Start

case10:1609

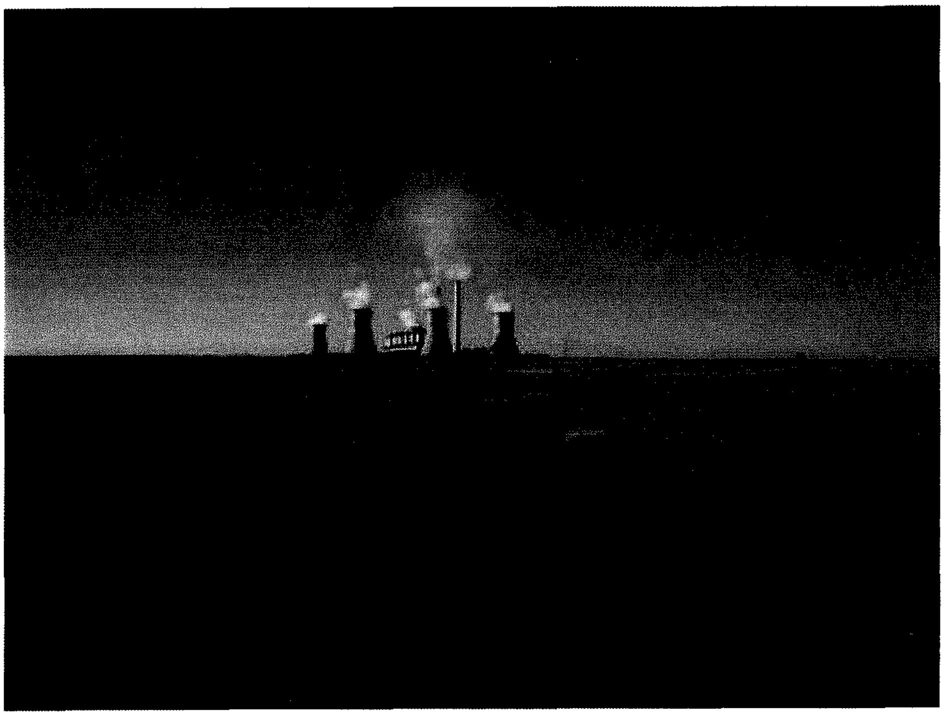
December 2010

CELEBRATING 50 YEARS in 2010

Environmental Impact Assessment for the Proposed Construction and Operation of an Evaporation Pond at New Denmark Colliery near Standerton, Mpumalanga

MDEDET REFERENCE NUMBER: 17/2/2/2GS09

For submission to authorities



Report Number. 12786-10092-9

AngloAmerican

Golder Associates

world capabilities locally

PURPOSE OF THE FINAL EIA REPORT

Anglo American proposes to construct new infrastructure at their thermal coal operation New Denmark Colliery (NDC). NDC is located in the Mpumalanga Province approximately 20 km north east of Standerton.

NDC is located adjacent to Eskom's Tutuka site and provides coal to Eskom's Tutuka Power Station for daily operations. The excess mine water that accumulates in the underground mine workings as a result of coal mining activities, is pumped to surface and treated. Treatment of the mine water takes place at a reverse osmosis (RO) water treatment plant at Tutuka Power Station, and the clean water is re-used in the plant while the "reject water" (dirty water) is currently disposed of in an underground compartment at NDC known as the 321 compartment.

In November 2009, NDC received a Directive from the Department of Water Affairs (DWA) instructing the mine to implement an alternative management option for the RO reject, by October 2011. Eskom is proposing to construct and operate a secondary RO reject concentrator plant at Tutuka Power Station. The purpose of this plant will be to reduce the volume of RO reject produced from 3 Mℓ/day to 1 Mℓ/day. The Eskom proposal to construct the additional concentrator plant forms part of a separate EIA, being conducted by Aurecon. The concentrated RO reject produced by Eskom's concentrator plant will be sent to NDC's evaporation pond proposed in this EIA.

In order to obtain Environmental Authorisation for the proposed project, Anglo is required to conduct an Environmental Impact Assessment (EIA) in terms of the National Environmental Management Act (Act 107 of 1998) (NEMA). Golder Associates Africa (Pty) Ltd, an independent company, is conducting the EIA and is compiling the Environmental Management Plan (EMP) to support the EIA application.

The first phase of the EIA, i.e. the Scoping Phase, involved the identification of issues and concerns which were then evaluated by technical specialists during the next phase of the EIA, the Impact Assessment Phase (see **Figure 1**). In accordance with the EIA Regulations published in terms of the NEMA, all Interested and Affected Parties (I&APs) must have the opportunity to comment on the findings of the EIA. The Draft EIA Report and its accompanying reports (including the Draft EMP) were available for comment from 22 November to 13 December 2010. The reports have subsequently been updated for submission to the lead authority for the EIA, the Mpumalanga Department of Economic Development, Environment and Tourism (MDEDET) for consideration of environmental authorisation, i.e. whether the proposed project may go ahead and, if authorised, under what conditions.

The full set of reports consists of:

- Final Environmental Impact Assessment Report, including the Final Environmental Management Plan (EMP);
- Specialist Reports; and
- Comment and Response Report.

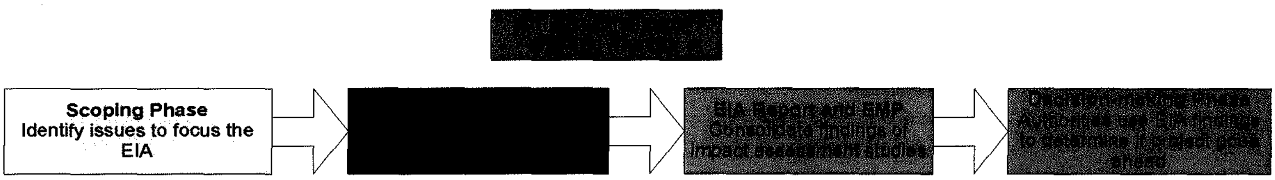


Figure 1: An Environmental Impact Assessment consists of various phases. The EIA for the proposed evaporation pond project is now in the Decision-making Phase.

ACRONYMS AND ABBREVIATIONS

ACRONYM	EXPLANATION
ASPT	Average Score per Taxa
BID	Background Information Document
CAA	Civil Aviation Authority
CBO	Community Based Organisation
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
DWA	Department of Water Affairs
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan / Environmental Management Programme
EMPR	Environmental Management Programme Report
GCL	Geosynthetic Clay Liner
HDPE	High Density Polyethylene
I&APs	Interested and Affected Parties
IHAS	Invertebrate Habitat Assessment System
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MBCP	Mpumalanga Biodiversity Conservation Plan
MDEDET	Mpumalanga Department of Economic Development, Environment and Tourism
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002)
NDC	New Denmark Colliery
NEMA	National Environmental Management Act, 1998 (Act 108 of 1998)
NEMWA	National Environmental Management: Waste Act, 2008 (Act 59 of 2008)
NGO	Non-governmental Organisation
NHRA	National Heritage Resources Act, 1999 (Act 25 of 1999)
NWA	National Water Act, 1998 (Act 36 of 1998)
RO	Reverse Osmosis
SAHRA	South African Heritage Resources Agency
SANS	South African National Standard

UNITS OF MEASUREMENT

UNIT OF MEASUREMENT	EXPLANATION
km	Kilometre (1 000 metres)
km^2	Square kilometres
ℓ	litres
ℓ/s	Litres per second
m	metres
m^3	Cubic metres
M^3	Mega cubic metres
mamsl	metres above mean sea level
Mℓ	Mega litres (million litres)
Mℓ/day	Mega litres per day
tpa	Tonnes per annum

Executive Summary

Introduction and project description

Anglo American proposes to construct new infrastructure at their thermal coal operation N Colliery (NDC). NDC is located in the Mpumalanga Province approximately 20 km north ea NDC provides coal to Eskom's Tutuka Power Station for daily operations. The excess mine accumulates in the underground mine workings as a result of coal mining activities, is pumpe and treated. Treatment of the mine water takes place at a reverse osmosis (RO) water treatm Tutuka Power Station, and the clean water is re-used in the plant, while some of the "reject wa water) is currently used on an ash dump for dust control and the rest is disposed of in an underg compartment at NDC known as the 321 compartment.

In November 2009, NDC received a Directive from the Department of Water Affairs (DWA) instruct mine to implement an alternative management option for the RO reject by October 2011. Eskom is to construct and operate a secondary RO reject concentrator plant at Tutuka Power Station. The pur this plant will be to reduce the volume of RO reject produced from 3 Mℓ/day to 1 Mℓ/day. The concentr RO reject produced by Eskom's concentrator plant will be sent to NDC's evaporation pond proposed in EIA.

The implementation of the proposed concentrator plant and evaporation pond project is a collective effort Eskom and Anglo American to meet the requirements of the Directive issued by the DWA. Key component for the development of this project include:

- Evaporation pond to dispose (evaporate) RO reject; and
- Pipeline to transmit RO reject from the concentrator plant to the evaporation pond.

The site for the proposed evaporation pond is located within the mine lease area of NDC. The surface rights of the relevant property belong to Eskom. The Tutuka runway is situated to the east of the site and the main entrance road to Tutuka Power Station is situated to the south. The evaporation pond will be constructed in phases, i.e. four cells, namely 2A South, 2A North, 2B South and 2B North. Construction of the first cell will start soon after authorisations from MDEDET and DMR have been received (expected to be in March 2011). The first cell is expected to be commissioned in October 2011. The lifespan of the facility will be 10 years. Thereafter, the pond will be capped, rehabilitated and closed.

Overview of the existing environment, impacts and mitigation measures

Geology

Baseline: The geological units within the study area belong to the Ecca Group of the Karoo Supergroup. Shale, sandstone and siltstone units typically define this Group with interbedded coal units of variable thicknesses at depths deeper than 180 m. The south-western portion of the site is underlain by a dolerite sill at depths less than 1 m below surface. The sill is several meters thick and is underlain by a succession of sandstone and siltstone units. Further to the north-east, the dolerite sill occurs at depths deeper than 30 m with overlying shale and siltstone units. The combined thickness of the dolerite varies from ±10 m to over 50 m.

Impact assessment and mitigation: Blasting in the excavation of the evaporation pond will displace / fracture sections of hard rock. This will result in high impacts on the underlying geology; however, by using appropriate blasting techniques the impact can be reduced to moderate.

Topography

Baseline: The study area is fairly flat without any areas with slopes greater than 9 %. The area surrounding the Tutuka Power Station is located at some 1 640 metres above mean sea level with the slope very gradually falling to the south towards the Grootdraai Dam. The power station precinct and ash dump are located at the highest point in the immediate surrounds.

t assessment and mitigation: The stockpiling, compaction of *in situ* material, excavation, mixing, and cement of excavated material will affect surface topography and drainage. The construction of the storm management infrastructure, especially berms, will further contribute to the impact on surface graphy and drainage. These impacts will occur in the medium term, affect only the site, and be of a low ificance.

ils, land capability and land use

seline: The soils at the proposed footprint of the pond are very homogenous and consist of well-drained, ongly structured, black, clay soils of the Arcadia form. These soils are on average 500-600 mm deep and e underlain by yellowish grey weathered rock. The high clay content, firm consistence and strong structure f black clay soils cause difficulties with cultivation and restrict suitable crop selection and are therefore nostly utilized for grazing purposes. Due to the fairly shallow effective soil depth, the land capability was classified as grazing potential. Soils along the proposed pipeline are similar to those on the footprint of the proposed pond.

Impact assessment and mitigation: The most significant impacts on soils will occur during the Construction Phase as a result of topsoil stripping which will cause loss of the original spatial distribution of soil types and natural soil horizon, sequences; loss of some original soil fertility; loss of original topography and drainage pattern; loss of original soil depth and soil volume; and loss of the natural functioning of the soil (habitat for fauna and flora). These impacts are considered to be high, but can be mitigated to moderate, by applying measures such as preventing soil mixing, appropriate stockpiling of topsoil, and fertilizer application during the rehabilitation process. About 39.9 ha of wilderness/grazing land capability will be impacted upon during construction. No commercial or non-commercial farming, housing, transporting or industrial use will be possible at the site. This impact is also considered to be high, but could be mitigated to low, should the mitigation measures for impacts on soils be implemented.

Terrestrial fauna and flora

Baseline: The site is situated in the Grassland biome. The natural vegetation cover of most of the study area has been replaced by either cultivated maize fields, some areas are used for livestock grazing purposes as is primarily the case with the site itself- and other have been degraded by industrial and mining-related activities. Small areas of somewhat disturbed, natural vegetation occur along watercourses or fringes of other activities. Localised clumps of alien invader trees are prominent elements in the landscape. No Red Data species were found during the terrestrial fauna and flora site survey. Based on physiognomy, moisture regime, rockiness, slope and soil properties, two vegetation communities were recognised, namely *Themeda* secondary grassland and artificial wetland communities. According to the Mpumalanga Biodiversity Conservation Plan the project area falls within the "Least Concern" and "No Natural Habitat Remaining" areas.

Impact assessment and mitigation: Moderate impacts of faunal habitat and flora will result from vegetation clearing and stripping of topsoil during construction. Noise of machinery and human activities will drive fauna away from the area temporarily. Existing alien species within the site will be removed during construction, which will be a positive impact. Should the pipelines and pond leak during the Operational Phase, impacts on fauna and flora may occur. This is considered an impact of high significance, but can be mitigated to moderate, should the liner system and leakage detection system of the pond be maintained, and regular pipeline maintenance (using, e.g. scour valves) be ensured.

Wetlands and aquatic ecology

Baseline: Eight wetland units were identified within the larger study area. Of all the wetland types, the floodplain wetlands are the most prominent. These are largely fed by channelled and unchanneled valley bottom wetlands and hillslope seeps. Habitat degradation due to agricultural activities (cropping and grazing) is impacting on the wetlands and river systems in the project area. Biodiversity is found to be moderate with mostly hardy/common grass and plant species and common bird species present. Natural ecosystem and human services supplied by the wetlands are generally moderate to low. Water quality results indicated eutrophication within some of the water systems. The availability of habitats for aquatic macroinvertebrates was found to be generally poor within the study area.

Impact assessment and mitigation: The most significant impacts will occur during construction as a result of smothering of aquatic and wetland biota due to increased sedimentation and dust generation, and habitat loss of an artificial wetland. The artificial wetland has little to no ecosystem function.

Surface water

Baseline: The proposed site for the evaporation pond is located in Drainage Region C, the Vaal River catchment. At a local scale the site is situated on the catchment divide between two sub-catchments of quaternary catchment C11K. The two sub-catchments drain into the Leeuspruit, which drains into the Grootdraai Dam, located on the Vaal River. An unnamed non-perennial tributary of the Leeuspruit is located to the north of the proposed evaporation pond.

Impact assessment and mitigation: Three potential negative surface water impacts have been identified, namely seepage through the liner system, streamflow reduction due to the reduction in catchment area, and overspill. These impacts are, however, all considered to be of low significance. Over and above the maintenance of the liner system and allowance for freeboard in the pond design, no additional mitigation measures are recommended. The pond site is located outside the 1 in 50- and 1 in 100 year floodlines of the nearby non-perennial tributary of the Leeuspruit.

Groundwater

Baseline: Two aquifers have been identified within the study area: a thin shallow aquifer of relatively high permeability and storage is located at approximately 15 m below the surface; and a considerably thick deep aquifer of low permeability is located at approximately 60 m below the surface. The average hydraulic conductivity for the shallow aquifer was established to be 0.006 m/day. Groundwater flows in a south to south-westerly direction in the shallow aquifer and is presumed to flow in the same direction in the deep aquifer, towards the Leeuspruit and Vaal Rivers which constitute regional sinks of surface and groundwater. The deep aquifer is recharged from the shallow aquifer through permeable fracture systems linking the two aquifer systems. Groundwater and surface water from the bodies within and close to the proposed evaporation pond site is of good quality. All the measured parameters recorded values that fall within the acceptable Classes I and II of the South African National Standards (SANS 241) specifications of 2005 for drinking water.

Impact assessment and mitigation: There is a potential for contamination of the groundwater due to leakage of RO reject from the pond and pipelines during the operational stage. Any groundwater contamination from RO reject/proposed pond water will show as elevated levels of sodium, chloride and sulphate concentration in accordance with the chemical signature of the RO reject. Considering that the pond will be lined and pipeline integrity will be regularly checked and maintained, this impact is highly unlikely. Moreover, in the event of leakage, the pollutants will not migrate fast within the shallow aquifer because of the low hydraulic conductivity of the aquifer (± 0.006 m/day). Therefore, this impact is considered of low significance and with a very low probability of occurrence.

Air quality

Baseline: Potentially, local air pollution may arise as a result of particulates entering the atmosphere. These particulates arise as dust from dumps and from conveyors at the mine– particularly at transfer points. Monitoring of the NDC area and surroundings indicated that the impacts of settable dust can be described as minimal, since dust will settle gravimetrically within 500 m of the dust source. Currently, all mining activities at NDC occur underground, with the result that these activities have no impact on surface air quality in the study area. However, the associated surface infrastructure (transfer points and conveyors) may contribute to dust generation.

Impact assessment and mitigation: Vehicle emissions and dust generated by vehicles traversing the construction site and excavation activities will result in low impacts on air quality. The excavation of the pipeline trench and the pond will contribute to dust and PM_{10}. Recommended mitigation measures include implementation of dust suppression measures and ensuring that vehicles are serviced regularly.

Environmental noise

Baseline: Existing noise sources in the area include Tutuka Power Station operations, vehicular traffic on the access road to Tutuka Power Station, occasional overflying aircraft, livestock and agricultural activity on surrounding land, and local community and domestic noise. Background noise levels are highly stable around 33 – 35 dB(A).

Impact assessment and mitigation: The most significant impacts on the noise environment will occur during construction as a result of blasting. The noise impact for blasting operations is considered to be moderate. However, minimisation of the number of times when blasting occurs, prior notification of blasting activities at predetermined times on stated days, careful design of the blasting regime to reduce the levels of both airborne blast noise and ground-borne vibration will contribute significantly to the minimisation of the overall impact of blasting on the surrounding community and reduce the impact to low. Impacts on noise levels as a result of movement of heavy machinery and vehicle traffic will be moderate, short-term, and will take place on a local scale. These impacts can, however, be mitigated to a low level.

Visual aspects

Baseline: The visual quality of the study area is of a low to medium value. Although the majority of the study area has a predominantly rural character, it is dominated by the Tutuka Power Station and has been visually altered by a number of other linear and other infrastructure features. Furthermore, it is not characterised by features that are visually exciting, such as prominent topography or attractive vegetation cover.

Impact assessment and mitigation: Due to the generally low levels of development in the area it is unlikely that a large number of people will be affected by the visual aspects of the proposed project. Only persons travelling along the smaller roads passing closer to the site, many of whom would be travelling to the power station, will be visually exposed to the new infrastructure to any significant degree. The level of visibility of the project components from within the study area is expected to be medium. Due to the close proximity of the Tutuka Power Station to the proposed site for the new evaporation pond it is not anticipated that the evaporation ponds will cause significant visual intrusion. The overall visual impact of the proposed evaporation pond and supporting infrastructure is therefore expected to be low. It is, however, recommended that the side walls of the evaporation pond mimic the surrounding landscape as far as possible and, if possible, vegetative screens be established along the road located south of and adjacent to evaporation pond.

Archaeological or cultural historical sites

Baseline: The project area, including the greater Standerton region, has been poorly surveyed for heritage sites in the past. The South African Heritage Resources Agency's national register of heritage sites does not list any heritage sites for the region. The majority of archaeological research has taken place to the immediate east and north of the study area – an area which is exceptionally rich in Stone Age sites, Iron Age sites, and historical features. Nevertheless, it is known from historical literature that San hunter-gatherers as well as Nguni and Sotho-speaking farmers occupied the area in the recent past. The area was also heavily affected during the Anglo-Boer War of 1899-1901 and it is to be expected that many old farmsteads and associated graveyards may occur on farms in the region.

Impact assessment and mitigation: No heritage or archaeological features were identified within the footprint of the proposed evaporation pond site and pipeline route. The results of the ground survey are also supported by the desktop survey that indicated that there are no heritage sites associated with the footprint.

Socio-economy

Baseline: The project area is located in the Lekwa Local Municipality, in Gert Sibande District Municipality, Mpumulanga Province. The Lekwa Local Municipality has a population of approximately 112,000 people and is predominantly inhabited by Nguni speaking people, namely: Zulu, Swati, Ndebele, Sotho and Xhosa and other race groups. The annual growth rate is 2.8% and the population density 22.5%; lower than the district municipal area. The development trend shows increasing urbanization in the municipality, with over 65% of the population living in urban areas, compared to 35% in rural areas. The occupation structure of the employed persons shows that the majority of employed people are concentrated in elementary occupations (39%) followed by agriculture (28%).

Impact assessment and mitigation: Approximately 200 additional employment opportunities will be created for skilled (~70%) and unskilled (~30%) workers during the Construction Phase. This will be a positive socio-economic impact. The evaporation pond and pipeline fall within the NDC mine boundary on Eskom-owned land. No private landowners would be directly impacted by the proposed project. There are therefore no land access issues and no relocation will be required. Environmentally intrusive impacts such as visual, dust, noise and vibration may be experienced by local community members or farmers. Leaks from the pond and/or pipeline may impact on the health and safety of the local community members or farmers. With appropriate mitigation measures, these impacts can, however, be limited to low impacts. It is recommended that signage be erected at the pond site and at points along the pipelines to illustrate the dangers of the contents of the pond and the pipelines. This in turn will reduce the risks of theft or vandalism.

Conclusion

The negative impacts identified during the impact assessment can all be managed and mitigated to low to moderate levels of impact. From an environmental perspective, there is therefore no reason why the proposed NDC Evaporation Project should not be implemented, provided that the mitigation measures and monitoring programmes recommended within this report are implemented diligently.

The implementation of the proposed project will:

- Enable NDC to comply with the directive issued by the Department of Water Affairs;
- Prevent a water management issue occurring at the site;
- Allow mining operations to continue at NDC; and
- Ensure continued coal and water supply to Eskom's Tutuka Power Station.

Taking the above into consideration, the proposed project can be **supported**.

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1.0 INTRODUCTION

1.1 Project Background

Anglo American proposes to construct new infrastructure at their thermal coal operation, New Denmark Colliery (NDC). The site is located in the Mpumalanga Province approximately 20 km north east of Standerton (Figure 2-1). NDC is located adjacent to Eskom's Tutuka site and provides coal to Eskom's Tutuka Power Station for daily operations. The excess mine water that accumulates in the underground mine workings as a result of coal mining activities, is pumped to the surface and treated. Treatment of the mine water takes place at a reverse osmosis (RO) water treatment plant at Tutuka Power Station, and the clean water is re-used in the plant, while some of the "reject water" (dirty water) is currently used on an ash dump for dust control and the rest is disposed of in an underground compartment at NDC known as the 321 compartment.(Figure 1-1).

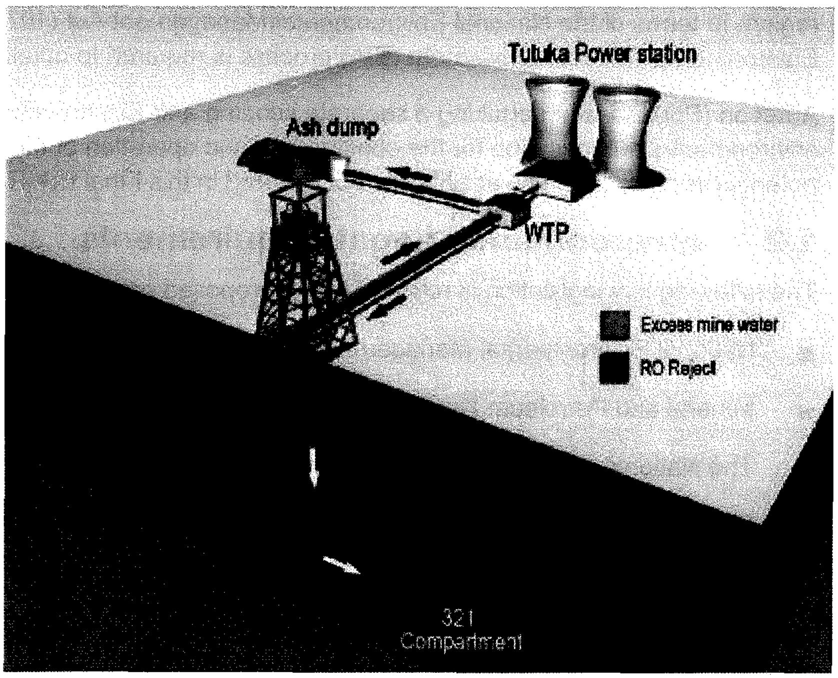


Figure 1-1: Currently in the process, RO reject is disposed into a mined out void ("321 compartment") at New Denmark Colliery

In November 2009, NDC received a Directive from the Department of Water Affairs (DWA) instructing the mine to implement an alternative management option for the RO reject, by October 2011. Eskom is proposing to construct and operate a secondary RO reject concentrator plant at Tutuka Power Station. The purpose of this plant will be to reduce the volume of RO reject produced from 3 Mℓ/day to 1 Mℓ/day. The Eskom proposal to construct the additional concentrator plant forms part of a separate EIA, being conducted by Aurecon.

The concentrated RO reject produced by Eskom's concentrator plant will be sent to NDC's evaporation pond proposed in this EIA (see Figure 1-2).

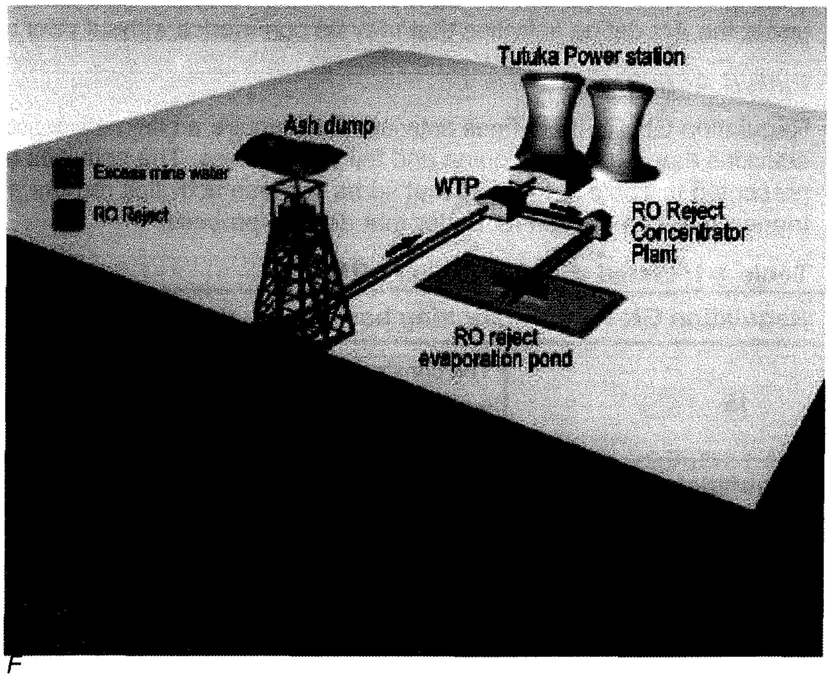


Figure 1-2: The proposed management of RO reject using the evaporation pond

The implementation of the proposed concentrator plant and evaporation pond project is a collective effort by Eskom and Anglo American to meet the requirements of the Directive issued by the DWA.

The construction of such infrastructure has the potential to affect the environmental and social setting in the region. In terms of the National Environmental Management Act (107 of 1998) (NEMA), a scoping and Environmental Impact Assessment (EIA) process is required to obtain authorisation for the proposed activity.

Aurecon (Pty) Ltd is undertaking a separate scoping and EIA process in support of an application for environmental authorisation for the construction and operation of the secondary RO plant at Tutuka. The potential impacts from this activity are not covered in this Final EIA Report

1.2 Environmental Legal Requirements

The following key legislation is relevant to the proposed project:

- National Environmental Management Act, 1998 (Act 107 of 1998);
- Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002);
- The National Water Act, 1998 (Act 36 of 1998);
- The National Heritage Resources Act, 1999 (Act 25 of 1999); and
- National Environmental Management: Waste Act, 2008 (Act 59 of 2008).

In order to obtain authorisations from the relevant authorities, a number of regulatory processes need to be followed. An integrated approach to conducting these processes is currently being undertaken. The following regulatory processes are being undertaken in parallel:

1.2.1 National Environmental Management Act, 1998

The NEMA provides environmental governance by providing principles for decision making on matters that affect the environment and defines the principles that apply to the organs of state involved in that decision making. The Act sets out the legal and procedural requirements for environmental compliance. Regulations under the Act define activities that may be commence without prior approval from the competent authority.

Listed Activities[1]

Regulation GN R.386 defines activities that require a basic assessment while Regulation GN R.387 defines activities that require a scoping and full EIA process. The activities triggered by the proposed project are presented in Table 1-1. Given that some of these activities require a scoping and EIA process, all activities triggered will be applied for under that defined process.

Table 1-1: Listed activities under NEMA

Regulation GN R.386 – requiring basic assessment	
15	The construction of a road that is more than 4 metres wide or that has a reserve wider than 6 metres, excluding roads that fall within the ambit of another listed activity or which are access roads of less than 30 metres long.
Regulation GN R.387 – requiring scoping and EIA	
1(e)	Any process or activity that requires a permit or license in terms of legislation governing the generation or release of emissions, pollution, effluent or waste and which is not identified in Government Notice No. R, 386 of 2006.

[1] Note: Since the EIA application was submitted prior to August 2010, the EIA is being conducted in terms of the previous EIA Regulations GN R385, and not the newly promulgated EIA Regulations GN R543

Regulation GN R.387 – requiring scoping and EIA

1(j)	The bulk transportation of dangerous goods using pipelines, funiculars or conveyors with a throughput capacity of 50 tons or 50 cubic metres or more per day.
2	Any development activity, including associated structures and infrastructure, where the total area of the developed area is, or is intended to be, 20 hectares or more.
6	The construction of a dam where the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, is 5 metres or higher or where the high-water mark of the dam covers an area of 10 hectares or more.

Lead Authority

The Mpumalanga Department of Economic Development, Environment and Tourism (MDEDET) is the lead authority in terms of the EIA. However, the MDEDET will consult with the following government departments:

- Department of Water Affairs;
- Department of Mineral Resources; and
- Lekwa Local Municipality.

1.2.2 Mineral and Petroleum Resources Development Act, 2002

NDC has an approved EMP that includes management of the mine water from the site by pumping it to the Eskom site, treatment at that site and disposal of the remaining reject water in the 321 compartment. The proposed project will result in a change to the brine management on site and as such an amendment to the EMP will be required.

1.2.3 National Water Act, 1998 (Act 36 of 1998)

New Denmark Colliery has a draft integrated water use licence in place. The proposed evaporation project constitutes a water use in terms of Section 21(g) of the National Water Act, 1998 (Act 36 of 1998) (NWA), namely 21(g): *"disposing of waste in a manner which may detrimentally impact on a water resource"* A new water use licence application will therefore be lodged with the Department of Water Affairs (DWA) for approval.

According to Chapter 12 of the NWA, a dam with a safety risk is defined as "*any dam which can contain, store or dam more than 50 000 cubic metres of water, whether that water contains any substance or not, and which has a wall of a vertical height of more than five metres, measured as the vertical difference between the lowest downstream ground elevation on the outside of the dam wall and the non-overspill crest level or the general top level of the dam wall*".

Since the evaporation pond will have a capacity which exceeds 50 000 cubic metres of water, and a wall height of more than five metres, the pond is considered a dam with a safety risk.

All dams with a safety risk must be registered. The registration process consists of the following steps:

- Submission of a Dam Registration Application to the DWA;
- Classification of the evaporation pond as a Category 1, 2 or 3 dam;
- Conducting a risk assessment; and
- Registration of the evaporation pond as a dam with a safety risk, with all supporting technical and engineering documentation.

Mr Helmut Keller, a professional Engineer, has been appointed by the DWA as the dam safety officer. The proposed evaporation pond has been classified as a Category 2 dam.

1.2.4 National Heritage Resources Act, 1999 (Act 25 of 1999)

As stipulated in Section 27(18) of the National Heritage Resources Act, 1999 (Act 25 of 1999), no person may destroy, damage, deface, excavate, alter, remove from its original position, subdivide or change the planning status of any heritage site without a permit. A Phase 1 Heritage Impact Assessment has been conducted as part of the EIA. The findings of the assessment indicate that no such heritage sites/resources stand to be affected by the proposed project. It is therefore not necessary to acquire a permit from the South African Heritage Resources Agency (SAHRA).

1.2.5 National Environmental Management: Waste Act, 2008 (Act 59 of 2008)

The National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEMWA) came into effect on 01 July 2009. A list of waste management activities was published in GN 718 of 03 July 2009 ("GN 718") identifying those waste management activities that require a Waste Management Licence in terms of the Act.

Since the proposed evaporation pond will be established on mining property which either holds mining or exploration rights, the MPRDA will have relevance and as a consequence, the NEMWA is not applicable. The reason for this is based on the interpretive rule which is known as *specialardus generalis non deragans* and which implies that Section 4 of NEMA takes precedence over the definition of waste in Section 1 of the NEMWA, and as a consequence excludes residue deposits, in this case, the RO reject.

1.2.6 Other

Servitude Registration

Registration of the servitude for the RO reject pipeline will be conducted.

Way-leave Agreement

The surface rights of Portions 7, 10, 19 of the farm Pretorius Vley 374 IS belong to Eskom. A way-leave agreement between Anglo and Eskom has been signed, thereby allowing Anglo the right to use the land for the construction and operation of the pond.

Aviation

The proposed evaporation pond site is bordered by the Tutuka Runway (Figure 1-3) and is therefore is regulated by the Civil Aviation Authority (CAA). CAA requirements include a 5 % obstruction plane from the centre of the runway as well as warning lights to be placed on top of the pond walls. These aspects need to be taken into consideration in the design of the pond.

Figure 1-3: The Tutuka runway situated along the eastern border of the proposed pond site

By-laws

The proposed evaporation pond is located within the Lekwa Local Municipality of the Gert Sibande District Municipality. The Council of the Gert Sibande District Municipality has in terms of Section 156 of the Constitution, 1996 (Act 108 of1996), read in conjunction with Sections 11 and 98 of the Local Government: Municipal Systems Act, 2000 (Act 32 of 2000), made a number of by-laws. The following by-laws in terms of the municipality are applicable to the proposed project and will be adhered to during construction and operation:

- Prohibition on causing public health hazards;
- Duty to report public health and environmental hazards;
- Prohibition on causing public health and nuisances;
- Prohibition on causing environmental health hazards;
- Prohibition against obstruction of sanitary service;
- Toilets for workers at building sites;
- Disposal of sewage, sewage effluent and wastewater without causing a public health nuisance and/or hazard;
- Pollution of sources of water supply;
- Dangerous wells, boreholes and excavations;
- Provision of adequate water supply;
- Use of water from sources other than the municipal supply; and
- Storm water runoff from premises which may impact on public or environmental health.

Copies of these by-laws will be kept on site for reference purposes.

1.3 Details of Environmental Assessment Practitioner (EAP)

The applicant, Anglo American (Anglo), appointed, Golder Associates Africa (Pty) Ltd (Golder), an independent environmental consultant, to undertake the EIA for the proposed evaporation pond for New Denmark Colliery (NDC).

Golder is experienced in environmental management and assessment and is familiar with the EIA requirements of the NEMA. The company is well known for its integrity and independence as well as for its skill in assisting I&APs to participate in the EIA process.

Golder has no vested interest in the proposed project or applicant company.

1.4 Structure of this report

This Final Environmental Impact Assessment Report is structured as follows:

- Chapter 1 is the introduction and gives an overview of the proposed project, the proponent, and the Integrated Regulatory Process;
- Chapter 2 describes the project phases, proposed evaporation pond design and pipeline system;
- Chapter 3 describes the study area. It presents a summary of knowledge about the existing physical, biological, social and cultural environment upon which the proposed project may impact;
- Chapter 4 describes the need for and desirability of the proposed project;

- Chapter 5 provides a description of alternatives that were examined prior to and during the EIA;
- Chapter 6 provides a summarised description of the EIA and public participation processes;
- Chapter 7 describes the potential impacts of and mitigation for the proposed project;
- Chapter 8 provides the Environmental Management Plan for the project;
- Chapter 9 contains the Environmental Impact Statement;
- Chapter 10 contains the EAP's opinion and recommended conditions; and
- Chapter 11 provides a list of references used throughout the report.

2.0 PROJECT DESCRIPTION

2.1 Key Project Components

Key components for the development of this project are listed below and discussed in the following sections.

- Evaporation pond to dispose (evaporate) RO reject; and
- Pipeline to transmit RO reject from concentrator plant to evaporation pond.

2.1.1 Reject water quality

The reject water quality following the secondary desalination process has been predicted based on the known water quality from the existing RO plant by using an RO simulation model for the secondary treatment stage (Table 2-1). The reject water is predicted to be mildly alkaline with highly elevated concentrations of some major ions. The predominant species are sulphate, sodium and chloride. The concentrations of these species are such that the water will not be suitable for re-use and could not be discharged to the environment.

Table 2-1: Predicted reject water quality

Parameter	Concentration (mg/ℓ unless otherwise stated)
pH ($-\log_{10}[H^+]$)	7.7
Total dissolved solids	65 000
Alkalinity (as $CaCO_3$)	61
Calcium	150
Chloride	9 900
Magnesium	600
Nitrate (as nitrogen)	47
Potassium	820
Silica (as SiO_2)	105
Sodium	20 000
Sulphate	33 000
Barium	0.2

2.1.2 Evaporation pond

2.1.2.1 Site

The site for the proposed evaporation pond is located within the mine lease area of New Denmark Colliery in the Mpumalanga Province, approximately 20 km north east of Standerton. The surface rights of the relevant property belong to Eskom. The Tutuka runway is situated to the east of the site and the main entrance road to Tutuka Power Station is situated to the south. See Figure 2-1.

The proposed pond site is located ± 100 m to the east of the current underground workings and is not underlain by mine workings. An unnamed non-perennial tributary of the Leeuspruit is located to the north of the site. A floodline determination was conducted for the stream (APPENDIX A). The analysis showed that the proposed evaporation pond will be located outside of the 1:50 and the 1:100 year floodlines.

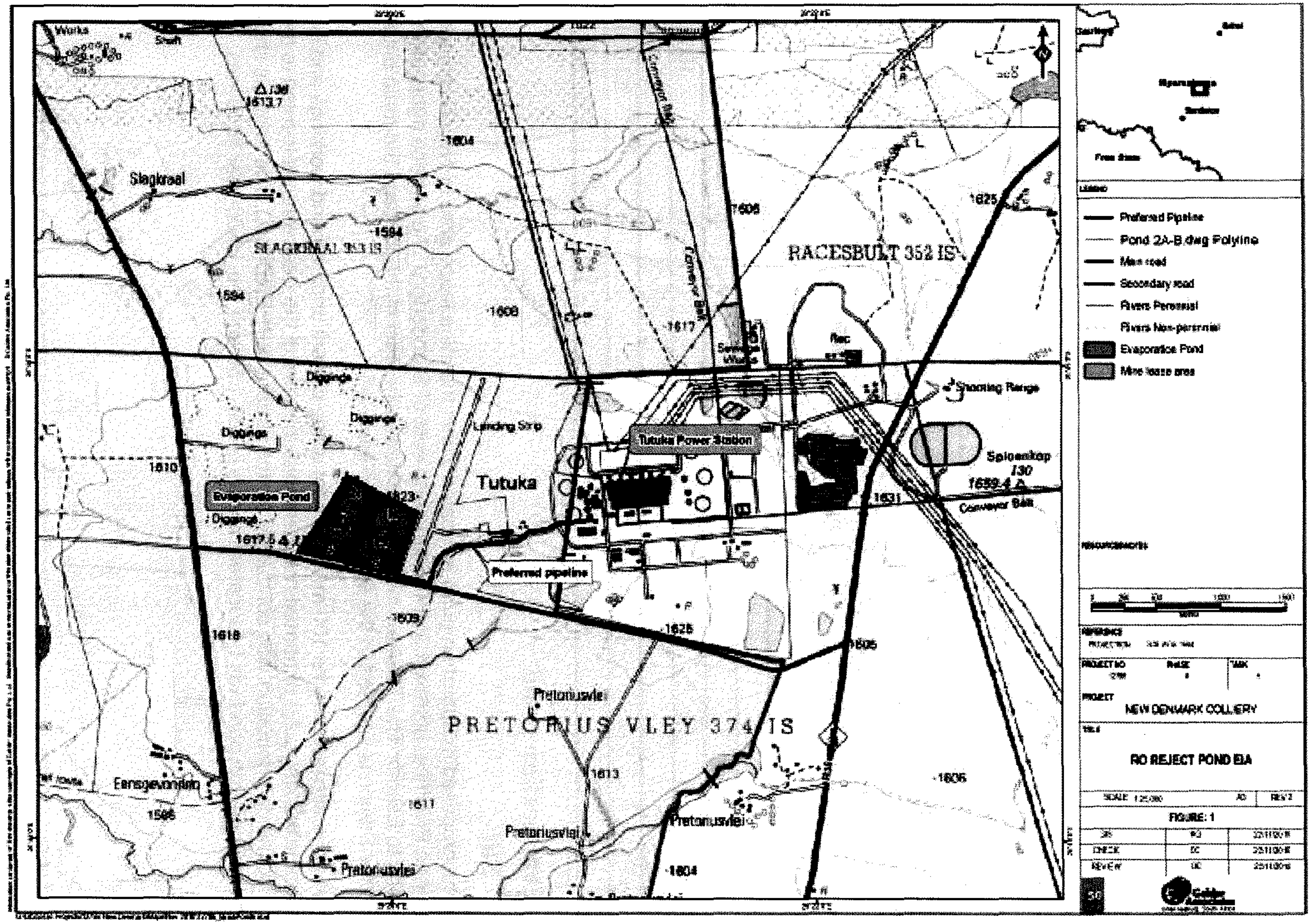


Figure 2-1: Evaporation pond site and location

2.1.2.2 Design of the facility

For detailed design drawings of the evaporation pond, refer to APPENDIX D.

Hydrological considerations

Rainfall data was obtained for the period 1932 to 2000 from measuring station 0441261 W (New Denmark Colliery). This data was supplemented with rainfall data recorded by Eskom from 1998 to 2010 at the ash disposal site at Tutuka Power Station.

During the period 1998 to 2010, the average monthly rainfall increased from 55.0 mm to 61.6 mm (see Figure 2-2). The cooling towers at Tutuka Power Station cause a higher moisture content in the air. Since there is the possibility of higher rainfall within the effective range of Tutuka Power Station, the higher value of 61.6 mm was adopted for the design of the pond. A design Mean Annual Precipitation (MAP) of 61.6 x 12 = 739.6 mm was therefore used for the design of the evaporation pond.

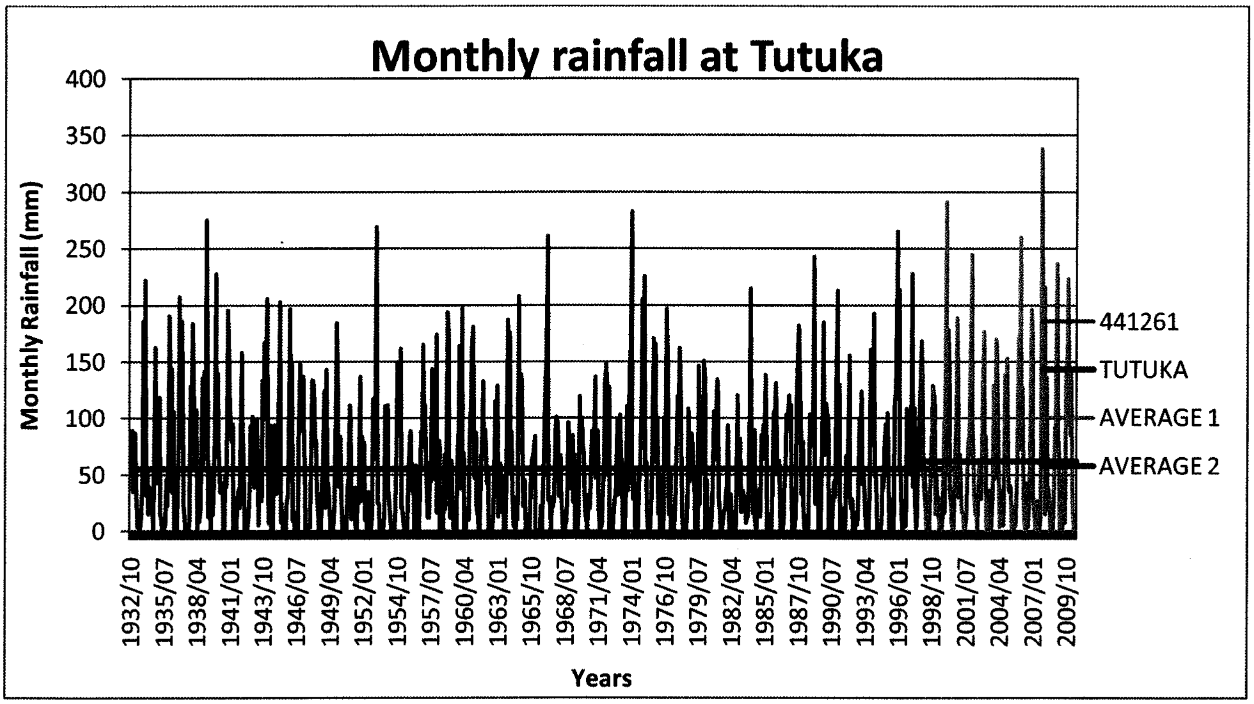


Figure 2-2: Monthly rainfall at Tutuka Power Station and weather station 0441261 W (New Denmark Colliery)

The depth duration data for station 0441523 W (New Denmark Colliery) is shown in Table below.

Table 2-2: Depth duration data for station 0441523 W (New Denmark Colliery)

m/h/d	2	5	10	20	50	100	200
1d	54.4	73	86.3	99.9.	118.7	133.8	149.7
2d	69.6	92.3	108.1	123.9	145.3	162.1	179.5
3d	77.6	102.2	119.3	136.2	159	176.8	195.1
4d	83	108.8	126.6	144.3	168	186.4	205.3
5d	87.5	114.1	132.3	150.2	174.1	192.4	211.1
6d	92.3	119.8	138.4	156.6	180.7	199.1	217.9
7d	96.9	125.4	144.6	163.1	187.4	205.7	224.1

The 1 day 1:50 year rainfall occurrence depth is 118.7 mm (Table 2-2).

Tutuka Power Station is located within evaporation zone 12A with a mean average evaporation (MAE) of 1 650 mm, based on the S-pan measuring system. Due to the increased monthly rainfall from 1998 to 2010, zone 13B with an MAE of 1 520 mm, was selected as being more representative.

The monthly evaporation varies from the average of 126.7 mm over the year. The monthly adjustment factor is depicted in Figure 2-3.

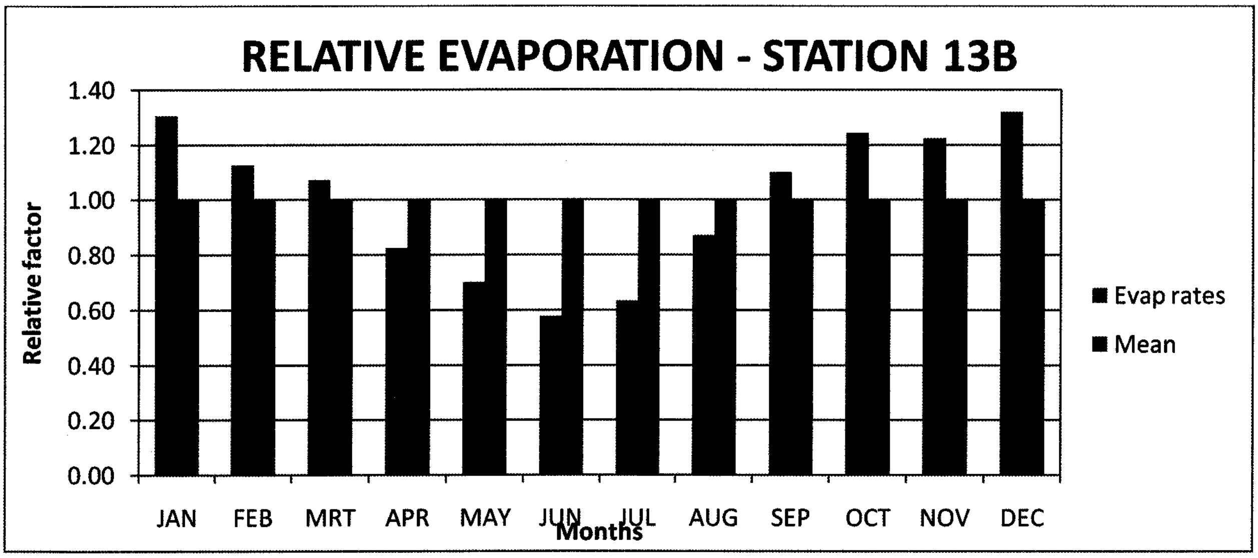


Figure 2-3: Relative evaporation for evaporation zone 13B

A salinity factor of 0.7, as proposed by Mickley (2001) is used to compensate for the lower evaporation due to the salinity concentration in the water, whilst an S-pan evaporation factor of 0.8 is adopted.

Based on the above adjustment factors, the assumed evaporation rate from the pond surface is:

1 520 mm x 0.7 x 0.8 = 851 mm per annum, compared to the MAP of 739.6 mm.

Lifespan of facility

The lifespan of the facility will be 10 years.

Sizing of facility

Based on the MAP of 740 mm and the comparable MAE of 851 mm, the net effect of rainfall is small compared to the RO reject inflow of 900 m^3/day. A first order analysis of the required volume was therefore determined as:

900 m^3/day x 365 days x 10 years = 3 285 000 m^3

Footprint of facility

Based on an assumed RO reject storage depth of 13 m, with 1:2.5 sloped wall sides, the required pond basin footprint would be 22 ha. Taking construction time constraints (due to the DWA directive date) as well as the natural ground slope over the area and findings of the geotechnical investigation (APPENDIX B) into consideration, it was decided to divide the pond into four equally sized compartments, each with a volume of approximately 820 000 m^3 and a basin footprint of 55 000 m^2, with a total a catchment area of 90 000 m^2. Each pond will have a lifespan of 2.5 years, giving a total of 10 years.

Adding provision for a ring road system requires a total site footprint measuring approximately 50 ha.

Civil aviation restrictions

The site is bordered by the Tutuka Runway and is therefore is regulated by the Civil Aviation Authority (CAA). CAA requirements include a 5 % obstruction plane from the centre of the runway as well as warning lights to be placed on top of the pond walls (Figure 2-4).

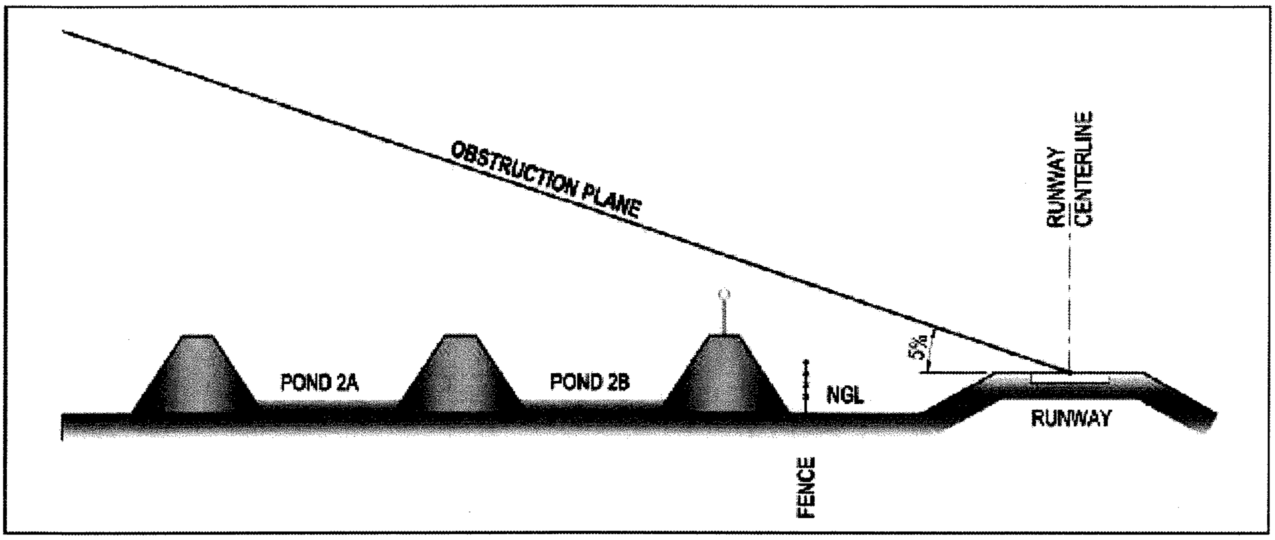


Figure 2-4: Civil Aviation wall height restrictions and lighting requirements

Assuming 2 m high light posts on top of the walls, the maximum height of the ponds closest to the runway is limited to 1 627.2 metres above mean sea level.

Phasing

In order to reduce the construction period (and hence meet the DWA directive date), the RO reject pond will be divided into four cells, namely 2A South, 2A North, 2B South and 2B North. Pond 2A South will be constructed first, followed by pond 2A North. Ponds 2B South and 2B North are only scheduled for completion five years after the commissioning of pond 2A South.

Catchment areas

The final catchment areas and RO reject levels over time for each of the four cells are given in Figure 2-5 and Figure 2-6 respectively.

NDC RO REJECT POND STAGE CURVE

AVERAGE ANNUAL RAINFALL		740	mm	
AVERAGE NETT ANNUAL EVAPORATION		851	mm	
CATCHMENT AREA m2				
2AS	86148			
2AN	85258			
2BS	86629			
2BN	93130			
	351165			
TOP OF WALL LEVEL				1626.5
MAXIMUM LVL OF RO REJECT PER POND		0.9		1625.6
MAXIMUM LVL OF RO LAST REJECT PER POND		2.3		1624.2
RO REJECT VOL PER DAY		900	m3	
RO REJECT VOL PER MONTH		27375	m3	

Figure 2-5: Final catchment areas for each of the four cells

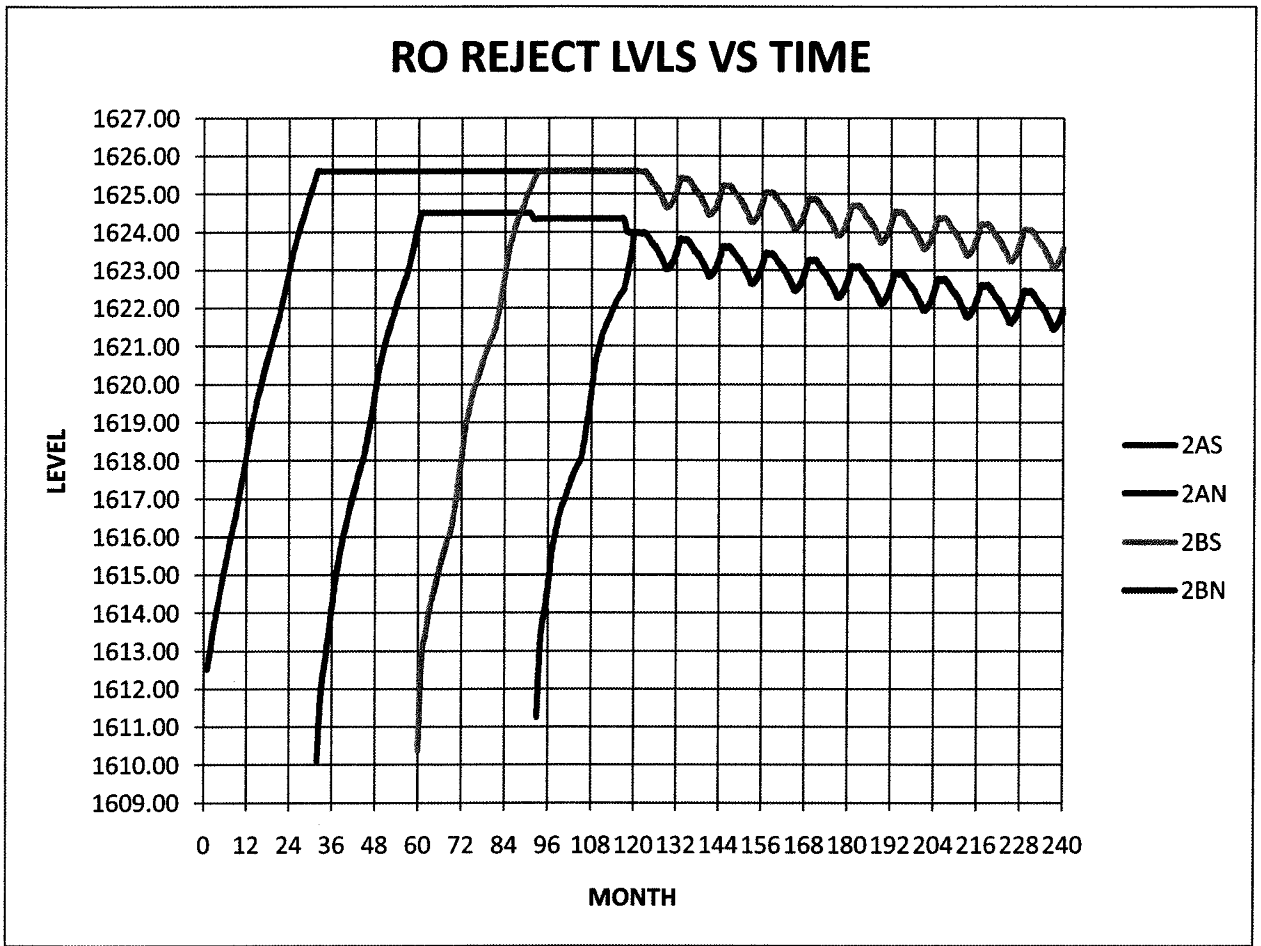


Figure 2-6: RO reject levels over time

Freeboard

Paragraph 6 of Regulation GN 704, states that:

6. *Capacity requirements of clean and dirty water systems*

Every person in control of a mine or activity must-

(d) *design, construct, maintain and operate any dirty water system at the mine or activity so that it is not likely to spill into any clean water system more than once in 50 years; and*

(e) *design, construct, maintain and operate any dam or tailings dam that forms part of a dirty water system to have a minimum freeboard of 0.8 metres above full supply level, unless otherwise specified in terms of Chapter 12 of the Act.*

(f) *design, construct and maintain all water systems in such a manner as to guarantee the serviceability of such conveyances for flows up to and including those arising as a result of the maximum flood with an average period of recurrence of once in 50 years*

The 0.8 m freeboard is assumed to allow for wave action only and therefore additional allowance is made for rainfall.

Based on a catchment area of 4 x 90 000 m^2 and a 1:50 year, one day rainfall depth of 118.7 mm, the volume of rainwater to be released through the emergency spillway would be:

4 x 90 000 x 118.7 / 1000 / 24/ 60/ 60 = 0.5 m^3/s

The flow depth for an Ogee spillway, measuring 6 m in width, with a flow of 0.5 m^3/s, would be 0.15 m.

Assuming a freeboard of 0.8 m above the full flood level, the spillway is to be placed at a depth of 0.80 + 0.15 ~ 0.95 m below the top of the embankment wall. Assuming additional road layer works will be placed on top of the final wall, the depth to the spillway is set at 0.9 m.

The four pond spillways will be placed at the same height and therefore rainwater rainfall depth in the final pond, linked to the emergency spillway, will be exaggerated by a factor of four.

In order to prevent spillage due to the 1:50 year rainfall event, the pond level of the final pond before the emergency spillway is limited to:

0.15 x 4 =	0.6 m	exaggerated rainfall depth
	0.8 m	Wave action safety allowance
	0.9 m	Height difference between spillway and top of wall
	= 2.3 m below top of wall	

Liner system

In order to cater for possibly more concentrated RO reject in future, a triple liner system will be used in the pond.

It is important to demonstrate that the liner materials proposed for the facility are chemically compatible with the RO reject, as liners can deteriorate over time when exposed to chemicals. Temperature usually plays a significant role in accelerating chemical reactions. The water treatment process generates an RO reject stream at ambient temperature; therefore, the impact of temperature is limited.

No identified published studies have raised any concerns about deterioration of the service life of high density polyethylene (HDPE) geomembranes when they come in contact a brine concentrate containing salts and heavy metals.

Published studies do, however, raise a concern with the long-term performance of geosynthetic clay liners (GCLs) with a divalent hazardous liquid such as the RO reject. The DWA recommends the avoidance of the usage of GCLs for facilities containing these liquids. GCLs will, however, be used as the last liner to improve attenuating behaviour of the permeable subsurface soil comprising the foundation since this liner is unlikely to be exposed to the RO reject.

Other materials for which compatibility needs to be addressed are the cuspated drains and geotextiles. While these materials do not serve a barrier function, they are provided either for removal of RO reject leakage or protection of the lining system and therefore they must continue to function when exposed to RO reject. Literature suggests that cuspated drains manufactured out of HDPE and geotextiles made from polypropylene provide adequate chemical and radiation resistance.

The liner system for the proposed evaporation pond will comprise the following (Figure 2-7):

- 2 mm HDPE geomembrane;
- 750 micron HDPE cuspated drain, basin primary leak detection layer;
- 1.5 mm HDPE geomembrane;
- 750 micron HDPE cuspated drain, secondary leakage detection layer;
- 1.5 mm HDPE geomembrane;
- 3 600 g/m^2 geosynthetic clay liner (GCL);
- Prepared soil layer to liner installer's specification; and
- 0.75mm HDPE geomembrane on base only and up slope for 2 m height.

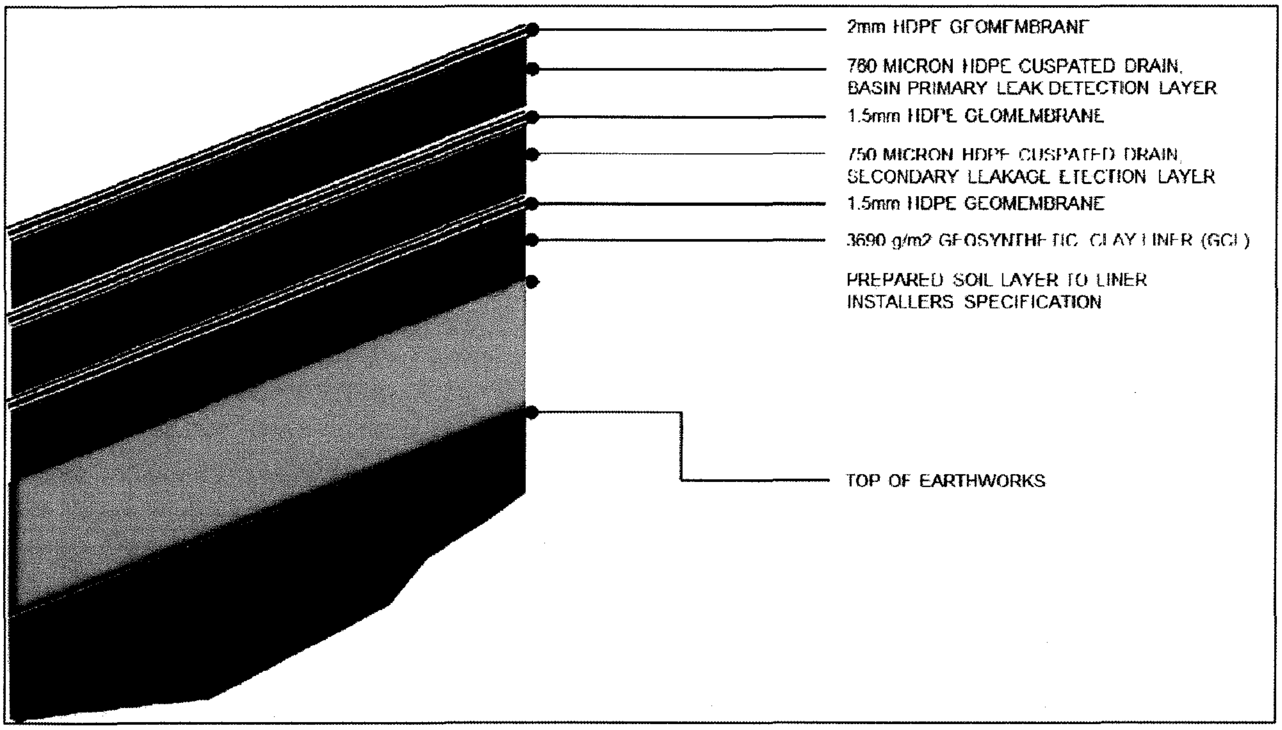


Figure 2-7: Liner system for the proposed evaporation pond

2.1.2.3 Pond development activities and considerations

Clearing and grubbing

Prior to construction of the pond, the vegetation will need to be cleared. The clearing operation will be limited to the area necessary for construction only. The area will be clearly marked prior to the commencement of clearing.

Topsoil removal

A geotechnical study was conducted for the proposed project (APPENDIX B). The results of the study indicated that the site is covered by approximately 550 mm topsoil. During the Construction Phase, the topsoil will be removed and stockpiled for use on the outer embankments of the pond walls. The remainder of the topsoil will be used to rehabilitate the borrow pit required for the development of the pond (see section below), as well as the pond site at the end of its lifespan.

Blasting of hard rock

The south-western portion of the proposed evaporation pond site is underlain by a dolerite sill at depths less than 1 m below surface. The sill is several meters thick and is underlain by a succession of sandstone and siltstone units. Further to the north-east the dolerite sill occurs at depths deeper than 30 m with overlying shale and siltstone units.

In order to construct the pond, the hard dolerite rock would need to be blasted. No geotechnical tests were conducted on the dolerite rock, but test results obtained from a borehole drilled for the proposed ventilation shaft project, indicate that the rock is highly weathered. It is expected that the rock would be suitable for blasting. Based on the estimated rock volumes to be encountered during construction, the following can reasonably be expected:

- Sixteen blasts over a period of 64 days, with each blast lasting approximately 2 seconds. If night shift drilling is allowed, this can be reduced to 40 days.
- The area to be blasted is approximately 2 x 50 000m^2.

- The overburden will be removed to expose the dolerite rock that is situated approximately 2.0 m below ground. The rock thickness to be blasted is 3.5 m – 6.0 m.

For ponds 2B North and South, the above will be repeated in 5 years time.

The following criteria can reasonably be expected:

- Air blast limit to be 120 dB.
- Maximum ground vibration limit to be 25 mm/s.
- Clear safe radius around blast site to be 500 m.

Construction materials

The fill material overlying the *in situ* transported or residual soil horizons generally has a highly variable composition including mixed sand, silt, clay, boulders, builder's rubble, concrete slabs and general waste. As a consequence, the fill identified at the site is not deemed suitable as construction material for the proposed development.

In all of the transported soils encountered on site, grass roots occur through approximately 80% of the horizon. This uppermost horizon, as mentioned above, is an average of 0.5m thick, making the presence of roots to a depth of generally 0.4m, thus leaving a 0.1m band of fine grained material, free of organic material.

The transported material overlying the residual soils consists of relatively fine grained sandy clay which classifies in most instances as a CL or CH soil in terms of the Unified Soil Classification (USC) system. The transported soils, which were sampled, may be suitable in the construction of compacted earth embankments. However, due to it being a thin horizon and mostly including grass roots and organic material, only very limited quantities are expected. To avoid contaminated materials being used in construction, it is not recommended.

It is unlikely that the dolerite rock, after blasting, will be suitable for construction of the pond embankments unless secondary blasting or crushing is done to reduce the blasted fragments to acceptable sizes and there are sufficient fines available (or mechanically mixed therein) to render it suitable for the intended purposes of the proposed embankment construction. Given the various processes that will be needed to reach an acceptable material, this option, as a source of material for construction of the embankments should only be considered if there is insufficient material from residual dolerite soils on site and the proposed borrow area, and only after field trials have proven that the desired embankment material can be delivered.

The residual dolerite found at the site is considered a suitable material for use in construction of an earth embankment. This material contains fine grained soil, which increases its plasticity, and hence cohesion between the gravels.

The siltstone encountered in the eastern and northern portions of the site has a similar jointed structure to that of the dolerite. However, due to the siltstone's brittle nature, it is not recommended as a suitable embankment construction material. The breakdown of the coarse particles with compaction would render the siltstone too fine and plastic for use as an embankment material.

In situ, the siltstone displays a stable structure for founding purposes for the proposed pond, but in a disturbed state, the rock is not considered suitable for construction.

Due to the possibility of a lack of suitable and sufficient *in situ* materials available at the site for pond construction, a "back-up" borrow pit may be developed adjacent to the pond site to provide the materials required to construct the pond. This will only be confirmed during construction[2].

[2] Note: A separate Basic Assessment process in terms of the NEMA for the proposed borrow pit is currently underway.

Embankment design

The following minimum placement and compaction requirements are to be implemented in the construction of all the earthworks pertaining to the evaporation pond:

- All embankments and founding layers below the liner system will be compacted to a minimum of 100% of Proctor maximum density;
- Compaction moisture content must be maintained between optimum moisture content (OMC) and 2% wet of OMC (Proctor standard); and
- Engineered fill must be constructed in layers not exceeding 200 mm (compacted) thick using pad foot or tamping rollers for the residual sandstone and ferricrete skins, and maximum 300 mm layers (compacted) for the bulk fill above natural ground level.

The primary reason for specifying Proctor compaction for water-retaining structures of the type required, is to minimise the risk of embankment cracking often associated with the brittle conditions accompanying both low construction water content as well as the higher compactive effort (of Modified AASHTO). Experience has shown that if the moisture content is decreased only a few percentage points below Proctor optimum, the rigidity (or brittleness) of embankments constructed in most soils is increased significantly. Differential settlement cracks will occur more readily in a rigid embankment than in a flexible embankment. A further advantage associated with Proctor compaction is the decreased permeability at the higher moisture content.

Slope stability

Due to the proposed construction being a possible cut to fill operation, laboratory testing of remoulded samples was carried out on samples of the transported and residual soils from the areas of proposed cut, to determine the shear strength of the materials after compaction.

Testing comprised slow, drained shear box tests on samples which had been remoulded to 100 % Proctor compaction to replicate, as best, the likely compaction process in the field.

The tested transported material produced a cohesion value of 7 kPa and effective friction angle of 33°. Although this material may support the proposed internal slope of 1:2.5, it is recommended that the material is fully stripped from site due to its high percentage of grass roots and occasional fill material.

The residual dolerite tested resulted in a cohesion value of 30 kPa and an effective friction angle of 47°. This value is relatively high compared to anticipated results, from published data, for SC classified soils. It may be explained by the relatively low percentage of fine grained material in the sample and justifies the previously mentioned statement that fines should not be excluded from the residual dolerite when forming the earth embankment.

Given the laboratory test results, as well as the physical characteristics of the residual dolerite and correlation with published data, effective shear strength parameters of the compacted residual dolerite for stability analysis are estimated to be:

$\Phi' = 31^\circ$ and $C' = 5$ to 10 kPa

After calculating the slope stability in the analysis programme RocScience SLIDE (v.5.0), it is shown that the residual dolerite is considered a suitable material for the construction of an earth embankment where the slope angles do not exceed the proposed internal slope of 1:2.5 and the external slope of 1:3.

Embankment protection

Stockpiled topsoil is to be placed on the outer embankments of the pond to protect the rock core against erosion. The embankments will be vegetated for stability and also to visually enhance the pond.

Subsoil drainage

Groundwater seepage was not encountered in any of the surface test pits excavated during the geotechnical investigation (APPENDIX B), except for the test pit located in proximity to standing water to the south of the site. The residual and reworked residual soils, however, had medium to high *in situ* moisture contents, at the time of profiling, due to possibly poor natural site drainage, surface water infiltration or moisture retention of the fine grained soils.

Notwithstanding the above, the development of near-surface, seasonal perched water tables during periods of intense or sustained rainfall cannot be excluded, making effective dewatering of the ground profile essential and requiring measures to improve material workability during construction.

A subsurface drainage system will be constructed below the dual blanket layer for collection and removal of seasonally rising perched water. To protect the facility from the impact of the perched groundwater during construction, operation and post closure, subsurface drains will be implemented. The essence of the sub-surface drains is as follows:

- 110 mm diameter auxiliary and 160 mm diameter main slotted HDPE pipes (water collection pipes) aligned with the slopes of the ponds' floors and arranged in a herringbone layout. These pipes will be covered with aggregate wrapped with geotextile;
- 160 mm diameter solid sub-surface water collection pipeline to daylight in a small concrete headwall, which will also serve as monitoring point for the discharge of groundwater;
- The subsoil drain systems serve to remove possible accumulation of storm water below the liner in the pond basin area. The liner system is susceptible to negative water pressure and as a precaution, cement filled Kaytech geocontainer bags (70 kg) will be placed at 4 m c/c to prevent uplift.
- The pond basin floor is sloped at 1:100 to facilitate the flow of seepage water within the slotted HDPE drainage pipes. Drainage pipe trenches will be lined with class A4 geofabric covering the 19 mm stone that will act as filter to prevent blocking of the slotted pipes.
- The subsoil drain system will accumulate water in two sumps, one located north west of the pond and the other located south of the pond. From these sumps, the clean water is to be pumped into the adjacent watercourse.

Anchor system

During construction, the geomembranes could experience pull-out forces caused by thermal expansion/contraction or wind uplift. However, tension from thermal expansion and contraction is expected to be small and the geosynthetic installer can use sand bags or other approved methods to control wind uplift during installation. After construction and at the start of deposition of the RO reject, the pull-out forces on the geomembranes are expected to be negligible, as there is no tension force on the liner.

The lining system interface strength exceeds the slope angle on the 1V: 3H side slope. Thus, the pull-out resistance attributes of the anchor trench will support the self-weight of the geomembrane and other lining system components. Analyses of the liner self-weight support requirements determined that the frictional resistance between geosynthetics exceeds the liner self-weight. Thus, no additional pull-out resistance is needed at the anchor trench to support the lining system self-weight.

Leakage detection

The general principle followed to protect the environment is to avoid any leakage or spillage of RO reject to the environment. The facility is also designed to prevent the RO reject from mixing with the clean water system at the site.

Because geosynthetic liner systems have inherent imperfections, a small amount of leakage through the primary liner generally occurs, despite the use of the best available materials, construction techniques and quality assurance procedures. Hence, it is important to include a leakage collection and conveyance system within the lining system. The liner system for the pond will incorporate two cuspated drainage systems to collect leaks from the primary and secondary HDPE geomembranes. The design of the leakage system is set out in the sub-section detailing the liner system.

Conceptual closure plan

The detailed closure plan for the facility will be developed during the life of the facility.

The purpose in preparing a conceptual closure plan is to ensure that the facility design, construction and operating procedures are compatible with the achievement of final closure and rehabilitation to acceptable environmental standards and at a reasonable cost. It is anticipated that the conceptual plan will be updated periodically before the preparation of the detailed closure plan.

There are two potential scenarios for closure of the facility, namely:

- Removal of the hazardous salt precipitate to a nearby hazardous landfill disposal facility followed by rehabilitation of the footprint.
- Leaving the facility in place.

The rehabilitation measures will be in accordance with the capping and closure requirements of the DWA *Minimum Requirements for Waste Disposal by Landfill* (DWAF, 1998a).

2.1.3 Pipeline

A pipeline will be constructed to transport the reject from the RO concentrator plant to the evaporation pond. This pipeline will be a high density polyethylene (HDPE) pipeline and will be buried below ground. A back-up pipeline will be installed alongside the main pipeline in the event of a pipeline leak/burst or a shutdown during times of maintenance. The pipeline will be approximately 2.2 km long with an internal diameter of 150 mm and the maximum flow rate will be 10.4 l/s.

Air valves will be placed at high points along the pipeline to facilitate the removal of air from the system, primarily for testing purposes. At low points, scour manholes will be provided with a sealed extraction system, allowing for the extraction of the RO reject into mobile tankers, if necessary.

The pipeline will be located approximately 1 m below ground in a backfilled trench within an existing road reserve.

2.1.4 Pump station

The new pump station located close to the proposed new Concentrator Plant, within the boundaries of the Tutuka Power Station, will consist of a reinforced concrete slab with two 37 kW pumps, delivering 10.4 l/s, 24 hours per day at a maximum head of 122 m. One pump will be operational with another serving as standby. The pump station will be covered by a basic steel framed and roofed structure.

2.1.5 Other Infrastructure

Supporting infrastructure for the proposed project will include an access road, storm water management structures at and around the pond site, a security fence and groundwater monitoring boreholes.

Security

The proposed evaporation pond will be fenced with a 1.8 m high diamond mesh fence with four strand barbed wire on top, to prevent unauthorised entry. Signs indicating that unauthorised entry is prohibited will be placed along the fence. Only pedestrian access will be allowed to the facility. Access to the facility will be controlled at an access control gate on the west edge of the site.

Service Road

A 5 m wide service ring road will be constructed with gravel that will be selected from the dolerite blasting and crushing process.

Storm water

Since the site is situated on the watershed, storm water will flow away from the pond. A subsoil drain system will, however, be implemented.

Lighting

Flood lighting at 40 m intervals will be provided on top of the embankments walls of the proposed pond.

Safety

Safety ropes in conjunction with safety buoys will be placed at regular intervals on top of the embankment walls of the pond. Pedestrian staircases with safety hand railings will be provided.

2.1.6 Supporting Infrastructure not part of this EIA

Other infrastructure that will support this development, but do not form part of the scope of this EIA include:

- An existing mine water collection system at New Denmark Colliery which delivers excess mine water to the RO plant;
- An existing RO plant used to treat saline mine water and produce the RO reject;
- The proposed upgrading of the Eskom Tutuka Power Station RO reject concentrator plant to reduce the reject produced (EIA done by Aurecon);
- The development of a borrow pit to support construction of the proposed evaporation pond (Basic Assessment currently being conducted); and
- A proposed 11 kVA overhead powerline to the proposed ventilation shaft site, situated south west of the pond site.

2.2 Project Related Services

2.2.1 Power supply

Power will need to be supplied to the site for the pump system and for lighting purposes. New Denmark Colliery is currently in the process of designing an 11 kVA overhead electrical supply to a proposed ventilation shaft site, situated south west of the pond site. A step down transformer system will provide power to the RO reject pump and lighting systems.

2.2.2 Water supply, sanitation and waste management

During construction and operation, potable water will be sourced from either Eskom or NDC's current water supply, and stored in a small tank on site. During construction, domestic solid waste and hazardous waste (such as oily rags) will be temporarily stored in separate containers on site. A licensed waste contractor will remove the contents of the containers on a regular basis for disposal at facilities licensed to receive such wastes. Temporary ablution facilities for staff will be available during the Construction Phase.

2.2.3 Labour and employment

Approximately 200 additional employment opportunities will be created for skilled (~70%) and unskilled (~30%) workers during the Construction Phase. Approximately three permanent jobs will be created for the routine operation and maintenance of the new pond and pipeline and for security purposes. Local labour will be used where possible.

2.2.4 Project roles and responsibilities

The responsibility for the operation and maintenance of the evaporation pond and associated infrastructure lies with NDC. Responsibilities in terms of operation and maintenance of the concentrator plant and pipeline to the pond lie with Eskom.

2.3 Project Phases

The evaporation pond will be constructed in phases. Construction of the first cell will start soon after authorisations from MDEDET and DMR have been received (expected to be in March 2011). The first cell is expected to be commissioned in October 2011.

3.0 BASELINE DESCRIPTION OF THE STUDY AREA

3.1 Geology

The geological units within the study area belong to the Ecca Group of the Karoo Supergroup (GHT Consulting, July 2005). Shale, sandstone and siltstone units typically define this Group with interbedded coal units of variable thicknesses at depths deeper than 180 m. Four coal seams have been identified in the area. These are No 3; No 4 Upper; No 4 Lower; and No 5 coal seams, all developed within the Vryheid Formation of the Ecca Group. The stratigraphic sequence of the rocks in the area is shown in Table 3-1 and graphically illustrated in Figure 3-1.

Table 3-1: Geological succession in the New Denmark Colliery area (GAA, 2009)

Sequence	Group	Formation	Lithology
Karoo	Ecca	Vryheid	Sandstone, siltstone, coal
		Pietermaritzburg	Siltstone
		Dwyka	Tillite, glacial sediments
Basement Complex	-	-	Granite

A series of dolerite dykes and sills also occur in the area. Figure 3-1 shows a typical borehole profile illustrating the relative succession and thicknesses of lithological units (Golder, 2009).

Local geology and structural setting

Figure 3-2 shows a SE-NW geological section across the preferred evaporation pond construction site. In the south-western portion of the site the pond is underlain by a dolerite sill at depths less than 1m below surface. The sill is several meters thick and is underlain by a succession of sandstone and siltstone units. Further to the north-east the dolerite sill occurs at depths deeper than 30m with overlying shale and siltstone units.

The dolerite sill underlying the proposed brine construction site belongs to the B4 dolerite sill type, which is one of the three types of dolerite sills in the Standerton Coalfield (Golder, 2009). The B4 dolerite sill outcrops on surface or occurs very close to the surface and has been entirely removed through erosion in some places (Golder, 2009). It may split into several horizontal dolerite layers of varying thickness but the combined thickness of the layers varies from ±10 m to over 50 m.

The dolerite units in the area are intrusive into the Karoo units and are associated with minor faulting and displacement of the Karoo sequence in some places within the study area (Golder, 2009).

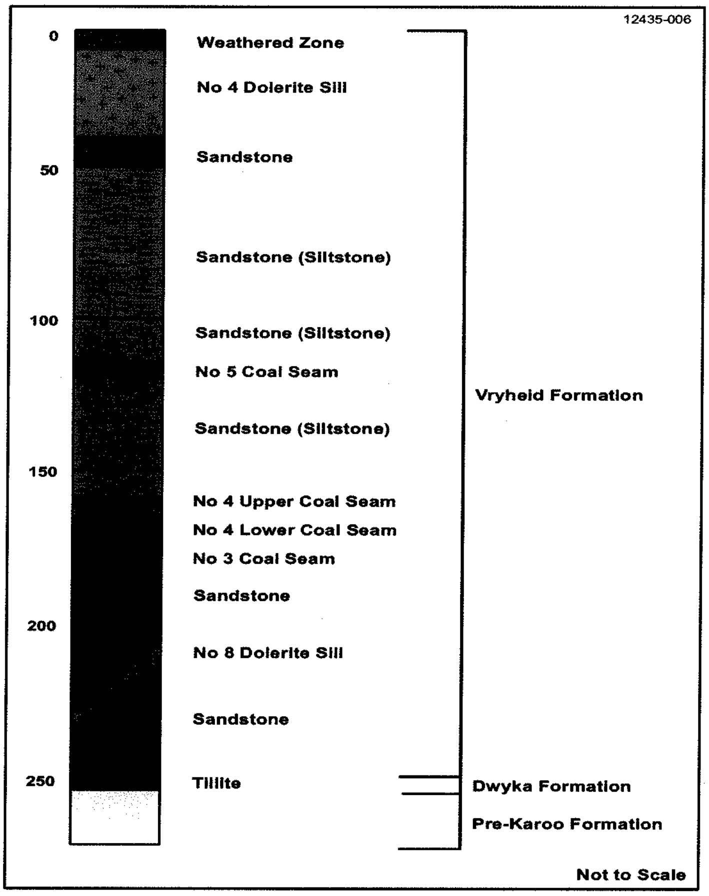


Figure 3-1: General stratigraphic column

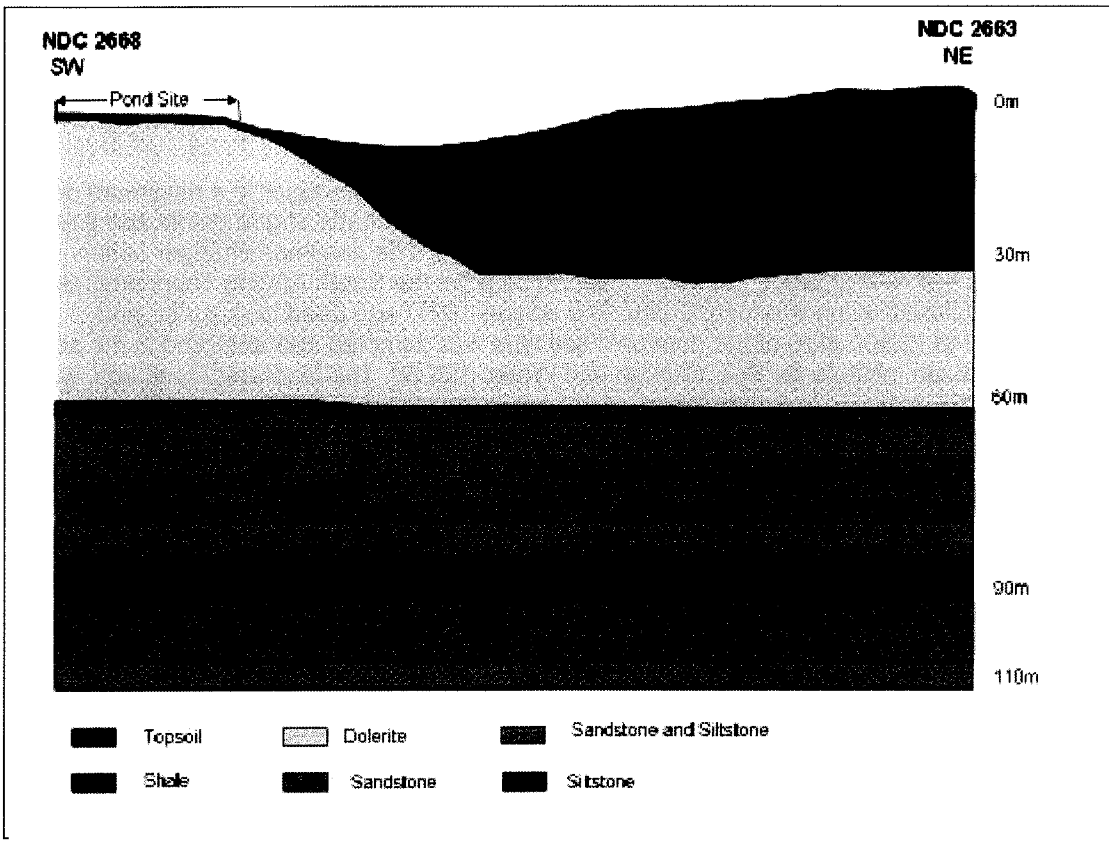


Figure 3-2: SW-NE geological cross section across the proposed evaporation pond construction site at NDC

3.2 Climate

The site falls within the summer rainfall region of the Highveld. The climate in the area is typical of the Highveld region of Mpumalanga, with warm, wet summers and cold, dry winters with frost in places. The amount of rainfall varies from 508 mm to 889 mm per annum and temperatures range from 38°C in the summer to as low as -4°C in the winter. As indicated in Section 2.1.2.2, a Mean Annual Precipitation (MAP) of 739.6 mm was used for the design of the evaporation pond. Tutuka Power Station is located within evaporation zone 12A with a mean average evaporation (MAE) of 1 650 mm, based on the S-pan measuring system. Due to the increased monthly rainfall from 1998 to 2010, zone 13B with an MAE of 1 520 mm, was selected as being more representative.

Air temperatures show significant daily and seasonal variations, with mean temperatures at their maximum in December and January, and at their minimum in June and July. Mean daily temperatures range from 12 to 25°C in summer and 0 to 20°C in winter.

Thunderstorms occur frequently during summer, between October and March, and are usually accompanied by lightning, heavy rain, strong winds and occasionally hail. Snow falls are recorded most winters in the high-lying areas of the study area's south-eastern portion. Winds in the study area blow predominantly from the north, west and north-west, and may reach speeds of up to 60 km/h in summer. Regular dust storms can also be expected during periods of prolonged dry weather.

3.3 Topography

The study area for the proposed project is representative of the topography in the greater area, which is fairly flat without any areas with slopes greater than 9 %. The area surrounding the Tutuka Power Station is located at some 1 640 metres above mean sea level with the slope very gradually falling to the south towards the Grootdraai Dam. The power station precinct and ash dump are located at the highest point in the immediate surrounds.

3.4 Soils, Land Capability and Land Use

A detailed soil assessment was conducted. Advanced surveying techniques supported by real-time navigation equipment, high resolution colour aerial photos and sophisticated geographic information software were used in the assessment. A field survey was conducted in July 2010.

The soils were investigated by making observations with the use of a bucket type auger to a maximum depth of 1 500 mm or to the depth of refusal. A total of 27 auger observations were made at grid points and 9 along the proposed pipeline route to locate and accurately map soil boundaries. The positions of auger observation points are shown on Figure 3 of APPENDIX E. At each observation point the South African Taxonomic Soil Classification System (Soil Classification Working Group, 2nd edition 1991) was used to describe and classify the soil. The A horizon (0-500 mm) of the dominant soil type was sampled and analysed in the soil laboratories of the South African Institute for Soil, Climate and Water (ISCW). The laboratory methods, which are currently in use for routine analyses in South Africa, as set out in the Handbook of Standard Testing for Advisory Purposes (Soil Science Society of South Africa, 1990), were used.

Land capability was assessed according to the definitions of the Chamber of Mines of South Africa and Coaltech Research Association (Guidelines for the Rehabilitation of Mined land. 2007, Johannesburg). Soil types were classified accordingly into 3 categories namely arable, grazing, and wilderness (excluding wetlands). The localities and extents of land use practices were surveyed during the time of the soil assessment. Erodiblity was broadly assessed based on soil texture, slope and the inherent stability of the parent rock (geology) from which the soil originated.

The results of the assessment indicated the following:

- The soils at the proposed footprint of the pond are very homogenous and consist of well-drained, strongly structured, black, clay soils of the Arcadia form. These soils are on average 500-600 mm deep and are underlain by yellowish grey weathered rock;
- A total of 4 soil types (Arcadia 1 100 being the dominant soil form and family), based on dominant soil form, effective soil depth, terrain unit and slope percentage were identified within the footprint of the evaporation pond: Ar1 (17.3%), Ar2 (73.4%), Ar3 (4.3%) and Ar-D (1.9%);
- The high clay content, firm consistence and strong structure of black clay soils cause difficulties with cultivation and restrict suitable crop selection and such areas are therefore mostly utilized for grazing purposes. Due to the fairly shallow effective soil depth, the land capability was classified as grazing potential;
- An excavated area (±500–1 000 mm deep) covering approximately 1.25 ha was found within the footprint of the evaporation pond. Since the topsoil of this area has been removed, the land capability was classified as wilderness land with low to no agricultural potential.
- Soils along the proposed pipeline are similar to those on the footprint of the proposed pond (Ar2, Ar3 and Ar-D). The soils are fairly shallow and have mostly been disturbed by the construction of the existing access road to the power station;
- The current land use for the proposed evaporation pond site is cattle grazing; and
- No evidence or data of historical agricultural production could be obtained.

For details, refer to APPENDIX E.

3.5 Terrestrial ecology

An ecological study of the terrestrial aspects of the proposed project was undertaken. The study aimed to develop baseline descriptions of floristic elements and fauna occurring within the study area, and to highlight sensitive biological and environmental attributes that may potentially be impacted by the proposed project. The assessment was based on information collected during a single visit site in July 2010, i.e. the dry season. The findings of the study are summarised below; for more detail, refer to APPENDIX F.

3.5.1 Vegetation

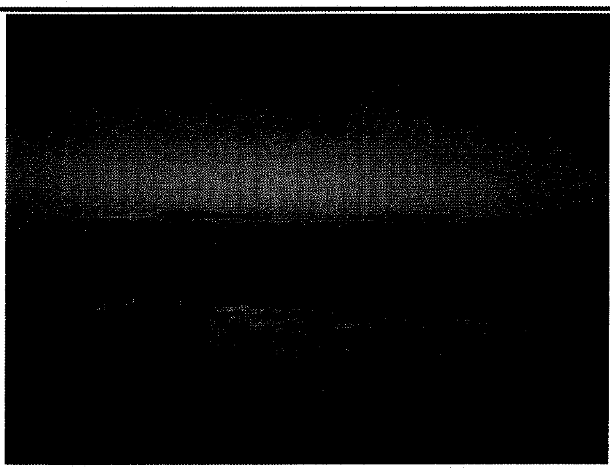
General

The site is situated in the Grassland biome. The Grassland biome is characterised as land that is dominated by grass species rather than trees or large shrubs. It receives less rain than the Savanna biome and the amount of precipitation determines the grass height; wetter regions have higher grasses.

The project area falls within the vegetation type described as Soweto Highveld Grassland by Mucina (2006). Its distribution stretches from Lichtenburg in the west to Middelburg in the east; in the south it includes Magaliesburg, the ridges of the Witwatersrand and the dolomite plains of Gauteng and the North-West Province. Sixty-five percent of this vegetation type is already transformed and 1.38% is conserved. Conservation areas include Suikerbosrand, Rustenburg, Abe Bailey and Boskop Dam Nature Reserves. Despite conservation attempts, this vegetation type is poorly conserved and is considered as threatened.

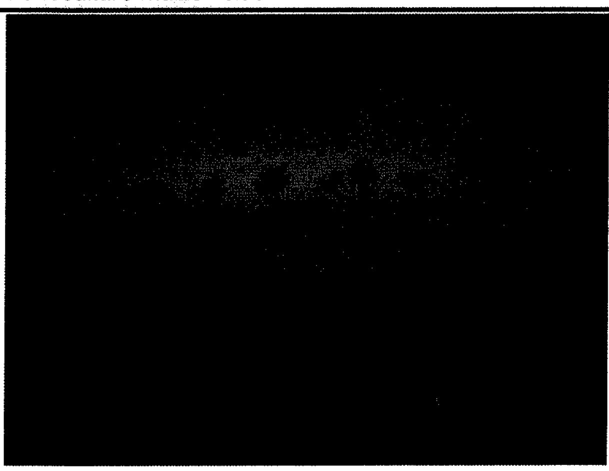
Site specific

The natural vegetation cover of most of the study area has either been replaced by cultivated maize fields, or is used for livestock grazing purposes as is primarily the case with the site itself; or has otherwise been degraded by industrial and mining-related activities. Small areas of somewhat disturbed, natural vegetation occur along watercourses or fringes of other activities. Localised clumps of alien invader trees are prominent elements in the landscape. See Figure 3-3.



The majority of the study area is characterised by monoculture maize fields

Livestock grazing also takes place within the study area



The remaining natural vegetation in the study area is largely confined to water bodies and drainage lines, as well as along fringes of roads and other infrastructure

Localised clumps of alien invader trees

Figure 3-3: Typical vegetation cover within the study area

Based on physiognomy, moisture regime, rockiness, slope and soil properties, two vegetation communities were recognised within the project footprint:

Themeda secondary grassland

This vegetation community covers the majority of the study area, which is characterised by a substrate of dark clay. The disturbed grassland or other disturbed areas such as road reserves or fallow fields, not cultivated for some years, are usually dominated by the species *Hyparrhenia*. *Themeda triandra* is, however, the dominant species for this vegetation unit.

Other species present are a result of historical disturbances such as over-grazing, sand mining and crop cultivation. This vegetation unit is low in species richness, with only a few species able to establish or survive in the shade of the dense sward of tall grass. The most prominent species include the following grasses: *Themeda, Eragrostis, Heteropogon, Aristida, Digitaria, Tristachya* and *Elionurus*. Invasive species occurring in this area include: *Cirsium vulgare; Bidens pilosa; Conyza albida; Schkuhhria pinnata; Tagetes minuta; Asclepias fruticosa; Datura stramonium;* and *Solanum sisymbrifolium.*

Artificial wetland region

There are a few isolated artificial wetlands within the study area which are associated with hydrophilic species. Artificial wetlands are any type of wetland constructed by man, or formed due to anthropogenic disturbances of natural areas. In this case these wetlands formed due to excavations filling up with rain and infiltration from the groundwater table. This area is, however, heavily disturbed and dominated by exotic species which form dense stands in the area. Very little natural vegetation occurs in this area; the few indigenous species are pioneer grasses and some annual species. Species include *Pragmites australis, Cyperus fastigiatus, Aristida bipartita, Hyparrhenia hirta, Datura stramonium,Datura ferox, Cirsium vulgare, Solanum sisymbriifolium, Verbena bonariensis* and *Xanthium strumarium.*

Red Data species

Red Data vegetation retrieved from SANBI for grid square 2629CD was taken into account during the assessment. Only one Red Data species is indicated to potentially occur within the project area, namely *Cineraria austrotransvaalensis*. This species has a Near Threatened status, but was not found during the site visit. Protected species of Mpumalanga were also considered, none of which were found on site.

3.5.2 Fauna

Mammals

Mammals were identified through visual identification of the species, prints or faeces. Species identified during the survey can be seen in Table 3-2. Red Data mammals were also taken into account; no Red Data species were, however, encountered. The Red Data mammal for this area is *Felis leptailurus serval* (Serval). The probability of occurrence of this species within the proposed project area is, however, considered moderate due to the high level of disturbance in certain areas. Large amounts of scat were found on the site. From the scat samples mammals were identified, however there was scat that could not be positively identified as a specific species.

Table 3-2: Mammals species identified during the survey

Species Name	Common Name
Canis mesomelas	Black-backed jackal
Cynictis penicillata	Yellow mongoose
Hystrix africaeaustralis	Porcupine

Avifauna (birds)

All birds species encountered or bird calls identified during the site visit were listed (see Table 4 of APPENDIX F). Bird species identified include the grey heron, common waxbill and African hoopoe. No Red

Data species were observed during the site visit. Due to the fact that the survey was conducted during the dry season and due to the already impacted nature of the grassland, avifauna diversity was low.

Herpetofauna (reptiles and amphibians)

No reptiles or amphibians were observed during the site survey. Reasons for not finding any species can be attributed to the time of the year the survey was conducted (July 2010) which falls within the cold, dry season when reptiles are not as active, but also to the amount of time spent in the field (two days). It is likely that reptiles such as snakes and lizards do occur on site. Red Data species possibly occurring within the study area include *Homoroselaps lacteus* (Spotted harlequin snake). The probability of occurrence of this species is seen as moderate due to the fact that the habitat type of this species includes grasslands.

Arthropoda (insects)

Arthropods identified during the site survey can be seen in Table 3-3. Unfortunately, at this time no Red Data butterflies list exists for Mpumalanga and therefore the probability of occurrence for Red Data species could not be determined.

Table 3-3: Arthropods found during the site survey

Family	Species
Acrididae	*Acrida acuminata*
Alydidae	*Mirperus faculus*
Bombyliidae	*Exoprosopa*
Bradyporidae	*Hetrodes pupus*
Calliphoridae	*Chrysomya chloropyga*
Gryllidae	*Gryllus bimaculatus*
Hymenopodidae	*Harpagomantis tricolor*
Libiduridae	*Labidura riparia*
Melirydae	*Melyris*
Nemopteridae	*Nemia costalis*
Pamphagidae	*Hoplolopha*
Pyrgomorphidae	*Phymateus morbillosus*
Pyrrhocoridae	*Scantius fosteri*
Reduviidae	*Etrichodia crux*
Tabanidae	*Tabanus taeniatus*
Tettigonidae	*Phaneroptera*

3.5.3 Sensitive habitats

According to the MBCP (Mpumalanga Biodiversity Conservation Plan) the project area falls within the "Least Concern" and "No Natural Habitat Remaining" areas. The definitions of these statuses are as follows:

- Least Concern: These areas have biodiversity value in the form of natural vegetation cover. Although they are not currently required in order to meet biodiversity targets, they do contribute significantly to functioning ecosystems including ecological connectivity. A greater variety of development choices exists in these areas. However, they are still subject to National EIA legislation, where at least a scoping report is required for all listed activities.

- No natural habitat remaining: This area covers the rest of the Mpumalanga Province in which natural vegetation has been lost. It includes all land transformed by urban/industrial development and cultivation. Biodiversity is irreversibly changed, reduced to levels that are virtually dysfunctional. These landscapes have only residual or negative effects on the functioning of natural ecosystems (SANBI, 2007 in APPENDIX F).

There are therefore no areas on site that are of conservation value. The site does, however, border on irreplaceable sites as identified by MBCP and for this reason no activities extending the project site should be implemented; management of the site area should be efficient enough to prevent escape of pollutants into neighbouring properties. In terms of protected areas, the closest nature reserve is Bloukop which is located approximately 25 km from the site and for this reason will not be impacted by the proposed project.

3.6 Aquatic ecology and wetlands

An aquatic ecology and wetland assessment was conducted, the objectives of which included the following:

- A baseline characterisation of the aquatic and wetland habitats associated with the proposed project area;
- An assessment of the current status of the aquatic and wetland habitats and their importance;
- Evaluation of the extent of existing site related impacts in terms of selected ecological indicators; and
- Identification of potential problems, direct impacts and cumulative impacts associated with the project and recommendation of suitable mitigation measures.

The results obtained from the assessment are based on a single survey conducted in August 2010, with supporting data collected in April 2010. Refer to APPENDIX G for details.

The sampling sites used in the aquatic ecology assessment are indicated in Figure 3-4. The following conclusions were reached based on the results of the aquatic ecology baseline assessment:

- *In situ* water quality parameters indicated that pH from site NDC5 to NDC7 increased rapidly and to above recommended guideline levels. This increase has been attributed to eutrophication of the system. The saturation and high oxygen levels recorded at site NDC7 may be limiting to aquatic biota if persistent;
- The availability of habitats for aquatic macroinvertebrates was found to be generally poor within the study area, with only site NDC7 showing varied biotopes and scoring a fair / adequate state. The poor IHAS scores were attributed to poor flow conditions (and variability), eroded channel banks, uniform marginal vegetation and poor substrate variety;
- The aquatic macroinvertebrates diversity at all sites showed were found to be similar with ASPT scores varying slightly. Site NDC5 showed the lowest ASPT score, indicating that cattle may be having an effect on the aquatic ecosystem. Site NDC7, which showed the most favourable habitat for aquatic macroinvertebrates, showed the same number of taxa as site NDC6, indicating that the unusual in situ water quality variables observed may be impacting on the aquatic biota;
- Aquatic macroinvertebrate data indicated that biotic integrity ranged from moderately modified to largely natural. Site NDC5, which scored as fair (moderately modified), displayed poor habitat availability and was further impacted by cattle watering;
- Of the 11 expected fish species, a total of six species were recorded at the sites. The fish species at the sites were dominated by *Barbus anoplus* (Chubbyhead Barb) and *Pseudocrenilabrus philander* (Southern Mouthbrooder), both widespread and tolerant species;
- The diversity and abundance of fish species at site NDC6 was lower than in the main stream of the Leeuspruit. This was expected due to the flow and habitat conditions of the site;
- Ichthyofaunal diversity increased in a downstream direction from site NDC5 to NDC7, as did abundance; and
- *Clarias gariepinus* was only recorded at site NDC5; however, skeletal remains at site NDC6 suggest it is widespread during the high flow season.

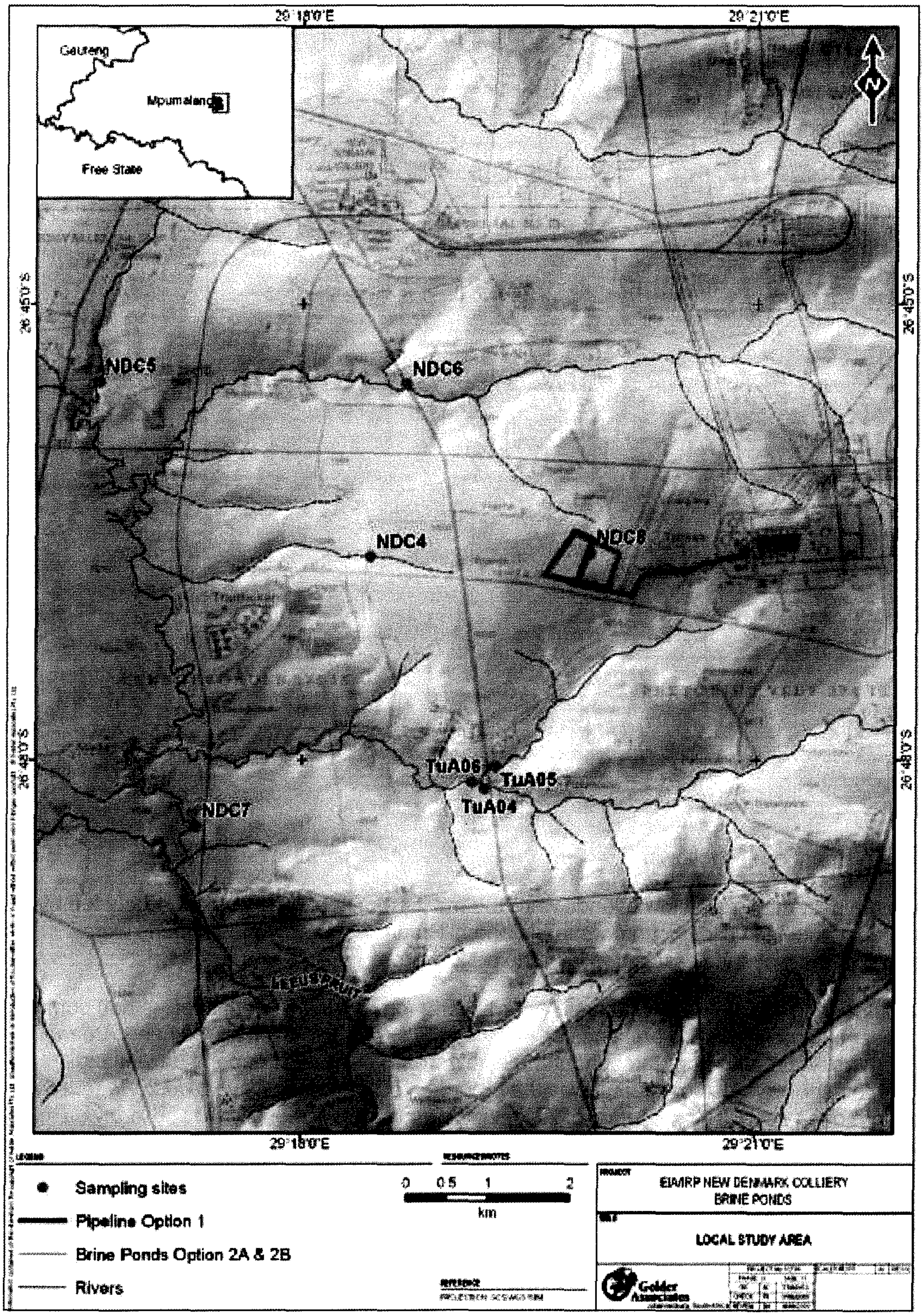


Figure 3-4: Aquatic ecology sampling localities

Eight wetland units were identified in association with the proposed project (Figure 3-5). For each of these wetland units the wetlands were delineated, classified and assessed.

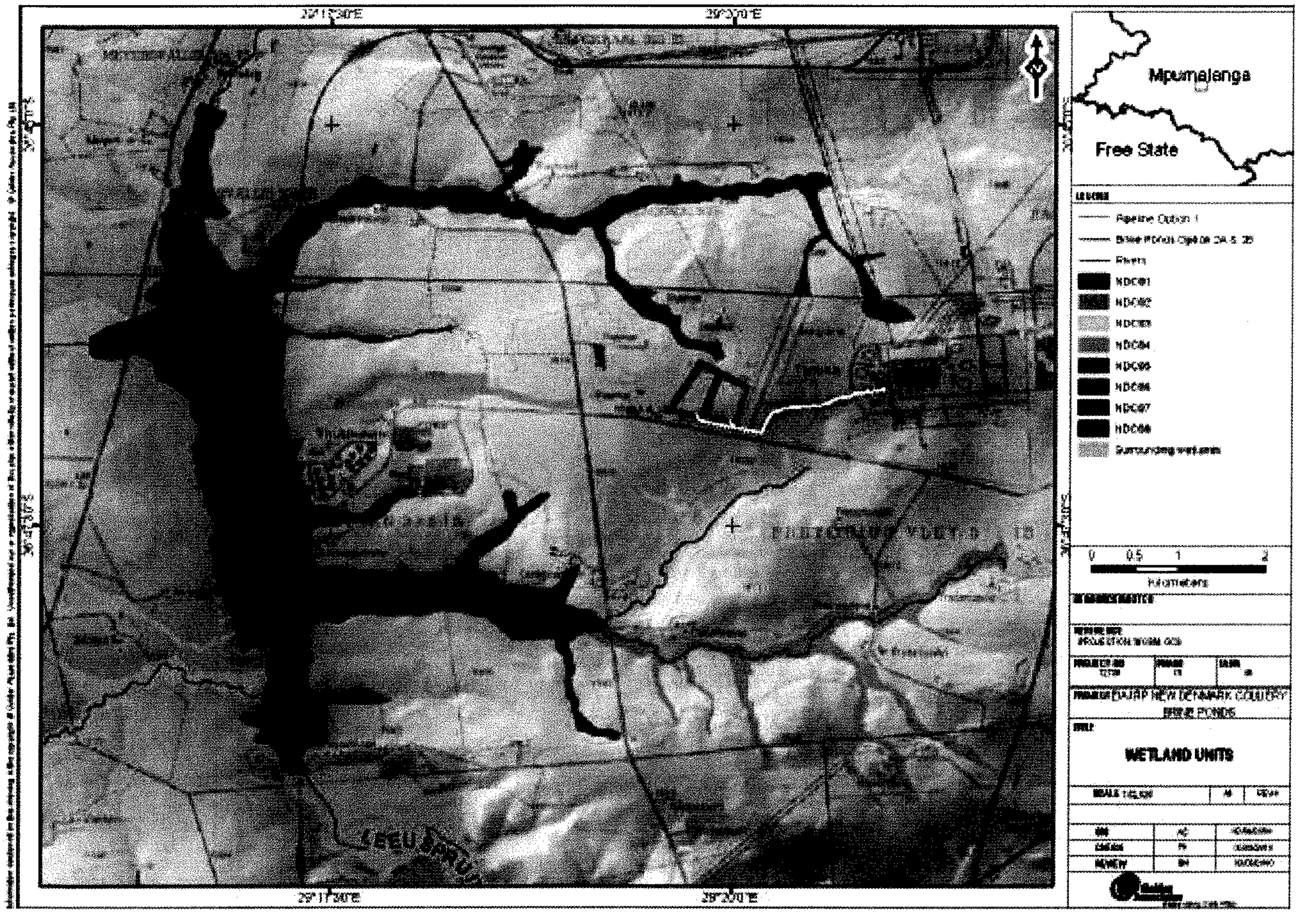


Figure 3-5: Wetland units associated with the project area

The results of the assessment are as follows:

- Of all the wetland types, the floodplain wetlands were the most prominent. These were largely fed by channelled and unchanneled valley bottom wetlands and hillslope seeps. Seventeen dams were delineated as part of the wetlands associated with the project area;
- Biodiversity was found to be moderate with mostly hardy/common grass and plant species and common bird species present. Of note was the presence of *Asio capensis* (marsh owl) at NDC04 and *Ardea melanocephala* (black-headed heron) throughout the study area. These birds depend on wetland ecosystems for their survival. Also of interest was the recording of *Euphorbia claveroides* (Vingerpol) at NDC05, as it is not often seen. The presence of *Atilax paludinosis* (water mongoose) and *Aonyx capensis* (Cape clawless otter) in the study area is also noteworthy.
- Habitat degradation due to agricultural activities (cropping and grazing) is impacting on the wetlands in the project area. Inundation due to impoundments such as dams and roads is also a common impact in the area;
- The Present Ecological State (PES) of most of the sites was rated as a class B with the exception of wetland units NDC05 and NDC07 which were rated as a class A/B;
- The Environmental Importance and Sensitivity (EIS) of the wetland units was found to be moderate with the exception of NDC08 which was ranked as low/marginal; and
- Natural ecosystem and human services supplied by the wetlands are generally moderate to low.

3.7 Surface water

A surface water assessment was conducted for the EIA; the relevant report is attached in APPENDIX H.

The proposed site for the evaporation ponds is located in Drainage Region C, the Vaal River catchment. At a local scale the site is situated on the catchment divide between two sub-catchments of quaternary catchment C11K (Figure 3-6). The two sub-catchments drain into the Leeuspruit, which drains into the Grootdraai Dam, located on the Vaal River.

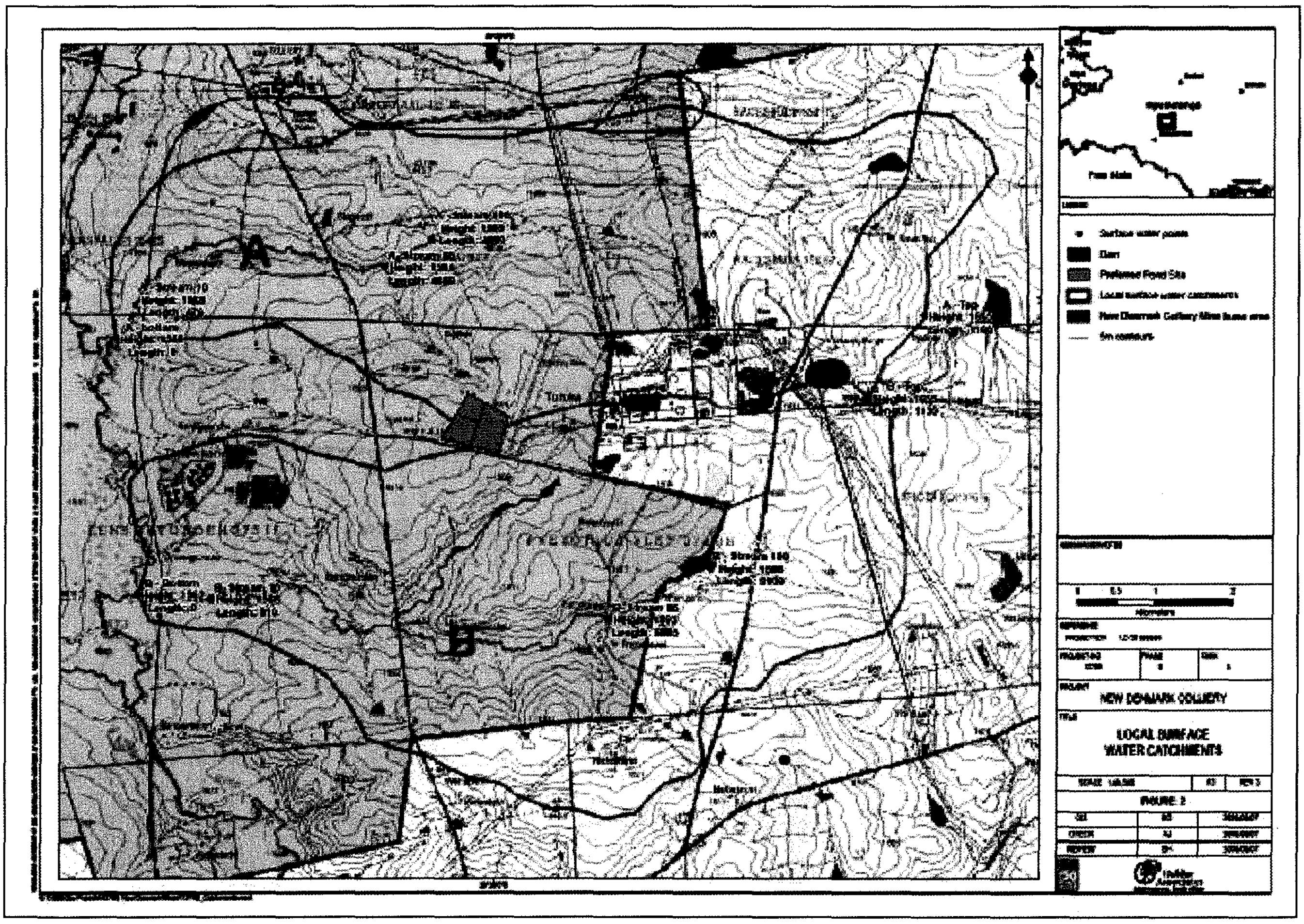


Figure3-6 : Local setting indicating the two affected sub-catchments A and B

The areas of the two sub-catchments (A and B) are relatively flat with an overall slope of 0.5 % draining from east to west. However, there are areas such as the last stretch of the river before the sub-catchment outlet that have slopes up to 0.84 % (Table 3-4). Slopes were calculated from distances and elevations calculated in Arc-GIS. The elevations vary from 1 660 mamsl in the upper catchment areas to 1 562 mamsl where sub-catchment B drains into the Leeuspruit.

Table 3-4: Sub-catchments A and B data

No	Area, (km^2)	Length, (m)	Elevation (mamsl)				Average slope (%)		
			At 0.0 L	At 0.1 L	At 0.85 L	At 1.0 L	0.0 L to 1.0 L	0.1 L to 0.85 L	0.0 L to 0.1 L
A	34.37	4 800	1565	1569	1584	1589	0.5	0.5	0.84
D	37.12	8 100	1562	1565	1593	1598	0.44	0.45	0.37

A summary of hydrological data of the study area is presented in Table 3-5.

Table 3-5: Hydrological data for the study area

Location	**Quaternary Catchment**	**C 11 K**
	Water Management Area	**Upper Vaal**
Rainfall	Rainfall gauge used (Jonkersdam)	0441261 W
	Mean Annual Precipitation (MAP) (Period of record 68 years)	665 mm
	Wet Season Rainfall (October - March) *	564 mm
	Wet Season Rainfall % of MAP	85 %
	Dry Season Rainfall (April - September) *	102 mm
	Dry Season Rainfall % of MAP	15 %
Evaporation	Mean Annual Evaporation (MAE) S-Pan	1520 mm
	Evaporation Zone (WR90 study) ≠	13 B

Note: **The sum of the average monthly rainfall does not necessarily correspond to the MAP*
≠ Midgley et al, 1994

Streamflow was recorded at the outlet of catchment C11K from 1964 to 1989 and the monthly measured flows at this gauge (C1H005) are shown in Figure 3-7. The mean annual runoff is 17.4 million m^3.

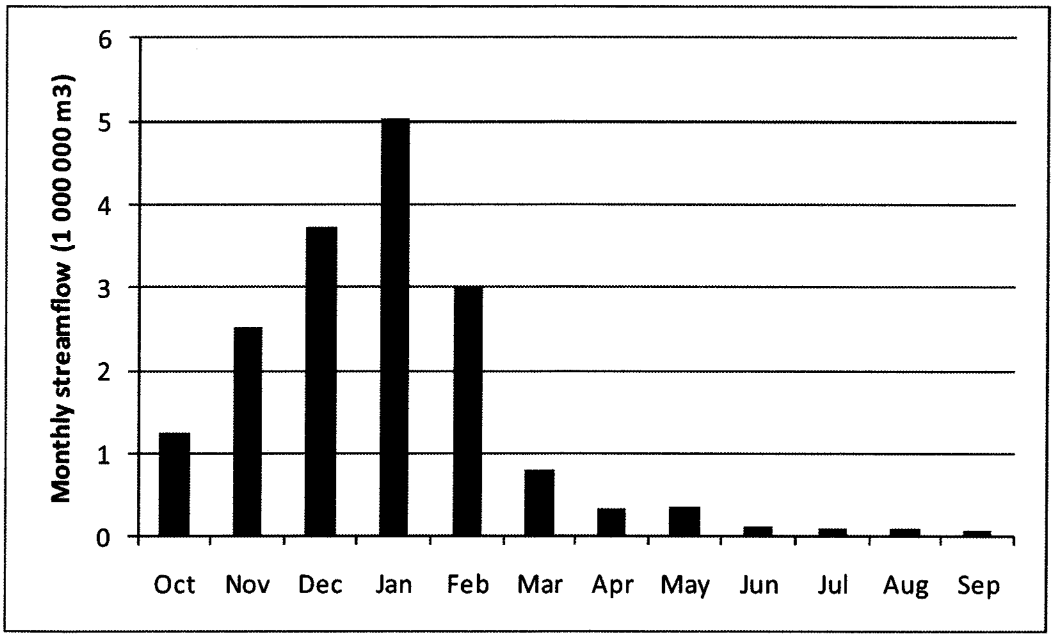


Figure 3-7: Monthly streamflow at gauge C1H005 at the outlet of catchment C11K

A floodline determination was undertaken for the unnamed tributary north of the proposed evaporation pond (APPENDIX A). The catchment characteristics used in applying the rational method are listed in Table 3-6. The estimated 50 year and 100 year recurrence interval flood peaks are listed in Table 3-7.

Table 3-6: Catchment parameters used in the flood peak determination

Parameter	**Catchment**
Area of Catchment (km^2)	2.35
Slope (m/m)	0.012
Hydraulic Length (km)	2.0
Time of Concentration (hrs)	1.127

Table 3-7: Flood peaks (m^3/s) calculated for the Catchment

Recurrence Interval Flood Peak	Flood Peak
50 year recurrence interval flood peak (m^3/s)	15.9
100 year recurrence interval flood peak (m^3/s)	20.25

3.8 Groundwater

A groundwater assessment was conducted to characterise the baseline groundwater situation and to assess the impact of the construction and operation of the proposed evaporation pond – see APPENDIX C. The study comprised the following:

- Review of existing information;
- Hydrocensus of the area around the evaporation pond site and pipeline;
- Collection and analysis of water samples from key representative boreholes at the site; and
- Reporting – site characterisation and qualitative impact discussion.

Aquifer Systems

Two aquifers have been identified within the study area (Golder, 2009):

- A thin shallow aquifer of relatively high permeability and storage and located at approximately 15 m below the surface; and
- A considerably thicker deep aquifer of low permeability located at approximately 60 m below the surface.

The shallow aquifer is developed in the saturated zone of the soil horizon and in the shallow weathered or fractured top surface of rocks close to the surface. It occurs within the top surface of the B4 dolerite sill and within weathered or fractured shale and sandstone / siltstone when the B4 dolerite is not present or has been eroded away at surface. The water body in the shallow aquifer is perched on relatively un-weathered and un-fractured bedrock (Golder, 2009). The maximum thickness of the shallow aquifer at NDC is estimated to be of the order of 50 m.

The average hydraulic conductivity for the shallow aquifer was established to be 0.006 m/day.

The deep aquifer comprises of the weathered bottom contact of dolerite, and faults and other geological contacts extending to depths deeper than 50m below surface. It occurs as discrete volumes or compartments, confined by impermeable or slightly permeable dolerite dykes and sills (Golder, 2009).

Groundwater flows in a south to south-westerly direction in the shallow aquifer and is presumed to flow in the same direction in the deep aquifer, towards the Leeuspruit and Vaal Rivers which constitute regional sinks of surface and groundwater (Golder, 2009).

Groundwater Recharge

Groundwater recharge in the shallow aquifer occurs by infiltration of rain water and infiltration from surface water sources such as streams, marshy ponds and dams. Recharge rates to the shallow aquifer have been estimated at 2%-5% (Golder, 2009).

The deep aquifer is recharged from the shallow aquifer through permeable fracture systems linking the two aquifer systems. The distribution of these fracture systems is highly variable and drainage of water from the shallow aquifer into the deep aquifer will generally be slow (Golder, 2009).

Groundwater quality

Available boreholes and surface water in close proximity to the proposed evaporation pond were sampled on 29 July 2010 (see Figure 4 of APPENDIX C for an indication of the sampling localities). The water level in borehole FBB085 was 21m bgl and no water levels were measured at boreholes FBB212 and FBB221 since the boreholes were fitted with pumps. FBB212 had a static water level of 34.45m bgl in September 2005. Boreholes FBB186, FBB187 and FBB188 had their pumps removed (or not in use) prior to the hydrocensus and the owner claimed they dried up due to the coal mining activities below.

The hydrochemistry results revealed that the groundwater and surface water from the bodies within and close to the proposed evaporation pond site is of good quality. All the measured parameters recorded values that fall within the acceptable Classes I and II of the South African National Standards (SANS 241) specifications for drinking water of 2005.

The Piper and Expanded Durov Plots also confirm that there is no contamination of water from the sampled sources. The type of water from the groundwater and surface water sources within the study area is classified as Ca-Mg-HCO_3 and is relatively young i.e. freshly recharged water.

3.9 Air quality

The proposed evaporation pond site is located within the Lekwa Local Municipality which is part of the Gert Sibande District Municipality. The Gert Sibande Spatial Development Plan (SDP, 2009) states that on 23 November 2007 the Highveld was declared a priority area, referred to as the Highveld Priority Area, in terms of section 18(1) of the National Environmental Management: Air Quality Act, 2004 (Act No 39 of 2004). A priority area may be declared when a situation exists which is causing or may cause a significant negative impact on air quality in the area, and the area requires specific air quality management actions to rectify the situation.

Potentially, local air pollution may arise as a result of particulates entering the atmosphere. These particulates arise as dust from dumps and from conveyors at the mine– particularly at transfer points. Monitoring of the NDC area and surroundings indicated that the impacts of settable dust can be described as minimal, since dust will settle gravimetrically within 500 m of the dust source.

Currently, all mining activities at NDC occur underground, with the result that these activities will have no impact on surface air quality in the study area. However, the associated surface infrastructure (transfer points and conveyors) may contribute to dust generation.

3.10 Visual aspects

A visual assessment specialist study was undertaken to inform the impact assessment for the proposed project. The terms of reference for the assessment were to determine the potential visual impacts of the proposed project components on potential viewers or receptors, in terms of the visual context within which the activity will take place and to develop mitigation strategies to address these. In order to achieve this aim, the following four steps were followed:

- Describing the landscape as visual resource by way of a baseline investigation, and characterising the nature and quality of the landscape and the visual sensitivity of the resource;
- Determining the change in the visual resource that would be brought about by elements of the proposed project, and how visible this change will be from the surrounding areas;
- Describing the expected visual impacts of key components of the proposed project; and
- Recommending mitigation measures to reduce the potential visual impacts of the project.

The results of the baseline investigation are summarised below (refer to APPENDIX I for details):

- Due to the gently rolling and largely featureless nature of the landscape the topography is not visually distinct and as such is not considered to be a significant visual resource;
- The only visually significant drainage features in the study area are the Leeuspruit, which drains northwards, and two east-west running tributary drainage lines situated north and south of the site respectively. However, both tributary drainage lines are non-perennial and are not considered to be prominent visual features in the study area. Several small pans are present in the study area and are considered to be localised visual resources but are not significant within the context of the entire study area.
- A number of small artificial dams also occur within the study area, but are not significant within the context of the project study area. The Grootdraai Dam is located south of the site, but is some 8 kilometres away and is not visible from the site. The project study area is therefore not considered to have any significant water body visual resources.
- The natural vegetation cover of most of the study area has either been replaced by cultivated maize fields, or is used for livestock grazing purposes as is primarily the case with the site itself; or has otherwise been degraded by industrial and mining-related activities. Small areas of somewhat disturbed natural vegetation occur along watercourses or fringes of other activities. Visually, these areas are largely homogenous in appearance and localised clumps of alien invader trees and human-made infrastructure become prominent elements in the landscape.
- The most significant settlement situated within the region is Standerton, although it does not fall within the study area. The result is that the area is largely rural in character; there are no large central business districts or tall, visually prominent buildings. The only significant exception is the Tutuka Power Station, which, due to its vertical height and footprint size, and the flat topography, forms a prominent landmark and is visible over a great distance.
- Other significant anthropogenic features situated in close vicinity of the site include:
  - Thuthukani township, situated some 2 kilometres west of the site;
  - The R39 and R38 Regional roads, which are situated south and east of the site respectively;
  - The R546 Road, which is situated to the west and falls outside of the study area of the VIA;
  - Various secondary asphalt roads, one of which forms the southern boundary of the site;
  - An aircraft landing strip, which is situated along the eastern boundary of the site;
  - High voltage high mast power lines leading to the north and south from Tutuka Power Station; and
  - A railway line passing north and west of the site.

In summary, the visual quality of the study area is of a low to medium value. Although the majority of the study area has a predominantly rural character, it is dominated by the power station and has been visually altered by a number of linear and other infrastructure features. Furthermore, it is not characterised by features that are visually exciting, such as prominent topography or attractive vegetation cover.

For details, refer to APPENDIX I.

3.11 Noise

A noise study was conducted as part of the impact assessment, (APPENDIX J). The purpose of the investigation was to assess the potential noise impact of the evaporation pond on the existing ambient noise climate outside the site boundaries, in particular at the Thuthukani residential area. This was achieved by predicting the noise levels generated by the evaporation pond operation and comparing these to measured noise levels at two points at the boundary between the existing power station site and the proposed evaporation pond site.

Ambient noise measurements were carried out on 29 July 2010 in accordance with the SANS Code of Practice 10103:2008 at two points on or near the property boundary between the Tutuka Power Station and the evaporation pond site (Figure 3-8).

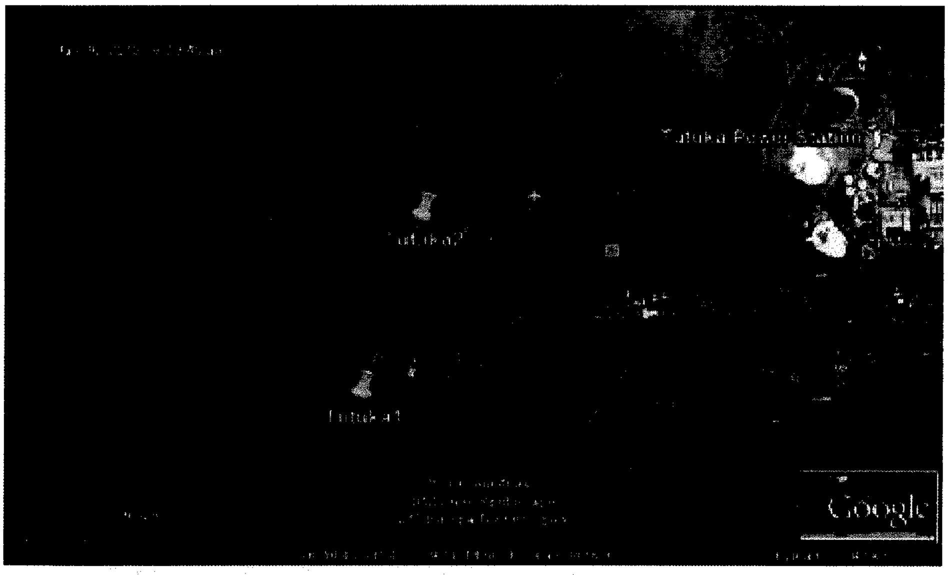


Figure 3-8: Baseline noise measurement localities (Tutuka 1 and Tutuka 2)

Baseline noise measurements for Tutuka 1 are typical of a sparsely trafficked road through a rural area, with the noise climate dominated by individual pass-bys of occasional road traffic. It was noted that traffic flow on this road is fairly regular, approximately one vehicle per minute. The background noise level is provided by the background operating noise of the power station, and is highly stable around 33 dB(A).

Baseline noise measurements for Tutuka 2 are typical of a rural area with the noise climate characterised by a single dominant noise source, i.e. the power station, and is consistently around 40 dB(A). It was noted that the traffic on the access road to the power station is masked by the noise from the power station at this measurement point. The background noise level is also provided by the background operating noise of the power station, and is highly stable around 35 dB(A).

In summary, existing noise sources in the area include:

- Tutuka Power Station operations;
- Vehicular traffic on the access road to Tutuka Power Station;
- Occasional overflying aircraft;
- Livestock and agricultural activity on surrounding land; and
- Local community and domestic noise.

3.12 Heritage aspects

A phase 1 heritage survey of the proposed evaporation pond site was conducted. This aims of this study were to identify and assess the significance of any heritage and archaeological resources occurring on the site. The results of the survey are summarised below – for details, refer to APPENDIX K.

The project area, including the greater Standerton region, has been poorly surveyed for heritage sites in the past. The South African Heritage Resources Agency's national register of heritage sites does not list any heritage sites for the region. The majority of archaeological research has taken place to the immediate east and north of the study area – an area which is exceptionally rich in Stone Age sites, Iron Age sites, and historical features. Nevertheless, it is known from historical literature that San hunter-gatherers as well as Nguni and Sotho-speaking farmers occupied the area in the recent past. The area was also heavily affected during the Anglo-Boer War of 1899-1901 and it is to be expected that many old farmsteads and associated graveyards may occur on farms in the region.

During the field survey, no heritage or archaeological features were identified within the footprint of the proposed evaporation pond site. The results of the ground survey are also supported by the desktop survey that indicated that there are no heritage sites associated with the footprint.

3.13 Socio-economic aspects

The project area is located in the Lekwa Local Municipality, in Gert Sibande District Municipality, Mpumulanga Province. Lekwa Local Municipality is one of seven municipalities within the Gert Sibande District Municipality, located in the south west of the district with immediate entrances to Kwa-Zulu Natal, Gauteng and Free State provinces through Newcastle, Heidelberg and Vrede.

Lekwa Municipality was established in December 2000 after the amalgamation of 3 former Transitional Local Councils namely Standerton, Sakhile and Morgenzon. The municipality lies on the large open plains of the Highveld region and is traversed by the Vaal River, the source of the name 'Lekwa', a Sotho name for Vaal River.

The Municipality has a population of approximately 112,000 people and is predominantly inhabited by Nguni speaking people, namely: Zulu, Swati, Ndebele, Sotho and Xhosa and other race groups. The annual growth rate is 2.8% and the population density 22.5%; lower than the district municipal area. The development trend shows increasing urbanization in the municipality, with over 65% of the population living in urban areas, compared to 35% in rural areas[3]. Influx numbers to towns continue to increase, many from outlying towns, driven by the hope of obtaining some form of employment and seeking better health and education services[4].

The economically active population (aged 20 – 64) makes up around 52% of the population, and approximately 64% of these are employed. Of the adults older than 20 years, 36% have education levels between Grade 1-7 (primary school), 55% have between Grade 8-12 (high school), 6% have some tertiary education and 2% have no schooling. The occupational structure of the employed persons shows that the majority of employed people are concentrated in elementary occupations (39%) followed by agriculture (28%).

The Lekwa economy is dependent on a limited number of sectors; namely agriculture, electricity generation and mining. Most of the other activities such as manufacturing, services and transport have been reliant on or have originated from these sectors. Lekwa's agricultural base covers cattle and sheep farming, maize, sorghum, mushrooms, flowers and sunflower cultivation, and the land surrounding the proposed development reflects this tendency, being dominated by grain farming and cattle. However, the increasing need for power generation and mining suggests a changing economic structure and land use within the local municipality, continuing the existing population shift towards urbanization and search for employment opportunities. Although economic growth is anticipated and is much needed, a risk of economic conversion rather than diversification is the impact of a sudden decline in the agricultural sector of the economy.

[3] Lekwa Municipality IDP 2008/11

[4] Lekwa Local Municipality: http://www.lekwamunicipality.org.za/infrastructure.htm. Accessed at 03/08/2010

4.0 NEED FOR AND DESIRABILITY OF THE PROPOSED PROJECT

NDC produces approximately 16.4 mega litres (Mℓ) per day of excess underground mine water that requires management. Eskom requires water for power generation operations and re-uses the mine water at the Tutuka site. The mine water contains some elevated concentrations of salts (e.g. sodium sulphate) and therefore requires treatment prior to use in the plant. Currently, the mine water is combined with cooling water (approximately 6 Mℓ/day) and treated by reverse osmosis (RO) at the site. A total of ±26 Mℓ/day is treated. The treatment system separates the "clean" water from the reject water and results in approximately 23 Mℓ/day of clean water for re-use and 3 Mℓ/day of reject water to be managed.

The current management of the water is as follows:

- Approximately 19.4 Mℓ/day re-used at the power station;
- Approximately 1 Mℓ/day used for dust suppression on an ash dump at the site for dust suppression;
- Approximately 1 Mℓ/day evaporated in boilers; and
- Less than 0.89 Mℓ/day disposed of in the 321 underground compartment of NDC.

In November 2009, NDC received a Directive from the Department of Water Affairs instructing the mine to implement an alternative management option for the RO reject, by October 2011. The reasons for this directive are:

- The underground 321 compartment is almost at full capacity;
- The current disposal method is considered inappropriate by DWA; and
- There is some concern that the constant application of water to the ash dump is resulting in increased seepage and contamination of the groundwater in the area.

Therefore, a new management method is required for the reject water. Investigations were undertaken to determine options for management of the water that minimise potential environmental impacts and would be economically feasible. The preferred option from these investigations was to:

- Upgrade the treatment system by construction of an RO reject concentration plant (covered under a separate EIA by Aurecon); the plant will reduce the volume of reject water from 3 Mℓ/day to 1 Mℓ/day; and
- Construct a pond at the site for storage and evaporation of the reject water.

The proposed evaporation pond will provide a solution to the management of RO reject for approximately ten years. The site has, however, been designed to accommodate reject for the life of mine. NDC has committed to continue with investigations into the long term and to develop post-closure water management measures for the mine.

5.0 CONSIDERATION OF PROJECT ALTERNATIVES

Alternatives are defined in Government Regulation No. 385, published in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA), as "*different means of meeting the general purpose and requirements of an activity, which may include alternatives to –*

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

This section will provide an overview of the alternatives consideration process forming part of this EIA, as required in terms of the NEMA. Where alternatives were not considered or have been discarded, reasons have been provided.

5.1 Technology and disposal alternatives

The following possible RO reject disposal options were assessed:

- Option 1: Direct disposal of RO reject in RO reject ponds; and
- Option 2: Volume reduction treatment of the RO reject in a secondary RO concentrator stage before disposal in the RO reject ponds.

A number of sub-options for the RO reject ponds were also investigated. These include:

- **A:** A single large pond sized to store and evaporate all RO reject;
- **B:** Phased implementation of smaller ponds where ponds are sized for evaporation and storage;
- **C:** Enhanced evaporation by spraying the reject water as a mist to increase surface area for evaporation; and
- **D:** Forced evaporation by heating and pressure reduction to reduce the volume before disposal in ponds.

The pond sizes required for the various options above were calculated. Disposing of the reject water without secondary RO concentration treatment would result in excessive pond sizes of up to 500 hectares and was not considered feasible. Therefore, the pre-treatment by RO concentration was selected.

The option of multiple ponds with staged construction and a RO concentration pre-treatment step was considered the most feasible from a technical and cost perspective.

The other sub-options following RO concentration were also considered but not preferred or in some cases they were not feasible. The single pond option would require a larger footprint and would take more time to construct and was not considered the preferred option. The forced evaporation option would result in significant additional construction costs, operating costs and additional on site infrastructure and was not considered feasible. The enhanced evaporation (sub-option C) option was found to result in clogging of nozzles and although it may be an option for future improvements, it was not selected as the primary option.

5.2 Location alternatives

5.2.1 Pond site

Initially, 13 potential sites for the evaporation pond were selected for investigation by desktop study and preliminary site visits. These sites had sufficient space available to accommodate the proposed pond. The potential sites were ranked according to a number of engineering, environmental and location (proximity to services and the Eskom site) criteria. An initial site located near the Eskom power station was selected for further investigation, known as site 2. A number of pond placement options within the selected site were investigated in more detail (Figure 5-1). As part of the selection process the proposed site was visited and assessed from an engineering and environmental perspective. The environmental site selection report is attached in APPENDIX L.

Option 1 was the most preferred option and was favoured over option 2 due to the proximity of option 2 to a trigonometric beacon and the larger artificial wetland area present in the option 2 footprint. Option 3 was the least favoured option as it was located on the neighbour's land and would result in a pipeline crossing the road.

5.2.2 Pipeline routes

Initially, two pipeline routes were considered (Figure 5-1). One route would pipe the flow from the treatment plant to the north of the site, west across the veld and south to the preferred pond location. The other would follow the road to the south of the plant and run along the road to the west to the pond locations. Both pipelines would remain on Eskom owned land. The southern pipeline option is considered the preferred option as it is located along an established road and is therefore easily accessible. It is also further from the runway.

5.3 Design and layout alternatives

The pond design was initially for two cells (A and B), split in an approximate north to south direction (Figure 5-1). Following a geotechnical investigation, it was found that there were certain limitations with respect to cell A. In order to resolve this, pond A will now be split into a further two cells, pond A north and pond A south, and Pond B will be split into pond B north and pond B south. In addition, by splitting (phasing) the cells, the likelihood of construction being completed by the time the directive date (i.e. October 2011) is reached, increases.

5.4 Land use development or activity alternatives

As indicated in Section 3.4, the high clay content, firm consistency and strong structure of black clay soils cause difficulties with cultivation and restrict suitable crop selection and such areas are therefore mostly utilized for grazing purposes. The veld has been highly modified in the past due to removal of dolerite in the area and the surface is undulating in nature. The site is located on land owned by Eskom and under a mining licence by NDC. Some maize is grown close to the proposed site, indicating that there is potential for some agricultural activities in the area.

5.5 The 'no go' alternative

The no go alternative scenario would result in a water management issue at the site. The mine would still produce excess mine water that would need to be pumped to the surface. Treatment would continue and a volume of reject water would be produced that requires management. The current disposal options (pumped to the underground compartment 321 and deposited on the ash dump) are considered inappropriate by the Department of Water Affairs. If this disposal method is discontinued, the no go alternative would result in a cessation of mining operations and Eskom's power plant would be affected by both coal and water supply shortfalls.

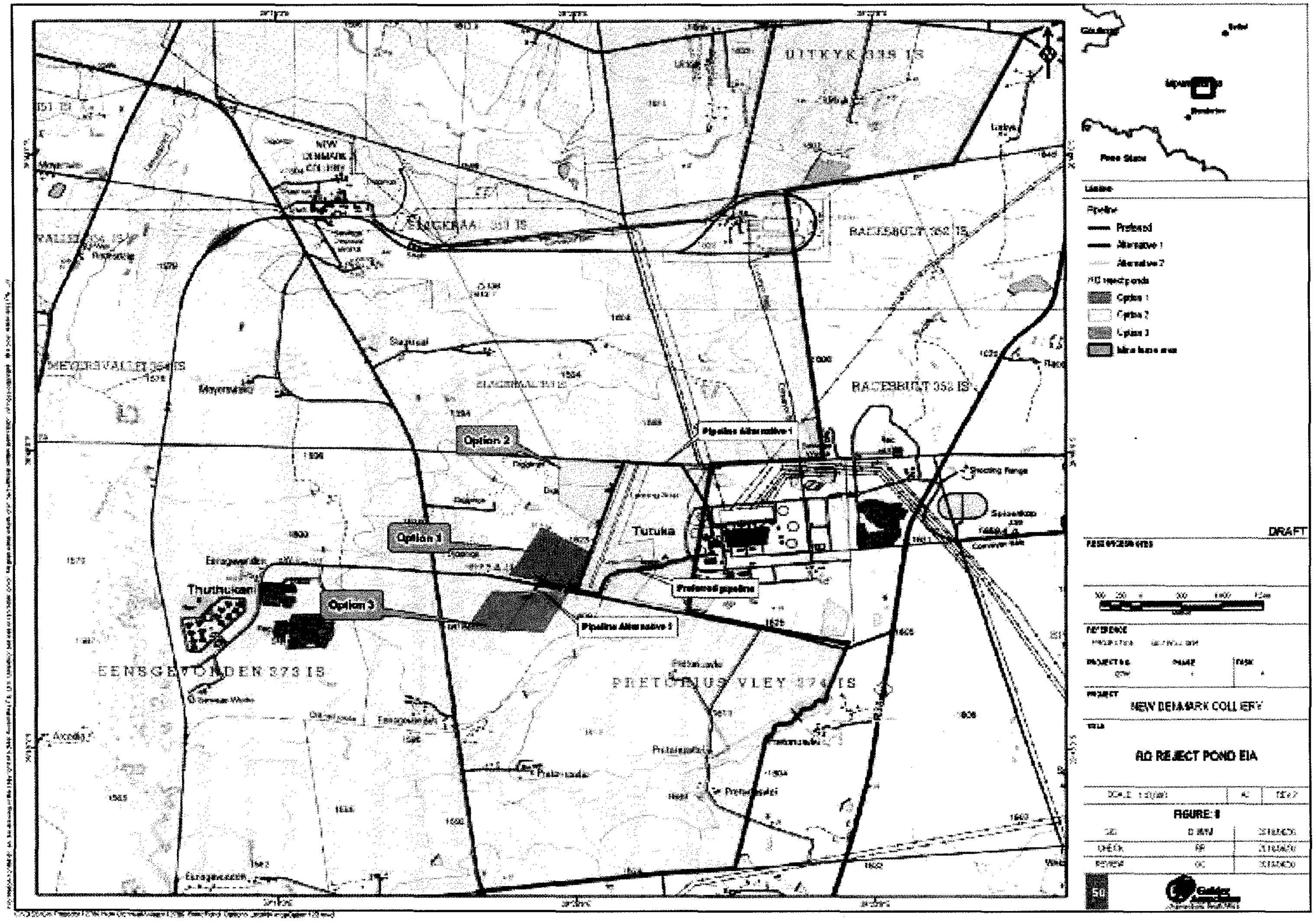


Figure 5-1: Pond and pipeline location alternatives

6.0 SUMMARY OF THE EIA AND PUBLIC PARTICIPATION PROCESS

A full EIA process is being followed for the proposed evaporation pond. An application form in terms of Section 27 of the NEMA EIA Regulations GN R385 was submitted to the Department of Economic Development, Environment and Tourism (MDEDET) on 02 July 2010. An EIA reference number and approval to proceed with the scoping process was issued on 03 August 2010. On 12 November 2010, approval to proceed with the impact assessment was received from the MDEDET (see **APPENDIX M** for copies of the MDEDET correspondence).

Public participation, an essential and regulatory requirement for an environmental authorisation process, has been conducted in accordance with the EIA Regulations GN R385 under the NEMA. The EIA process, including the public participation process, is summarised below.

6.1 Scoping Phase

6.1.1 Technical

Information gathering during the Scoping Phase served to collate all the required information about the proposed project as well as baseline information regarding the biophysical and social environment that would be affected by the proposed project. Based on that information, and the issues that emerged from the landowner, authority and other stakeholder consultation, issues requiring specialist technical assessment were prioritised and translated into terms of reference for the respective specialist studies.

6.1.2 Public Participation

Public participation in an EIA is not only a statutory requirement, but a process that is designed to lead to a joint effort by Interested and Affected Parties (I&APs) to evaluate all aspects of the proposed development, with the objective of improving the project by maximising its benefits while minimising its adverse effects. I&APs should represent all relevant interests and sectors of society, technical specialists and the various relevant organs of state who work together to produce better decisions than if they had acted independently, and better implementation of decisions through I&APs participating in the process. The public participation process must be guided by certain principles in order to be satisfactory to all parties. The requirements for such a process are guided by Regulation (GNR 385) under the NEMA.

The public participation process for the proposed construction and operation of an evaporation pond has been designed to provide sufficient and accessible information to I&APs in an objective manner to assist them to:

During the Scoping Phase

- Raise issues of concern;
- Make suggestions for enhanced project benefits and reasonable alternatives;
- Verify that their issues have been accurately recorded; and
- Contribute relevant local knowledge and information to the environmental assessment.

During the Impact Assessment phase

- Comment on the findings of the specialist assessments; and
- Raise additional issues and suggestions.

During the Decision-making phase

When the lead authority has made a decision stating whether or not the project may proceed, Golder will inform registered stakeholders of the decision, and the opportunity to appeal the decision, should they wish to.

Who are the I&APs?

Interested and Affected Parties (I&APs) include representatives from several sectors of society, including relevant government departments at all levels (national, local and provincial), spokespeople of key organisations, non-governmental organizations (NGOs), and community leaders in the area. A stakeholder database was proactively compiled for this project, resulting in a total of 123 individuals and organisations being informed about this EIA.

Public participation activities

Table 6-1 below provides details of the public participation activities conducted during the scoping phase of the EIA. Where activities have already been completed appendices of supporting material are indicated.

Table 6-1: Summary of Public Participation process during the Announcement and Scoping Phase

Activity	Details	Reference in EIA Report
ANNOUNCEMENT PHASE		
Identification of stakeholders.	Development of Stakeholder database which includes interested and affected parties from various sectors of society including directly affected landowners in and around the project area.	**Appendix N1** NDC Stakeholder Database. **Appendix N2** Registered I&APs Database.
Obtained comments from stakeholders.	Comments, issues of concerns and suggestions received from stakeholders are captured in the Comment and Response Report.	**Appendix N3** Comment and Response Report.
Distribution of project announcement letter, invitation to register as Interested and Affected Parties (I&APs), and Background Information Document (BID).	BID and announcement documentation emailed and posted to 123 stakeholders on 26 July 2010. (Public comment period: 10 August to 7 September 2010)	**Appendix N4** BID, announcement letter, registration and comment sheet.
Placing of BID in publically accessible places to obtain comments from I&APs.	60 BIDs distributed to 3 public places in Standerton.	**Appendix N4** List of public places in announcement
Newspaper advertisements to announce the project.	2 Advertisements (English) published in Standerton Advertiser on 16 July 2010 and Mpumalanga Mirror on 20 July 2010.	**Appendix N5** Copies of published advertisements.
Displaying site notices in and around the project area.	15 sites notices were placed at various locations in the project area. GPS coordinates of locations were taken.	**Appendix N6** Site notices and list of GPS coordinates.
Distribution of postponement letter.	Postponement of public comment period: 18 August to 15 September 2010.	**Appendix N7** Postponement letter.
SCOPING PHASE		
Announcing the availability of the Draft Scoping Report (DSR).	Letter announcing the availability of DSR emailed and posted to 123 stakeholders on the database on 16 July 2010. (Public comment period: 18 August to 15 September 2010).	**Appendix N4** DSR announcement letter, comment sheet and invitation to Open House.
Making DSR available on the Golder website during public review period.	Placed documentation on www.golder.com/public between	www.golder.com/public.

	18 August and 15 September 2010.	
Placing DSR in publically accessible places to obtain stakeholder comments.	DSR and accompanying documentation were placed in 3 public places for public review in Standerton.	**Appendix N4** List of public places in scoping.
Open House for stakeholders to comment on the DSR.	An Open House was held on 24 August 2010 at the Thuthukani Hall near Standerton.	**Appendix N8** Open House attendance register and photos
	IMPACT ASSESSMENT PHASE	
Announcing the availability of the Draft Environmental Impact Assessment Report (DEIAR) and public review period.	Letter emailed and posted to 134 stakeholders on 10 November 2010. (Public comment period 22 November to 13 December 2010)	**Appendix N9** DEIAR announcement and invitation letter.
Invitation letter for Open House.	Letter emailed and posted to 134 stakeholders on 10 November 2010.	**Appendix N9** DEIAR announcement and invitation letter.
Making DEIAR available on the Golder website during public review period.	Placed documentation on www.golder.com/public between 22 November and 13 December 2010.	www.golder.com/public.
Placing DEIAR in publically accessible places to obtain stakeholder comments.	DEIAR and accompanying documentation were placed at public places in Standerton for public review.	**Appendix N10** List of public places during impact assessment.
Open House for stakeholders to comment on the DEAIR.	An Open House was held on 29 November 2010 at the Thuthukani Hall near Standerton.	**Appendix N11** Open House attendance register and photos.
Obtained comments from stakeholders.	Comments, issues of concerns and suggestions received from stakeholders are captured in the Comment and Response Report.	**Appendix N3** Comment and Response Report.

Authority consultation

In addition to the above, consultation has held with the MDEDET, DWA (regional and head office), and DMR to establish specific guidance for individual regulatory processes and to provide feedback on progress of the project.

In addition, a meeting with the Department of Water Affairs (regional office in Pretoria) was held on 12 November 2010. The purpose of this meeting was to present to the Department progress on the Integrated Regulatory Process. The minutes of this meeting are attached hereto as **Appendix N12**.

A joint authorities meeting will be convened during January and February 2011. The purpose of this meeting(s) will be to ensure that each authority is satisfied with the findings of the EIA and conclusions reached. Authorities will be able to discuss findings of the Final Environmental Impact Assessment (EIAR) Report, ensuring that the Final EIAR and its framework EMP form a comprehensive document that will regulate the construction and operation of the proposed evaporation pond.

6.2 Assessment Phase

6.2.1 Technical

During this phase, the appointed specialists conducted individual specialist studies to identify, characterise and critically evaluate all potential impacts and the significance of those impacts. This was done using recognised evaluation criteria, as defined in the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998. Baseline data gathering for the EIA specialist studies commenced during the Scoping Phase. As stakeholder issues were received during scoping and the need for additional specialist studies was identified, these were commissioned. The following specialist studies were conducted; (the relevant reports are appended to this report):

- Soil, land use and land capability (APPENDIX E);
- Surface water (APPENDIX H);
- Floodline determination (APPENDIX A);
- Groundwater (APPENDIX C);
- Terrestrial ecology (APPENDIX F);
- Aquatic ecology and wetland (APPENDIX G);
- Visual (APPENDIX I);
- Noise (APPENDIX J); and
- Heritage (APPENDIX K).

The individual findings of the specialist studies have been integrated into a Draft Environmental Impact Assessment Report (EIAR) which synthesises the main impact assessment findings and recommendations. A draft Environmental Management Plan (EMP) has also been prepared, based on the recommendations for impact mitigation presented by the specialists.

6.2.2 Public participation

During the IA phase, specialist studies are conducted and the findings will be presented in the Draft EIA Report and EMP (this report). Public participation during the Impact Assessment Phase of the EIA mainly involves a review of the findings of the EIA. An invitation/announcement letter to inform IA&Ps of the availability of the Draft EIA Report and EMP was sent on 16 November 2010 (see **Appendix N10**). Consultation during the Impact Assessment Phase of the EIA will be with registered I&APs.

Distribution of the reports for public comment

The Draft EIA Report and its accompanying reports will be available for public review and comment from 22 November to 13 December 2010. These reports will be made available for comment by way of the following:

- Making reports available at public places within the project area (see **Appendix N10**);
- Mailing hard copies or CDs to key stakeholders and other I&APs who have requested a copy;
- Placing the reports on the Golder website (www.golder.com/public); and
- Making the reports available at the Open House meeting.

Open House

An Open House will be held on Monday, 29 November 2010 from 14:00 – 17:00 at the Thuthukani Hall near Standerton. The primary purpose of this meeting will be to discuss the content of the draft EIAR and to obtain comments from stakeholders on the draft findings of the EIA. Issues raised during the meeting will be incorporated into the Comment and Response Report.

Authority consultation

A joint authorities meeting will be convened end November / beginning December 2010. The purpose of this meeting will be to ensure that each authority is satisfied with the findings of the EIA and conclusions reached. During the meeting, authorities will be able to contribute to the Draft EIAR and assist to ensure that the final EIAR and its framework EMP form a comprehensive document that will regulate the construction and operation of the proposed evaporation pond. Comments raised at this meeting will be incorporated into the Comment and Response Report.

Final EIA Report

The Draft EIAR and specialist reports will be amended, as necessary, following comment received during the public review period. The Final EIA Report and specialist reports will be distributed to the authorities for decision making about the proposed project and stakeholders requesting a copy of the reports.

6.2.3 Decision-making

I&APs will be informed about the authority's decision about the proposed project and the appeal procedure. This notification will be as follows:

- A letter will be sent to all registered I&APs, summarising the authority's decision and explaining the procedure to appeal should they wish to; and
- An advertisement to announce the Lead Authority's decision will be published in the Mpumalanga Mirror and Standerton Advertiser.

6.3 Summary of key issues raised

Table 6-2: Summary of key issues raised

Category	Comments raised
Air quality	■ Dust from the ash dumps are currently blown by winds into farming areas.
Public participation	■ Requests that invitation information for the Open House also appears on the site notices. ■ Requests that the site notices also be translated into either IsiZulu, Sotho or Afrikaans.
Water	■ Concerns that the evaporation pond might overflow and pollute groundwater. ■ Concerns around the evaporation pond leaking and affecting groundwater users and potentially surface water resources in the region. ■ Groundwater or surface water pollution will have a negative impact on cattle grazing in the field. ■ Concerns that the pond at the site will capture surface water and therefore remove some water from the surface water system in the region. This can impact on downstream users and aquatic resources.
Environmental management and rehabilitation	■ Concerns around the closure and rehabilitation of the evaporation pond once its life expectancy has been reached.
Soil, land capability and land use	■ Concerns that there will be a disturbance to soils within the proposed site due to construction of the pond. This disturbance will occur during the Construction Phase and continue during the Operational Phase.

Category	Comments raised
	■ Concerns that the soil will not be stable enough and could cause cracking of the evaporation pond walls.
Terrestrial ecology	■ Due to the disturbance of soils and the removal of surface vegetation, the terrestrial ecology of the site will be affected. The terrestrial habit for animal species will be reduced by a relatively small area. The effect will occur during construction and will continue in the Operational Phase. The long term effects will depend on the closure scenario.
Socio-economic	■ Concerns that sub-contractors might steal or cause veld fires during construction of the evaporation pond.
Heritage resources	■ Concerns that the disturbance of the land in the site area has the potential to impact on any heritage resources in the area. Should this occur, the impact is likely to be permanent.
Visual impacts	■ Concerns that the construction of the pond and associated infrastructure will result in visual impacts for the duration of the project.

7.0 IMPACT ASSESSMENT

7.1 Description of the impact assessment methodology

Potential significance of impacts was based on occurrence and severity, which are further sub-divided as follows:

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Magnitude (severity) of impact	Scale / extent of impact

To assess each impact, the following four ranking scales are used:

PROBABILITY	DURATION
5 - Definite/don't know	5 - Permanent
4 - Highly probable	4 - Long-term
3 - Medium probability	3 - Medium-term (8-15 years)
2 - Low probability	2 - Short-term (0-7 years) (impact ceases after the operational life of the activity)
1 - Improbable	1 – Immediate
0 - None	
SCALE	**MAGNITUDE**
5 - International	10 - Very high/don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	

The significance of the two aspects, occurrence and severity, is assessed using the following formula:

SP (significance points) = (probability + duration + scale) x magnitude

The maximum value is 150 significance points (SP). The impact significance will then be rated as follows:

SP >75	[redacted]	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30 – 75	Indicates **moderate** environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP <30	[redacted]	Impacts with little real effect and which should not have an influence on or require modification of the project design.
+	[redacted]	An impact that is likely to result in positive consequences/effects.

Potential impacts were assessed using the above calculation and rating system, and mitigation measures were proposed for all relevant project phases (construction to decommissioning). The full impact assessment matrices for the three project phases are tabulated in Table 7-1, Table 7-2 and Table 7-3.

7.2 Summary of environmental components considered

The impact assessment considered the potential impacts of the proposed evaporation pond and pipeline on each of the following environmental components:

- Geology;
- Topography;
- Soil;
- Land capability and land use;
- Terrestrial ecology: fauna and flora;
- Aquatic and wetland ecology
- Surface water;
- Groundwater;
- Air quality;
- Noise and vibration;
- Sites of heritage significance;
- Visual aspects; and
- Socio-economic.

7.3 Project phases and activities

For the purposes of this impact assessment, the project timeframe was subdivided into the following three phases:

- Construction Phase;
- Operational Phase; and
- Decommissioning Phase.

Potential cumulative impacts were also identified and assessed for each component, where applicable.

The **Construction Phase** marks the beginning of physical changes to the site. During this phase, the following activities will take place:

- Surveying and pegging out of the construction areas, pipeline route, new evaporation pond footprint and new associated infrastructure on the pond site;
- Utilisation of existing access roads to the proposed evaporation pond site;
- Transporting materials and personnel to the proposed evaporation pond site;
- Preparation of construction servitudes (10 – 20 m in width) along the pipeline route;
- Clearing of vegetation;
- Stockpiling of topsoil and spoil material;
- Blasting of hard rock areas beneath the proposed evaporation pond;
- Excavation and shaping of the pond basins;
- Preparation and compaction of the pond floor;
- Installation of the liners, leak detection systems and seepage collection systems;
- Trenching along the pipeline route;
- Dewatering trenches, as required;

- Preparing and laying of pipes;
- Backfilling trenches and marking the route of the pipeline;
- Construction of storm water management structures (drains);
- Grading of gravel ring road surrounding pond site which; and
- Erecting security fence surrounding the pond site.

It is anticipated that the Construction Phase will take approximately **12 months** to complete.

NB: It is of crucial importance that the construction of the liners, leak detection systems and seepage collection systems, as well as the dam walls, be overseen and monitored by a suitably qualified and experienced engineer to ensure liner integrity and dam safety.

During the **Operational Phase**, the new evaporation pond and pipeline will be commissioned. Activities will comprise:

- Conveyance of RO reject from the new RO reject concentrator plant to the evaporation pond via pipeline;
- Storage of RO reject in the new evaporation pond;
- Groundwater seepage below the pond will be pumped to the unnamed non-perennial watercourse to the north of the site;
- Maintenance;
- Repairing and replacing infrastructure; and
- Lighting/illumination at the pond site.

The Operational Phase of the proposed project has been allocated a life of **10 years**. The site has, however, been designed to accommodate RO reject for the life of mine. NDC has committed to continue with investigations into long term and post-closure water management measures for the mine.

The **Decommissioning Phase** for this project is assumed to be after 10 years of operations (this is not linked to the decommissioning plans of the mining operations). Plans will be drawn up for dismantling the infrastructure and rehabilitation of the pond site. The detailed closure plan for the facility will be developed during the life of the facility.

The purpose in preparing a conceptual closure plan is to ensure that the facility design, construction and operating procedures are compatible with the achievement of final closure and rehabilitation to acceptable environmental standards and at a reasonable cost. It is anticipated that the conceptual plan will be updated periodically before the preparation of the detailed closure plan.

There are two potential closure scenarios for the facility, namely:

- Removal of the hazardous salt precipitate to a nearby hazardous landfill disposal facility followed by rehabilitation of the footprint.
- Leaving the facility in place.

The rehabilitation measures will be in accordance with the capping and closure requirements of the DWA *Minimum Requirements for Waste Disposal by Landfill* (DWAF, 1998a).

7.4 Construction Phase

Table 7-1 below summarises those impacts directly related to the Construction Phase of the proposed project and provides a significance rating for each impact before and after mitigation.

Table 7-1: Environmental Impact Assessment Matrix for the proposed NDC Evaporation pond project: Construction Phase

POTENTIAL ENVIRONMENTAL IMPACT: CONSTRUCTION PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	Total	SP	M	D	S	P	Total	SP
1. Geology												
Blasting in the excavation of the evaporation pond will displace / fracture sections of hard rock.	8	5	1	4	80		6	5	1	4	60	Mod
2. Topography												
During pipeline and pond construction, the temporary stockpiling, compaction of *in situ* material, excavation, mixing, and replacement of excavated material will affect surface topography.	2	3	1	3	14	Low	2	3	1	2	12	Low
3. Soil												
Topsoil stripping will result in loss of the original spatial distribution of soil types and natural soil horizon, sequences, loss of some original soil fertility, loss of original topography and drainage pattern, loss of original soil depth and soil volume and loss of the natural functioning of the soil – habitat for fauna and flora.	8	4	1	5	80		4	4	1	5	40	Mod
Soil may be polluted with oil and fuel spillages from mechanical equipment.	6	2	1	3	36	Mod	4	2	1	1	16	Low
4. Land capability and Land use												
39.9 ha of wilderness/grazing land capability will be impacted upon during construction. No commercial or non-commercial farming, housing, transporting or industrial use will be possible at the site.	10	4	1	5	100		2	4	1	5	20	Low
5. Ecology: terrestrial fauna and flora												
Vegetation clearing and stripping of topsoil during construction.	6	4	1	4	54	Mod	4	4	1	3	32	Mod
Noise of machinery and human activities will drive fauna away from the area.	6	2	1	4	42	Mod	4	2	1	3	24	Low

POTENTIAL ENVIRONMENTAL IMPACT: CONSTRUCTION PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	Total	SP	M	D	S	P	Tota l	SP
Removal of current alien species.	10	4	1	5	100		10	4	1	5	100	
6. Ecology: aquatics and wetland												
Smothering of aquatic and wetland biota due to increased sedimentation.	6	2	2	3	42	Mod	4	1	1	2	16	Low
Smothering of aquatic and wetland biota due to increased dust generation.	4	1	1	3	20	Low	2	1	2	2	10	Low
Contamination of aquatic and wetland ecosystems due to spillage of oils and hydrocarbons from machinery.	4	1	1	2	16	Low	2	1	0	1	4	Low
Loss of aquatic and wetland species diversity due to disturbance of the local environment.	6	3	2	2	42	Mod	4	3	2	2	28	Low
Changes in species abundance and shifts in community structure due to disturbances.	6	3	2	2	42	Mod	4	3	2	2	28	Low
Loss of artificial wetland habitat.	4	5	1	4	40	Mod	4	5	1	4	40	Mod
7. Surface water												
Surface water may be polluted with oil and fuel spillages from mechanical equipment.	4	2	1	3	24		4	2	1	1	16	
Further impacts to surface water resources may occur as a result of increased sedimentation of water sources as a result of exposed soils due to vegetation clearing and soil stripping operations.	4	1	1	3	20		2	1	1	2	8	
8. Groundwater												
The opening up and widening of micro-fractures as a result of pond excavation, as well as fracturing of underlying rock during blasting may provide pathways for the transmission of pollutants from sources at and around	2	2	2	2	12		2	2	2	2	12	

POTENTIAL ENVIRONMENTAL IMPACT: CONSTRUCTION PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	Total	SP	M	D	S	P	Total	SP
the proposed pond site.												
Accidental spillage of oil or other hydrocarbons and pollutants within the construction site may result in groundwater contamination.	2	2	1	2	10	Low	2	2	1	1	8	Low
9. Air quality												
Vehicle emissions and dust generated by vehicles traversing the construction site and by excavation of pipeline trenches will contribute to dust and PM_{10}.	2	2	2	4	16	Low	2	2	1	4	14	Low
10. Noise												
Blasting in areas of hard rock within the pond site will temporarily increase ambient noise levels.	6	1	2	4	42	**Mod**	4	1	2	4	28	Low
Movement of heavy machinery and vehicle traffic, will impact temporarily on existing noise levels in the area.	6	2	2	3	42	**Mod**	4	2	2	3	28	Low
11. Heritage												
n/a	-	-	-	-	-	-	-	-	-	-	-	-
12. Visual aspects												
Construction activities, dust mobilisation, and construction vehicles traversing the proposed site, as well as the presence of new infrastructure will transform the landscape.	4	3	2	4	36	**Mod**	2	2	2	4	16	Low
13. Socio-economic												
Creation of employment opportunities.	4	2	2	2	24	[redacted]	4	2	2	4	32	[redacted]
Environmentally intrusive impacts (i.e. visual, noise, vibration and dust).	6	2	2	3	42	**Mod**	4	2	2	2	24	Low
Construction crew may cause fires; theft and vandalism may increase in the study area.	6	2	2	2	36	**Mod**	4	2	2	1	20	Low

7.4.1 Geology

Impact assessment

Blasting of hard rock below the proposed evaporation pond footprint will impact on underlying geology. Blasting would displace / fracture sections of hard rock and impact on ambient noise levels and animal life in the study area, and generate dust.

Mitigation measures

The permanent displacement of *in situ* rock cannot be mitigated; however, by using appropriate blasting techniques the impact can be minimised.

Impact significance

Blasting activities will result in **high** impacts on the underlying geology of the site; however, should appropriate blasting techniques be used to minimise this impact, impact significance can be reduced to **moderate**.

7.4.2 Topography

Impact assessment

In situ material will be excavated and placed on the surface during the construction of the pond and pipeline. The stockpiling of material on the surface will only be a temporary measure for the construction of the pipeline, and the material will be replaced and rehabilitated within a relatively short period of time. However, for the construction of the pond, the stockpiling of topsoil will be present for the entire life of the facility. Settling is expected to occur over the areas where the buried pipelines have been laid as well as the topsoil stockpiles from the excavation of the pond. Compaction is also expected in areas where vehicles and plant equipment travel regularly.

The stockpiling, compaction of *in situ* material, excavation, mixing, and replacement of excavated material will affect surface topography and drainage. The construction of the storm water management infrastructure, especially berms, will further contribute to the impact on surface topography and drainage.

Mitigation measures

Recommended mitigation measures include:

- Excavated material is to be stockpiled in windrows not exceeding 1.5 m in height adjacent to the excavation for the pipelines;
- Excavated material should be stockpiled in a manner where it can act as storm water control berms during the Construction Phase;
- Storm water cut-off drains should be located regularly along the construction road;
- Separate stripping and stockpiling of topsoil and subsoil is required when constructing bulk earthworks to ensure that materials are not mixed, and can be returned to their former positions during rehabilitation;
- Ensure that rehabilitated areas are ripped to a suitable depth (minimum of 500 mm or to refusal);
- Ensure that the pipeline affected area is shaped to be free draining after rehabilitation is complete;
- Profile the pipeline affected area to be the same as the original topography;
- Harrow the pipeline affected area after seeding to ensure that the topography is re-established so that deep furrows are avoided; and
- A surface water drainage plan should be compiled prior to construction.

Impact significance

The negative impact on topography as a result of temporary stockpiling, compaction of *in situ* material, excavation, mixing, and replacement of excavated material will occur in the medium term, affect only the site, and be of a **low** significance.

7.4.3 Soils

Impact assessment

During the construction of the evaporation pond and the pipeline, stripping and storing of the topsoil will result in the following impacts:

- Loss of the original spatial distribution of soil types and natural soil horizon sequences. The upper and lower parts of the soil profile will be mixed (cannot be reconstructed during rehabilitation) and some weathered rock below the soil profile might also be stripped and mixed in, depending on skill, awareness and attitude of the operators who do the stripping. The transition from the black clay soil to the underlying yellowish grey weathered rock is abrupt and clearly visible and operators should be properly informed to strip the clean topsoil apart from weathered rock material. The disturbance of the soil horizon sequence cannot be prevented but mixing of topsoil and underlying rock can;
- Loss of some original soil fertility. The natural balance of elements in the soil profile will be disturbed during the stripping and storing process. However, this impact is much lower on black clay soil than sandier soils. The impact will in fact be fairly low;
- Loss of original topography and drainage pattern;
- Loss of original soil depth and soil volume. This is the most adverse impact on the natural soil resource. Loss of the original effective soil depth is the main reason for a dramatic degradation of pre-operation land capability to post-operation land capability; and
- Loss of the natural functioning of the soil. All natural vegetation will be destroyed where stripping occurs. Various processes take place in the soil profile such as root development, carbonation of organic material, oxidizing of elements and numerous microbial activities. The proposed operation will remove at least 40 ha of a habitat which includes numerous fauna and flora. Storing of topsoil will cause these processes to cease.

Spillages of hydrocarbons from construction vehicles and equipment on the pond site will have an impact on the soil chemistry and quality.

Mitigation measures

The following mitigation measures need to be implemented:

- Loss of the original spatial distribution of soil types and natural soil horizon sequences
  - Operators should be properly informed to strip the topsoil clearly and apart from underlying material;
  - Proper stockpiling of topsoil should be ensured. The topsoil will be stockpiled temporally until the walls are constructed. Any contamination of topsoil with underlying rock material should be prevented;
  - Topsoil should not be mixed with rock material of the wall, but should be stored as clean topsoil on the outer embankment of the wall;
- Loss of some original soil fertility
  - A fertilizer application during the rehabilitation process can be done after which the natural balancing of elements in the soil profile will re-establish over time;
- Loss of original topography and drainage pattern

- The original topography can be mitigated by proper backfill of the pond area to the original elevation prior to the construction.

- Loss of original soil depth and soil volume
  - Strip all topsoil above the transition to underlying weathered rock which is abrupt and clearly visible (average of 500 mm);
  - Store all topsoil on the outer embankment of the pond wall (approximately 2.5 m thick);
  - Inform operators properly about the stripping and storing procedure (APPENDIX E).
- Loss of the natural functioning of the soil
  - Limited mitigation is possible. Establish a grass layer on the outer embankment of the wall (stored topsoil layer). This will re-establish the natural processes to some extent.
- Seal the floor of the pond properly with synthetic products such as a HDPE liner or by means of a clay layer treated with an acrylic co-polymer consisting of molecular weight polymers such as "Damseal" developed to prevent water loss through leakage;
- The outer embankment should be planted with S*ynodon dactylon* or any other species with the ability to properly stabilize the edges;
- Soil pollution resulting from spillages of oil and/or hydrocarbons
  - Contamination due to oil and fuel spillages should be avoided;
  - Strict guidelines should be given to contractors in terms of the mechanical condition of equipment used, the maintenance of equipment as well as the reporting and cleaning up procedures of spillages, should they occur; and
  - All oil contaminated or otherwise polluted soil and wastes from the construction areas is to be removed to licensed landfill sites by a registered waste disposal company.

Impact significance

The significance rating of the impacts resulting from stripping and stockpiling soil is **high**, but they can be mitigated to moderate significance, should the above mitigation measures be implemented. Soil pollution resulting from oil and fuel spillages is considered a higher magnitude impact, with a **moderate** significance rating. However, should the relevant mitigation measures be implemented, the impact significance can be reduced to **low**.

7.4.4 Land capability and land use

Impact assessment

39.9 ha of wilderness/grazing land capability will be impacted upon during construction. No commercial or non-commercial farming, housing, transporting or industrial use will be possible at the site. The current land use for the pipelines will, however, return to subsequent to backfilling of the pipelines and rehabilitation.

Mitigation measures

See mitigation measures for soil.

Impact significance

The impact on land capability and land use of the pond site will be a **high** negative impact. Should the mitigation measures for soil indicated in Section 7.4.3 above be implemented, the impact significance can be reduced to **low**.

7.4.5 Terrestrial ecology

Impact assessment

During the Construction Phase, the vegetation clearing and stripping of topsoil will be the primary mechanism impacting fauna and flora. In total ±39.90 ha of land will be impacted. This is mostly made up of the pond, pipeline route and associated infrastructure (gravel ring road and security fencing). The removal of existing alien invasive species is, however, a positive impact. Noise of machinery, human activities and possible blasting will also drive fauna away from the area.

Mitigation measures

The following mitigation measures are proposed:

- Avoid dens, burrows, and nests where possible;
- Re-establish indigenous vegetation as habitat cover. Species include grasses such as *Eragrostis*;
- Minimise the project footprint as far as possible;
- Avoid accidental hydrocarbon spillages or pollution;
- Implementation of noise and vibration measures (Section 7.4.11) and
- Remove all alien and invasive vegetation.

Impact significance

The impacts on the terrestrial ecology of the site range between **low** and **moderate** significance due to the current disturbed status of the site. No Red Data species were found. A **high positive** impact will result from the removal of alien species.

7.4.6 Aquatic and wetland ecology

Impact assessment

Impacts associated with the construction of the evaporation pond and pipeline are as follows:

- Water quality impacts include:
  - Increased sedimentation within the water courses and wetland units as a result of the construction activities such as grading and excavation.
  - Leaks or spillage of hydrocarbons;
  - Dust generation.
- Habitat impacts:
  - Sedimentation and dust as a result of construction activities may result in increased sedimentation in the channel feeding into wetland unit NDC06 from surface water runoff.
  - Habitat loss will occur in wetland unit NDC08. This is, however, an artificial wetland with a low/marginal ecological importance and sensitivity.
- Biotic changes:
  - Loss or decline of sensitive aquatic species as a result of water quality or habitat impacts;
  - Increase in abundance of tolerant and invasive fish species; and
  - Shift in community structure to favour tolerant taxa.

Mitigation measures

The following mitigation measures should be implemented during construction:

- Sedimentation of the aquatic and wetland ecosystems during the construction period should be avoided where possible and runoff from site should be prevented from entering aquatic and wetland ecosystems;
- Clear only areas necessary for immediate construction;
- Numbers of construction vehicles and personnel accessing the construction site should be restricted. Silt traps should be put into place where runoff of silt or sedimentation is likely to occur as a result of the construction. Sediment traps should be erected around wetland unit NDC06 in particular;
- Rehabilitation of impacted areas should be done in conjunction with the construction process;
- Monitoring of sediment loads and water quality in the adjacent and downstream aquatic and wetland ecosystems will allow for early warning of any potential problems.
- Wetting of dirt roads and placing speed limits within the project area will reduce dust.
- All construction and clearing should be done in the dry season, if possible,
- Rehabilitate and the re-vegetate disturbed areas as soon as possible, using indigenous vegetation;
- Prevent any hydrocarbons from entering the aquatic and wetland ecosystems. Conduct maintenance and regular check-ups to prevent any vehicles, machinery or generators from spilling contaminants.
- Any spills or leaks of hydrocarbons should be contained and addressed immediately.
- All construction and clearing should be done in the dry season, if possible, so as to minimise surface water transport of sediments or contaminants into the aquatic ecosystems.
- Implement good construction practices, whereby waste and degradation or destruction of the aquatic and wetland ecosystems is minimised or prevented.
- Construction vehicles and personnel should be prevented from entering wetland and riparian buffer zones, including the streams and rivers;
- Noise and vibration levels should be kept to a minimum during the Construction Phase; and
- Discharges of RO reject into the surrounding environment should not be allowed.

Impact significance

Negative impacts associated with the Construction Phase range from **low** to **moderate**. For the proposed pond site, the loss of an artificial wetland has **moderate** significance.

7.4.7 Surface water

Impact assessment

The possible negative impacts on surface water during the pond Construction Phase are increased sedimentation due to surface water runoff and contamination of stream flow due to oil and fuel spillages from mechanical equipment.

As part of the floodline determination (APPENDIX A), the proposed evaporation ponds were measured to be 181 m and 182.5 m from the 1:50- and 1:100-year floodlines respectively of the unnamed non-perennial tributary of the Leeuspruit located to the north of the site. No impacts on stream flow are therefore anticipated.

Mitigation measures

Mitigation measures for potential oil and fuel spillages:

- Prevent any hydrocarbon spillage by preventive maintenance and regular checks on vehicles, machinery and generators.
- Implement best practices for storm water management procedures.
- Any spills or leaks should be contained and addressed immediately.

Mitigation measures against increased sedimentation due to surface water runoff:

- Proper stockpiling and storing of topsoil during construction;
- Implement erosion control methods.

It is also recommended that all infrastructure and construction related activities remain outside of the flood levels of the watercourse located to the north of the site (see Figure 2 of APPENDIX A).

Impact significance

The proposed project will have a **low** impact on the surface water in the area during the Construction Phase.

7.4.8 Groundwater

Impact assessment

The construction of the proposed evaporation pond is likely to open up and widen existing small or micro-fractures within the rocks close to the surface during soil excavation. Blasting will also result in fractures in the underlying hard rock (dolerite).The fractures will provide pathways for the transmission of pollutants from sources at and around the proposed pond site. In addition, there may be an impact on groundwater due to oil spillage from construction vehicles on the pond site and pipeline route.

Mitigation measures

Should appropriate blasting techniques which will keep blast shock to a minimum be implemented, the fracturing will be limited to some extent.

For the impact of oil spills on the site, mitigation measures addressed under soils will be applicable.

Impact significance

The fracturing of rock is considered to be a minor impact because minor fractures have already been reported in the area and the dolerite sill is up to 50 m thick in some places; these aspects will reduce the impact. Impact significance as result of fracturing is therefore considered to be **low**. The impact of oil spills is of **low** significance and can be easily be prevented / mitigated.

7.4.9 Air quality

Impact assessment

Vehicle emissions and dust generated by vehicles traversing the construction site will impact on air quality. The excavation of the pipeline trench and the pond will contribute to dust and PM_{10}.

Mitigation measures

Recommended mitigation measures include:

- Ensure that dust suppression measures are implemented on exposed soils and dust generating roads; and
- Ensure that vehicles are serviced regularly and that vehicles with emission problems are identified speedily and rectified.

Impact significance

Air quality impacts resulting from vehicle emissions and dust are considered to be **low** within the context of existing air quality impacts in the area. Impacts will act over the short-term, and affect the local extent. Should the appropriate mitigation measures, such as dust suppression, be implemented, impact significance can be further reduced.

7.4.10 Visual impacts

Impact assessment

It is anticipated that the most determining factor in terms of visual impact caused by the proposed evaporation pond, will be the degree to which it will be visible within the study area. The pipeline and additional infrastructure will not be of a significantly intrusive nature and only a relatively small number of receptors will be exposed to it.

Due to the generally low levels of development in the area it is unlikely that a large number of people will be visually affected by the proposed project. Standerton is the largest settlement in the vicinity of the site; and is connected to Ermelo via the R39 Road and to Bethal via the R38 Road. It is therefore likely that residents of the aforementioned towns as well as Thuthukani Township will constitute the majority of receptors. However, most receptors will only drive by and there are very few resident receptors within the study area. It is therefore expected that the receptor sensitivity for this project will be low.

The results of the viewshed analysis (APPENDIX I) clearly indicate the visual significance of Tutuka Power Station as it noticeably affects the visibility within the study area. The great height of the burner structure and especially the cooling towers is evident in the manner in which the viewshed is fragmented by it. Based on the above assessment, in summary it is stated that the level of visibility of the project components from within the study area is expected to be medium.

Due to the close proximity of the Tutuka Power Station to the proposed site for the new evaporation pond it is not anticipated that the evaporation ponds will cause significant visual intrusion. Compared to the power station infrastructure the evaporation pond and associated infrastructure are small in scale and mostly do not have visually complex shapes. Furthermore, the evaporation pond will be similar in appearance to a number of.

The majority of travellers through the study (along the R38 and R39 Roads) area will not come within 3 kilometres of the evaporation pond, pipeline and additional infrastructure; and as a result will only experience a very low visual exposure to the proposed project. Only persons travelling along the smaller roads passing closer to the site, and many of whom will be travelling to the power station, will be visually exposed to the new infrastructure to any significant degree. As a result it is expected that the overall visual exposure of receptors to the proposed infrastructure will be low.

Mitigation measures

Visual mitigation of a proposed mining or industrial area can be done by implementing measures that attempt to reduce the visibility of the structures and site disturbances associated with the activity. Thus an attempt is made to "hide" the visual impact from view by placing visually appealing, or visually less disruptive elements between the viewer and the activity causing a visual impact. This can be done as follows:

- Berms and embankments
  - Side walls of the evaporation pond should mimic the surrounding landscape as far as possible to minimise visual impacts;
  - All embankments or artificial slopes should be vegetated and sloped in such a manner that they do not erode, as these elements are often more visually intrusive than the infrastructure that they intend to screen; and
  - Berms should not be used for visual screening purposes except in instances where vegetative screens are not feasible and shall be undulating in nature with side lopes no greater than 1:3.

- Vegetative screening
  - It is recommended that a vegetative screen be established along the road located south of and adjacent to the evaporation pond. However, due to the extreme climate of the region, which is characterised by frost and sub-zero temperatures during winter, the feasibility of this recommendation, will have to be assessed by a botanical specialist.
  - Trees should be planted along the boundaries of the evaporation pond site and arranged in as natural a formation as possible, with trees in clumps and shrubs as undergrowth, to encourage nesting birds and create potential habitat for other small animals.
  - It is also important that all existing trees be retained where possible, as they already provide valuable screening. Only in instances where a combination of trees and shrubs is not feasible, may berms be employed for visual screening.
- Ongoing monitoring and maintenance of the rehabilitation areas will be required in order to ensure that they establish successfully and that erosion does not occur. The growth of the vegetation should be monitored continuously. Due to the unpredictable nature of vegetation growth and the challenging climatic conditions, the effectiveness of the re-vegetation will only become apparent after several years. Where specimens die, grow poorly or do not effect sufficient coverage the cause of the problem should be established and the afflicted specimens replaced, or a more suitable alternative established, based on a case-to-case basis.

Impact significance

Based on the above, the overall visual impact of the proposed evaporation pond and supporting infrastructure is expected to be **low**.

7.4.11 Noise and vibration

Impact assessment

Blasting in areas of hard rock within the pond site will temporarily increase ambient noise levels. In addition, movement of heavy machinery and vehicle traffic, will impact on existing noise levels in the area.

Mitigation measures

Mitigation measures for blasting include:

- Calculating the charge size and blast regime to optimise required excavation and fragmentation and thus keeping air blast and ground vibration levels below pre-determined acceptable values;
- Monitoring air blast noise, ground vibration and human response to ensure that accepted levels are in fact acceptable and are being adhered to, and modifying the blasting design as required;
- Pre-notification to affected persons of the intention to blast and the time of the blast, preferably at the same time of day to remove the element of surprise; and
- Correct stemming of blast holes.

Recommended mitigation measures for heavy machinery and traffic are as follows:

- Ensure efficient design and maintenance of silencers on diesel-powered vehicles and equipment; and
- Train personnel to adhere to operational procedures that reduce the occurrence and magnitude of individual noisy events.

Impact significance

The nature and magnitude of the response to noise from blasting operations will depend critically on the blasting regime chosen, the nature of the rock to be blasted, the size and depth of the charge, the type of explosive, the local topography, and the detonation sequence. As mentioned in APPENDIX J, there are at present no reliable national or international guidelines to accurately predict human or livestock response to blast noise. The closest habitations around the site are at distances of approximately 2.5 km from the nearest point of blasting. Impulsive noise levels are likely to be a maximum of approximately 75 dB(A) at the nearest dwellings, in the worst case that blasting is at the surface in the early stages of development. It should be noted that the proposed blasting frequency, once or twice per week, will not add to the overall noise level for normal noise assessment purposes as it is too short to be of significance in this regard, the response being entirely to the abrupt and unpredictable nature of the event, rather than its 'average' noise level over the day.

Neither the air blast nor the ground vibration are likely to have any damaging effect on humans, livestock, or buildings in the vicinity, if they are designed and carried out with due regard to good blasting practice and with the desire to obtain cost-effective results in operational terms. However, both air blast and ground vibration may give rise to secondary noise in a building, such as the rattling of windows and other loose objects in a state of neutral equilibrium, and this is often interpreted as a far more serious occurrence than it really is. An additional complication is that the blast will in general contain frequencies below those which can be heard by the human ear i.e. below 20Hz. These low frequencies also contain sufficient energy to give rise to secondary noise, just as with ground vibration, making it characteristically difficult to differentiate between what is attributable to airborne blast and what is attributable to ground-borne vibration. The maximum A-weighted sound level from most blasts, is, in fact, not much greater than the maximum A-weighted sound level from other machinery such as loading, tipping, and permanent plant operations.

Humans are extremely sensitive to vibration and can detect levels of ground vibration of less than 0.1 mm/s, which is less than $1/100^{th}$ of the levels which could potentially cause even minor cosmetic damage to a building. Complaints and annoyance regarding ground vibration are therefore much more likely to be determined by human perception than by noticing minor structural damage. However, these effects, and the startling effect of sudden impulses of both sound and vibration are often perceived as intrusion of privacy and could be a source of considerable annoyance to the local community. For this reason, and because of the absence of information on either the likely community response to blast noise or the likely levels of blast overpressure or audible noise, the noise impact for blasting operations is considered to be **moderate**. However, minimisation of the number of times when blasting occurs, and prior notification of blasting activities at predetermined times on stated days, and careful design of the blasting regime to reduce the levels of both airborne blast noise and ground-borne vibration will contribute significantly to the minimisation of the overall impact of blasting on the surrounding community to **low**.

Impacts on noise levels as a result of movement of heavy machinery and vehicle traffic will be **moderate**, short-term, and will take place on a local scale. These impacts can, however, be mitigated to **low**.

7.4.12 Heritage

The Phase 1 Heritage Impact Assessment (APPENDIX K) indicated that there are no impacts on archaeological or cultural historical sites for any phases of the project.

Should, however, any heritage resources of significance be exposed during the construction of the project, the South African Heritage Resources Authority (SAHRA) should be notified immediately, all development activities should be stopped and an archaeologist accredited with the Association for Southern African Professional Archaeologist (ASAPA) should be involved in order to determine appropriate mitigation measures for the discovered finds. This may include obtaining the necessary authorisation (permits) from SAHRA to conduct the required mitigation measures.

7.4.13 Socio-economic

Impact assessment

The evaporation pond and pipeline fall within the NDC mine boundary on Eskom-owned land. No private landowners would be directly impacted by the proposed project. There are therefore no land access issues or relocation required.

Approximately 200 additional employment opportunities will be created over a 12-month period for skilled (~70%) and unskilled (~30%) workers during the Construction Phase.

Environmentally intrusive impacts such as visual, dust, noise and vibration are addressed in the relevant sections above. With appropriate mitigation measures, these can be limited to low impacts.

Construction crew on site may cause fires; theft and vandalism in the study area may increase.

Mitigation measures

Make use of local labour as far as possible. Employment recruitment policies should be put in place.

Mitigation measures relating to visual, dust, noise and vibration impacts should be implemented.

Construction crew will only be present on site during the day; they will not stay overnight. Sub-contractor agreements and contracts will specify fire and theft prevention measures.

Impact significance

Although employment creation is **positive**, the limited number of opportunities available means this impact will be of **low** significance. The environmentally intrusive impacts and potential for fires and increased theft and vandalism are of **moderate** significance, but can be mitigated to **low**, should appropriate mitigation measures be implemented.

7.5 Operational Phase

Table 7-2 below summarises those impacts directly related to the Operational Phase of the proposed project, and provides a significance rating for each impact before and after mitigation.

Table 7-2: Environmental Impact Assessment Matrix for the proposed NDC Evaporation Pond Project: Operational Phase

POTENTIAL ENVIRONMENTAL IMPACT: OPERATIONAL PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	Total	SP	M	D	S	P	Total	SP
1. Geology												
n/a	-	-	-	-	-	-	-	-	-	-	-	-
2. Topography												
n/a	-	-	-	-	-	-	-	-	-	-	-	-
3. Soil												
Degradation of topsoil due to erosion of wall edges.	4	4	1	2	28	Low	2	4	1	1	12	Low
4. Land capability and Land use												
n/a	-	-	-	-	-	-	-	-	-	-	-	-
5. Ecology: Terrestrial												
Leaks from the pipelines and pond may impact on fauna and flora.	10	4	2	3	90	[redacted]	8	4	2	2	64	Mod
6. Ecology: aquatics and wetland												
Increased TDS concentrations due to spills or leaks	8	2	3	3	64	Mod	4	2	2	2	24	Low
Seepage from the evaporation pond.	6	4	2	3	54	Mod	4	2	1	2	20	Low
7. Surface water												
Seepage through pond liner.	4	2	2	2	24	Low	4	2	2	2	24	Low
Stream flow reduction.	2	5	2	1	16	Low	2	5	2	1	16	Low
Overspill of evaporation ponds.	6	1	2	1	24	Low	6	1	2	1	24	Low
8. Groundwater												
Groundwater contamination due to leakage of RO reject from the pond.	6	2	2	3	42	Mod	4	2	2	2	24	Low
9. Air quality												
n/a	-	-	-	-	-	-	-	-	-	-	-	-
10. Visual aspects												
Presence of new infrastructure in the landscape will transform the landscape.	4	3	2	4	36	Mod	2	2	2	4	16	Low
11. Noise												
n/a	-	-	-	-	-	-	-	-	-	-	-	-

POTENTIAL ENVIRONMENTAL IMPACT: OPERATIONAL PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	Total	SP	M	D	S	P	Total	SP
12. Heritage												
n/a	-	-	-	-	-	-	-	-	-	-	-	-
13. Socio-economic												
Creation of employment opportunities.	2	2	4	1	14	[illegible]	2	2	4	2	16	[illegible]
Impacts on health and safety of local communities / residents resulting from leaks from pond and pipeline.	2	1	2	2	10	Low	2	1	2	1	8	Low

7.5.1 Geology

There will be no impacts on geology during the Operational Phase of the proposed project.

7.5.2 Topography

No additional impacts are expected to occur on topography during the Operational Phase of the project. Should sections of the pipeline need to be replaced, the impacts described under the Construction Phase resulting from temporary stockpiling, compaction of *in situ* material, excavation, mixing, and replacement of excavated material will take place.

7.5.3 Soils

Impact assessment

During the Operational Phase the topsoil will be stockpiled on the outer embankment of the pond wall. The pond wall edges may be subject to erosion.

Mitigation measures

- Maintain vegetation on the outer embankment of the pond wall.

Impact significance

Impact significance is considered to be **low**.

7.5.4 Land capability and land use

The initial impact on land capability and land use takes place during the Construction Phase. No additional impacts take place during the Operational Phase.

7.5.5 Terrestrial ecology

Impact assessment

Leaks from the pipelines and pond may impact on fauna and flora.

Mitigation measures

See mitigation measures for surface and groundwater.

Impact significance

During the Operational Phase of the proposed project, the potential impact on terrestrial ecology is considered to be **high**. Should, however, appropriate mitigation measures be implemented, impact significance can be reduced to **moderate**.

7.5.6 Aquatic and wetland ecology

Impact assessment

In the event of an accidental spill from either the evaporation ponds or pipeline, high salinity water will enter the aquatic ecosystems and impact on the water quality and the aquatic biota.

Habitat impacts are considered to be minimal during the operational phase as the proposed location of the evaporation ponds does not sit within any drainage line and there are few disturbances to fauna and flora near the ponds during this phase.

Biotic integrity should not be influenced during the normal operation of the evaporation ponds.

Mitigation measures

Prevention of contaminated runoff from site entering aquatic and wetland ecosystems:

- Suitable storm water management, erosion prevention and runoff control measures should be constructed and maintained so as to prevent any runoff into the aquatic and wetland ecosystems. Early warning overflow systems should be monitored. An investigation as to whether seepage is occurring should be conducted. Measures for containment of accidental overflow or spill should be implemented around the proposed evaporation ponds;
- All pipelines and the proposed evaporation pond should be properly maintained, so as to minimize the risk of spills or leaks of contaminated water from entering the surrounding ecosystems; and
- Any spills or leaks should be contained to prevent downstream contamination and be cleaned up immediately.

Prevention of seepage into the surrounding aquatic and wetland ecosystems:

- Suitable lining and maintenance of the evaporation pond should be implemented. Monitoring of the surrounding environment will serve as an early warning mechanism if such a leak occurs.

Impact significance

The potential impact on aquatic and wetland ecology during the operational phase of the proposed project is rated as **moderate** and it can be mitigated to **low** significance.

7.5.7 Surface water

Impact assessment

Three potential negative surface water impacts have been identified, namely seepage through the liner system, stream flow reduction due to the reduction in catchment area, and overspill.

Seepage through liner

The evaporation ponds will be lined according to the minimum requirements and therefore seepage through the liner will be limited. The small amount of seepage that does get through the liner will be collected in the underdrains and pumped back into the ponds. Seepage to the shallow groundwater system will therefore be minimal; the possibility of contaminated groundwater discharging into the surface water environment is therefore also limited.

Stream flow reduction

The proposed evaporation pond is located on the boundary between two sub-catchments. The impact in terms of stream flow reduction will be limited by the relatively small reduction in the size of the catchment area. The two sub-catchments combined represent 21 % of the area of catchment C11K. If it is assumed that the flow is proportional to the area, these two catchments will produce an annual average contribution to the catchment runoff of 4.29 million m^3.

Sub-catchment A has an area of 3 437 ha of which the evaporation pond will take up 23 ha or 0.7 % of the area. Sub-catchment B has an area of 3 712 ha of which the evaporation ponds will take up 6 ha or 0.2 % of the area. Since the area is reduced by less than 1 %, the streamflow reduction will be insignificant.

Overspill

Overspill from the evaporation pond may occur in the event of an intense rainfall event. However, the probability of overspill is very low, since a 1:100 year flood event will raise the water level in the pond by 133.8 mm; however, a freeboard of at least 0.8 m will be added to the height of the pond wall. A spillway will, however, be provided to direct flow into the unnamed tributary to the north of the site, in the event of an intense rainfall event.

Mitigation measures

Over and above the maintenance of the liner system and allowance for freeboard in the pond design, no additional mitigation measures are recommended. The following good practices are, however, recommended:

- The liner for the evaporation ponds needs to be properly designed and developed according to the minimum requirements (DWAF, 1998). The liner specifications for hazardous waste lagoons require at least (from top to bottom):
  - A 2 mm geomembrane;
  - A 600 mm compacted clay liner;
  - A 150 mm leakage detection layer;
  - A second geomembrane of 1 mm; and
  - A 300 mm compacted clay liner.
- To prevent pollution of the surface water, the operational water level in the ponds should be managed in such a way as to maintain the 0.8 m freeboard.
- The Dam Safety Office of the DWA normally requires a spillway on evaporation ponds. If required, a spillway should be sized for the ponds to pass the probable maximum flood.

NB: It is of crucial importance that the construction of the liners, leak detection systems and seepage collection systems, as well as the dam walls, be overseen and monitored by a suitably qualified and experienced engineer to ensure liner integrity and dam safety.

Impact significance

The evaporation ponds will have an overall **low** impact on the surface water in the area.

7.5.8 Groundwater

Impact assessment

Groundwater contamination due to leakage of RO reject from the pond and pipeline during the operational phase is possible. Any groundwater contamination by RO reject will manifest as elevated levels of sodium, chloride and sulphate concentration in accordance with the chemical signature of the RO reject.

Mitigation measures

The pond will be lined with a triple liner system. A leakage collection and conveyance system will be included within the lining system. The liner system for the pond will incorporate two cuspated drainage systems to collect leaks from the primary and secondary HDPE geomembranes. Pipeline integrity will be regularly checked and maintained.

Impact significance

Considering that the pond will be lined and pipeline integrity will be regularly checked and maintained, this impact is highly unlikely. Moreover, in the event of leakage, the pollutants will not migrate fast within the shallow aquifer because of the low hydraulic conductivity of the aquifer (± 0.006 m/day). Therefore, this impact is considered to be of **low** significance and with a very low probability of occurrence.

7.5.9 Air quality

There will be no impacts on air quality during the Operational Phase of the proposed project.

7.5.10 Visual impact

The visual impacts described in the Construction Phase will continue into the Operational Phase. No additional visual impacts are envisaged.

7.5.11 Noise

The noise generated by the proposed project during the Operational Phase by, for example, the pump station, it will be absorbed into the already existing ambient noise levels. Therefore, this impact has no significance.

7.5.12 Heritage

There will be no impacts on heritage during the Operational Phase of the proposed project.

7.5.13 Socio-economic

Impact assessment

Limited employment opportunities will be created by the Operational Phase. Leaks from the pond and/or pipeline may impact on the health and safety of the local community members or farmers.

Mitigation measures

It is recommended that local labour be used as far as possible.

Signage should be erected at the pond site and at points along the pipelines to illustrate the dangers of the contents of the pond and the pipelines. This in turn will reduce the risks of theft or vandalism.

Impact significance

Although employment creation is **positive**, the limited number of opportunities available means this impact will be of **low** significance.

Impacts of **low** significance on the health and safety of members of the local community members or farmers are anticipated. The pipelines will be buried, and a triple liner system with leakage detection will be installed. Leaks of RO reject into the environment are therefore unlikely.

7.6 Decommissioning Phase

Table 7-3 below summarises those impacts directly related to the Decommissioning Phase of the proposed project, and provides a significance rating for each impact before and after mitigation.

Table 7-3: Environmental Impact Assessment Matrix for the proposed NDC Evaporation Pond Project: Decommissioning Phase

POTENTIAL ENVIRONMENTAL IMPACT: DECOMMISSIONING PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	Total	SP	M	D	S	P	Total	SP
1. Geology												
n/a	-	-	-	-	-	-	-	-	-	-	-	-
2. Topography												
Should the pipelines and evaporation pond be removed, the temporary stockpiling, compaction of in situ material, excavation, mixing, and replacement of excavated material will affect surface topography.	2	3	1	3	14	Low	2	3	1	2	12	Low
3. Soil												
Should pipelines be removed, topsoil stripping will result in loss of the original spatial distribution of soil types and natural soil horizon, sequences, loss of some original soil fertility, loss of original topography and drainage pattern, loss of original soil depth and soil volume and loss of the natural functioning of the soil – habitat for fauna and flora.	8	4	1	5	80		4	4	1	5	40	Mod
Soil may be polluted with oil and fuel spillages from mechanical equipment.	6	2	1	3	36	Mod	4	2	1	1	16	Low
4. Land capability and Land use												
39.9 ha of land will be returned to wilderness/grazing land	6	4	1	4	54		6	4	1	4	54	
5. Ecology: terrestrial fauna and flora												
Vegetation clearing and stripping of topsoil during construction.	6	4	1	4	54	Mod	4	4	1	3	32	Mod
Noise of machinery and human activities will drive fauna away from the area.	6	2	1	4	42	Mod	4	2	1	3	24	Low
6. Ecology: aquatics and wetland												
Smothering of aquatic and wetland biota due to	6	2	2	3	42	Mod	4	1	1	2	16	Low

POTENTIAL ENVIRONMENTAL IMPACT: DECOMMISSIONING PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	Total	SP	M	D	S	P	Total	SP
increased sedimentation												
Smothering of aquatic and wetland biota due to increased dust generation	4	1	1	3	20	Low	2	1	2	2	10	Low
Contamination of aquatic and wetland ecosystems due to spillage of hydrocarbons from machinery	4	1	1	2	16	Low	2	1	0	1	4	Low
Loss of aquatic and wetland species diversity due to disturbance to the local environment	6	3	2	2	42	Mod	4	3	2	2	28	Low
Change in species abundances and shifts in community structure due to disturbances	6	3	2	2	42	Mod	4	3	2	2	28	Low
7. Surface water												
Surface water may be polluted by oil and fuel spillages from mechanical equipment.	4	2	1	3	24	Low	4	2	1	1	16	Low
Increased sedimentation of water resources as a result of exposed soils due to decommissioning activities.	4	1	1	3	20	Low	2	1	1	2	8	Low
8. Groundwater												
Accidental spillage of oil or other hydrocarbons and pollutants within the decommissioning site may result in groundwater contamination.	2	2	1	2	10	Low	2	2	1	1	8	Low
9. Air quality												
Vehicle emissions, and dust generated by vehicles traversing the decommissioning sites. Should the pipelines be removed, dust from pipeline excavations will also result.	2	2	2	4	16	Low	2	2	1	4	14	Low
10. Visual aspects												
Decommissioning activities, dust mobilisation, and construction vehicles traversing the proposed site.	4	3	2	4	36	Mod	2	2	2	4	16	Low
The removal of project infrastructure will positively transform the landscape.	4	5	2	5	48		4	5	2	5	48	

POTENTIAL ENVIRONMENTAL IMPACT: DECOMMISSIONING PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	Total	SP	M	D	S	P	Total	SP
11. Noise												
Decommissioning related activities, such as movement of heavy machinery and vehicle traffic, will temporarily increase noise levels.	6	2	2	3	42	**Mod**	4	2	2	3	28	Low
12. Heritage												
n/a	-	-	-	-	-	-	-	-	-	-	-	-
13. Socio-economic												
A temporary increase in employment opportunities followed by a decrease.	4	2	2	2	24	[illegible]	4	2	2	4	32	[illegible]
Noise, dust and visual impacts associated with decommissioning activities.	See 9, 10 and 11 above											

7.6.1 Geology

No additional impacts on geology are expected during the Decommissioning Phase.

7.6.2 Topography

Should the pond and pipeline be removed during decommissioning, the impacts described under the Construction Phase as a result of the temporary stockpiling, compaction of *in situ* material, excavation, mixing, and replacement of excavated material will take place. All relevant mitigation measures provided for the Construction Phase should therefore be implemented.

7.6.3 Soils

Should the pipelines be removed during the Decommissioning Phase, all impacts which took place during the Construction Phase will be repeated. All relevant mitigation measures provided for the Construction Phase should therefore be implemented.

Over and above the mitigation measures already implemented, the site should be rehabilitated along the following guidelines:

- The approximately 2.5 m topsoil layer on the outer edge of the pond wall should be removed downwards to the toe of the wall. The wall consisting of rock material should be backfilled into the dam basin to reconstruct the original topography of the area, taking in account the 500 mm of topsoil that needs to be replaced. The surface should be gradually sloped to ensure a free draining surface with no accumulation of water anywhere. The topsoil should be spread evenly over the entire footprint of the pond.

- Because the original soil profile will be disturbed and the chemical status will change, it is important to do intensive soil analysis (determine soil fertility) after replacing of the top soil. The soil fertilizing programmes should therefore be based on the soil chemical status after replacing of the topsoil. A fertilizer programme should consists of a pre-seeding fertilizer application, an application simultaneously with the seeding process, and an annual maintenance application.

- The seed mixture and proportions in Table 7-4 are recommended. The mixture can be discussed with an ecologist. As many as possible of the natural species which occurred prior to construction should be included in the seed mixture. The aim of the seed mixture is to stabilize the soil rapidly and prevent soil erosion and not to establish highly productive pasture.

Table 7-4: Recommended seed mixture for rehabilitation

Seed	Common name	Kg/ha
Cynodon dactylon	Kweek	10
Digitaria smitsi	Smuts finger grass	3
Eragrostis teff	Teff	3
Themeda triandra	Red grass	4
Other natural species to be added if available	**	x
Total		**20**

***Synodon dactylon* is an indigenes pioneer species, a fast and strong grower and a good stabilizer. *Digitaria smitsi* is a variant of *Digitariea eriantha*, highly palatable and also adapted to soils with lower pH. *Eragrostis teff* is an annual, less strong growing species which will help stabilize the soil in the first year but will not prevent natural species from re-establishing. *Themeda triandra* is a climax species observed during the time of the soil assessment.

7.6.4 Land capability and land use

After decommissioning, the aim will be to rehabilitate the pond site to pre-construction capability (see soils). This will be a positive impact on land capability and land use of the site.

Terrestrial ecology

Should the pipelines be removed during the Decommissioning Phase, all impacts which took place during the Construction Phase will be repeated. All relevant mitigation measures provided for the Construction Phase should therefore be implemented.

Over and above the mitigation measures already implemented, the site would be rehabilitated along the following guidelines:

- By restoring the biophysical environment, the habitat may be improved, which can, in turn, be adequate for ecological restoration if sources are sufficient for colonization of species. An ecosystem has characteristics that need to materialise in order for it to regain integrity.
    - It needs to undergo natural development, where bare soil slowly releases nutrients through weathering; nutrients are in turn utilised by plants, which colonize the area.
    - The initial vegetation releases more nutrients which allow the colonization of more species.
    - The exotic species will have to be reduced, removed and managed (Cairns, 1995).
    - Treatment of soil may be required to restore fertility and ensure healthy plant growth. The soil should allow all the natural nutrient cycles and therefore it will need "plant food" to provide the carbons, nitrogen and other important plant elements for growth. This should also be associated with the type of soil, organic material will assist in improving the drainage of the soil (Harris, 2000). However, care must be taken to prevent the spread of pollutants and dangerous components.
- Rehabilitation of the project area can be conducted by vegetation or landscaping specialists. Small mammals were found on site and the rectification of the site by establishing indigenous species will provide habitat for fauna and will reduce the significance of most of the impacts identified. Monitoring of the site can be conducted by continually removing exotic species that might encroach. Disturbance to the environment should be reduced as far as possible and should be limited to the project site, as irreplaceable areas are identified adjacent to the project site by MBCP.

7.6.5 Aquatic and Wetland Ecology

The impacts which took place during the Construction Phase will be repeated. All relevant mitigation measures provided for the Construction Phase should therefore be implemented.

7.6.6 Surface water

The impacts which took place during the Construction Phase will be repeated. All relevant mitigation measures provided for the Construction Phase should therefore be implemented.

7.6.7 Groundwater

There may be an impact on groundwater due to oil spillage from construction vehicles on the pond site and pipeline route. For the impact of oil spills on the site, mitigation measures addressed under soils will be applicable. The impact of oil spills is of **low** significance and can be easily prevented/mitigated.

7.6.8 Air quality

The impacts from vehicle emissions and dust generated by vehicles traversing the decommissioning sites, which took place during the construction phase will be repeated.. Should the pipelines be removed, dust from pipeline excavations will also result. All relevant mitigation measures provided for the construction phase should therefore be implemented.

7.6.9 Visual impact

Should the pipelines be removed during decommissioning, the impacts of the construction phase will be repeated. The pond will be removed or capped and rehabilitated. Other infrastructure associated with the pond will be removed. This will be a **moderate** positive impact on the visual aspects of the study area. All relevant mitigation measures provided for the construction phase should therefore be implemented.

7.6.10 Noise

Decommissioning related activities, such as movement of heavy machinery and vehicle traffic, will temporarily increase noise levels. All relevant mitigation measures provided for the Construction Phase should therefore be implemented.

7.6.11 Heritage

No additional impacts are expected during the Decommissioning Phase

7.6.12 Socio-economic

Impact assessment

Potential impacts associated with the Decommissioning Phase may include:

- A temporary increase in employment opportunities followed by a decrease; and
- Noise, visual and dust impacts associated with decommissioning activities.

Mitigation measures

Potential mitigation measures may include:

- Undertake a programme of retrenchment and re-training during the Operational Phase, providing employees with clear, transparent information on planned activities and closure dates, offering employment at similar sites where possible and full retrenchment packages; and
- Implement appropriate noise, visual and dust mitigation measures.

Impact significance

There will be a temporary increase in employment opportunities, resulting in a **low positive** impact. This impact could be enhanced to **moderate**, should labour be sourced from local communities. Impact significance pertaining to noise, dust and visual impacts will range from **low** to **moderate**.

7.7 Cumulative Impacts

Soils, land capability and land use

Due to the already highly disturbed nature of the soils in the study area, the proposed project will probably result in low cumulative negative impact to soils acting over the long-term, and affecting the immediate site.

Terrestrial Ecology

The pond site is located within a highly disturbed area. Currently, the vegetation at the site is utilised for grazing of livestock and wildlife farming purposes. The total cumulative negative impact will probably be of low significance, affecting the local extent.

Aquatic and Wetland Ecology

There are wetland areas within the broader area surrounding the project site. These were identified during the site selection process (part of the scoping phase of the project). Some of these wetlands are artificial with little to no ecosystem function as is the case with the artificial wetland within the preferred pond site. Cumulative impacts from the proposed pond site will probably have a low significance and only affect the local site, should there be any seepage or overspill from the phases of the project.

Noise

Since the proposed project components are situated in close proximity to existing noise impacts such as the power station, etc., the contributions of the proposed project to cumulative impacts are considered to be insignificant.

7.8 Knowledge gaps, assumptions and limitations

Heritage

It is possible that the Phase 1 HIA may have missed heritage resources in the project area, as some heritage sites may occur in thick clumps of vegetation while others may lie below the surface of the earth and may only be exposed once development commences.

Terrestrial ecology

The terrestrial ecology assessment was based on information collected during a single site visit during July 2010, i.e. in the cold and dry season. No detailed soil, geological or geotechnical information was available at the time of the survey. In order to obtain a comprehensive understanding of the dynamics of communities and the status of endemic, rare or threatened species in any area, vegetation and faunal assessments should consider investigations at different time scales (across seasons/years) and through repetition.

Furthermore, due to the fact that the single survey was conducted during the dry season and not the wet season, many plant species could not be identified due to absent inflorescence above ground. In such a scenario, the precautionary principle should be applied and all natural portions of grassland should be regarded as sensitive.

Limitations of this method of sampling include the following:

- Temporal changes in biodiversity are not taken into account during single sampling efforts;
- Geophytic Red Data species could not be identified;
- Species could have been missed during the survey;

- Variations in biodiversity due to temporal animal movements, such as migrations, are not taken into account; and
- Unusual environmental conditions (such as unusually high or unusually low rainfall) may cause unusual states of biodiversity during the period of study, which may not usually exist.

No vegetative Red Data species or protected species of Mpumalanga were identified during the site visit. However, due to the fact that the survey was conducted during the dry season, the potential occurrence of protected species on site cannot be eliminated.

Aquatic ecology and wetlands

- GPS points taken in the field are within an accuracy of 10 m;
- Historical data relating to aquatic and wetland ecosystems has been incorporated to increase the understanding of the localised aquatic ecosystems; and
- The results of aquatic ecology and wetland assessment have been generated from a single survey which took place in August 2010, before the onset of spring.

8.0 ENVIRONMENTAL MANAGEMENT PLAN

8.1 Purpose of the EMP

This Environmental Management Plan (EMP) is based on the results of the Environmental Impact Assessment as outlined in Chapter 7 of this document, and addresses the management and mitigation of the environmental impacts resulting from the proposed activities associated with the New Denmark Colliery Evaporation Pond Project. Both the EIA Report and this EMP have been prepared in accordance with the requirements of the Regulations GN R 385 under the National Environmental Management Act, 1998 (Act 107 of 1998).

8.2 Implementation of the EMP

A number of activities must take place before commencement of construction. Certain of these activities are not directly related to physical work on site, but are presented below, as they should be addressed before commencement of, or during the early phases of construction.

8.2.1 Anglo's responsibility for EMP implementation

Primary responsibility for implementation of the EMP rests with Anglo, who must ensure that all contracting companies tendering for work receive a copy of the EMP and understand their responsibility to operate within the framework of the measures defined in the EMP. When adjudicating tenders, Anglo will ensure that contractors have made appropriate allowance for the management of environmental matters. Anglo will include adherence to the EMP as a contractual condition in all agreements with contractors. Anglo will appoint an Environmental Control Officer (ECO) who will be present on site as often as possible, but who will, as a minimum, undertake EMP audits every month during the Construction Phase. ECO audit intervals during the Operational Phase should be confirmed and agreed with the ECO before commencement with this phase.

8.2.2 Responsibility of contractors

All contracting companies will receive a copy of the EMP at time of tender. Each contractor is to familiarise himself with the environmental management measures for the site and ensure that contracting prices allow for environmental costs.

At appointment each contractor must have his copy of the EMP on site. It is the responsibility of the contractors to ensure that all of their staff are aware of the measures applicable to their area of work on site. It is the responsibility of the contractor to bring to the attention of the Anglo ECO any environmental incident or breach of the conditions of the EMP, within 24 hours of occurrence of such event, through the company's Incident Reporting System.

8.2.3 Environmental incidents and breaches of EMP conditions

The ECO will bring to the attention of the Anglo site manager any significant environmental incidents or breaches of the conditions of the EMP, within 24 hours of occurrence of such event. The site manager will notify the controlling authority within 48 hours of such an incident, if the environmental incident constitutes a reportable breach of any permit or licence condition.

The ECO will continuously monitor the contractor's adherence to the EMP and will issue the contractor with a notice of non-compliance whenever transgressions are observed. The ECO will record the nature and magnitude of the non-compliance in a register, the action taken to discontinue the non-compliance, the action taken to mitigate its effects and the results of the actions. The contractor should act immediately when a notice of non-compliance is received and implement the agreed corrective action.

Any avoidable non-compliance with the EMP will be considered sufficient grounds for the imposition of a penalty. The value of the penalty will be equal to the cost of corrective action, i.e. the cost to the contractor equals twice the cost of corrective action. Any non-compliance with the agreed procedures of the EMP is a transgression of the various statutes and laws that define the manner in which the environment is managed. Set penalties should be enforced. Penalties shall be specified in the contract with the Contractor.

8.2.4 Complaints management

Complaints received regarding activities on the construction site pertaining to the environment should be recorded in a register and the response noted with the date and action taken. This record should be submitted with the monthly reports and a verbal report should be given at regular site meetings.

8.3 Construction Phase EMP

The mitigation measures that have been identified for the Construction Phase of the proposed project are listed in Table 8-1).

8.4 Operational Phase EMP

See Table 8-2 for the mitigation measures identified for the Operational Phase of the proposed project.

8.5 Decommissioning Phase EMP

The mitigation measures have been identified for the Decommissioning Phase of the proposed project are provided in Table 8-3.

Table 8-1: Environmental Management Plan for the NDC Evaporation Pond Project – Construction Phase

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
1. Geology				
1.1	**Project activity:**	Blasting of hard rock underlying the pond site.	-	-
	Impact:	Blasting in the excavation of the evaporation pond will displace / fracture sections of hard rock, cause noise at local receptor sites and place structures at risk of damage.	-	-
	Mitigation measure(s):	Implement appropriate blasting techniques which will keep blast shock to a minimum.	As appropriate, throughout construction	Contractor
2. Topography				
2.1	**Project activity:**	During pond and pipeline construction, the temporary stockpiling, compaction of *in situ* material, excavation, mixing, and replacement of excavated material will occur.	-	-
	Impact:	The stockpiling of material on surface will alter surface topography. Compaction is expected over areas where vehicles and plant equipment travel regularly.	-	-
	Mitigation measure(s):	Excavated material is to be stockpiled in windrows not exceeding 1.5 m in height adjacent to the excavation for the collection and distribution pipelines.	As necessary, throughout excavation	
		Excavated material should be stockpiled in a manner where it can act as storm water control berms.	As necessary, throughout excavation	Contractor
		Storm water cut-off drains should be located regularly along construction servitudes.	As necessary, throughout construction	Contractor

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
		Separate stripping of topsoil and subsoil is required when constructing bulk earthworks to ensure that excavated materials are not mixed, and can be returned in the former position during rehabilitation.	As necessary, throughout excavation	Contractor
		Ensure that rehabilitation areas are ripped to a suitable depth (minimum of 500 mm).	As necessary, during rehabilitation	Contractor
		Ensure that pipeline affected areas re shaped to be free draining after rehabilitation is complete.	As necessary, during rehabilitation	Contractor
		Profile pipeline affected areas to be the same as the original topography.	As necessary, during rehabilitation	Contractor
		Harrow pipeline affected areas after seeding to ensure that the topography is re-established so that deep furrows are avoided.	As necessary, during rehabilitation	Contractor
		A surface water drainage plan should be compiled prior to construction.	Once, prior to construction	Contractor
3. Soil				
3.1	**Project activity:**	Topsoil stripping and storage	-	-
	Impact:	Loss of the original spatial distribution of soil types and natural soil horizon sequences, loss of some original soil fertility, loss of original topography and drainage pattern, loss of original soil depth and soil volume, loss of the natural functioning of the soil	-	-
	Mitigation measure(s):	Strip the topsoil clean apart from underlying material. Strip all topsoil above the transition to the underlying weathered rock, which is abrupt and clearly visible (average of 500 mm). Implement the stripping and storing procedure (APPENDIX E).	As necessary, throughout excavation	Contractor

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
		Proper stockpiling of topsoil should be ensured. The topsoil will temporally be stockpiled until the pond walls are constructed. Once the pond walls are in place, store all topsoil on the outer embankment of the pond wall (approximately 2.5 m thick).	As necessary, throughout construction	Contractor
		Topsoil should not be mixed with rock material of the wall, but should be stored as clean topsoil on the outer embankment of the wall. Any contamination of topsoil with underlying rock material should be prevented.	As necessary, throughout construction	Contractor
		A fertilizer application during the rehabilitation process should be done after which the natural balancing of elements in the soil profile will re-establish over time.	As necessary, during rehabilitation	Contractor
		Establish a grass layer on the outer embankment of the wall (stored topsoil layer). The outer embankment should be planted with *Synodon dactylon* or any other species with the ability to properly stabilize the edges.	As necessary, subsequent to wall embankment construction	Contractor
		Seal the floor of the pond properly with synthetic products such as a HDPE liner or by means of a clay layer treated with an acrylic co-polymer consisting of molecular weight polymers such as "Damseal" developed to prevent water loss through leakage;	As necessary, during construction	Contractor
3.2	**Project activity:**	Oil and fuel spillages from mechanical equipment	-	-
	Impact:	Soil pollution	-	-
	Mitigation measure(s):	Contamination due to oil and fuel spillages should be avoided.	As necessary, throughout construction	Contractor
		Strict guidelines should be given to contractors in terms of the mechanical condition of equipment used, the maintenance of equipment as well as the reporting and cleaning up procedures of spillages, should they occur.	ction	

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Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
		All oil contaminated or otherwise polluted soil and wastes from the construction areas are to be removed to licensed landfill sites using a registered waste disposal company.	As necessary, throughout construction	Contractor
4. Land capability and land use				
4.1	**Project activity:**	Excavating pond footprint and pipeline trench.	-	-
	Impact:	39.9 ha of wilderness/grazing land capability will be impacted upon during construction.	-	-
	Mitigation measure(s):	See 3.1-3.2 above.	As necessary, throughout construction	Contractor
5. Ecology: terrestrial flora and fauna				
5.1	**Project activity:**	Vegetation clearing and stripping of topsoil during construction.	-	-
	Impact:	Loss of vegetation communities and animal habitat; loss of biodiversity	-	-
	Mitigation measure(s):	All exotic and invasive species should be removed within the pond site.	As necessary, throughout construction	Contractor
		Avoid dens, burrows, nests where possible;	As necessary, throughout construction	Contractor
		Re-establish indigenous vegetation as habitat cover. Species include grasses such as *Eragrostis*;	As necessary, during rehabilitation	Contractor
		Inspect rehabilitated areas at three monthly intervals during the first and second	As necessary, during	Contractor

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
		growing season to determine the efficacy of rehabilitation measures.	rehabilitation	
		Minimise the project footprint as far as possible.	As necessary, throughout construction	Contractor
5.2	**Project activity:**	Presence of machinery and human activities.	-	-
	Impact:	Drives fauna away from the area.	-	-
	Mitigation measure(s):	See Section 10 below.		
6. Ecology: aquatics and wetland				
6.1	**Project activity:**	Construction of pipeline and pond site.	-	-
	Impacts:	Impact on water quality, aquatic biota, and macro-channel, riparian and in-stream habitats.	-	-
	Mitigation measure(s):	Sedimentation of the aquatic and wetland ecosystems during the construction period should be avoided where possible and runoff from site should be prevented from entering aquatic and wetland ecosystems.	As necessary, throughout construction	Contractor
		Clear only areas necessary for immediate construction.	As necessary, throughout construction	Contractor
		Numbers of construction vehicles and personnel accessing the construction site should be restricted. Silt traps should be put into place where runoff of silt or sedimentation is likely to occur as a result of the construction. Sediment traps should be erected around wetland unit NDC06 in particular.	As necessary, throughout construction	Contractor

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
		Wetting of dirt roads and enforcing speed limits within the project area will reduce dust.	As necessary, throughout construction	Contractor
		Rehabilitation of impacted areas should be done in conjunction with the construction process.	As necessary, throughout construction	ECO
		Rehabilitate and the re-vegetate disturbed areas as soon as possible, using locally indigenous vegetation.	As necessary, throughout construction	ECO
		Prevent any hydrocarbons from entering the aquatic and wetland ecosystems. Undertake preventive maintenance and regular checks to prevent any vehicles, machinery and generators from spilling contaminants.	As necessary, throughout construction	Contractor
		Any spills or leaks of hydrocarbons should be contained and addressed immediately.	As necessary, throughout construction	Contractor
		All construction and clearing should be done in the dry season, if possible, so as to minimise surface water transport of sediments or contaminants into the aquatic ecosystems.	As necessary, throughout construction	Contractor

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
		Implement good construction practices, whereby waste and degradation or destruction of the aquatic and wetland ecosystems is minimised or prevented.	As necessary, throughout construction	Contractor
		Construction vehicles and personnel should be restricted from entering wetland and riparian buffer zones, including the streams and rivers.	As necessary, throughout construction	Contractor
		Noise and vibration levels should be kept to a minimum during the Construction Phase.	As necessary, throughout construction	Contractor
		Implement corrective mitigation measures should any significant decrease in ecological integrity occur (both aquatic and wetland) within any biomonitoring period as a result of impacts associated with the pipeline and pond site.	As necessary, throughout construction	ECO
7. Surface water				
7.1	**Project activity:**	Pond and pipeline construction.	-	-
	Impact:	Impact on water resources due to increased sedimentation from exposed soils.	-	-
	Mitigation measure(s):	All mitigation measures for soil, vegetation, and wetlands should be implemented.	As necessary, throughout construction	Contractor
		During backfilling of pipeline trenches and stockpiling, soils should be well compacted and vegetation re-established as soon as possible to prevent erosion.	As necessary, throughout	Contractor

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
			construction	
		No construction activities should be located within the floodlines of the watercourse to the north of the site. All stockpiles should be located outside the 1:50 year floodline (see Figure 2 of APPENDIX A for floodlines).	As necessary, throughout construction	Contractor
		During pipeline trenching, strip soils and replace in the same order according to the former position in the soil profile to avoid significant mixing of soils.	As necessary, throughout excavation	Contractor
		Ensure soils are adequately ripped in areas of disturbance to ensure optimal re-growth of the vegetation and percolation of water is optimal.	As necessary, throughout rehabilitation	Contractor
		Where possible, soil and vegetation must be rehabilitated before the next rainy season.	As necessary, throughout rehabilitation	Contractor
7.2	**Project activity:**	Accidental spillage of oil or other hydrocarbons and pollutants within the proposed pond site and pipeline route.	-	-
	Impact:	Degradation of surface water quality.	-	-
	Mitigation measure(s):	Prevent any hydrocarbons spillages by undertaking preventive maintenance and regulars on vehicles, machinery and generators.	As necessary, throughout construction	Contractor
		Implement best practices for storm water management procedures.	As necessary, throughout construction	Contractor
		Any spills or leaks should be contained and addressed immediately	As necessary, throughout construction	Contractor

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
8. Groundwater				
8.1	**Project activity:**	Pond excavation and blasting	-	-
	Impact:	Fractures will provide pathways for the transmission of pollutants from sources at and around the proposed pond site.	-	-
	Mitigation measure(s):	Implement appropriate blasting techniques which will keep blast shock to a minimum.	As appropriate, throughout construction	Contractor
8.2	**Project activity:**	Accidental spillage of oil or other hydrocarbons and pollutants within the proposed pond site and pipeline route.	-	-
	Impact:	Groundwater contamination	-	-
	Mitigation measure(s):	Implement pollution prevention techniques on all construction equipment, e.g. place drip trays under parked trucks.	As necessary, throughout construction	Contractor
		Immediately remove soils contaminated with oils and other hydrocarbons or pollutants and dispose as hazardous waste.	As necessary, throughout construction	Contractor
9. Air quality				
9.1	**Project activity:**	Vehicles traversing the construction site, and pipeline and pond excavations.	-	-
	Impact:	Vehicle emissions, and dust generation.	-	-
	Mitigation measure(s):	Ensure that dust suppression measures are implemented on exposed soils and unpaved roads.	As necessary, throughout construction	Contractor

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
		Ensure that vehicles are serviced regularly and that vehicles with emission problems are identified speedily and rectified.	As necessary, throughout construction	Contractor
10. Noise and vibration				
10.1	**Project activity:**	Blasting in areas of hard rock within the proposed pond site.	-	-
	Impact:	Increased ambient noise levels.	-	-
	Mitigation measure(s):	Calculate the charge size and blast regime to limit noise, vibration and potential damage to structures, while optimising required excavation and fragmentation.	As necessary, prior to blasting	Contractor
		Should blast, ground vibration and human response monitoring indicate that noise and vibration levels exceed accepted levels (the generally accepted 'no damage' level of 140 dB, or any other levels that may apply to a specific area as determined by municipal ordinances, etc.), modify the blasting design as required;	As necessary, prior to continued blasting	Contractor
		Pre-notify potentially affected persons of the intention to blast and the time of blast, preferably at the same time of day to remove the element of surprise.	As necessary, prior to blasting	Contractor
		Ensure correct stemming of blast holes.	As necessary, during blasting	Contractor
10.2	**Project activity:**	Other construction related activities, such as movement of heavy machinery and vehicle traffic.	-	-
	Impact:	Increased ambient noise levels.	-	-
	Mitigation measure(s):	Ensure efficient design and maintenance of silencers on diesel-powered vehicles and equipment.	As necessary, throughout construction	Contractor
		Train personnel to adhere to operational procedures that reduce the occurrence	As necessary,	Contractor

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
		and magnitude of individual noisy events.	throughout construction	
11. Heritage				
11.1	**Project activity:**	Pond and pipeline construction and related activities	-	-
	Impact:	Impacts on heritage resources / archaeological or cultural historical sites.	-	-
	Mitigation measure(s):	Should any heritage resources of significance be exposed during the construction of the project, the South African Heritage Resources Authority (SAHRA) should be notified immediately, all development activities should be stopped and an archaeologist accredited with the Association for Southern African Professional Archaeologist (ASAPA) should be notified in order to determine appropriate mitigation measures for the discovered finds. This may include obtaining the necessary authorisation (permits) from SAHRA to undertake the required mitigation measures.	If required, prior to continuing with construction	Anglo
12. Visual				
12.1	**Project activity:**	Construction activities, dust mobilisation, and construction vehicles traversing the proposed site.	-	-
	Impact:	These activities will temporarily transform the physical landscape, i.e. removal of natural vegetation and land cover, transformation of the site topography; presence of new infrastructure; and dust pollution.	-	-
	Mitigation measure(s):	The construction activities, on the proposed site will be incorporated into the existing visual intrusion levels in the area.	As necessary, throughout construction	Contractor
		Rehabilitate affected areas as soon as possible to combat erosion.	As necessary, throughout	Contractor

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
			rehabilitation	
		Implement effective dust suppression.	As necessary, throughout construction	Contractor
12.2	**Project activity:**	Installation of new infrastructure, e.g. evaporation pond	-	-
	Impact:	Presence of new infrastructure will transform the landscape.	-	-
	Mitigation measure(s):	Side walls of the evaporation pond should mimic the surrounding landscape as far as possible to minimise visual impacts.	Once, during construction	Contractor
		All embankments or artificial slopes should be vegetated and sloped in such a manner that they do not erode.	Once, during construction	Contractor
		Appoint a suitably qualified person to investigate the feasibility of establishing a suitable visual screen along the road located south of and adjacent to evaporation pond, e.g. vegetative screen, berm, etc.	Once, during construction	Anglo
		Trees should be planted along the boundaries of the evaporation pond site and arranged in as natural a formation as possible, with trees in clumps and shrubs as undergrowth, to encourage nesting birds and create potential habitat for other small animals.	Once, during construction	Anglo
		All existing trees should be retained where possible, as they already provide valuable screening.	As necessary, throughout construction	Contractor
		Ongoing monitoring and maintenance of rehabilitated areas to ensure that they establish successfully and that erosion does not occur.	Ongoing, throughout all phases	Anglo / Contractor
13. Socio-economic				

Construction Phase Environmental Management Plan			Timeline and frequency	Responsible party
13.1	**Project activity:**	Pond and pipeline construction.		
	Impact:	Creation of employment opportunities.		
	Mitigation measure(s):	Make use of local labour as far as possible. Employment recruitment policies should be put in place.	As necessary, throughout construction	Anglo
13.2	**Project activity:**	Pond and pipeline construction related activities.	-	-
	Impact:	Environmentally intrusive impacts, e.g. visual, dust, noise and vibration.	-	-
	Mitigation measure(s):	See Sections 12, 9 and 10 above for visual, dust, and noise and vibration respectively	As necessary, throughout construction	Contractor
13.3	**Project activity:**	Construction crew on site.	-	-
	Impact:	Fires, theft and vandalism.	-	-
	Mitigation measure(s):	Construction crew will only be present on site during the day; they will not stay overnight.	As necessary, throughout construction	Contractor
		Sub-contractor agreements and contracts will specify fire and theft prevention measures.	As necessary, throughout construction	Anglo

Table 8-2: Environmental Management Plan for the NDC Evaporation Pond Project – Operational Phase

Operational Phase Environmental Management Plan			Frequency and Timeline	Responsible party
1. Geology				
1.1	**Project activity:**	n/a	-	-
	Impact:	n/a	-	-
	Mitigation measure(s):	n/a	-	-
2. Topography				
2.1	**Project activity:**	n/a	-	-
	Impact:	n/a	-	-
	Mitigation measure(s):	n/a		
3. Soil				
3.1	**Project activity:**	Stockpiling topsoil on pond wall embankments.		
	Impact:	Degradation of topsoil due to erosion of wall edges.		
	Mitigation measure(s):	Maintain vegetation on pond wall embankments. Control establishment of alien species.	As necessary, throughout the Operational Phase	ECO
4. Land capability and Land use				
4.1	**Project activity:**	n/a	-	-
	Impact:	n/a	-	-
	Mitigation measure(s):	n/a	-	-
5. Ecology: Terrestrial flora and fauna				
5.1	**Project activity:**	Accidental spills and leaks from ponds and pipeline.	-	-
	Impact:	Impacts on fauna, faunal habitat and flora	-	-

Operational Phase Environmental Management Plan			Frequency and Timeline	Responsible party
	Mitigation measure(s):	Maintain triple liner system. Continue to collect the small amount of seepage that may get through the liner in the under drain system and pump back into the pond. Regular maintenance and repair of pipelines.	As necessary, throughout Operational Phase	Anglo
6. Ecology: aquatics and wetlands				
6.1	**Project activity:**	Accidental spills and leaks from ponds and pipeline.	-	-
	Impact:	Increased TDS concentrations due to spills or leaks.	-	-
	Mitigation measure(s):	Prevent site runoff from entering aquatic and wetland ecosystems. Suitable storm water management, erosion prevention and runoff control measures should be implemented so as to prevent any runoff into the aquatic and wetland ecosystems.	As necessary, throughout Operational Phase	Anglo / Contractor
		All pipelines and the proposed evaporation ponds should be properly maintained, so as to minimize the risk of spills or leaks of contaminated water from entering the surrounding ecosystems.	As necessary, throughout Operational Phase	Anglo / Contractor
		Any spills or leaks should be contained to prevent downstream contamination and should be cleaned up immediately.	As necessary, throughout Operational Phase	Anglo / Contractor
		Discharges of RO reject into the surrounding environment should not be allowed.	As necessary, throughout operations	Contractor
		Monitor the water quality within the surrounding environment as well as the levels of the ponds, on a regular basis. Institute a long-term biomonitoring programme of the health of the surrounding ecosystems so as to detect any trends which may arise.	As necessary, throughout Operational Phase	Anglo

Operational Phase Environmental Management Plan			Frequency and Timeline	Responsible party
6.2	**Project activity:**	Accidental spills and leaks from ponds and pipeline.	-	-
	Impact:	Seepage from evaporation ponds.	-	-
	Mitigation measure(s):	Prevention of seepage into the surrounding aquatic and wetland ecosystems. Suitable lining and maintenance of the evaporation ponds should be implemented. Monitoring of the surrounding environment will serve as an early warning mechanism if such a leak does occur.	As necessary, throughout Operational Phase	Anglo / Contractor
		All pipelines and the proposed evaporation ponds should be properly maintained, so as to minimize the risk of spills or seepage of contaminated water from entering the surrounding ecosystems.	As necessary, throughout Operational Phase	Anglo / Contractor
		Any seepage which is detected should be contained to prevent downstream contamination and should be cleaned up immediately	As necessary, throughout Operational Phase	Anglo / Contractor
		Implement corrective mitigation measures if any significant decrease in ecological integrity occurs (both aquatic and wetland) within any biomonitoring period as a result of impacts associated with the pipeline and pond site.	As necessary, throughout operations	ECO
7. Surface water				
7.1	**Project activity:**	Pond operations	-	-
	Impact:	Seepage through liner.	-	-
	Mitigation measure(s):	Maintain triple liner system. Continue to collect the small amount of seepage that gets through the liner in the under drain system and pump back into the pond.	As necessary, throughout Operational Phase	Anglo
7.2	**Project activity:**	Pond operations	-	-
	Impact:	Reduction in stream flow.	-	-
	Mitigation measure(s):	n/a	-	-
7.3	**Project activity:**	Pond operations	-	-

Operational Phase Environmental Management Plan			Frequency and Timeline	Responsible party
	Impact:	Overspill of ponds	-	-
	Mitigation measure(s):	A spillway should be sized for the ponds to pass the probable maximum flood.	During Construction Phase	Anglo/ Contractor
		The operational water level in the ponds should be managed in such a way to maintain the freeboard.	As necessary, throughout Operational Phase	Anglo
8. Groundwater				
8.1	**Project activity:**	Pond operation.	-	-
	Impact:	Contamination of groundwater due to leakage of RO reject water from ponds.	-	-
	Mitigation measure(s):	Maintain triple liner system. Continue to collect the small amounts of seepage that get through the liner in the under drain system and pump back into the pond.	As necessary, throughout Operational Phase	Anglo
9. Air quality				
9.1	**Project activity:**	n/a	-	-
	Impact:	n/a	-	-
	Mitigation measure(s):	n/a	-	-
10. Noise				
10.1	**Project activity:**	n/a	-	-
	Impact:	n/a	-	-
	Mitigation measure(s):	n/a	-	-
11. Heritage				
11.1	**Project activity:**	n/a	-	-

Operational Phase Environmental Management Plan			Frequency and Timeline	Responsible party
	Impact:	n/a	-	-
	Mitigation measure(s):	n/a	-	-
12. Visual				
12.1	**Project activity:**	Pond operation.	-	-
	Impact:	Presence of pond and associated infrastructure will transform the landscape.	-	-
	Mitigation measure(s):	See 12.2 Construction Phase EMP.		
13. Socio-economic				
13.1	**Project activity:**	Operation of pond infrastructure.	-	-
	Impact:	Creation of employment opportunities.	-	-
	Mitigation measure(s):	Where possible, use local labour.	As necessary, throughout operations	Anglo
		Employment recruitment policies should be put in place.	As necessary, throughout operations	Anglo
13.2	**Project activity:**	Operation of pond and pipeline.	-	-
	Impact:	Health and safety of local community members	-	-
	Mitigation measure(s):	Signage should be erected at the pond site and at points along the pipelines to illustrate the dangers of the contents of the pond and the pipelines.	Once, prior to commissioning	Anglo

Table 8-3: Environmental Management Plan for the NDC Evaporation Pond Project – Decommissioning Phase

Decommissioning Phase Environmental Management Plan			Frequency and Timeline	Responsible party
1. Geology				
1.1	**Project activity:**	n/a	-	-
	Impact:	n/a	-	-
	Mitigation measure(s):	n/a	-	-
2. Topography				
2.1	**Project activity:**	If necessary, the temporary stockpiling, compaction of *in situ* material, excavation, mixing, and replacement of excavated material during pond and pipeline removal.	-	-
	Impact:	The stockpiling of material on surface will alter surface topography. Compaction is also expected over areas where vehicles and plant equipment travel regularly.	-	-
	Mitigation measure(s):	See 2.1 Construction Phase EMP.		
		The pond area should be backfilled to the original elevation prior to the construction.	Once, during rehabilitation	Contractor
3. Soil				
3.1	**Project activity:**	Topsoil stripping and storage	-	-
	Impact:	Loss of the original spatial distribution of soil types and natural soil horizon sequences, loss of some original soil fertility, loss of original topography and drainage pattern, loss of original soil depth and soil volume, loss of the natural functioning of the soil	-	-
	Mitigation measure(s):	See Section 3.1 of the Construction Phase EMP.	-	-
3.2	**Project activity:**	Oil and fuel spillages from mechanical equipment		
	Impact:	Soil pollution		
	Mitigation measure(s):	See Section 3.2 of the Construction Phase EMP.		
3.3.	**Additional**	The approximately 2.5 m topsoil layer on the outer edge of the pond wall should be	As necessary,	ECO /

Decommissioning Phase Environmental Management Plan			Frequency and Timeline	Responsible party
	Mitigation	removed downwards to the toe of the wall. The wall consisting of rock material should be backfilled into the dam basin to reconstruct the original topography of the pond area taking in account the 500 mm of topsoil that need to be replaced. The surface should be gradually sloped to ensure a free draining surface with no accumulation of water anywhere. The topsoil should be spread evenly over the entire footprint of the pond.	throughout rehabilitation	suitably qualified person
		Because the original soil profile will be disturbed and the chemical status will change it is important to do intensive soil analysis (determine soil fertility) after replacing of the top soil. The soil fertilizing programmes should therefore be based on the soil chemical status after replacing of the topsoil. A fertilizer programme should consist of a pre-seeding fertilizer application, an application simultaneously with the seeding process and an annual maintenance application.	As necessary, throughout rehabilitation	ECO / suitably qualified person
		The seed mixture and proportions in Table 7-4 are recommended. As many as possible natural species which occurred prior to construction should be included in the seed mixture. The aim of the seed mixture is to stabilize the soil rapidly and prevent soil erosion and not to establish highly productive pasture.	As necessary, throughout rehabilitation	ECO / suitably qualified person
4. Land capability and Land use				
4.1	**Project activity:**	n/a	-	-
	Impact:	n/a	-	-
	Mitigation measure(s):	n/a	-	-
5. Ecology: terrestrial flora and fauna				
5.1	**Project activity:**	Vegetation clearing and stripping of topsoil during construction.	-	-
	Impact:	Loss of vegetation communities and animal habitat; loss of biodiversity	-	-
	Mitigation measure(s):	See Section 5.1. Construction Phase EMP	Decommissioning Phase	Anglo
5.2	**Project activity:**	Presence of machinery and human activities.	-	-

Decommissioning Phase Environmental Management Plan			Frequency and Timeline	Responsible party
	Impact:	Drives fauna away from the area.	-	-
	Mitigation measure(s):	See Section 5.2 Construction Phase EMP	Decommissioning Phase	Anglo
	Project activity:	Disturbance at pipeline and pond site.		
	Impact:	Establishment of exotic species in rehabilitated areas.		
	Mitigation measure(s):	Continually remove exotic species that might encroach.	As necessary, during the Decommissioning Phase	ECO
6. Ecology: aquatics and wetland				
6.1	**Project activity:**	Decommissioning of pipeline and pond site.	-	-
	Impact:	Impact on water quality, aquatic biota, and macro-channel, riparian and in-stream habitats.	-	-
	Mitigation measure(s):	All relevant mitigation measures provided for the Construction Phase should therefore be implemented. This is only relevant for the surrounding wetland areas (see section 6.1 in the construction EMP table).	-	-
7. Surface water				
7.1	**Project activity:**	Pond and pipeline decommissioning.	-	-
	Impact:	Impact of water resources due to increased sedimentation from exposed soils.	-	-
	Mitigation measure(s):	See 7.1 Construction Phase EMP		

Decommissioning Phase Environmental Management Plan			Frequency and Timeline	Responsible party
7.2	**Project activity:**	Accidental spillage of hydrocarbons and pollutants within the proposed pond site and pipeline route.	-	-
	Impact:	Impact of surface water quality.	-	-
	Mitigation measure(s):	See 7.2 Construction Phase EMP		
8. Groundwater				
8.1	**Project activity:**	Accidental spillage of oil or other hydrocarbons and pollutants within the decommissioning site.	-	-
	Impact:	Groundwater contamination	-	-
	Mitigation measure(s):	See 8.1 Construction Phase EMP		
9. Air quality				
9.1	**Project activity:**	Vehicles traversing the decommissioning site and pipeline trenching.	-	-
	Impact:	Vehicle emissions, and dust generation.	-	-
	Mitigation measure(s):	See 9.1 Construction Phase EMP		
10. Noise				
10.1	**Project activity:**	Movement of heavy machinery and vehicle traffic during decommissioning.	-	-
	Impact:	Increased ambient noise levels.	-	-
	Mitigation measure(s):	See 10.2 Construction Phase EMP		
11. Heritage				
11.1	**Project activity:**	n/a	-	-
	Impact:	n/a	-	-
	Mitigation measure(s):	n/a	-	-

Decommissioning Phase Environmental Management Plan			Frequency and Timeline	Responsible party
12. Visual				
12.1	**Project activity:**	Decommissioning activities, dust mobilisation, and construction vehicles traversing the proposed site. If necessary, the removal of pipelines and hence pipeline trenching.	-	-
	Impact:	These activities will temporarily transform the physical landscape.	-	-
	Mitigation measure(s):	This will only be relevant for the limited 2.2 km length of pipeline. See 12.1 Construction Phase EMP		
12.2	**Project activity:**	The removal of pond infrastructure.	-	-
	Impact:	Positive impact on physical landscape.	-	-
	Mitigation measure(s):	Rehabilitate affected site to ensure that it becomes stabilised and self-sustaining.	As necessary, during rehabilitation	Anglo / Contractor
13. Socio-economy				
13.1	**Project activity:**	Decommissioning of the pond and pipeline infrastructure.	-	-
	Impact:	A temporary increase in employment opportunities followed by a decrease.	-	-
	Mitigation measure(s):	A programme of retrenchment and re-training should be implemented, providing employees with clear, transparent information on planned activities and closure dates, offering employment at similar sites where possible and full retrenchment packages.	As necessary, during the Operational Phase	Anglo
13.2	**Project activity:**	Decommissioning of the pond and pipeline infrastructure.	-	-
	Impact:	Noise, dust and visual impacts associated with decommissioning activities.	-	-
	Mitigation measure(s):	See 9, 10 and 12 above		

9.0 MONITORING

The monitoring programme is summarised in Table 9-1 below and discussed in the sections to follow.

Table 9-1: Monitoring programme

Aspect to be monitored	Parameter(s)	Timeline	Frequency	Responsible party
Groundwater (boreholes)	Electrical conductivity, sodium, chloride and sulphate	Throughout the Operational Phase	Quarterly	Suitably qualified person
Sub-soil seepage (collected by subsurface drainage system)	Electrical conductivity, sodium, chloride and sulphate	Prior to discharge to adjacent watercourse	Once	Anglo / Contractor
Soil	Stripping of topsoil at correct depths over the footprint of the proposed pond.	Construction Phase	As necessary	Suitably qualified person
	Proper storing of topsoil on the outer embankment of the pond wall.	Construction Phase	As necessary	
	Evaluation of a free draining surface before topsoil is replaced during the rehabilitation process.	Rehabilitation		
	Calculation of the available topsoil volume and replaceable thickness.			
	Verification of topsoil thickness to ensure that topsoil is evenly spread over the entire footprint.			
	Soil amelioration based on soil analysis before seeding of the rehabilitated area.			
Rehabilitated areas	Soil erosion	During rehabilitation, until the grass mixture has established fully and is self sustaining.	As necessary	Suitably qualified person / ECO
	Vegetation growth and removal of exotic species	Rehabilitation	As necessary	Suitably qualified person / ECO
Surface water and biomonitoring	Implement existing NDC monitoring programmes			
Blasting	Air blast noise, ground vibration and human response	Construction Phase	As necessary	Suitably qualified person / ECO

9.1 Groundwater

A network of monitoring boreholes is recommended around the proposed evaporation pond site during the Operational Phase to monitor any possible seepage from the pond. Due to the limited extent of the pond only two borehole pairs are recommended, one up-gradient and one down-gradient of the pond. A borehole pair will consist of one shallow borehole (±15 m through the weathered material) and one deep borehole (±40m into the fractured strata). Any groundwater contamination from RO reject/ pond water will show as elevated levels of Na, chloride and sulphate concentration in accordance with the chemical signature of the RO reject.

9.2 Sub-soil seepage

A subsurface drainage system will be constructed below the dual blanket layer for collection and removal of seasonally rising perched water. To protect the facility from the impact of the perched groundwater during construction, operation and post closure, subsurface drains will be implemented. The subsoil drain system will accumulate water in two sumps, one located north west of the pond and the other located south of the pond. From these sumps, the clean water is to be pumped into the adjacent watercourse. Prior to discharge, it is recommended that the water is monitored for electrical conductivity, sodium, chloride and sulphate. Should monitoring results indicate that the water is contaminated, the water should not be discharged to the watercourse, but disposed of into the evaporation pond,

9.3 Soil

The following monitoring should take place by a soil specialist:

- Stripping of topsoil at correct depths over the footprint of the proposed pond;
- Proper storing of topsoil on the outer embankment of the pond wall;
- Evaluation of a free draining surface before topsoil is replaced during the rehabilitation process;
- Calculation of the available topsoil volume and replaceable thickness;
- Verification of topsoil thickness to ensure that topsoil is evenly spread over the entire footprint;
- Soil amelioration based on soil analysis before seeding of the rehabilitated area; and
- Monitoring of soil erosion of the rehabilitated area until the grass mixture has established fully and is self sustaining.

9.4 Rehabilitated areas

Ongoing monitoring and maintenance of the rehabilitated areas will be required in order to ensure that they establish successfully and that erosion does not occur. The growth of the vegetation should be continuously monitored; however, due to the unpredictable nature of vegetation growth and challenging climatic conditions the effectiveness of the re-vegetation will only become apparent after several years. Where specimens die, grow poorly or do not effect sufficient coverage the cause of the problem should be established and the afflicted specimens replaced, or a more suitable alternative established, based on a case-to-case basis. The establishment of exotic species in disturbed areas should also be monitored.

9.5 Surface water and biomonitoring

The existing surface water and biomonitoring programmes at NDC can be used to monitor and assess the health of the surrounding ecosystems so as to detect any trends which may arise, including sediment load.

9.6 Air blast noise

Monitoring air blast noise, ground vibration and human response to ensure that accepted levels are in fact acceptable and are being adhered to, and modifying the blasting design as required.

10.0 ENVIRONMENTAL IMPACT STATEMENT

Introduction and project description

Anglo American proposes to construct new infrastructure at their thermal coal operation New Denmark Colliery (NDC). NDC is located in the Mpumalanga Province approximately 20 km north east of Standerton. NDC provides coal to Eskom's Tutuka Power Station for daily operations. The excess mine water that accumulates in the underground mine workings as a result of coal mining activities, is pumped to the surface and treated. Treatment of the mine water takes place at a reverse osmosis (RO) water treatment plant at Tutuka Power Station, and the clean water is re-used in the plant, while some of the "reject water" (dirty water) is currently used on an ash dump for dust control and the rest is disposed of in an underground compartment at NDC known as the 321 compartment.

In November 2009, NDC received a Directive from the Department of Water Affairs (DWA) instructing the mine to implement an alternative management option for the RO reject by October 2011. Eskom is proposing to construct and operate a secondary RO reject concentrator plant at Tutuka Power Station. The purpose of this plant will be to reduce the volume of RO reject produced from 3 Mℓ/day to 1 Mℓ/day. The concentrated RO reject produced by Eskom's concentrator plant will be sent to NDC's evaporation pond proposed in this EIA.

The implementation of the proposed concentrator plant and evaporation pond project is a collective effort by Eskom and Anglo American to meet the requirements of the Directive issued by the DWA.

Key components for the development of this project include:

- Evaporation pond to dispose (evaporate) RO reject; and
- Pipeline to transmit RO reject from the concentrator plant to the evaporation pond.

The evaporation pond will be constructed in phases, i.e. four cells, namely 2A South, 2A North, 2B South and 2B North. Construction of the first cell will start soon after authorisations from MDEDET and DMR have been received (expected to be in March 2011). The first cell is expected to be commissioned in October 2011. The lifespan of the facility will be 10 years. Thereafter, the pond will be capped, rehabilitated and closed.

Overview of the existing environment, impacts and mitigation measures

Geology

Baseline: The geological units within the study area belong to the Ecca Group of the Karoo Supergroup. Shale, sandstone and siltstone units typically define this Group with interbedded coal units of variable thicknesses at depths deeper than 180 m. The south-western portion of the site is underlain by a dolerite sill at depths less than 1 m below surface. The sill is several meters thick and is underlain by a succession of sandstone and siltstone units. Further to the north-east, the dolerite sill occurs at depths deeper than 30 m with overlying shale and siltstone units. The combined thickness of the dolerite varies from ±10 m to over 50 m.

Impact assessment and mitigation: Blasting in the excavation of the evaporation pond will displace / fracture sections of hard rock. This will result in high impacts on the underlying geology; however, by using appropriate blasting techniques the impact can be reduced to moderate.

Topography

Baseline: The study area is fairly flat without any areas with slopes greater than 9 %. The area surrounding the Tutuka Power Station is located at some 1 640 metres above mean sea level with the slope very gradually falling to the south towards the Grootdraai Dam. The power station precinct and ash dump are located at the highest point in the immediate surrounds.

Impact assessment and mitigation: The stockpiling, compaction of *in situ* material, excavation, mixing, and replacement of excavated material will affect surface topography and drainage. The construction of the storm water management infrastructure, especially berms, will further contribute to the impact on surface topography and drainage. These impacts will occur in the medium term, affect only the site, and be of a low significance.

Soils, land capability and land use

Baseline: The soils at the proposed footprint of the pond are very homogenous and consist of well-drained, strongly structured, black, clay soils of the Arcadia form. These soils are on average 500-600 mm deep and are underlain by yellowish grey weathered rock. The high clay content, firm consistence and strong structure of black clay soils cause difficulties with cultivation and restrict suitable crop selection and are therefore mostly utilized for grazing purposes. Due to the fairly shallow effective soil depth, the land capability was classified as grazing potential. Soils along the proposed pipeline are similar to those on the footprint of the proposed pond.

Impact assessment and mitigation: The most significant impacts on soils will occur during the Construction Phase as a result of topsoil stripping which will cause loss of the original spatial distribution of soil types and natural soil horizon, sequences; loss of some original soil fertility; loss of original topography and drainage pattern; loss of original soil depth and soil volume; and loss of the natural functioning of the soil (habitat for fauna and flora). These impacts are considered to be high, but can be mitigated to moderate, by applying measures such as preventing soil mixing, appropriate stockpiling of topsoil, and fertilizer application during the rehabilitation process. About 39.9 ha of wilderness/grazing land capability will be impacted upon during construction. No commercial or non-commercial farming, housing, transporting or industrial use will be possible at the site. This impact is also considered to be high, but could be mitigated to low, should the mitigation measures for impacts on soils be implemented.

Terrestrial fauna and flora

Baseline: The site is situated in the Grassland biome. The natural vegetation cover of most of the study area has been replaced by either cultivated maize fields, some areas are used for livestock grazing purposes as is primarily the case with the site itself- and other have been degraded by industrial and mining-related activities. Small areas of somewhat disturbed, natural vegetation occur along watercourses or fringes of other activities. Localised clumps of alien invader trees are prominent elements in the landscape. No Red Data species were found during the terrestrial fauna and flora site survey. Based on physiognomy, moisture regime, rockiness, slope and soil properties, two vegetation communities were recognised, namely *Themeda* secondary grassland and artificial wetland communities. According to the Mpumalanga Biodiversity Conservation Plan the project area falls within the "Least Concern" and "No Natural Habitat Remaining" areas.

Impact assessment and mitigation: Moderate impacts of faunal habitat and flora will result from vegetation clearing and stripping of topsoil during construction. Noise of machinery and human activities will drive fauna away from the area temporarily. Existing alien species within the site will be removed during construction, which will be a positive impact. Should the pipelines and pond leak during the Operational Phase, impacts on fauna and flora may occur. This is considered an impact of high significance, but can be mitigated to moderate, should the liner system and leakage detection system of the pond be maintained, and regular pipeline maintenance (using, e.g. scour valves) be ensured.

Wetlands and aquatic ecology

Baseline: Eight wetland units were identified within the larger study area. Of all the wetland types, the floodplain wetlands are the most prominent. These are largely fed by channelled and unchanneled valley bottom wetlands and hillslope seeps. Habitat degradation due to agricultural activities (cropping and grazing) is impacting on the wetlands and river systems in the project area. Biodiversity is found to be moderate with mostly hardy/common grass and plant species and common bird species present. Natural ecosystem and human services supplied by the wetlands are generally moderate to low. Water quality results indicated eutrophication within some of the water systems. The availability of habitats for aquatic macroinvertebrates was found to be generally poor within the study area.

Impact assessment and mitigation: The most significant impacts will occur during construction as a result of smothering of aquatic and wetland biota due to increased sedimentation and dust generation, and habitat loss of an artificial wetland. The artificial wetland has little to no ecosystem function.

Surface water

Baseline: The proposed site for the evaporation pond is located in Drainage Region C, the Vaal River catchment. At a local scale the site is situated on the catchment divide between two sub-catchments of quaternary catchment C11K. The two sub-catchments drain into the Leeuspruit, which drains into the Grootdraai Dam, located on the Vaal River. An unnamed non-perennial tributary of the Leeuspruit is located to the north of the proposed evaporation pond.

Impact assessment and mitigation: Three potential negative surface water impacts have been identified, namely seepage through the liner system, streamflow reduction due to the reduction in catchment area, and overspill. These impacts are, however, all considered to be of low significance. Over and above the maintenance of the liner system and allowance for freeboard in the pond design, no additional mitigation measures are recommended. The pond site is located outside the 1 in 50- and 1 in 100 year floodlines of the nearby non-perennial tributary of the Leeuspruit.

Groundwater

Baseline: Two aquifers have been identified within the study area: a thin shallow aquifer of relatively high permeability and storage is located at approximately 15 m below the surface; and a considerably thick deep aquifer of low permeability is located at approximately 60 m below the surface. The average hydraulic conductivity for the shallow aquifer was established to be 0.006 m/day. Groundwater flows in a south to south-westerly direction in the shallow aquifer and is presumed to flow in the same direction in the deep aquifer, towards the Leeuspruit and Vaal Rivers which constitute regional sinks of surface and groundwater. The deep aquifer is recharged from the shallow aquifer through permeable fracture systems linking the two aquifer systems. Groundwater and surface water from the bodies within and close to the proposed evaporation pond site is of good quality. All the measured parameters recorded values that fall within the acceptable Classes I and II of the South African National Standards (SANS 241) specifications of 2005 for drinking water.

Impact assessment and mitigation: There is a potential for contamination of the groundwater due to leakage of RO reject from the pond and pipelines during the operational stage. Any groundwater contamination from RO reject/proposed pond water will show as elevated levels of sodium, chloride and sulphate concentration in accordance with the chemical signature of the RO reject. Considering that the pond will be lined and pipeline integrity will be regularly checked and maintained, this impact is highly unlikely. Moreover, in the event of leakage, the pollutants will not migrate fast within the shallow aquifer because of the low hydraulic conductivity of the aquifer (± 0.006 m/day). Therefore, this impact is considered of low significance and with a very low probability of occurrence.

Air quality

Baseline: Potentially, local air pollution may arise as a result of particulates entering the atmosphere. These particulates arise as dust from dumps and from conveyors at the mine– particularly at transfer points. Monitoring of the NDC area and surroundings indicated that the impacts of settable dust can be described as minimal, since dust will settle gravimetrically within 500 m of the dust source. Currently, all mining activities at NDC occur underground, with the result that these activities have no impact on surface air quality in the study area. However, the associated surface infrastructure (transfer points and conveyors) may contribute to dust generation.

Impact assessment and mitigation: Vehicle emissions and dust generated by vehicles traversing the construction site and excavation activities will result in low impacts on air quality. The excavation of the pipeline trench and the pond will contribute to dust and PM_{10}. Recommended mitigation measures include implementation of dust suppression measures and ensuring that vehicles are serviced regularly.

Environmental noise

Baseline: Existing noise sources in the area include Tutuka Power Station operations, vehicular traffic on the access road to Tutuka Power Station, occasional overflying aircraft, livestock and agricultural activity on surrounding land, and local community and domestic noise. Background noise levels are highly stable around 33 – 35 dB(A).

Impact assessment and mitigation: The most significant impacts on the noise environment will occur during construction as a result of blasting. The noise impact for blasting operations is considered to be moderate. However, minimisation of the number of times when blasting occurs, prior notification of blasting activities at predetermined times on stated days, careful design of the blasting regime to reduce the levels of both airborne blast noise and ground-borne vibration will contribute significantly to the minimisation of the overall impact of blasting on the surrounding community and reduce the impact to low. Impacts on noise levels as a result of movement of heavy machinery and vehicle traffic will be moderate, short-term, and will take place on a local scale. These impacts can, however, be mitigated to a low level.

Visual aspects

Baseline: The visual quality of the study area is of a low to medium value. Although the majority of the study area has a predominantly rural character, it is dominated by the Tutuka Power Station and has been visually altered by a number of other linear and other infrastructure features. Furthermore, it is not characterised by features that are visually exciting, such as prominent topography or attractive vegetation cover.

Impact assessment and mitigation: Due to the generally low levels of development in the area it is unlikely that a large number of people will be affected by the visual aspects of the proposed project. Only persons travelling along the smaller roads passing closer to the site, many of whom would be travelling to the power station, will be visually exposed to the new infrastructure to any significant degree. The level of visibility of the project components from within the study area is expected to be medium. Due to the close proximity of the Tutuka Power Station to the proposed site for the new evaporation pond it is not anticipated that the evaporation ponds will cause significant visual intrusion. The overall visual impact of the proposed evaporation pond and supporting infrastructure is therefore expected to be low. It is, however, recommended that the side walls of the evaporation pond mimic the surrounding landscape as far as possible and, if possible, vegetative screens be established along the road located south of and adjacent to evaporation pond.

Archaeological or cultural historical sites

Baseline: The project area, including the greater Standerton region, has been poorly surveyed for heritage sites in the past. The South African Heritage Resources Agency's national register of heritage sites does not list any heritage sites for the region. The majority of archaeological research has taken place to the immediate east and north of the study area – an area which is exceptionally rich in Stone Age sites, Iron Age sites, and historical features. Nevertheless, it is known from historical literature that San hunter-gatherers as well as Nguni and Sotho-speaking farmers occupied the area in the recent past. The area was also heavily affected during the Anglo-Boer War of 1899-1901 and it is to be expected that many old farmsteads and associated graveyards may occur on farms in the region.

Impact assessment and mitigation: No heritage or archaeological features were identified within the footprint of the proposed evaporation pond site and pipeline route. The results of the ground survey are also supported by the desktop survey that indicated that there are no heritage sites associated with the footprint.

Socio-economy

Baseline: The project area is located in the Lekwa Local Municipality, in Gert Sibande District Municipality, Mpumulanga Province. The Lekwa Local Municipality has a population of approximately 112,000 people and is predominantly inhabited by Nguni speaking people, namely: Zulu, Swati, Ndebele, Sotho and Xhosa and other race groups. The annual growth rate is 2.8% and the population density 22.5%; lower than the district municipal area. The development trend shows increasing urbanization in the municipality, with over 65% of the population living in urban areas, compared to 35% in rural areas. The occupation structure of the employed persons shows that the majority of employed people are concentrated in elementary occupations (39%) followed by agriculture (28%).

Impact assessment and mitigation: Approximately 200 additional employment opportunities will be created for skilled (~70%) and unskilled (~30%) workers during the Construction Phase. This will be a positive socio-economic impact. The evaporation pond and pipeline fall within the NDC mine boundary on Eskom-owned land. No private landowners would be directly impacted by the proposed project. There are therefore no land access issues and no relocation will be required. Environmentally intrusive impacts such as visual, dust, noise and vibration may be experienced by local community members or farmers. Leaks from the pond and/or pipeline may impact on the health and safety of the local community members or farmers. With appropriate mitigation measures, these impacts can, however, be limited to low impacts. It is recommended that signage be erected at the pond site and at points along the pipelines to illustrate the dangers of the contents of the pond and the pipelines. This in turn will reduce the risks of theft or vandalism.

Cumulative impacts

Soils, land capability and land use

Due to the already highly disturbed nature of the soils in the study area, the proposed project will probably result in low cumulative negative impact to soils acting over the long-term, and affecting the immediate site.

Terrestrial Ecology

The pond site is located within a highly disturbed area. Currently, the vegetation at the site is utilised for grazing of livestock and wildlife farming purposes. The total cumulative negative impact will probably be of low significance, affecting the local extent.

Aquatic and Wetland Ecology

There are wetland areas within the broader area surrounding the project site. These were identified during the site selection process (part of the scoping phase of the project). Some of these wetlands are artificial with little to no ecosystem function as is the case with the artificial wetland within the preferred pond site. Cumulative impacts from the proposed pond site will probably have a low significance and only affect the local site, should there be any seepage or overspill from the phases of the project.

Noise

Since the proposed project components are situated in close proximity to existing noise impacts such as the power station, etc., the contributions of the proposed project to cumulative impacts are considered to be insignificant.

Need and desirability of the proposed project

In November 2009, NDC received a Directive from the Department of Water Affairs instructing the mine to implement an alternative management option for the RO reject, by October 2011. The reasons for this directive are:

- The underground 321 compartment is almost at full capacity; and
- There is some concern that the constant application of water to the ash dump is resulting in increased seepage and contamination of the groundwater in the area.

Therefore, a new management method is required for the reject water. Investigations were undertaken to determine options for management of the water that minimises potential environmental impacts and was economically feasible. The preferred option from these investigations was to:

- Upgrade the treatment system by construction of an RO reject concentration plant (covered under a separate EIA by Aurecon); the plant will reduce the volume of reject water from 3 Mℓ/day to 1 Mℓ/day; and
- Construct a pond at the site for storage and evaporation of the reject water.

The proposed evaporation pond will provide a solution to the management of the mine water for approximately ten years. The site has, however, been designed to accommodate reject for the life of mine.

NDC has committed to continue with investigations into long term and closure mine water management for the mine.

Assessment of alternatives

Three alternative pond site locations were assessed. A site selection exercise, which looked at aspects such as land ownership, agricultural potential and wetlands, revealed that Option 2 is the preferred site for the location of the pond. The results of the impact assessment revealed the following:

- No significant negative impacts are associated with the site;
- The soils of the site have low to moderate agricultural potential;
- The site is currently used for cattle grazing;
- No Red Data faunal and floral species were identified;
- No heritage resources are associated with the site; and
- An artificial wetland is located within the preferred pond site; however, the wetland has little to no ecosystem function.

Since no fatal flaws were identified for the proposed site for evaporation pond, it is recommended that the evaporation pond be constructed at the site indicated in indicated in Figure 2-1.

Two pipeline routes were considered (Figure 5-1). One route piped the flow from the treatment plant to the north of the site, west across the veld and south to the preferred pond location. The other followed the road to the south of the plant and along the road to the west to the pond location. Both pipelines remained on Eskom owned land. The southern pipeline option is considered the preferred option as it is located along an established road and is therefore easily accessible and is further from the runway.

The results of the impact assessment revealed that the soils along the proposed pipeline are fairly shallow and have already been disturbed during the construction of the road; and no sensitive or Red Data fauna / flora species or heritage resources were identified. Since no fatal flaws were identified for the proposed pipeline route, it is recommended that the pipeline be routed to follow the road to the south of the plant and along the road to the west to the pond locations, as indicated in Figure 2-1.

11.0 OPINION OF THE ENVIRONMENTAL PRACTITIONER

The negative impacts identified during the impact assessment can all be managed and mitigated to low to moderate levels of impact. From an environmental perspective, there is therefore no reason why the proposed NDC Evaporation Project should not be implemented, provided that the mitigation measures and monitoring programmes recommended within this report are implemented diligently.

The implementation of the proposed project will:

- Enable NDC to comply with the directive issued by the Department of Water Affairs;
- Prevent a water management issue occurring at the site;
- Allow mining operations to continue at NDC; and
- Ensure continued coal and water supply to Eskom's Tutuka Power Station.

Taking the above into consideration, the proposed project can be **supported**.

11.1 Final Conclusion

From an environmental perspective, there is therefore no reason why the proposed NDC Evaporation Project should not be implemented, provided that the mitigation measures and monitoring programmes recommended within this report are implemented diligently.

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DIRECTORS: FR SUTHERLAND, AM VAN NIEKERK, SAP BROWN, L GREYLING, SM MANYAKA

Olivia Chapman
EIA Project Manager

Etienne Roux
Senior Reviewer

Reg. No. 2002/007104/07

Directors: FR Sutherland, AM van Niekerk, SAP Brown, L Greyling, SM Manyaka

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APPENDIX A

FLOODLINE DETERMINATION

December 2010

CELEBRATING 50 YEARS in 2010

NEW DENMARK COLLIERY EVAPORATION POND EIA

Floodline determination

Report Number:12786-10095-10

Golder Associates

world capabilities locally

EXECUTIVE SUMMARY

This report documents the findings of the floodline determination for a 2 km stretch of an unnamed stream directly to the north of the proposed evaporation pond at New Denmark Colliery near Standerton in the Mpumalanga Province. The objective of the study was to determine the 1:50 and the 1:100 year floodlines to be used as part of the environmental impact assessment and integrated water use license application, where the proximity of the proposed evaporation ponds to the unnamed stream needs to be determined.

The approach adopted in the study is summarised below:

- The catchment areas of the unnamed tributary were estimated;
- A flood peak analysis was undertaken to determine the 50 year and 100 year recurrence interval flood peaks for the unnamed tributary;
- The flood peaks and the survey data of the study area were used as inputs to the HEC-RAS backwater programme to determine the surface water elevations for the 1: 50 and 1: 100 year floods peaks; and
- The floodlines were plotted on the available maps.

The analysis showed that the proposed evaporation ponds are outside of the 1:50 and the 1:100 year floodlines.

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1.0 INTRODUCTION

This floodline delineation has been prepared in response to a request from New Denmark Colliery to determine the 1:50 and 1:100 year floodlines for the unnamed tributary in the vicinity of the proposed evaporation pond near the Tutuka Power Station.

2.0 OBJECTIVE

The objective of the study is to determine the 1:50 and the 1:100 year floodlines for a 2 km stretch of the unnamed stream directly to the north of the proposed evaporation pond. The floodlines will be used as part of the environmental impact assessment and integrated water use license application, where the proximity of the proposed evaporation ponds to the unnamed stream needs to be determined.

3.0 STUDY APPROACH AND METHODS

The approach adopted in the study is summarised below:

- The catchment areas of the unnamed tributary were estimated;
- A flood peak analysis was undertaken to determine the 50 year and 100 year recurrence interval flood peaks for the unnamed tributary;
- The flood peaks and the survey data of the study area were used as inputs to the HEC-RAS backwater programme to determine the surface water elevations for the 1: 50 and 1: 100 year floods peaks; and
- The floodlines were plotted on the available maps.

4.0 LIMITATIONS AND ASSUMPTIONS

The following limitations and assumptions were made in this specialist study:

- No flow or rainfall data against which the runoff calculations could be calibrated were available. The runoff volumes were therefore calculated theoretically;
- Since no flow data was available for estimation of the roughness coefficients, the Manning's *n* coefficients were estimated by comparing the vegetation and nature of the channel surfaces to published data (Barnes, 1967; Chow, 1959; Hicks and Mason, 1991);
- There are no culverts along the unnamed tributary, although there is a small dam with a 2 m high wall; and
- The floodline was determined from a 1 m contour data set provided by the client.

5.0 CATCHMENT DESCRIPTION

The catchment is located in quaternary catchment C11K. The naturalised mean annual runoff from this quaternary catchment (C11K) is 60 mm. This equates to 9.5 % of the mean annual precipitation for the quaternary (Midgley et al, 1994). The mean annual precipitation of the catchment is 633 mm. The mean annual S-Pan evaporation is 1 520 mm.

The catchment of the unnamed tributary can be seen in Figure 1.

6.0 MODELLING

6.1 Rainfall

The rainfall depths were extracted from the closest weather station obtained from the Design Rainfall Estimation Program (details given in Table 1). The selection of station 0441261_W (Jonkersdam) is based on the fact that this is the closest station to the study area with a reliable record.

Table 1: Rainfall Station used in the study

Station Name	Station No	Distance (km)	Latitude (°)(')	Longitude (°)(')	Record (Years)	MAP (mm)	Altitude (m)
Jonkersdam	0441261_W	21.02	26°51'	29°09'	82	667	1584

The 24 hour rainfall depths for the 2 year, 10 year, 20 year, 50 year, 100 year and 200 year recurrence interval events for the rainfall data recorded at the Jonkersdam station (0441261_W) were determined using the Design Rainfall Estimation in South Africa package (Smithers and Schulze, 2003). The 24 hour storm rainfall for the 1:2, 1:5, 1:10, 1:20, 1:50 and 1:100-year recurrence intervals and their respective rainfall depths are presented in Table 2.

Table 2: Recommended 24 hour rainfall storm depths for different recurrence intervals

Recurrence interval (years)	2	5	10	20	50	100	200
24 hour rainfall depth (mm)	55.6	74.6	88.1	102.1	121.2	136.6	152.9

6.2 Flood peak calculation

The rational method was applied to the catchment of the unnamed tributary north of the proposed evaporation pond. The catchment characteristics used in applying the rational method are listed in Table 3. The estimated 50 year and 100 year recurrence interval flood peaks are listed in Table 4.

Table 3: Catchment parameters used in the flood peak determination

Parameter	Catchment
Area of Catchment (km^2)	2.35
Slope (m/m)	0.012
Hydraulic Length (km)	2.0
Time of Concentration (hrs)	1.127

Table 4: Flood peaks (m^3/s) calculated for the Catchment

Recurrence Interval Flood Peak	Flood Peak
50 year recurrence interval flood peak (m^3/s)	15.9
100 year recurrence interval flood peak (m^3/s)	20.25

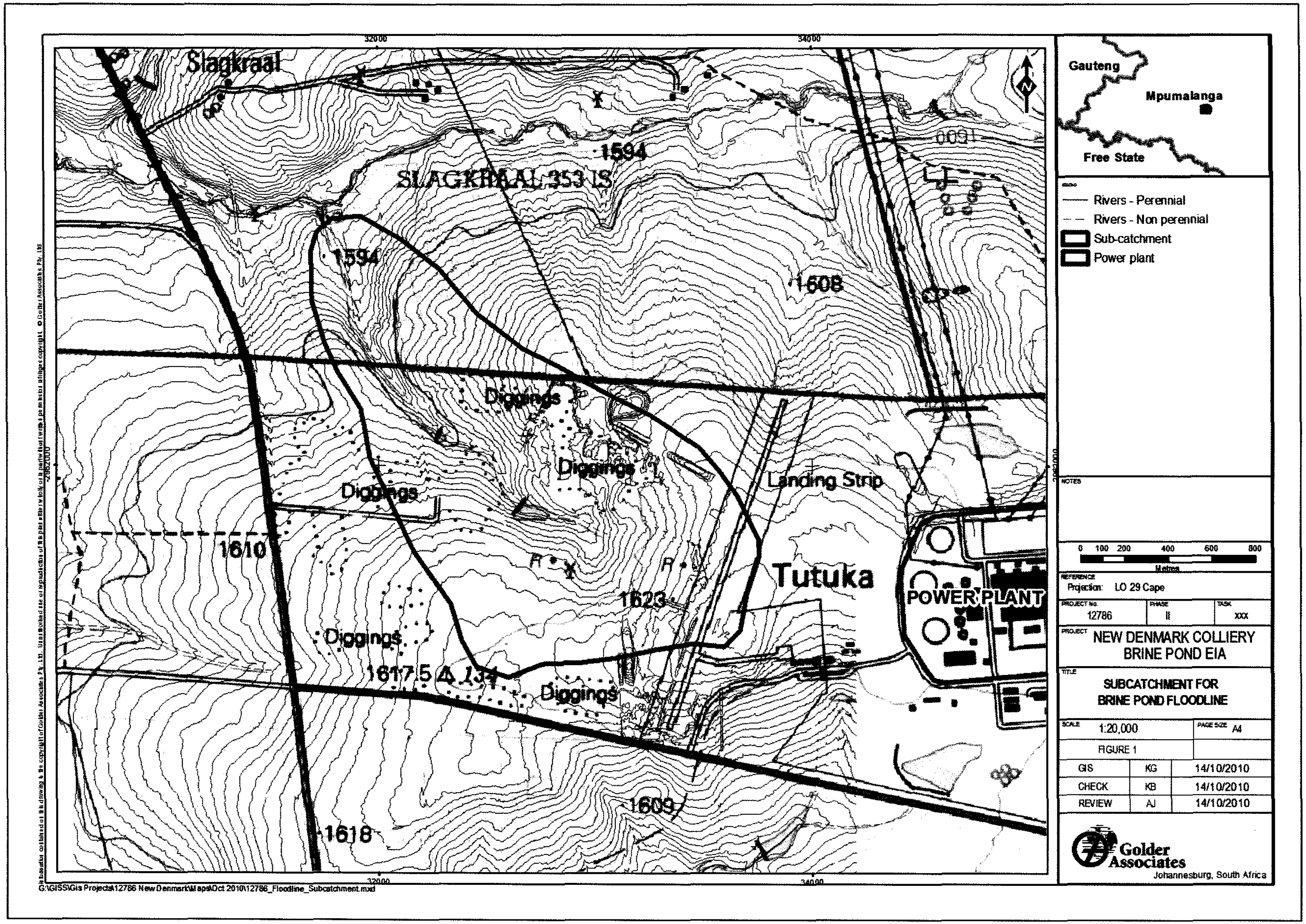

Figure 1: Catchment of the unnamed tributary located to the north of the proposed evaporation ponds

7.0 FLOODLINE MODELLING

7.1 HEC-RAS model set up

Cross-sectional data was obtained from the 1 m contour survey provided by the client. The Manning's n resistance coefficients for the stream channel and the stream banks were estimated by comparing the vegetation and nature of the channel surface with published data (Barnes, 1967; Chow, 1959; Hicks and Mason, 1991). Since no flow data was available for estimation of the roughness coefficients, slightly conservative estimations were adopted. The Manning's n coefficient of 0.03 and 0.035 has been estimated for the river bed and river banks respectively

7.2 Floodline determination

The floodlines were calculated using US Army Corp of Engineers HEC-RAS model. The flood levels for the 1:50-year and 1:100-year flood peaks were determined and are shown in Figure 2. The 1:50- and 1:100-year flood levels, velocities and flood widths are presented in Table A1 in Appendix A for the different river stations (chainages) from the HEC-RAS output. Table A1 illustrates that there is a difference in the water surface elevations for the 50- and 100-year flows. As a result, for purposes of clarity the floodlines have been differentiated by lines with different colours in the drawings.

8.0 CONCLUSIONS AND RECOMMENDATIONS

- From the available maps, the proposed evaporation ponds were measured to be 181 m and 182.5 m from the 1:50- and 1:100-year floodlines respectively.
- It is recommended that all infrastructure and construction related activities remain outside of the 1:50- and 1:100-year flood levels.

9.0 REFERENCES

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Chow, V.T (1959). Open channel hydraulics, McGraw-Hill, New York.

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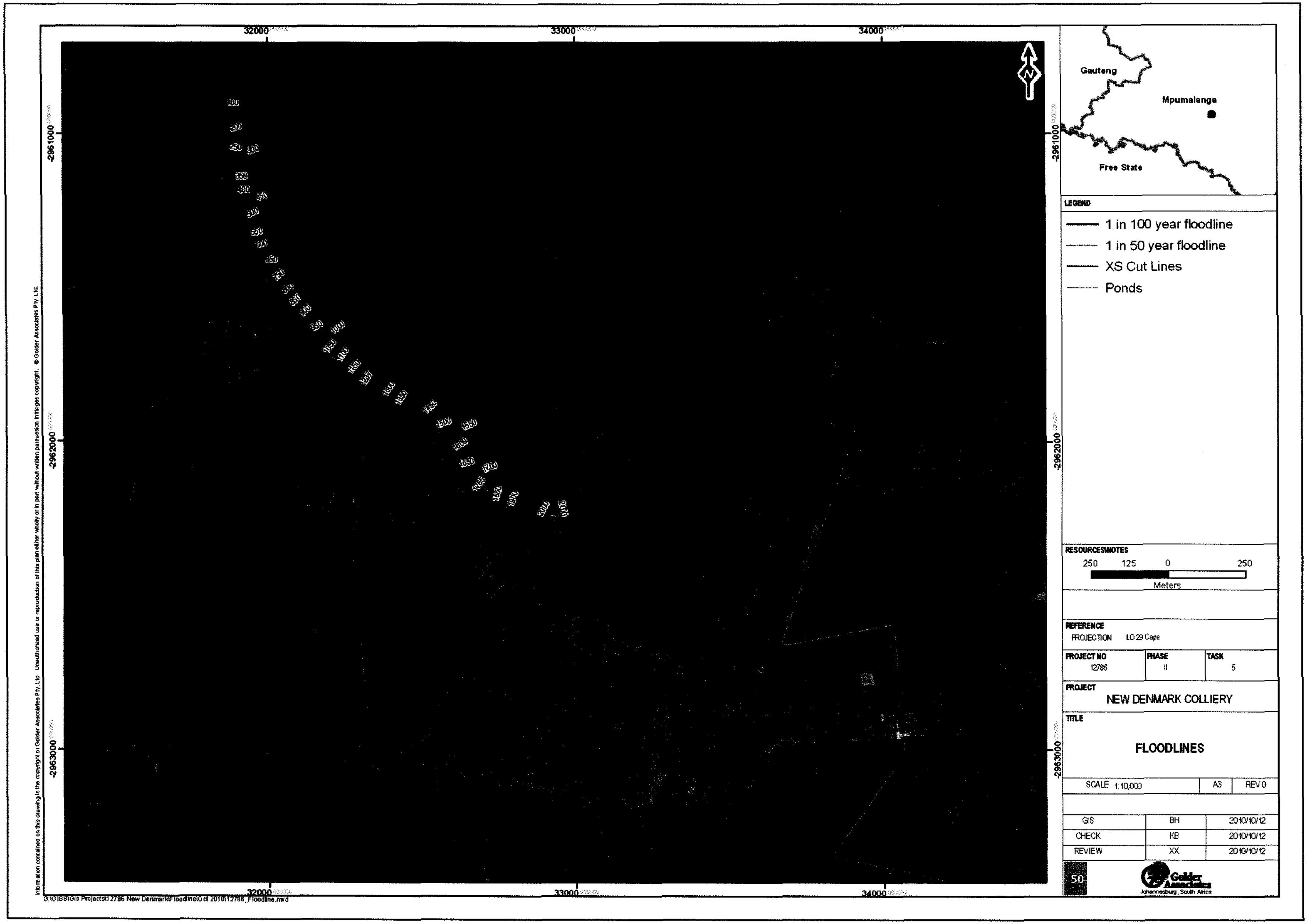

Figure 2: 1:50 year and 1:100 year floodlines for the unnamed river to the north of the proposed evaporation ponds

GOLDER ASSOCIATES AFRICA (PTY) LTD.

Kevin Bursey
Hydrologist

Trevor Coleman
Water Resources Engineer

KB/TC/jn

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APPENDIX A

HecRas Output for the unnamed river to the north of the proposed evaporation ponds

Table A1: HecRas Output for the unnamed river to the north of the proposed evaporation ponds

Reach	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(m3/s)	(m)	(m)	(m/s)	(m)
River	2100	1in50year	16	1607.93	1608.17	1.63	91.6
River	2100	1in100year	20.5	1607.93	1608.19	1.76	93.36
River	2050	1in50year	16	1607.1	1607.79	1.24	51.15
River	2050	1in100year	20.5	1607.1	1607.87	1.32	56.79
River	2000	1in50year	16	1607	1607.63	1.35	38.36
River	2000	1in100year	20.5	1607	1607.7	1.51	41.14
River	1951	1in50year	16	1607	1607.3	1.67	43.78
River	1951	1in100year	20.5	1607	1607.35	1.79	46.78
River	1900	1in50year	16	1606	1606.69	1.66	27.24
River	1900	1in100year	20.5	1606	1606.79	1.77	29.87
River	1850	1in50year	16	1606	1606.67	0.74	48.12
River	1850	1in100year	20.5	1606	1606.78	0.79	51.8
River	1781	1in50year	16	1606	1606.65	0.37	79.75
River	1781	1in100year	20.5	1606	1606.76	0.41	84.83
River	1774	1in50year	16	1606	1606.44	2.03	20.95
River	1774	1in100year	20.5	1606	1606.51	2.21	21.61
River	1765	1in50year	16	1605	1605.16	4.7	23.19
River	1765	1in100year	20.5	1605	1605.2	4.9	23.81
River	1700	1in50year	16	1604	1604.54	1.16	48.12
River	1700	1in100year	20.5	1604	1604.6	1.31	50.44
River	1650	1in50year	16	1603.92	1604.21	1.72	59.76
River	1650	1in100year	20.5	1603.92	1604.25	1.84	61.74
River	1600	1in50year	16	1603	1603.35	2.01	43.59
River	1600	1in100year	20.5	1603	1603.39	2.19	45.77
River	1550	1in50year	16	1602.27	1602.71	1.76	40.34

Reach	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
River	1550	1in100year	20.5	1602.27	1602.77	1.89	43.64
River	1500	1in50year	16	1602	1602.51	1.19	55.97
River	1500	1in100year	20.5	1602	1602.57	1.32	60.54
River	1450	1in50year	16	1601.8	1602.19	1.59	60.84
River	1450	1in100year	20.5	1601.8	1602.22	1.72	63.16
River	1350	1in50year	16	1601	1601.44	0.83	60.69
River	1350	1in100year	20.5	1601	1601.49	0.93	64.85
River	1300	1in50year	16	1600.9	1601.23	1.33	70.36
River	1300	1in100year	20.5	1600.9	1601.26	1.47	72.44
River	1217	1in50year	16	1600	1600.24	1.54	47.98
River	1217	1in100year	20.5	1600	1600.29	1.66	49.22
River	1150	1in50year	16	1599	1599.6	1.18	37.54
River	1150	1in100year	20.5	1599	1599.67	1.32	39.84
River	1100	1in50year	16	1599	1599.44	1.2	41.56
River	1100	1in100year	20.5	1599	1599.49	1.34	43.48
River	1050	1in50year	16	1598.69	1599.05	1.66	40.07
River	1050	1in100year	20.5	1598.69	1599.1	1.78	42.8
River	1000	1in50year	16	1598	1598.23	1.8	44.33
River	1000	1in100year	20.5	1598	1598.26	2.03	45.24
River	950	1in50year	16	1597	1597.48	1.02	41.22
River	950	1in100year	20.5	1597	1597.54	1.15	42.65
River	900	1in50year	16	1596.87	1597.16	1.54	46.57
River	900	1in100year	20.5	1596.87	1597.2	1.68	47.88
River	850	1in50year	16	1596	1596.51	0.87	44.63
River	850	1in100year	20.5	1596	1596.57	0.98	46.02

Reach	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
River	800	1in50year	16	1596	1596.23	1.51	49.45
River	800	1in100year	20.5	1596	1596.28	1.64	50.42
River	750	1in50year	16	1595	1595.23	1.95	39.34
River	750	1in100year	20.5	1595	1595.26	2.18	40.1
River	700	1in50year	16	1594	1594.48	2.08	26.46
River	700	1in100year	20.5	1594	1594.54	2.29	28.46
River	650	1in50year	16	1593.53	1593.99	1.67	46.63
River	650	1in100year	20.5	1593.53	1594.02	1.87	47.86
River	600	1in50year	16	1592.96	1593.24	1.78	46.5
River	600	1in100year	20.5	1592.96	1593.28	1.9	49.11
River	550	1in50year	16	1592	1592.39	2.12	40.94
River	550	1in100year	20.5	1592	1592.43	2.35	44.05
River	500	1in50year	16	1591	1591.54	1.36	53.53
River	500	1in100year	20.5	1591	1591.59	1.51	57.63
River	450	1in50year	16	1590.86	1591.18	1.55	69.2
River	450	1in100year	20.5	1590.86	1591.21	1.67	71.67
River	400	1in50year	16	1590	1590.37	1.19	61.22
River	400	1in100year	20.5	1590	1590.43	1.27	64.8
River	350	1in50year	16	1589.57	1589.94	1.77	49.73
River	350	1in100year	20.5	1589.57	1589.98	1.99	52.38
River	300	1in50year	16	1589	1589.43	1.27	61.31
River	300	1in100year	20.5	1589	1589.48	1.4	67.53
River	250	1in50year	16	1588.65	1589.06	1.61	69.11
River	250	1in100year	20.5	1588.65	1589.1	1.72	76.06
River	200	1in50year	16	1588	1588.46	1.03	76.73
River	200	1in100year	20.5	1588	1588.51	1.14	82.75

Reach	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
River	150	1in50year	16	1588	1588.26	1.13	89.07
River	150	1in100year	20.5	1588	1588.3	1.23	93.92
River	100	1in50year	16	1587.49	1587.78	1.56	82.1
River	100	1in100year	20.5	1587.49	1587.82	1.7	93.89

APPENDIX B

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South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Africa (Pty) Ltd.
Thandanani Park
Matuka Close
Midrand
South Africa
T: [+27] (11) 254 4800

Golder Associates

APPENDIX B

GEOTECHNICAL STUDY

September 2010

NEW DENMARK COLLIERY

Geotechnical Investigation for the Proposed New Evaporation Ponds

Report Number. 12787-10068-3

world
capabilities
locally

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APPENDICES

1.0 INTRODUCTION AND TERMS OF REFERENCE

At the request of Anglo American Thermal Coal (Anglo), Golder Associates Africa (Golder) were appointed to carry out a geotechnical investigation for the development of proposed Brine Evaporation Pond at sites 2, for New Denmark Colliery in June 2010.Whilst this investigation was underway, the project brief was extended to include an additional Brine Evaporation facility, name Site 13, as well as an investigation of a borrow area near Site 2, in August 2010. Only a broadly spaced and limited investigation was undertaken in the case of the extended areas of investigation.

This report deals with the geotechnical stability as well as overall engineering design of these facilities.

The geotechnical investigation was conducted to make recommendations on the following:

- Engineering properties of the near surface strata with the view of using liners in conjunction with compacted earth linings
- Excavation characteristics of the soil/rock strata underlying the site to provide input data in respect of the earthwork operations envisaged in the proposed construction
- Potential for shallow groundwater and its potential effects on the infrastructure
- Long term slope stability of the slopes formed by the bulk earthwork operations of the ponds.

2.0 INFORMATION CONSULTED

The following information was consulted during the course of the investigation:

- 1:1 000 000 scale Geological Map of South Africa
- 1:250 000 scale "East Rand" Geological Sheet 2628, published by the Government Printer, 1986

3.0 SITE DESCRIPTION

The investigation was undertaken at three separate locations, namely Site 2, Site 13 and the Borrow Area.

Attached in Appendix A is Figure 1, Site Locality, which shows the positions of the respective sites, and borrow area which are briefly described below.

3.1 Site 2

Site 2 is located roughly midway between Secunda and Standerton, in Mpumalanga, directly west of the existing Tutuka power plant

The site is covered in natural veld grass with no trees. The general elevation of the land has a high point in the middle with drainage toward the north and south.

A few occurrences of fill material are encountered on site in the form of raised mounds standing proud of the natural ground and an approximately oval section of land in the north east of the site where an apparent disused borrow area has been back filled and re-established.

A site locality plan with approximate fieldwork positions is attached in Appendix A, labelled Figure 2.

3.2 Site 13

This provisional site is located just north of the existing coal ash dump of the Tutuka plant, east of the plant.

The area is divided roughly into four quadrants. The eastern blocks are covered by natural veld grass with an abandoned farm house on the eastern boundary. The western two blocks are cultivated land with an apparent peanut crop.

Overall, the site drains gently to the south east.

The site locality plan with approximate fieldwork positions is attached in Appendix A and labelled Figure 3.

3.3 Borrow Area

The existing borrow area, used by Anglo, is situated less than a kilometer north west of Site 2.

The current area is fenced enclosing an area of approximately 150m x 300m of which roughly 30-40% of the area has been excavated to a depth of 4-5m. The face of the excavation showed dolerite rock at various degrees of weathering.

Surrounding the open excavation is veld grass with no trees, similar to that of Site 2.

The area slopes gently to the north.

A site locality plan with approximate fieldwork positions is attached in Appendix A, labelled Figure 4.

4.0 METHOD OF INVESTIGATION

Prior to investigation, the Golder Engineer, and relevant sub-contractors underwent the Anglo Induction and Medicals before commencing fieldwork.

The method of investigation was the same for all sites and is summarised as follows:

4.1 Test Pitting

Due to the field work being broken up over two periods and between 3 different sites, the fieldwork schedule looked as such:

- Twenty four (24 No) test pits, numbered TP01-TP24, were excavated at Site 2 on the 1st and 2nd of July 2010 using a CAT 330C tracked excavator supplied by Thokozela Trading.
- Eight (8 No) test pits, numbered TP25-TP32, were excavated at Site 2 on the 30th of August 2010 using a CASE 580R Tractor Loader Backhoe (TLB) supplied by Thokozela Trading.
- Five (5 No) test pits, numbered TP13-1 – TP13-5, were excavated at Site 13 on the 31st of August 2010 using the same CASE 580R TLB from Thokozela Trading.
- Ten (10 No) test pits, numbered TPB01-TPB10, were excavated in and around the borrow area on the 31st of August and 1st of September 2010, using the same CASE TLB.

All the pits were either excavated to the depth limit of the machine (4.8m in the case of the excavator, or 3.0m with the TLB) or to the depth of effective machine refusal such that the surface soil profile could be examined in-situ.

Test pits were profiled by a geotechnical specialist in accordance with industry accepted standards and, where appropriate, representative soil samples were recovered for laboratory testing. The test pit profiles are presented in Appendix B.

4.2 Laboratory Testing

Laboratory testing was carried out by specialist soils laboratory, Geopractica, on selected representative soil samples, recovered from the test pits by Golder personnel, which were marked and sealed for transporting and delivered to the laboratory.

The following laboratory testing has been carried out in accordance with Golder requirements:

- Grading, hydrometer and Atterberg Limit tests to determine the engineering properties of the in-situ soils for classification purposes
- Natural moisture content to determine the in-situ moisture regime

- Moisture : Density relationship tests (at Mod AASHTO and Standard Proctor compactive efforts) to determine the optimal compaction characteristics of the soil
- Basic chemistry indicators of the in-situ soils were determined to provide a preliminary evaluation of the aggressiveness or corrosiveness potential
- Shear box testing, on remoulded samples, to establish the shear strength parameters for use in slope stability calculations in respect of the proposed ponds
- Falling head permeability tests on remoulded samples

The laboratory results are shown in Appendix D and summarised in Table 1 of Appendix B.

At the time of report submission, permeability test results were not yet available.

5.0 GEOLOGY

According to the available geological mapping, the general area is underlain by rocks of the Vryheid Formation, Ecca Group of the Karoo Supergroup, including Shale, Siltstone, which have been intruded by younger Dolerite.

Generally, the area is expected to be covered by a nominal to moderate cover of transported soils of mixed origin.

A summary of the soil/rock horizons encountered on site can be found in Appendix B, Table 2, and are described below.

5.1 Site 2 – Soil Profile

The presence of dolerite and siltstone was confirmed during the course of the investigation in the form of weathered residual soils and bedrock of both rock types.

It must be cautioned however that, as a consequence of normal variances which must be expected, not all of the horizons necessarily appear across the site or are represented at every test pit locality:

As mentioned in the site description, occasional occurrences or fill material are apparent on site. The fill includes soils of mixed origin as well as plastic and building materials. Where encountered the horizons are generally in the order of 0.3m to 1.0m thick.

In most instances, the uppermost soil horizon encountered below natural ground level is of a transported origin. This layer comprises moist, dark grey, firm sandy clay which is generally 0.5m thick with a consistent depth range of 0.3m to 0.7m.

Below the transported material, the residual dolerite was encountered, which is occasionally reworked in places. This layer comprises moist, orange brown speckled black clayey coarse sand which is highly relict jointed and has an overall dense consistency. The horizon varies in depth from 0.8m to 2.4m to the base of the horizon.

Competent dolerite bedrock occurs below the residual dolerite horizon. This orange brown stained black, highly jointed coarse grained rock has an approximately northern strike and is encountered at depths of between 0.3m and 2.4m. However, the test pits in which the shallow rock was encountered, were generally the test pits where fill material has been dumped, so it is unclear what the original depth to rock may have been. The average depth to rock can be estimated in the region of 1.0m to 1.2m.

In a thin section, approximately 50m wide, running up the eastern boundary of the site, and widening in the north, siltstone was encountered in the test pits. The overlying residual siltstone comprises a moist, light grey brown sandy clay with an overall firm consistency. In the northern section, where the siltstone band widens, the residual soil was encountered to a depth of 0.6m to 1.2m. Transported material covers the residual siltstone as for the dolerite mentioned above.

The siltstone is a highly weathered and jointed, brittle blue grey rock of soft rock quality, improving rapidly to medium hard rock on which excavator refusal occurred. The depths at which refusal was proven was between 1.7m and 3.2m.

5.2 Site 13 – Soil Profile

The two test pits in the south of Site 13, namely TP13-3 and TP13-4, display a similar profile to the residual dolerite encountered on Site 2 with a layer of transported material to 0,6m underlain by jointed residual soils in the form of silty coarse sand to depths of 1.1m in both instances.

The dolerite rock is yellow brown, coarse grained medium hard rock on which the TLB refused.

Further north in the remaining three test pits, the profile changes somewhat. The same transported layer is evident to a consistent depth of 0.6m. Below the transported soil, a horizon of residual dolerite, which has been highly reworked is evident. This moist, grey brown, slickensided, sandy clayey silt which, overall, is soft to firm in consistency occurs to depths of between 1.3m in the west (TP13-1) to 2.6m in the eastern test pit (TP13-2).

At the base of these test pits, residual dolerite which has been reworked to a lesser degree is encountered. This soil is similar to the above but exhibits a lower clay percentage and is slightly coarser, and occurs to 3.0m, the full depth limit of the TLB.

5.3 Borrow Area – Soil Profile

Test pits in and around the borrow area showed the most consistency in terms of soil horizons.

After examining, and sampling the exposed face within the borrow area, coarse grained residual dolerite and dolerite rock were expected in the test pits nearby.

Test pits near the borrow area showed a similar profile to those test pits at Site 2 which included dolerite.

Below the transported layer, again of consistent depth to 0.5m, the residual dolerite comprised a slightly moist, yellow brown speckled black silty coarse sand of overall medium dense consistency. The residual dolerite occurs to depths of between 0.7m to 1.0m.

The dolerite rock at the base of the test pits was similar to that exposed in the borrow area comprising an orange brown, highly jointed rock, with rock quality rapidly improving with depth from soft rock to medium hard rock, on which the TLB refused. The range of refusal depths was between 1.0m to 1.4m with two exceptions within TPB03 and TPB04 which refused at 3.0m and 2.1m respectively. These deeper refusal depths may be attributed to the TLB being able to rip through the jointed material before refusing on rock weathered to a lesser degree.

6.0 GEOTECHNICAL ASSESSMENT

6.1 Material Properties

6.1.1 Fill

The fill material overlying the in situ transported or residual soil horizons generally has a highly variable composition including mixed sand, silt, clay, boulders, builder's rubble, concrete slabs and general waste. As a consequence the fill identified on Site 2 (and elsewhere if encountered) is not deemed suitable as construction material for the proposed development.

6.1.2 Organic Material

In all of the transported soils encountered on site, grass roots occur through approximately 80% of the horizon. This uppermost horizon, as mentioned above, is an average of 0.5m thick, making the presence of roots to a depth of generally 0.4m, thus leaving a 0.1m band of fine grained material, free of organic material.

6.1.3 Transported Soils

The transported material overlying the residual soils consists of relatively fine grained sandy clay which classifies in most instances as a CL or CH soil in terms of the Unified Soil Classification (USC) system. The transported soils, which were sampled, may be suitable in the construction of compacted earth embankments. However, due to it being a thin horizon and mostly including grass roots and organic material, only very limited quantities are expected and to avoid contaminated materials being used in construction, it is not recommended.

6.1.4 Dolerite and Residual Dolerite

The residual dolerite was encountered with different degrees of reworking across the three sites.

Site 13 showed highly reworked residual dolerite, resulting in the soil being fine grained and classified generally as a CH soil. This material is generally not considered suitable for the construction of a compacted earth embankment. Also, Site 13 is a fair distance from the proposed Site 2 location and hauling of the material may be costly.

The residual dolerite found on Site 2 is a much coarser soil and is classified mainly as a SC soil, in terms of the USC, with occasional zones of GC. Based on the results of Mod-CBR testing on the residual dolerite, it was shown that this material, i.e. where no reworking has taken place, classifies as a G7 and G8 material in terms of the Road Building Materials Classification (TRH14). Due to this material containing fine grained soil, which increases its plasticity, it is considered a suitable material for use in construction of an earth embankment. It must be stressed that the fine grained soil must not be excluded from the material before construction, as the absence of this fine soil may results in voids forming between the gravels and lower its cohesion. These voids may lead to increased permeability and potential for settlement and/or collapse.

The current plans for the brine pond show that its base would be below the level at which dolerite rock was encountered. It is unlikely that the rock, after blasting, will be suitable for construction of the pond embankments unless secondary blasting or crushing is done to reduce the blasted fragments to acceptable sizes and there is sufficient fines available (or mechanically mixed therein) to render it suitable for the intended purposes of the proposed embankment construction. Given the various processes that will be needed to reach an acceptable material, this option, as a source of material for construction of the embankments should only be considered if there is insufficient material from the residual dolerite soils on site and the nearby borrow area, and then only after field trials have proven that the desired embankment material can be delivered.

It is advised that the Golder Geotechnical Engineer is periodically present on site, to confirm the quality of the blasted bedrock for the proposed embankments.

6.1.5 Siltstone and Residual Siltstone

The siltstone encountered in the eastern and northern portions of Site 2 has a similar jointed structure to that of the dolerite. However, the siltstone is a visibly more brittle rock, which is proven in the Mod-CBR test results. The representative siltstone sample which underwent compaction tests resulted in a G10 classification material in terms of TRH14.

Even though, in terms of its USC, the residual and weathered siltstone is also classified as a SC soil, it is not recommended as a suitable embankment construction material due to the rocks brittle nature. The breakdown of the coarse particles with compaction, renders the siltstone too fine and plastic for use as an embankment material

In-situ, the siltstone displays a stable structure for founding purposes for the proposed structure, but in a disturbed state, the rock is not considered suitable for construction.

6.2 Foundations

Foundations of the embankment should be taken through all the transported soils and founded in residual dolerite, and where it occurs, residual siltstone, or on material of at least dense consistency. The upper

300mm of in situ soils below the base of the embankment should be ripped and compacted to 98% of its maximum Proctor dry density

6.3 Compaction Criteria for an Embankment

It is recommended that the embankment be compacted to a minimum dry density of 100% Proctor with compaction moisture content ranging between Proctor optimum moisture content (omc) and 3% above Proctor omc. Compaction should be carried out using a sheepsfoot or tamping rollers. Compacting at Proctor density compactive effort will prevent over-shearing of the soil and allow a more flexible embankment thereby minimising differential cracking. Compacting at the higher Proctor moisture contents will significantly decrease the permeability of the compacted material.

6.4 Shear Strength and Slope Stability

Due to the proposed construction being a possible cut to fill operation, laboratory testing of remoulded samples was carried out on samples of the transported and residual soils from the areas of proposed cut, to determine the shear strength of the materials after compaction.

Testing comprised slow, drained shear box tests on samples which had been remoulded to 100% proctor compaction to replicate, as best, the likely compaction process in the field.

The tested transported material produced a cohesion value of 7kPa and effective friction angle of 33°. Although this material may support the proposed internal slope of 1:2.5, it is recommended that the material is fully stripped from site due to its high percentage of grass roots and occasional fill material.

The residual dolerite tested resulted in a cohesion value of 30kPa and an effective friction angle of 47°. This value is relatively high compared to anticipated results, from published data, for SC classified soils. It may be explained by the relatively low percentage of fine grained material in the sample and justifies the previously mentioned statement that fines should not be excluded from the residual dolerite when forming the earth embankment.

In our judgment, given the laboratory test results, as well as the physical characteristics of the residual dolerite and correlation with published data, effective shear strength parameters of the compacted residual dolerite for stability analysis are estimated to be:

$\Phi' = 31^{\circ}$ and $C' = 5$ to 10kPa

After calculating the slope stability in the analysis program RocScience SLIDE (v.5.0), it is shown that the residual dolerite is considered a suitable material for the construction of an earth embankment where the slope angles do not exceed the proposed internal slope of 1:2.5 and the external slope of 1:3.

6.5 Excavation Characteristics

Generally the transported and reworked residual soils encountered on the site will typically classify as "*Soft Excavation*" according SABS 1200D.

Below which, in most instances, the residual material, which includes boulders, is classified as *"Intermediate Excavation"*. A nominal allowance for boulder excavation should be made due to the jointed structure of the residual and rock quality dolerite.

"*Hard Excavation"* was proven in nearly all test pits and is defined by the rock quality material on which the respective machines refused further excavation.

A summary of the excavation classifications can be found in Table 3, in Appendix B.

6.6 Groundwater

Groundwater seepage was not encountered in any of the surface test pits excavated during the investigation, except for TP10, which was in proximity to standing water in the south of Site 2. The residual and reworked residual soils however had medium to high in-situ moisture contents, at the time of profiling, due to possibly poor natural site drainage, surface water infiltration or moisture retention of the fine-grained soils.

Notwithstanding the above the development of near-surface, seasonal perched water tables during periods of intense or sustained rainfall cannot be excluded, making effective dewatering of the ground profile essential as well as measures to improve material workability during construction.

Due to the occurrence of standing surface water in the southern section of site, it is recommended that appropriate drainage controls are put in place. A network of sub-surface drains at the base of the bulk earthworks, as well as fin drains (where indicated by groundwater seepage) on excavated slopes to control seepage are proposed mitigation controls.

6.7 Soil Permeability

Due to the period of time needed for the testing of permeability on remoulded soils, laboratory results were not available at the time of this report's submission. A follow up report will become available as soon as the results have been received and analysed.

6.8 Soil Chemistry

Laboratory testing was conducted to determine potential corrosiveness of the upper soils encountered during the investigation. The results indicate that:

- The sampled soils have a pH ranging between 7.3 and 8.4, with one rare case of 6.5 on Site 13. These soils are therefore classified as neutral to slightly alkaline;
- The sampled soils have an electrical conductivity ranging from 11 mS/m to 45 mS/m. Consequently the soils may be classified as mildly to moderately corrosive towards buried steel and ferrous fittings in terms of the measured conductivity values.

Due to the neutral nature and the moderate corrosiveness of the soil, it would appear that the onsite materials do not pose a major threat to concrete and/or ferrous services.

Specialist testing for corrosiveness should, however, be undertaken to verify design parameters in regard to highly sensitive (or costly) buried equipment and installations within the upper soil profile.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Transported soil horizons are unsuitable for use in embankment construction and should be removed to stockpile wherever encountered in the embankment foundations.

The use of this soil should be limited to topsoiling of pond slopes to promote establishment of vegetation and mitigate erosion.

The residual dolerite will provide the bulk of the material that will be obtained from the excavation of the brine pond basin, and represents an important material source for construction.

Residual dolerite samples from the borrow area nearby proved to provide material properties fairly similar to those found within the pond basin. Material from the borrow area may also be used within the planned embankment construction provided that normal quality controls and material verification tests are routinely undertaken and compliance with specifications established.

If blasting of the bedrock within the brine pond basin is employed, it is imperative that the appropriate material testing is undertaken to ensure the rock is of a similar, or better, quality compared to that of the residual material above which was tested for this investigation.

It is recommended that provision be made for the installation of permanent sub-surface drains to intercept any sub-surface water that may stem from the development of seasonal, perched or permanent groundwater tables. These drains are required to prevent potential uplift of the proposed lining system as a consequence of hydrostatic pressure as well as to improve the long-term stability of the two ponds.

Soils on site are neutral but moderately corrosive. Precautions may be necessary to protect buried steel, concrete and other components susceptible to corrosion. Specialist advice should be sought in the case of sensitive (or costly) installations in and around the proposed construction.

GOLDER ASSOCIATES AFRICA (PTY) LTD.

Ross Dold
Geotechnical Engineer

Bryan Tromp
Principal Consultant

RD/BT/rd

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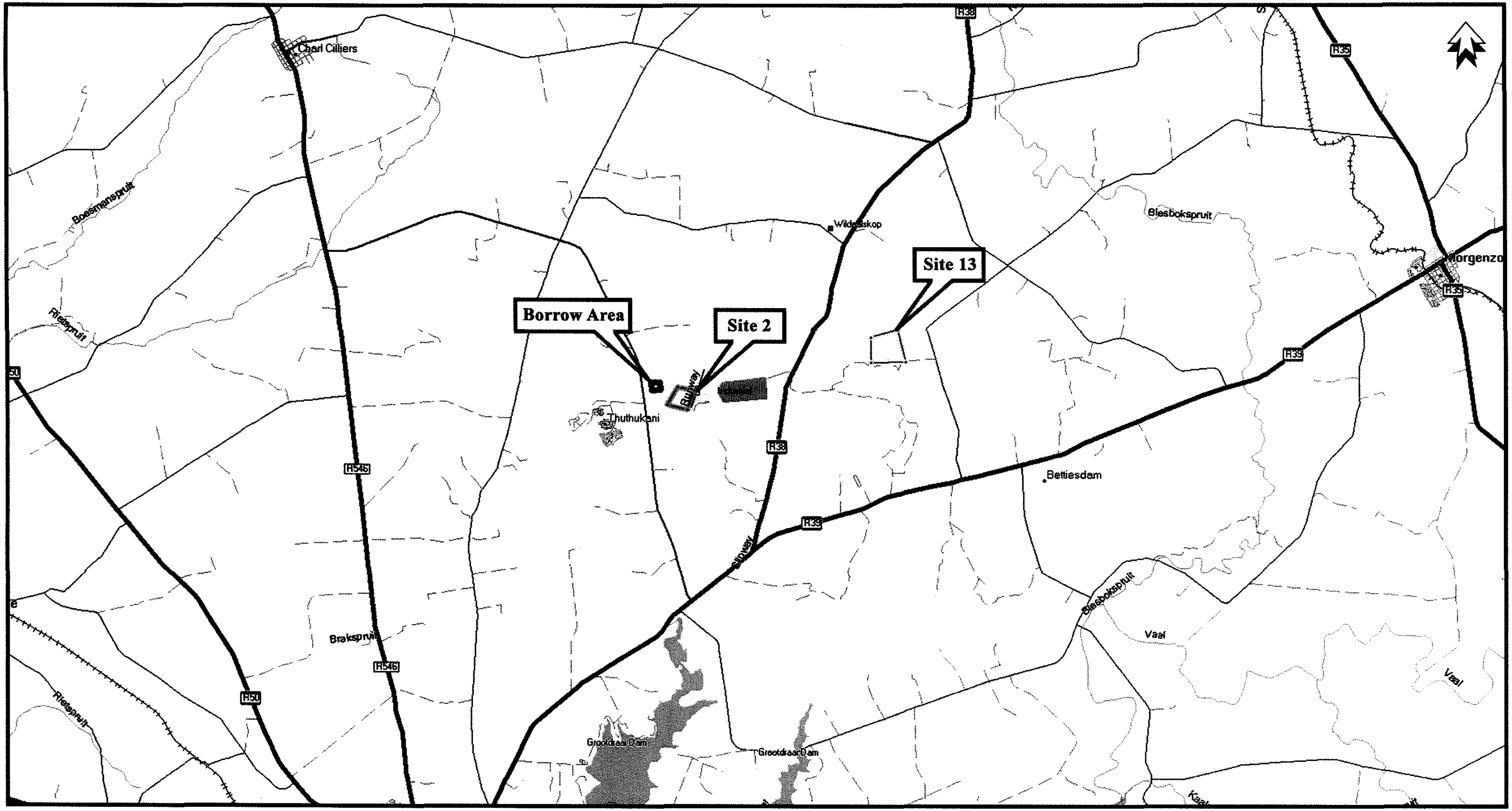
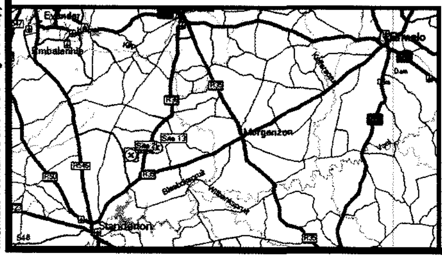
APPENDIX A

Figures





LEGEND

NOTES

0 3 6 9

Kilometres

REFERENCE

PROJECT

ANGLO AMERICAN THERMAL COAL
NEW DENMARK COLLIERY

TITLE

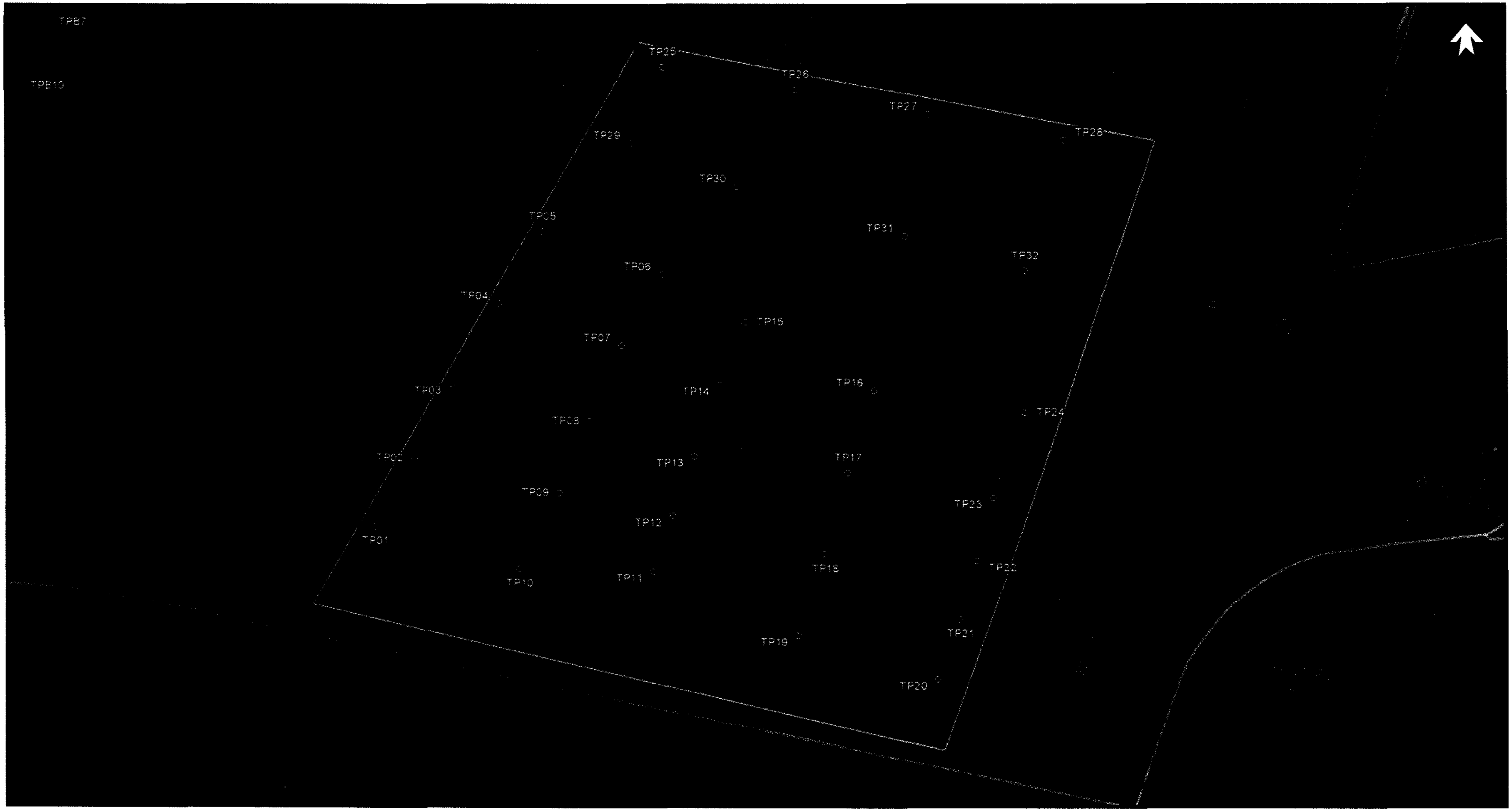
SITE LOCALITY PLAN

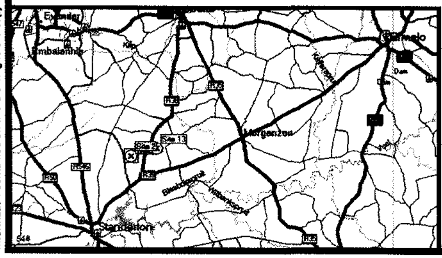
Golder Associates

PROJECT No:	12787		
PHASE:	TASK: 300		
DRAWN	SG	2010/10/01	
CHECK	RD	2010/10/01	
REVIEW	BT	2010/10/01	

SCALE: Bar | A4 | REV.0

FIGURE: 1





LEGEND

- Approximate Test Pit Position - Site 2
- Approximate Test Pit Position - Site 13
- Approximate Test Pit Position - Borrow Area

NOTES

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Metres

REFERENCE

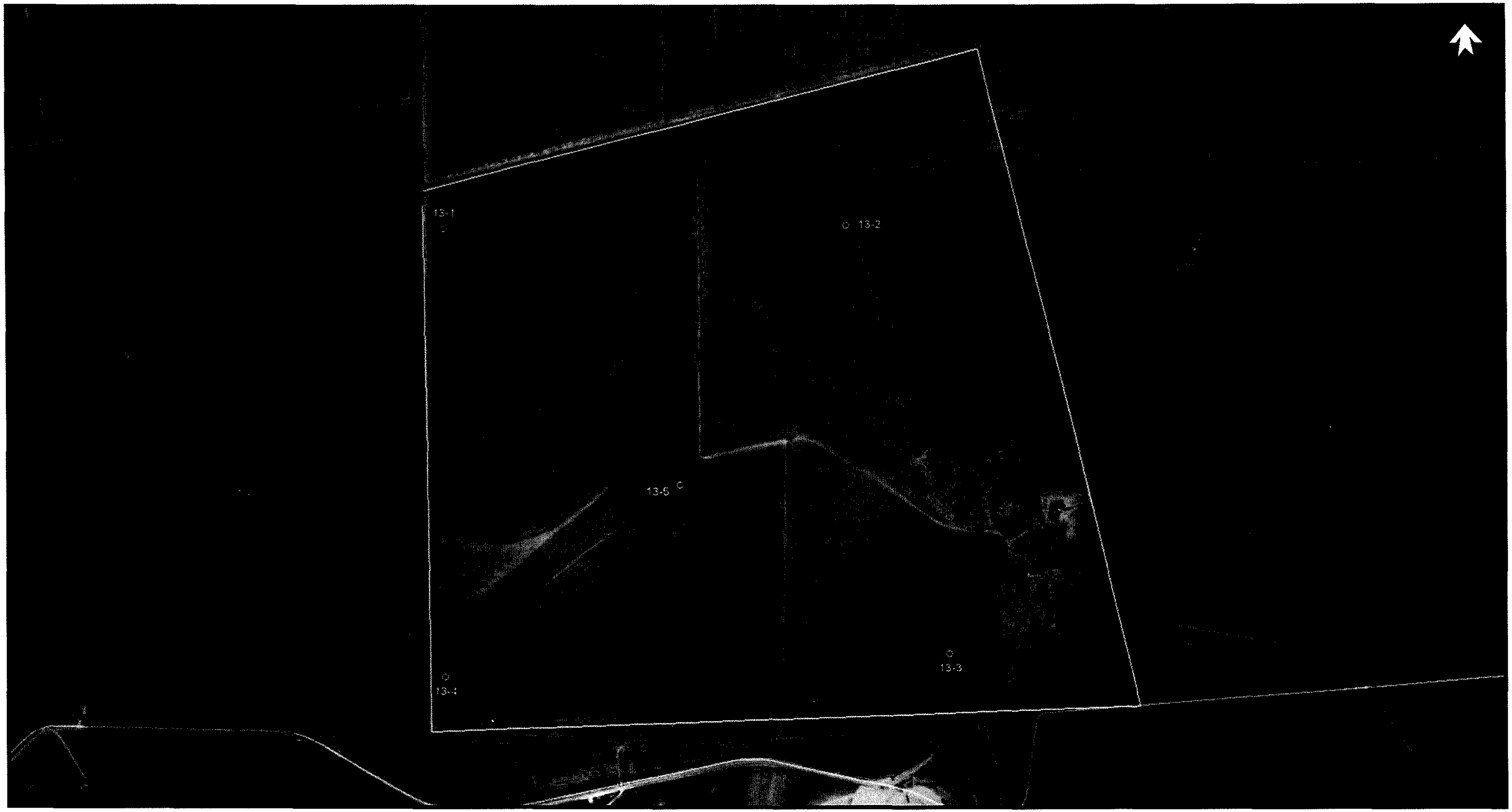
PROJECT
ANGLO AMERICAN THERMAL COAL
NEW DENMARK COLLIERY

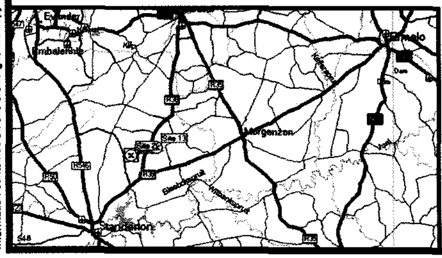
TITLE
APPROXIMATE FIELDWORK POSITIONS - SITE 2

Golder Associates

PROJECT No:	12787	SCALE: Bar	A4 REV.0
PHASE:	TASK: 300		
DRAWN	SG	2010/10/01	
CHECK	RD	2010/10/01	
REVIEW	BT	2010/10/01	

FIGURE: 2





LEGEND

- Approximate Test Pit Position - Site 2
- Approximate Test Pit Position - Site 13
- Approximate Test Pit Position - Borrow Area

NOTES

0 150 300 450

Metres

REFERENCE

PROJECT

ANGLO AMERICAN THERMAL COAL
NEW DENMARK COLLIERY

TITLE

APPROXIMATE FIELDWORK POSITIONS - SITE 13

Golder Associates

PROJECT No:	12787	SCALE: Bar	A4 REV.0
PHASE:	TASK: 300		
DRAWN	SG 2010/10/01	**FIGURE: 3**	
CHECK	RD 2010/10/01		
REVIEW	BT 2010/10/01		