and
- The mitigation measures required to be implemented when carrying out their work activities.

ZITHOLELE CONSULTING (PTY) LTD

ENVIROSERV IS A PROUD B-BBEE LEVEL 2 CONTRIBUTOR

ENVIROSERV
WASTE MANAGEMENT

Att: Theuns Blom 11 May 2018
Eskom : Medupi Project

RE: Medupi WFGD: WASTE STREAM HANDLING

Good day Theuns

Based on the theoretical assessments carried out by Jones & Wagner, the waste streams that will be generated by Eskom's Medupi Power Station will be permitted to be disposed at Holfontein's H:H Landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed. DWAF, 1998) which is equivalent to a Class A landfill designed in accordance with section 3(1) and (2) of the National Norms and Standards for Disposal of Waste to Landfill (GN R636).

The wastes streams, once generated by Eskom's Medupi Power Station, shall be re-assessed in order to confirm the theoretical assessments carried out by Jones & Wagner.

Table 1: Summary of waste assessment results and

Waste	Assessment and Class of Landfill required for disposal	Percentage of waste (%)
Ash	Type 3 waste – Class C Landfill	79 or 68
FGD Gypsum	Type 3 waste – Class C Landfill	19 or 29
FGD WWTP Sludge 85% Limestone	Type 2 waste – Class A landfill*	2.4
FGD WWTP Sludge 96% Limestone	Type 1 waste – Class A landfill	1.4
FGD WWTP Crystalliser Solids	Type 1 waste – Class A landfill	0.72 or 0.62

*** The Type 2 assessment was based on theoretical values and therefore a conservative approach should be followed and the 85% Limestone FGD WWTP Sludge should be disposed of on a Class A landfill until the assessments can be confirmed on actual waste samples.**

Kind regards

LUCY MULLER
Sales Manager

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16/2/7/C212/Y121/1

PERMIT NUMBER:	16/2/7/C212/Y121/P3 (Amendment to Permit number B33/2/321/121/P3 issued on 25 April 1996)
CLASS:	H:H
WASTE DISPOSAL SITE:	HOLFONTEIN
LOCATION:	PORTIONS 23 AND 24 OF THE FARM HOLFONTEIN 71 IR AND PORTION 8 OF THE FARM MODDERFONTEIN 236 IR, DISTRICT OF BENONI
PERMIT HOLDER:	DISPOSE TECH, A DIVISION OF ENVIROSERV WASTE MANAGEMENT (PTY) LTD
ADDRESS:	PO BOX 13420, NORTHMEAD 1511

PERMIT IN TERMS OF SECTION 20 OF THE ENVIRONMENT CONSERVATION ACT, 1989 (ACT 73 OF 1989)

By virtue of the powers delegated to me by the Minister of Water Affairs and Forestry (hereinafter referred to as "the Minister"), I, Cornelius Ruiters, in my capacity as Manager: Water Use in the Department of Water Affairs and Forestry (hereinafter referred to as "the Department"), hereby, in terms of section 20(1) of the Environment Conservation Act, 1989 (Act 73 of 1989), authorise the abovementioned Permit Holder to further develop and operate the Holfontein H:H Landfill Site, subject to the conditions specified herein

PERMIT CONDITIONS

In this Permit, "Manager" means the Manager: Waste Discharge and Disposal of the Department, who may be contacted at the address below:

Director General
Department of Water Affairs and Forestry
Private Bag X313
PRETORIA
0001

ATTENTION: Manager: Waste Discharge and Disposal

1. **LOCATION**

1.1 This Permit authorises the further development and operation of a waste disposal site on Portions 23 and 24 of the farm Holfontein 71 IR and Portion 8 of the farm Modderfontein 236 IR, District of Benoni, (hereinafter referred to as "the Site") according to the following reports numbered –

(a) *Environmental Impact Control Report for Holfontein Hazardous Waste Disposal Site- Updated for 2003* (report number JW20/03/6923) by Jones & Wagener dated May 2003;
(b) *Projection of a Health Buffer Zone for the Holfontein Landfill Site* (report number EMS/01/EWM-04) by Environmental Management Services CC dated 23 February 2001;
(c) *Holfontein Operations Manual* by J Nicholson dated August 2003;
(d) *Scoping Report, Holfontein Leachate Treatment Plant* by Environmental and Chemical Consultants and Environmental Risk Management dated 25 April 2002;
(e) *Addendum to Scoping Report for the Holfontein Leachate Treatment Plant* by Environmental and Chemical Consultants and Environmental Risk Management dated 27 September 2002;
(f) Emergency Response Plan (report number DTWI-17/gau/holf);
(g) *Holfontein H:H Landfill – Design and Operational Manual for Encapsulation in Large Volume Silos* (report number JW165/02/6444-7) by Jones and Wagener dated November 2002

(unless specifically stated otherwise, hereinafter referred to as "the Reports"), submitted by the Permit Holder.

1.2 Portion 8 of the farm Modderfontein 236 IR may not be used for the disposal of waste and may only be used for the purposes of a bufferzone as required in this permit.

1.3 The boundaries of the Site must be as indicated by the co-ordinates on Drawing number 6444-02-019 dated 11 July 2003 of the Report referred to in condition 1.1 (c).

2. PERMISSIBLE WASTE

2.1. Any portion of the Site which has been constructed or developed according to condition 3 of this Permit, may be used for the disposal of all waste types which are classified according to the latest edition of the "Minimum Requirement" series of documents as published by the Department (hereinafter referred to as the "Minimum Requirements"), as waste suitable for disposal at a H:H disposal facility, excluding those waste types listed in Annexure I

2.2 Pharmaceuticals (narcotics) confiscated by the South African Police Service may be disposed of according to Annexure III after written approval by the Manager for a specific batch

2.3 The classification, acceptance and disposal criteria as listed in the latest edition of the Minimum Requirements must be conformed to

3. CONSTRUCTION

3.1 The Site or any portion thereof may only be used for the disposal of permissible waste or leachate if the Site or any portion have been constructed and developed according to condition 3 of this Permit

3.2 The construction of further developments within the Site, may only be undertaken by the Permit Holder after specified engineering plans have been submitted to the Manager and approved in writing by the Manager.

3.3 The construction of further developments within the Site must be carried out under the supervision of a Professional Civil Engineer, registered under the Engineering Profession of South Africa Act, 1990 (Act 114 of 1990) as proposed by the Permit Holder and approved by the Manager.

3.4 Should a portion of the Site be further developed, according to plans for which approval has been obtained under condition 3.2 and in accordance with condition 3.3, the Permit Holder must notify the Manager of the estimated date of completion of the development. The completed development shall be inspected by a Registered Professional Civil Engineer from the Department and by the person referred to in condition 3.3. Should the Manager be satisfied with the development after the inspection is completed and has granted written permission thereto, the Permit Holder may use that portion of the Site for the disposal of waste

3.5. The Site must be constructed in accordance with recognised civil engineering practice, with special consideration to stability

3.6. The slope of the outer walls of the waste disposal cells on the Site shall not be steeper than 1 vertical to 3 horizontal length units, unless an equivalent engineered alternative has been approved by the Manager

3.7. The slope of the sides of the Site must be constructed and maintained in such a manner that the occurrence of erosion is prevented

3.8 The maximum height of the Site must not exceed 35 metres above ground level

3.9. Stormwater diversion works constructed in compliance with condition 5.1 must be of such a capacity as to accommodate all stormwater runoff which could be expected as a result of the estimated maximum precipitation during a period of 24 hours with an average frequency of once in fifty years (hereinafter referred to as the "estimated maximum precipitation").

3.10 Containment works constructed in compliance with condition 5.1.2 must be of such a capacity as to maintain a freeboard of half a metre and to accommodate all stormwater runoff which could be expected as a result of the estimated maximum precipitation

3.11. Containment works constructed in compliance with conditions 5.1 for contaminated stormwater must be lined according to the relevant Minimum Requirements and in compliance with condition 3.2.

3.12 Leachate containment works constructed in compliance with condition 5.2 must be of such a capacity as to contain all expected leachate as a result of disposal operations and the estimated maximum precipitation and must maintain a freeboard of half a metre and must be lined according to the specifications contained in the Minimum Requirements for Hazardous lagoons.

3.13. Plans for the leachate treatment plant and associated containment structures as referred to in the Report listed in condition 1.1(d) and (e) must be submitted within six months from the date of this Permit to the Manager for his approval

3.14. The leachate treatment works must be constructed in accordance with the approved plans, and must be in operation by 31 December 2004

3.15. The Permit Holder must compile annual written reports on the construction of all works within the Site. These reports must contain an assessment by the person referred to in condition 3.3, of all works constructed on the Site in comparison with the specified engineering drawings as submitted to and approved by the Manager and must also contain the detailed results of all quality control tests performed on the construction. All reports must contain a photographic record of the construction up to the written report date

4. GENERAL IMPACT MANAGEMENT AND OPERATION

4.1 Disposal of Waste

4.1.1 The Permit Holder must ensure that the disposal of permissible waste and the operation of the Site is done in accordance with –

(a) the latest edition of the *Minimum Requirements* as published by the Department of Water Affairs and Forestry;
(b) the conditions of this Permit;
(c) the Reports or subsequent approved versions there-of;
(d) the approved Operational Plan;
(e) any written Operational Procedures or amendments of the Operational Plan submitted by the Permit Holder and approved by the Manager; and
(f) any other written direction issued by the Manager to the Permit Holder

4.2 Co-disposal

4.2.1 The Permit Holder must ensure that the co-disposal of solid and liquid waste is done in such a manner that the hydraulic head of leachate on the liner of the Site is less than 200 mm per annum as specified in the Minimum Requirements

4.2.2 The co-disposal ratio shall be managed according to the methodology specified in Appendix 10.1 of the Minimum Requirements for Waste Disposal by Landfill (second edition, 1998) or subsequent versions thereof.

4.2.3 The Permit Holder shall develop and maintain a calibrated liquid management model to ensure compliance to condition 4.2.2.

4.2.4 The Permit Holder shall submit the results of the liquid management model to the Manager on a monthly basis.

4.2.5 The Permit Holder may not exceed the co-disposal ratio of the liquid management model, which ensures compliance to conditions 4.2.1 and 4.2.2 without written approval by the Manager.

4.3 Bufferzone

4.3.1 The Permit Holder must take all reasonable steps, such as suitable zoning, written agreements with adjacent landowners, buying out land and/or obtaining a servitude, to establish and maintain a "bufferzone", between the Site and the nearest residential and/or light industrial area not closer to the Site than:

(a) 400 metres to the north
(b) 700 metres to the South
(c) 350 metres to the east, and
(d) 500 metres to the west

during the operative life of the Site.

4.3.2 The Permit Holder must submit written proof to the Manager of the steps taken according to condition 4.3.1, within one year from the date of this Permit.

4.3.3 Heavy industries or industries which may create nuisance conditions may be permitted within the bufferzone in terms of the appropriate legislation.

4.3.4 Should the operation of the Site change in such a manner that the approved bufferzone referred to in condition 4.3.1 may be influenced, the Permit Holder may be directed by the Manager to review the air dispersion modeling as contained in the report referred to in condition 1.1 (b) to confirm whether the approved bufferzone is adequate.

4.4 General Operational Measures

4.4.1. Municipal waste disposed of on Site shall be compacted and covered on a daily basis with a minimum of 150 millimetres of soil or other material as approved by the Manager.

4.4.2 Where applicable, the Permit Holder must operate the Site in such a manner that the height of the embankment or perimeter wall is at all times maintained at a higher elevation than the level of the operating floor

4.4.3 Waste disposed of on the Site is not allowed to burn.

4.4.4. Waste disposed of on the Site may not be reclaimed.

4.4.5. Containers in which waste is accepted on Site may be reclaimed after a management plan has been approved by the Manager.

4.4.6. The Permit Holder must take all reasonable steps to ensure that the Site is operated in such a manner that nuisance conditions or health hazards, or the potential creation of nuisance conditions or health hazards, are prevented.

4.4.7 The Permit Holder must make provision for adequate sanitation facilities on the Site.

4.4.8. The Permit Holder must implement, maintain and at all times apply sufficient dust control measures to prevent wind-blown dust from causing nuisance conditions or health hazards.

4.4.9. The Permit Holder must implement, maintain and at all times apply sufficient odour control measures to prevent odours from causing nuisance conditions or health hazards.

4.4.10 The measured concentration of flammable gas, amended for Standard Temperature and Pressure, in the atmosphere inside buildings on the Site must not exceed 0.5% by volume in air. Should the levels above 0.5% be detected, the Permit Holder must submit a contingency plan regarding occupational safety to the Manager, which must be implemented on the Site, after written approval by the Manager.

4.4.11. The Permit Holder must implement adequate measures to the satisfaction of the Manager, to ventilate methane gas generated in the waste disposal area and to prevent lateral migration of methane gas in order to prevent the build-up of dangerous concentrations within the Site.

4.4.12. The Permit Holder must implement, maintain and at all times apply sufficient noise control measures to prevent noise from causing nuisance conditions or health hazards.

4.5. Access Control

4.5.1. Weatherproof, durable and legible notices in at least three official languages applicable in the area, must be displayed at each entrance to the Site. These notices must prohibit unauthorised entry and state the hours of operation, the name, address and telephone number of the Permit Holder and the person responsible for the operation of the Site.

4.5.2 Notices prohibiting unauthorised persons from entering the Site, as well as an internationally accepted sign indicating the risks involved in unauthorised entry must be displayed at 50 metre intervals along the boundary fence of the Site.

4.5.3. The Site must be fenced to a minimum height of 1,8 metres, with gates of the same height at all entrances, to reasonably prevent unauthorised entry.

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4.5.4 All leachate containment works must be fenced to a minimum height of 1,8 metres, with gates of the same height at all entrances, to reasonably prevent unauthorised entry.

4.5.5 The Permit Holder must take all reasonable steps to maintain service roads within his jurisdiction in a condition which ensures unimpeded access to the Site for vehicles transporting waste.

4.5.6. The Permit Holder must ensure that all entrance gates are manned during the hours of operation and locked outside the hours of operation.

4.5.7 The Permit Holder must ensure effective access control.

4.5.8. The Permit Holder must take all reasonable steps to prevent the disposal of waste on the Site for which the Site has not been approved.

5. STORMWATER AND LEACHATE MANAGEMENT

5.1. Runoff Management

5.1.1. All runoff water (stormwater) arising as a result of precipitation on land adjacent to the Site, must be reasonably prevented from coming into contact with any substance, whether such substance is a solid, liquid, vapour or gas, or a combination thereof, which is produced, stored, dumped or spilled on the premises, including leachate and must be diverted and drained around the Site by means of works constructed by the Permit Holder in accordance with condition 3.9.

5.1.2 Runoff water (stormwater) arising as a result of precipitation on the Site, must be prevented where possible from coming into contact with any substance, as enumerated in condition 5.1.1 and must be diverted and drained from the Site and working face of the Site, by means of works constructed by the Permit Holder in accordance with condition 3 and must be contained in works constructed by the Permit Holder in accordance with condition 3.

5.1.3 Runoff water, as referred to in condition 5.1.2, may not be discharged to the Ericsons Dam unless it complies with the quality requirements specified in Annexure III, or with such quality requirements as may from time to time be determined by the Manager, but must be diverted to and contained in works constructed by the Permit Holder in accordance with condition 3.10.

5.1.4. Uncontaminated runoff water as referred to in condition 5.1.1, must be diverted away from the Site and discharged into the Ericsons Dam.

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5.1.5 In the event that runoff water referred to in condition 5.1.1 becomes contaminated with leachate or as a result of the operational activities on the Site and/or the premises of the Permit Holder, it must be regarded as leachate and must be dealt with according to condition 5.2

5.1.6. Runoff water arising from operational actions, for example the washing of vehicle exteriors, or which are suspected to be contaminated must be regarded as contaminated and must be dealt with according to condition 5.1.7

5.1.7 Contaminated runoff must be contained in the works constructed according to condition 3.10.

5.1.8. A management plan for contaminated runoff must be submitted to the Manager for approval within 60 days from the date of this permit

5.1.9. Until the management plan referred to in condition 5.1.8 has been approved, contaminated runoff referred to in condition 5.1.7 must be:

(a) evaporated in dams and/or be evaporated by spraying over those portions of the Site which comply with the requirements set in terms of condition 3.1; or
(b) used for the suppression of dust; or
(c) discharged into any convenient sewer only if accepted in writing by the authority in control of the sewer.

5.1.10. Uncontaminated runoff water must under no circumstances be used to dilute waste water resulting from any activities on the Site or actions relating to the operation of the Site, contaminated stormwater or leachate emanating from the Site, but must be dealt with according to condition 5.1.7.

5.2. Leachate Management

5.2.1. All leachate produced by the Site must be collected in containment works constructed according to condition 3.11 from where it must be treated in the leachate treatment plant constructed according to conditions 3.12 and 3.13

5.2.2. The capacity of the leachate treatment plant must be reviewed annually and a report submitted to the Manager, starting within one year from the commissioning of the leachate treatment plant according to condition 3.12. Should the capacity not be adequate, the Permit Holder may be instructed by the Manager to increase the capacity

5.2.3. Leachate which has been treated in works constructed in accordance with conditions 3.12 and 3.13 may not be discharged into the environment

6. MONITORING

6.1. AIR QUALITY AND GAS MONITORING

6.1.1 Air quality and gas monitoring during the normal operative lifetime of the Site

6.1.1.1 The Permit Holder shall conduct air quality monitoring according to sections 4.3.1 and 4.3.2 of the Report referred to in condition 1.1.(a) or subsequent versions thereof, submitted by the Permit Holder and approved by the Manager.

6.1.1.2 The air quality monitoring programme must be reviewed annually and updated as necessary as the site development takes place.

6.1.2 Post-closure air quality and gas monitoring

6.1.2.1. Air quality and gas monitoring, as described in the monitoring programme referred to in condition 6.1.1, must continue after closure of the Site and must be maintained for a period of 30 years, or for such period and/or frequency as may be determined by the Manager.

6.2 WATER QUALITY MONITORING

6.2.1 Location of points and specifications for water quality monitoring network

6.2.1.1 Monitoring of groundwater, surface water and leachate must be conducted at the locations specified in conditions 6.2.2 and 6.2.3 and at any other location or locations that may from time to time be specified by the Manager.

6.2.1.2 The water quality monitoring network shall be reviewed annually and updated as necessary as site development takes place.

6.2.2 Groundwater quality monitoring network

6.2.2.1 A monitoring borehole network for the Site must be maintained by the Permit Holder according to Table 4.2.3(a) of the Report referred to in condition 1.1.(a) or subsequent approved versions thereof, to the satisfaction of the Manager so that unobstructed sampling, as required in terms of the Permit, can be undertaken.

6.2.2.2 Monitoring boreholes must be equipped with lockable caps. The Department reserves the right to take water samples at any time and to analyse those samples, or to have them taken and analysed.

6.2.3 Surface water quality and leachate monitoring network

6.2.3.1 Surface water and leachate monitoring network for the Site must be maintained by the Permit Holder according to Table 4.1.2(a) of the Report referred to in condition 1.1 (a) or subsequent approved versions thereof

6.2.3.2 Monitoring of treated leachate shall be conducted at locations which shall be approved by the Manager

6.2.4 Background monitoring

6.2.4.1 Samples from the borehole where the groundwater in the borehole is at an expected higher hydraulic pressure level than the hydraulic pressure level of the ground water under the Site, shall be considered as background monitoring

6.2.4.2 Background groundwater monitoring must be conducted during each monitoring occasion according to Table 4.2.4(a) of the report referred to in condition 1.1.(a) or subsequent approved versions thereof.

6.2.5 Detection monitoring

6.2.5.1. Monitoring for surface water, groundwater and leachate quality must be conducted for the variables listed in Table 4.2.3.(b) and at the frequency listed in Tables 4.1.2(a) and 4.2.4(a) of the Report referred to in condition 1.1 (a) or subsequent approved versions thereof.

6.2.6 Investigative monitoring

6.2.6.1 If, in the opinion of the Manager, a water quality variable at any monitoring point listed under the detection monitoring programme, as referred to in condition 6.2.5, shows an increasing trend, the Permit Holder shall initiate a monthly monitoring programme for the water quality variables listed in Annexure IV.

6.2.7 Post-closure water monitoring

6.2.7.1 Groundwater, surface water and leachate monitoring by the Permit Holder, in accordance with conditions 6.2.4 and 6.2.5 must continue after closure of the Site and must be maintained for a period of 30 years, or for such period and/or frequency as may be determined by the Manager

6.3. LEAK AND FAILURE DETECTION MONITORING

6.3.1 The leachate detection system must be monitored on a daily basis for the occurrence of leakages and a higher frequency of monitoring, as approved by the Manager, must be initiated should a leak be suspected and/or identified

6.3.2 Inspection of liners, where liners are accessible, must be performed monthly by the Permit Holder and bi-annually by an external contractor and reported annually to the Manager.

6.3.3 Liners must be repaired when possible, or replaced when necessary, when inspection tests show deterioration or leaking and these corrective actions shall be performed to the satisfaction of the Manager.

6.3.4 Pipes exposed to leachate shall be subjected to annual pressure cleaning where possible

6.3.5 Should a leak or failure be suspected or detected during monitoring or tests performed in accordance with conditions 6.3.1 to 6.3.3, or at any other time, it must be regarded as an incident according to condition 12.1 and addressed accordingly

7. FURTHER INVESTIGATIONS

7.1. If, in the opinion of the Manager, groundwater, surface water and/or air pollution have occurred or may possibly occur, the Permit Holder must conduct, and/or appoint specialists to conduct the necessary investigations and implement additional monitoring and remediation measures to the satisfaction of the Manager

8. AUDITS

8.1 Internal audits

8.1.1 Inspections must be conducted weekly by the Permit Holder as described in the Report referred to in condition 1.1.(c) and the findings of these inspections must be available to the external auditor specified in condition 8.2.

8.1.2 Internal auditing must be conducted quarterly by the Permit Holder and on each audit occasion an official report must be compiled by the relevant auditor to report the findings of these audits, which must be available to the external auditor according to condition 12.2.1 and the Department on request

8.2 External audits

8.2.1 The Permit Holder must appoint an independent external auditor to audit the Site bi-annually and this auditor must compile an audit report documenting the findings of the audit within 60 days from the date of the audit, which must be submitted by the Permit Holder according to condition 12.2.2

8.2.2 The audit report must specifically state whether conditions of this Permit are adhered to and must include whether monitoring required in terms of condition 6 of this permit has been carried out and whether reasonable interpretation of the data has been undertaken in accordance with condition 12.3.1 of this permit.

8.2.3 The audit report must contain recommendations regarding non-compliance or potential non-compliance and must recommend target dates for the implementation of critical recommendations by the Permit Holder

8.2.4 Based on the audit report, the Permit Holder must prepare a programme detailing target dates for implementation of all the recommendations made, which must be submitted to the Manager and to the external auditor within 30 days after submission of the audit report in accordance with condition 12.2.2

8.3 Departmental audits and inspection

8.3.1 The Department reserves the right to audit and/or inspect the Site at any time and at such a frequency as the Manager may decide, or to have the Site audited or inspected

8.3.2 The Permit Holder must make any records or documentation available to the Manager upon request, as well as any other information the Manager may require.

8.3.3 The findings of these audits or inspections shall be made available to the Permit Holder and the Monitoring Committee within 30 days of the end of the audit or inspection. Information from the audits must be treated in accordance with the Promotion of Access to Information Act, 2000 (Act 2 of 2000).

9. MONITORING COMMITTEE

9.1 The Permit Holder must take all reasonable steps to maintain and ensure the continued functioning of the Holfontein Monitoring Committee (in this Permit referred to as the "Monitoring Committee") for the normal operative lifetime of the Site and for a period of at least two years after the closure of the Site, or such longer period as may be determined by the Manager

9.2 The Monitoring Committee shall be representative of relevant interested and affected persons and may consist of at least the following persons:

(a) Permit Holder and/or his appointed consultant(s) or advisor(s);
(b) representative(s) of the Health, Environment and/or Waste Departments of the relevant local authority;
(c) representative(s) of this Department;
(d) representative(s) of the Provincial Government responsible for waste management and environmental functions; and
(e) at least 3 (three) persons/parties, or their representatives elected by the local residents

9.3 The Monitoring Committee shall meet at least once every three months and not later than 30 days after the external audit report specified in condition 8.2 has been submitted according to condition 12.2.2.

9.4 The Permit Holder must keep minutes of all meetings of the Monitoring Committee and distribute these minutes to all members of the Monitoring Committee within 30 days after the meeting

10. ANALYSIS OF SAMPLES

10.1 The Permit Holder must ensure that all samples taken in accordance with condition 6, are-

10.1.1 analysed by a laboratory accredited by the South African National Accreditation System (SANAS); and

10.1.2 according to the methods prescribed in terms of Government Notice 991 of 18 May 1984, or another method of analysis for which written approval has been obtained from the Manager.

M. [illegible]

11. RECORDING

11.1 The Permit Holder must keep records of all water monitoring data in the format depicted in Annexure VI, as well as from air quality and gas monitoring conducted in accordance with condition 6.

11.2 The Permit Holder must keep records of the following for all waste deposited on the Site and must update all the information referred to in Annexure V on an annual basis:

(a) date and time of arrival of the waste at the Site;
(b) generator (source of the waste);
(c) mass or volume of the specific wastes;
(d) type, classification and composition of the waste, with a separate list of hazardous components where the composition is not evident from the name of the waste;
(e) any specified pre-treatment procedures and/or method of disposal to which the waste was subjected before its disposal was permitted on the Site; and
(f) the location of encapsulated waste within the Site.

11.3 Safe disposal certificates must be issued in the name of the generator.

11.4 Records must be kept of all tests and inspections conducted in accordance with condition 6.3.

12. REPORTING

12.1 Reporting of incidents

12.1.1 The Permit Holder must, within 24 hours, notify the Manager of the occurrence or detection of any incident on the Site, or incidental to the operation of the Site, which has the potential to cause, or has caused water pollution, pollution of the environment, health risks or nuisance conditions.

12.1.2 The Permit Holder must, within 14 days, or a shorter period of time, if specified by the Department, from the occurrence or detection of any incident referred to in condition 12.1.1, submit an action plan to the satisfaction of the Manager, which shall include a detailed time schedule of measures taken to-

(a) correct the impact resulting from the incident;
(b) prevent the incident from causing any further impacts; and
(c) prevent a recurrence of a similar incident.

12.1.3 In the event that measures have not been implemented within 21 days to address impacts caused by the incident referred to in condition 12.1.1, or measures which have been implemented are inadequate, the Department may implement the necessary measures at the cost and risk of the Permit Holder

12.1.4 The Permit Holder must keep an incident report and complaints register, which must be made available to both external and Departmental auditors for the purpose of their audits

12.2 Audit reports

12.2.1 All internal audit reports referred to in condition 8.1 must be made available to the external auditor referred to in condition 8.2.

12.2.2 Each external audit report referred to in condition 8.2 must be submitted to the Manager and the Monitoring Committee within 14 days from the date on which the external auditor finalised the audit report

12.3 Other reports

12.3.1 The information required in terms of condition 6 must be reported to the Manager, in the format specified in condition 11.1 where applicable, within a period of 30 days or less following the completion of analysis of the samples. The information must also be compiled into a trend report, which must contain a graphical presentation of all results obtained previously at any specific point, as well as an interpretation and discussion of the results of each monitoring occasion.

12.3.2 Should the results of analysis required in terms of condition 6 show that a significant risk exist, the information should be reported to the Manager within a period of 7 days following the analysis of the samples

12.3.3 The information required in terms of condition 11.2, must be submitted to the Manager within a period of one year from the date of issuing of this Permit and annually thereafter

12.3.4 The Report referred to in condition 1.1 (a) must be reviewed annually and be updated to reflect development on Site and must be submitted to the Manager for approval. Monitoring as specified in condition 6 must be conducted according to the updated approved Report

12.3.5 The Report referred to in condition 1.1.(c) must be reviewed annually and updated if necessary. The updated report must be submitted to the Manager for approval.

12.3.6 The Permit Holder must submit a written report to the Manager regarding any deviations from plans and/or operation procedures described in this

Permit and must obtain written permission from the Manager before such deviations may be implemented.

13. REHABILITATION AND CLOSURE OF THE SITE

13.1 The Permit Holder must rehabilitate the Site, or any portion thereof, in accordance with a rehabilitation plan, which must be submitted to the Manager for approval at least one year prior to the intended closure of the Site.

13.2 The Permit Holder must, at least 120 days prior to the intended closure of the Site, or any portion thereof, notify the Manager by registered mail of such intention and submit any final rehabilitation plans or amendments for his approval.

13.3 Immediately following the cessation of operations with the intention to close the Site, or any portion thereof, the surface of the Site must be capped with an interim capping as approved by the Manager and the Site must be maintained in such a way that-

(a) the formation of pools due to rain is prevented;
(b) free surface runoff of rainwater is ensured;
(c) contamination of stormwater is prevented;
(d) no objects or material which may hamper the rehabilitation of the Site are present; and
(e) little or no erosion occurs,

until the approved rehabilitation plan referred to in condition 13.1 is completely implemented.

13.4 The Permit Holder shall be responsible for the Site, or its impacts on the environment, after operations on the Site have ceased.

14. GENERAL

14.1 This Permit is not transferable.

14.2 The Permit must not be construed as exempting the Permit Holder from compliance with the provisions of the National Environmental Management Act, 1998 (Act 107 of 1998), Health Act, 1977 (Act 63 of 1977), the National Water Act, 1998 (Act 36 of 1998), the Occupational Health and Safety Act, 1993 (Act 85 of 1993), other sections of the Environment Conservation Act, 1989 (Act 73 of 1989) or any other applicable act, ordinance, regulation or by-law.

14.3 All reports and results that should be submitted to the Manager in terms of this Permit should also be submitted to the Gauteng Provincial Department for the Environment

14.4 The Permit Holder must provide the Manager with any information which he may require to enable him to fulfil the objective of the Environment Conservation Act, 1989 (Act 73 of 1989) for waste disposal purposes

14.5 The Permit Holder must make adequate financial provision for the closure and rehabilitation of the Site and proof of this must be submitted to the Manager on an annual basis.

14.6 The Permit Holder must inform the Manager of any agreements or contracts which are entered into and which might affect any aspect of the Permit.

14.7 Should transgression of any condition of this Permit not be rectified to the satisfaction of the Manager, this could result in the Permit being terminated by the Minister.

14.8 This Permit replaces all previous Permits issued in terms of section 20(1) of the Environment Conservation Act, 1989 (Act 73 of 1989) for the operation of this Site

MANAGER: WATER USE
p.p. MINISTER OF WATER AFFAIRS AND FORESTRY

DATE: 05/02/2004

ANNEXURE I

PERMISSIBLE WASTE:
WASTE WHICH MAY BE ACCEPTED ON THE SITE BUT NOT DISPOSED OF ON SITE PRIOR TO TREATMENT:

CONDITION 2.1.

1. Waste where specific control has been established in terms of the Nuclear Energy Act, 1993 (Act 131 of 1993).

2. Waste types controlled in terms of the Minerals Act, 1991 (Act 50 of 1991) and the Electricity Act, 1987 (Act 41 of 1987), unless written permission has been obtained from the Manager: Waste Discharge and Disposal

3 Waste with the following hazardous characteristics, unless the waste has been treated to remove those characteristics:

3.1.1 flammable wastes, with a closed cup flash point less than 61°C,
3.1.2. waste for which the pH of the waste or the pH of a 1:1 w/w extract with water are below pH 6 or above pH 12;
3.1.3 explosive waste, i.e. class 1 or containing a substance that can react with water, air or other waste as defined in SABS 0228: 1995;
3.1.4. compressed gasses, i.e. Class 2 as defined in SABS 0228: 1995;
3.1.5 radioactive with a specific activity of greater than 74 Bq/g, i.e. Class 7 as defined in SABS 0228: 1995, and as regulated in terms of the Nuclear Energy Act (Act 131 of 1993) and the Hazardous Substances Act (Act 15 of 1973).

4. Any healthcare risk waste unless it has been treated with a treatment technology supported by the Department to render the healthcare risk waste unrecognisable and sterile.

5 Scheduled pharmaceutical products must be disposed according to the Minimum Requirements and the requirements of Section 27 of the Regulations made in terms of the Medicines and Related Substances Control Act, 1965 (Act 101 of 1965) as amended 2003

6 Asbestos waste unless it has been packed in special plastic bags in accordance with the Asbestos Regulations No 440 in the Government Gazette Number 23108 dated 10 February 2000

ANNEXURE II

DISPOSAL OF PHARMACEUTICAL WASTE CONFISCATED BY THE SOUTH AFRICAN POLICE SERVICE

CONDITION 2.2

1. The Permit Holder shall ensure that the packets and containers shall be broken, punctured or opened to ensure that the contents will come into contact with other waste and leachate when co-disposed on the Site

2. The waste shall be disposed of into trenches of at least 4 metres deep, cut by mechanical means, and filled with leachate which has been treated with at least 100 kilograms of caustic soda. The waste shall be properly mixed into the alkaline leachate to effectively destroy the waste.

3. Trenches should be filled with other waste and compacted immediately after disposal.

4. The Permit Holder shall ensure that the handling and disposal of the waste will be done under the supervision of the South African Police Service

5. All workers coming into contact with the waste during transport and disposal shall be equipped with suitable protective clothing.

6. Detailed records shall be kept of the quantity and types of waste, date received and date disposed and reported to the Manager: Waste Discharge and Disposal after the disposal has been completed.

7. Detailed records shall be kept of the position and placement of the pharmaceutical waste within the waste body. This information shall be submitted to the Manager: Waste Discharge and Disposal within six weeks of the date of this permit amendment

ANNEXURE III

WATER QUALITY REQUIREMENTS TO WHICH UNCONTAMINATED RUNOFF WATER MUST COMPLY BEFORE DISCHARGE INTO THE ERICSON DAM:

CONDITION 5.1 3

Determinant	Value
pH	6.5-8.5
Electrical conductivity (mS/m)	< 70
Chemical oxygen demand (COD in mg/l)	<35
Manganese (Mn in mg/l)	< 0.5
Sulphate (SO_4 in mg/l)	< 300
Chloride (Cl in mg/l)	< 150
Aluminium (Al in mg/l)	< 0.3
Ammonia (mg/l N)	< 1.5
Iron (Fe in mg/l)	< 0.5
Magnesium (Mg in mg/l)	< 30
Nitrate (NO_3 as mg/l N)	< 3
Phosphate (PO_4 in mg/l)	< 0.4
Sodium (Na in mg/l)	< 100
Fluoride (F in mg/l)	< 0.7

ANNEXURE IV

WATER QUALITY VARIABLES REQUIRED FOR INVESTIGATIVE MONITORING

CONDITION 6.2.6

Alkalinity (as mg $CaCO_3$/l)	pH
Free & saline ammonia as N (NH_4-N)	Soluble orto-phosphate (PO_4 - P)
Calcium (Ca)	Potassium (K)
Chemical oxygen demand (COD)	Sodium (Na)
Chloride (Cl)	Sulphate (SO_4)
Chromium (hexavalent) (Cr^{6+})	Chromium (Total) (Cr)
Total free cyanide (CN)	Arsenic (As)
Dissolved organic carbon (DOC)	Boron (B)
E. coli (counts per 100ml)	Cadmium (Cd)
Electrical conductivity (EC)	Lead (Pb)
Fluoride (F)	Mercury (Hg)
Iron (Fe)	Total phenol
Manganese (Mn)	Poly Aromatic Hydrocarbons (PAH)
Magnesium (Mg)	Poly Chlorinated Hydrocarbons (PCH)
Nitrate (as N) (NO_3-N)	Uranium (U)
Total organic carbon (TOC)	Vanadium (V)

ANNEXURE V

INFORMATION WHICH SHALL BE SUBMITTED ON AN ANNUAL BASIS:

CONDITIONS 11.2

** = Indicate with an X. Please print legibly.*

NAME OF SITE: DATE OF REPORT: ________(y/m/d)

1. Registered owner(s) of property on which disposal site is situated:

Name		Telephone	
Postal Address		Fax	
		Postal Code	

2. Operator in control of disposal site:

Name				Telephone			
Identity number				After hours			
Educational	std 6		std 8		matric		Other (specify)
Qualifications (*)	diploma		higher diploma		degree		

3. Latest estimated lifetime of the disposal site: ________yr

4. Indicate the type of waste and approximate quantities of waste disposed of during the year:

[illegible] Type of waste [illegible]	Quantity ([illegible])	Compacted (C)	Uncompacted (U)
Non-hazardous waste [illegible]			
Household			
Garden refuse			
Building rubble			
Industrial (not hazardous) - (specify)			
TOTAL			
Hazardous wastes [illegible]			
Flammable solids			
Flammable liquids			
Oxidising agents			
Toxic wastes			
Corrosive wastes			
Hospital and infectious wastes (specify)			
TOTAL			

5. (a) Indicate the method of disposal of waste (*).

Landbuilding		Landfilling	

(b) Indicate the present dimensions of the site (metre)

Height/depth		
Length		
Breadth		

6. Indicate the applicable waste types and quantities salvaged during the year (*)

Salvaging undertaken?		Yes	No		
Type	(*)	Quantity (m³)	Type	(*)	Quantity (m³)
Paper/wood fibre			Rubber		
Plastics			Textiles		
Glass			Iron		
Copper			Aluminium		
Zinc			Lead		
Phospho-gypsum			Fly-ash		
Waste for composting			Food residues		
Flammable gases			Other		
Other			Other		
Other			Other		

7. Indicate the types, sources and approximate quantities of available covering material (*).

Type	(*)	Sources	Quantity (m³)
Soil			
Sand			
Ash			
Gravel			
Clay			
Building rubble			
Other (specify)			

I, the undersigned, declare that the information stated above is to my knowledge a true reflection of the status at the HOLFONTEIN landfill site.

Signature: ______________________

Name: ______________________

Capacity: ______________________

Place: ______________ Date ______________

ANNEXURE VI

FORM TO BE USED FOR CHEMICAL INFORMATION: CONDITIONS 6 AND 11.1

Name of Site:			
Borehole/observation point name/number:			
Sampling date:		Method:	Bailer
Sampling Time:			Pump
Time taken to purge:	5 min	Depth of Sample:	m
Date of analysis:		Laboratory:	

General chemistry

Constituent	Units	Value	Constituent	Units	Value
pH	(-log[H⁺])		Al	(mg/l)	
EC	(mS/m)		As (III)	(mg/l)	
TDS	(mg/l)		B	(mg/l)	
Ca	(mg/l)		Cd	(mg/l)	
Mg	(mg/l)		free CN	(mg/l)	
Na	(mg/l)		Cr (Total)	(mg/l)	
K	(mg/l)		Cr (VI)	(mg/l)	
Alkalinity	(mg $CaCO_3$/l)		Cu	(mg/l)	
Cl	(mg/l)		Fe	(mg/l)	
SO4	(mg/l)		Mn	(mg/l)	
NO3-N	(mg/l)		Pb	(mg/l)	
F	(mg/l)		Zn	(mg/l)	
COD	(mg/l)		Co	(mg/l)	
NH4-N	(mg/l)		Hg	(mg/l)	
Organic N	(mg/l)		Li	(mg/l)	
Phenol	(mg/l)		Ni	(mg/l)	
PO4	(mg/l)		Se	(mg/l)	
E. Coli	counts/100ml		U	(mg/l)	
DOC	mg/l		V	(mg/l)	
TOX	µg/l				
TOC	mg/l				
PAH	µg/l				
PCH	µg/l				
VCH	(mg/l)				

M.VAN

* * * Memory TX Result Report (19 May 2004 14:21) * * *

Date/Time: 19 May 2004 14:18

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Reason for error
E.1) Hang up or line fail
E.3) No answer
E.2) Busy
E.4) No facsimile connection

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DEPARTMENT: WATER AFFAIRS AND FORESTRY

T-R (012) 336 7324

PERMIT NUMBER:	16/2/7/C212/M121/P3 (Amendment to Permit Number 16/2/7/C212/P3 issued on 25 April 1996)
CLASS:	H:H
WASTE DISPOSAL SITE:	HOLFONTEIN
LOCATION:	PORTIONS 23 AND 24 OF THE FARM HOLFONTEIN 71 IR AND PORTION 8 OF THE FARM MODDERFONTEIN 236 IR, DISTRICT OF BENONI
PERMIT HOLDER:	DISPOSE TECH, A DIVISION OF ENVIROSERV WASTE MANAGEMENT (PTY) LTD
ADDRESS:	PO BOX 13420, NORTHMEAD 1511

PERMIT IN TERMS OF SECTION 20 OF THE ENVIRONMENT CONSERVATION ACT, 1989 (ACT 73 OF 1989)

By virtue of the powers delegated to me by the Minister of Water Affairs and Forestry (hereinafter referred to as "the Minister"), I, Cornelius Ruiters, in my capacity as Manager: Water Use in the Department of Water Affairs and Forestry (hereinafter referred to as "the Department"), hereby in terms of section 20(1) of the Environment Conservation Act, 1989 (Act 73 of 1989), authorise the abovementioned Permit Holder to further develop and operate the Holfontein H:H Landfill Site, subject to the conditions specified herein.