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DOORNHOEK FLUORSPAR MINE

FINAL REHABILITATION, DECOMMISSIONING AND MINE CLOSURE PLAN

November 2016

SA Fluorite (Pty) Ltd &
Southern Palace 398 (Pty) Ltd

Document version 2.0 – Final

Compiled by C F Theron

REDE
Engineering & Management Solutions

DOORNHOEK FLUORSPAR MINE

FINAL REHABILITATION, DECOMMISSIONING AND MINE CLOSURE PLAN

10 November 2016

Conducted on behalf of:

SA Fluorite (Pty) Ltd & Southern Palace 398 (Pty) Ltd

Compiled by:

CF Theron Pr CPM

Project team:

J Msiza

CF Theron

REPORT DISTRIBUTION LIST

Name	Institution
Mr. A Saad	SA Fluorite (Pty) Ltd & Southern Palace 398 (Pty) Ltd
Mr. M Grobler	Exigo Sustainability (Pty) Ltd
Me. C Uys	Exigo Sustainability (Pty) Ltd

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C F Theron (Pr. CPM)
Technical Director

LIST OF ABBREVIATIONS

Project Specific Abbreviations	
Abbreviation	**Description**
AGES	Africa Geo-Environmental Services Gauteng (Pty) Ltd
DMR	Department of Mineral Resources
DWS	Department of Water and Sanitation
DFM	Doornhoek Fluorspar Mine
EXIGO	Exigo Sustainability (Pty) Ltd – An EOH Company
MPRDA	Mineral and Petroleum Resource Development Act and Amendments
General Abbreviations	
Abbreviation	**Description**
CAPEX	Capital Expenditure
DFS	Definitive Feasibility Study
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Regulations
EMPr	Environmental Management Programme
EXIGO	Exigo Sustainability (Pty) Ltd
LoM	Life of Mine
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
mbgl	Meters Below Ground Level
MPRDA	Mineral and Petroleum Resource Development Act
NEMA	National Environmental Management Act
OPEX	Operational Expenditure
PFS	Preliminary Feasibility Study
PPI	Producer Price Index
REDE	REDE Engineering & Management Solutions (Pty) Ltd
RoM	Run of Mine
RSA / SA	South Africa
SLP	Social and Labor Plan
TSF	Tailings Storage Facility
Units	
Abbreviation	**Description**
bar	Unit of Pressure (1 Bar = 100 kPa)
c/kWh	Cents per Kilowatt Hour
cm	Centimeters
ea	Each
ha	Hectare
hrs	Hours
km	Kilometer
kPa	Kilo Pascal
l	Liter
l /d	Liter per Day
Ml	Mega Liter

m^2	Square Meter
m^3	Cubic Meter
mm	Millimeter
m	Meter
m/s	Meter per Second
Ml/d	Mega Liters per Day
Nr	Number
Qty	Quantity
R	South African Rand
R/m^3	South African Rand per Cubic Meter
t	Tonne (1 000 Kilograms or 2 204.62 pounds)
tpa	Tonnes per annum
%	Percentage

EXECUTIVE SUMMARY

REDE Engineering and Management Solutions (Pty) Ltd was appointed by SA Fluorite (Pty) Ltd & Southern Palace 398 (Pty) Ltd to compile a Final Rehabilitation, Decommissioning and Closure Plan in order to estimate of financial provision for the infrastructure and activities associated with the proposed Doornhoek Fluorspar Mine. This report supports the mining rights application process.

The proposed mine is located in the Ngaka Modiri Molema District Municipality. The project area is located between Zeerust and Mafikeng in the western section of the Ditsobotla Local Municipality and the southern section of the Ramotshere Moila Local Municipality in the North West Province, South Africa.

The proposed Doornhoek Mine will mine Fluorspar on the Farms Kafferskraal 306 JP, Knoflookfontein 310 JP and Rhenosterfontein 304 JP. Physical mining will only begin in year 5 after mining license has been granted.

The current mining model proposes to mine 1.5Mt of ore per year over a 30-year Life of Mine using opencast mining methods. It is estimated that this process will produce 250 000 tpa of acid grade fluorspar.

The infrastructure associated with the project and that was included in this report, includes:

- Mining complex infrastructure
- Electrical sub-station and reticulation;
- Minerals processing plant;
- Administrative buildings including Change House;
- Ore loading facility;
- Temporary overburden dump;
- Tailings Storage Facility (TSF);
- Storm water management infrastructure including dams;
- Water supply infrastructure including pipelines;
- Water- and wastewater treatment facilities;
- Haul and access roads; and
- Perimeter and internal fencing.

The financial provision for closure was calculated based on information made available by the client, using a methodology in line with the Department of Mineral Resource (DMR) guidelines, NEMA regulations and other known best-practice principles.

Both an ‘immediate’ (based on an end of year 1 lights out scenario) which will be in the eighth year after start of construction activities and the ‘life-of-mine’ closure liability for the site were calculated and are summarized in the table below:

Description	Operational	Closure	Aftercare (3yrs)	TOTAL
Immediate Closure Provision – Year 8		R 17 688 778	R 3 207 144	**R 20 895 922**
Life-of-Mine Closure Provision – 30 yrs LoM	R 92 101 784	R 7 112 492	R 3 207 144	**R 102 421 420**

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1 INTRODUCTION

REDE Engineering and Management Solutions (Pty) Ltd was appointed by SA Fluorite (Pty) Ltd & Southern Palace 398 (Pty) Ltd to compile a Final Rehabilitation, Decommissioning and Closure Plan in order to estimate of financial provision for the infrastructure and activities associated with the proposed Doornhoek Fluorspar Mine. This report supports the mining rights application process.

The proposed mine is located in the Ngaka Modiri Molema District Municipality. The project area is located approximately 15km southeast of Zeerust along the R510 provincial road to Koster, in the western section of the Ditsobotla Local Municipality and the southern section of the Ramotshere Moila Local Municipality in the North West Province, South Africa. Most of the labour will be sourced from local communities as far as possible and they will be housed in Zeerust.

The proposed open cast mine development will be a phased development and entails the opencast mining of Fluorspar and the development of mining infrastructure including access and haul roads on the following farms:

- Doornhoek 305 JP
- Kafferskraal 306 JP
- Knoflookfontein 310 JP; and
- Rhenosterfontein 304 JP.

The entire larger mining right area will however also include the following farms:

- Kwaggafontein 297 JP;
- Paardeplaats 296 JP;
- Saamgevoeg 320 JP;
- Strydfontein 326 JP; and
- Witrand 325 JP.

The project area is at an average elevation of approximately 1450 mamsl and the general site coordinates (Datum: D_WGS_1984) is:

Latitude - 25.75

Longitude 26.21

The study area is situated within quaternary catchment A31D which falls within the Crocodile (West) and Marico water management area. The quaternary catchment is drained by the perennial Klein Marico River, a tributary of the Groot Marico River, which in turn is a tributary of the Marico which flows into the Limpopo River north of the project site.

The project site is located on Vaalian age Chunniespoort group sediments (Transvaal Super Group). The Chunniespoort group is largely represented by dolomite, dolomitic limestone, chert and shale and is intruded by numerous basic dykes and sills. The fluorspar deposits are large bedded replacement deposits of the classical Mississippi Valley type. Fluorspar mineralisation occurs mainly associated with stromalites in the Middle Frisco Zone and appears to have been introduced post deposition by hydrothermal brines. The fluorite occurs as a filling in permeable beds; within small gas cavities in the stromalites (Ref. 10.51). The ore body is situated between 40m and 90m below surface.

The current mining model proposes to mine 1.5Mt of ore per year over a 30-year Life of Mine using opencast mining methods. Ore from different sources / positions will be blended before production and an active stockpile of approximately 30 000 t is envisaged. It is estimated that this process will produce 250 000 tpa of acid grade fluorspar.

The infrastructure associated with the project and that was included in this report, includes:

- Opencast mine development;
- General Mining complex infrastructure;
- Electrical sub-station and reticulation;
- Processing plant / concentrator;
- Administrative buildings including Change House;
- Workshop and fuel storage facilities;
- Ore loading facility;
- Temporary overburden dump;
- Tailings Storage Facility;
- Stormwater management infrastructure including settling ponds / dams;
- Water supply and distribution infrastructure;
- Water- and wastewater treatment facilities;
- Haul, maintenance and access roads; and
- Perimeter and internal fencing.

Physical mining will only begin in year 5 after mining license has been granted. Access road, haul roads, upgrading to the rail siding, tailings storage facility and plant construction

will take place in the years before this. All facets of the plant construction will however only be concluded in year 7 after construction started. Below are two figures indicating the position of resources and the general locality of the proposed project.

This closure plan will aim to establish the expected environmental liability for all phases of the **Doornhoek Fluorspar Mine Project.**

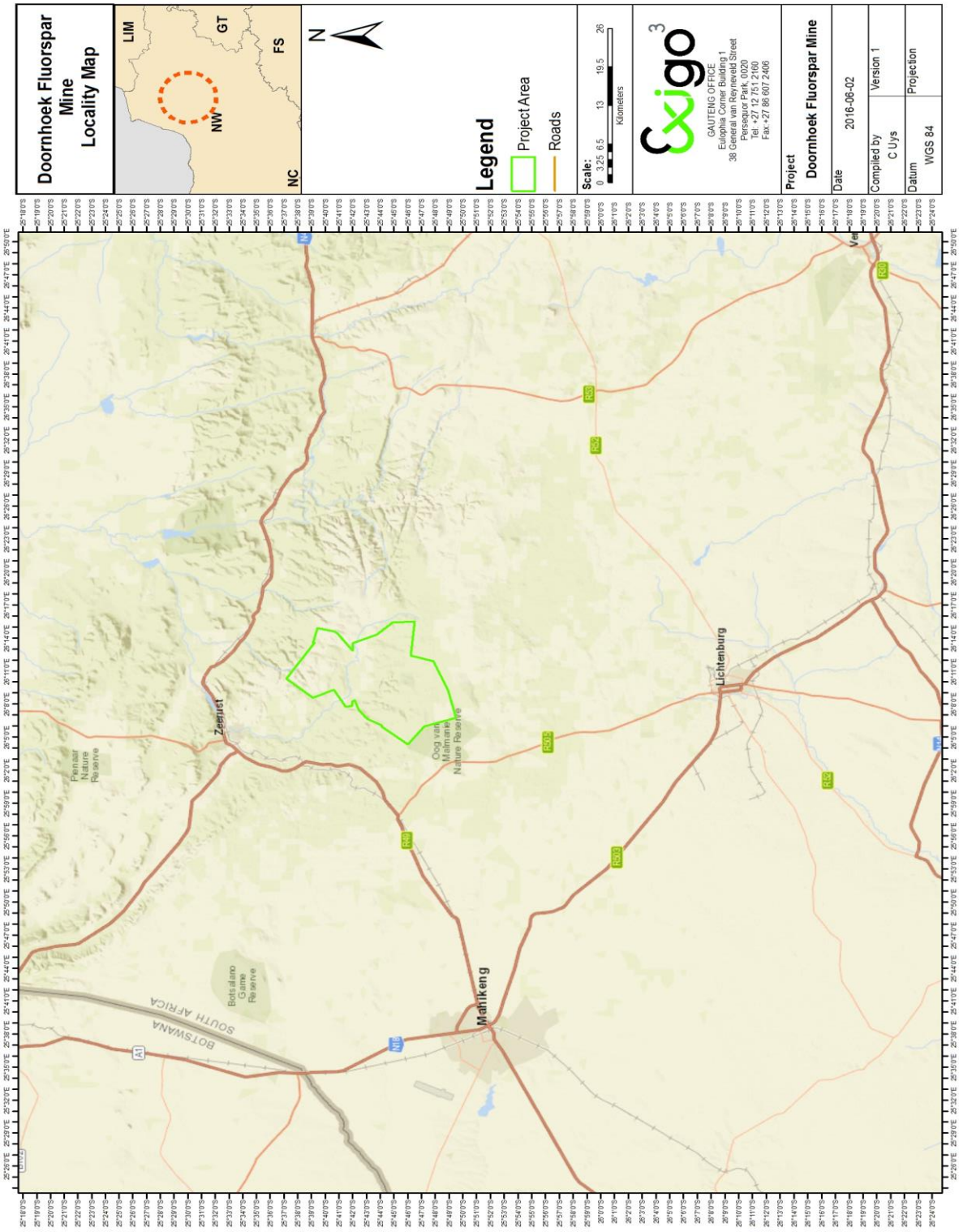
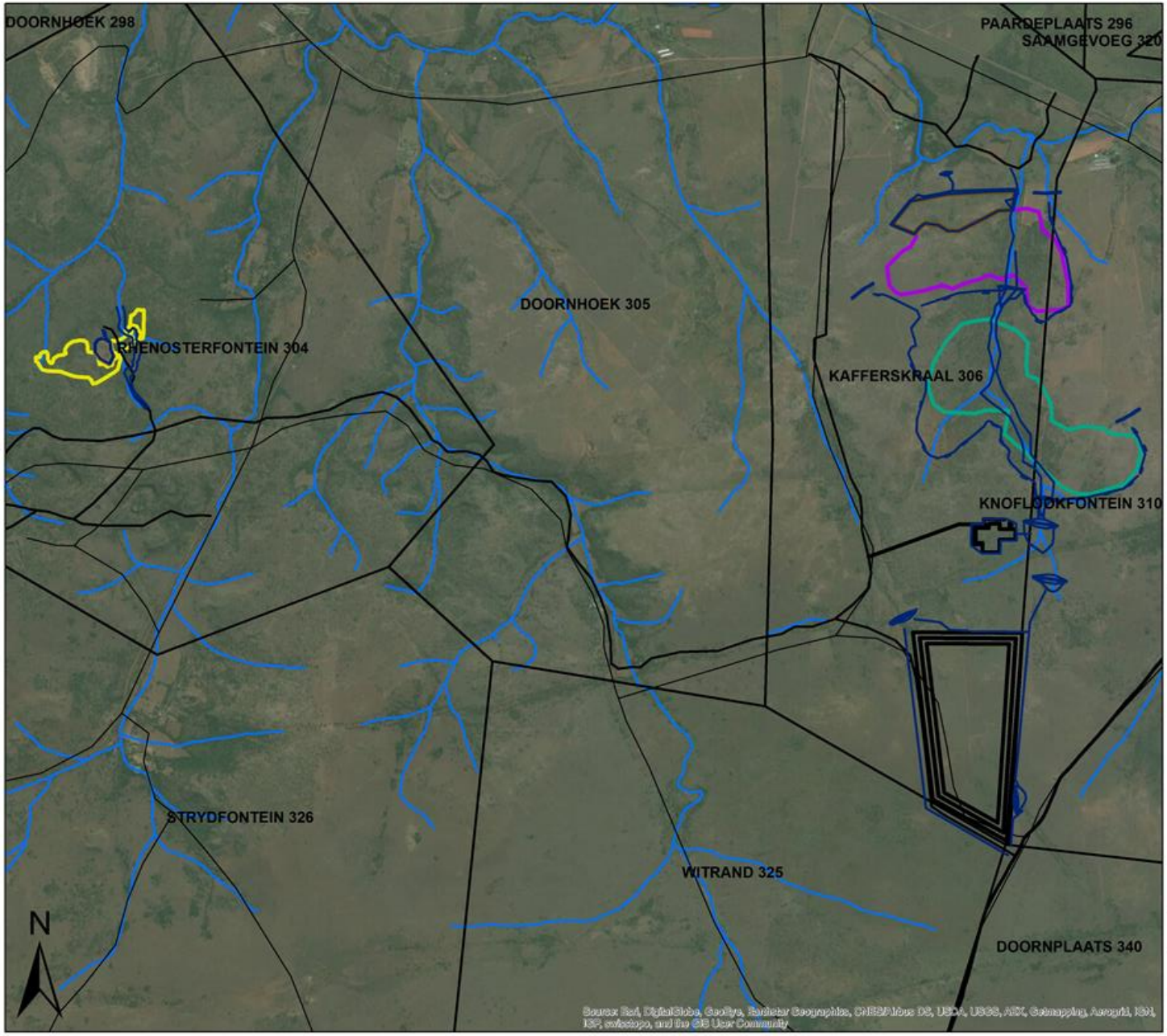


Figure 1: (Above and below) Doornhoek Fluorspar Mine - Locality Map



Doornhoek Fluorspar Mine
Draft Site Plan

Legend

- River Diversions and Stormwater Infrastructure
- Layout Option 4
- Overburden Dump 1
- Overburden Dump 3
- Resource Area A
- Resource Area C
- Resource Area D
- Roads
- Rivers and streams

Scale:

Meters
0 625 1,250 2,500

Exigo 3
Eulophia Corner Building 1
38 General van Reyneveld Street
Persequor Park, 0020
Tel: +27 12 751 2160
Fax:+27 86 607 2406

Date 2016-11-07	
Compiled by C Uys	Version 1
Datum WGS 84	Projection Geographic

2 MINE REHABILITATION BACKGROUND

The Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA) aims:

"To make provision for equitable access to and sustainable development of the nation's mineral and petroleum resource; and to provide for matters connected therewith."

In terms of section 41(3) of the MPRDA:

"The holder of a prospecting right, mining right or mining permit must annually assess his or her environmental liability and increase his or her financial provision to the satisfaction of the Minister."

This section above taken from the MPRDA was however deleted through the publication of the MPRDA Amendment Act. Through this gradual change in legislation to move to One Environmental System, the Minister of Environmental Affairs published the *'Regulations pertaining to the Financial Provision for Prospecting, Exploration, Mining or Production Operations'* in GN R1147 in *Government Gazette* 39425 (the "Regulations") on 20 November 2015. These Regulations now govern the transition from the MPRDA section 41 regime to the new NEMA section 25P regime.

Financial provision is defined in NEMA as:
"the insurance, bank guarantee, trust fund or cash that applicants for an environmental authorization must provide in terms of this Act, guaranteeing the availability of sufficient funds to undertake the (a) the rehabilitation of the adverse environmental impacts of the listed or specified activities; (b) rehabilitation of the impacts of the prospecting, exploration, mining or production activities, including the pumping and treatment of polluted or extraneous water, (c) decommissioning and closure of the operations, (d) remediation of latent or residual environmental impacts which become known in the future; (e) removal of building structures and other objects; or (f) remediation of any other negative environmental impacts".

This document was compiled through a combination of Regulations 53 and 54 of the MPRDA as well as Regulation 1147 of NEMA. Regulation 17 (2) Chapter 4 of these regulations state that:
"Financial provision submitted in terms of regulations 53 and 54 of the Mineral and Petroleum Resources Development Regulations, 2004 for which approval is pending when these Regulations take effect, must despite the repeal of regulations 53 and 54 of the Mineral and Petroleum Resources Development Regulations, 2004 be dispensed with in

terms of regulations 53 and 54 the Mineral and Petroleum Resources Development Regulations, 2004 as if regulations 53 and 54 of the Mineral and Petroleum Resources Development Regulations, 2004 were not repealed"

On 26 October 2016, the Department of Environmental Affairs published an amendment to Financial Provisioning Regulations, 2015 in Notice No. 1314 in Government Gazette No. 40371. The main amendment was the deletion of Regulation 17(5) dealing with the transitional period. The new requirement now states that:

"A holder, or holder of a right or permit who applied for such right oir permit prior to the commencement of the Regulations but who obtained such right or permit after the commencement of the Regulation, must within 39 months of the commencement of the Regulations and annually thereafter -

(a) ensure that a review, assessment and adjustment of the financial provision is conducted in accordance with regulation 11 of the Regulation, read with the necessary changes; and

(b) submit an updated financial provision, including the plans and report contemplated in regulation 11(1), a copy of the independent auditor's report and proof of arrangements to provide the financial provision for approval by the Minister responsible for mineral resources, which updated financial provision must be –

(i) included in any audit required in terms of an environmental authorisation issued in terms of the Act; and

(ii) attached to any amendment of the environmental management programme to be submitted in terms of the Environmental Impact Assessnet Regulations, 2014."

This document will aim to establish the "*current*" and "*future*" environmental liability for the project, taking into account the provision that should be associated with the development, operational rehabilitation, closure and the post-closure phases of the mine.

The above described hybrid system of evaluation was chosen in light of the transitional arrangement as described in Regulation.

3 TERMS OF REFERENCE

The terms of reference for this study are as follows:

- Provide a project description;
- Outline the extent of the study area, proposed activities and infrastructure;
- Understand the development and potential environmental liabilities during development, right through to closure;
- Prepare rehabilitation specifications for the closure costing; and
- Calculate an estimate of the rehabilitation and closure provision required.

4 SCOPE OF WORK

REDE has identified the scope of work to enable them to address the terms of reference and includes:

- Project initiation;
- Project administration and meetings as required;
- Review of available specialist studies and mine infrastructure designs;
- Design closure methodology;
- Quantify closure plan actions;
- Calculate closure provision required; and
- Prepare Final Rehabilitation, Decommissioning and Mine Closure Report.

5 INFORMATION AND REFERENCES USED

This document and all the calculations and assumptions contained in it, are based on information received from the various involved parties, as listed below:

1. DEPARTMENT OF MINERALS AND ENERGY, 2005. Guideline Document for the Evaluation of the Quantum of Closure-related Financial Provision provided by a Mine;
2. SOUTH AFRICA, 2002. Mineral and Petroleum Resources Development Act (No 28 of 2002) and the Mineral and Petroleum Resources Development Amendment Act (No 49 of 2008), the amendments and regulations;
3. SOUTH AFRICA, 1998. National Environmental Management Act (No 107 of 1998), the

amendments and regulations;

4. SOUTH AFRICA, 2015. National Environmental Management Act (No 107 of 1998), 'Regulation pertaining to the Financial Provision for Prospecting, Mining or Production Operations' in GN R1147;
5. STATS SA, 2016. Producer Price Index Sept 2016 – Statistical Release P0142.1;
6. Layout drawings received from the Client;
7. Site Visit conducted by C F Theron on 25 May 2016;
8. SA FLUORITE (PTY) LTD & SOUTHERN PALACE 398 (PTY) LTD. Prospecting Right 228/2006, DMR Ref: LP 30/5/1/2/3/2/1/10108 EM – Project Description. 9 September 2015;
9. SA FLUORITE (PTY) LTD & SOUTHERN PALACE 398 (PTY) LTD. Social and Labour Plan. July 2016;
10. Specialist studies completed for the project:
    - 10.1. Broughton, E, Fourie, R. Environmental Impact Assessment for Doornhoek Fluorspar Mine Project – Socio-Economic Impact Study – Scoping Phase Input. May 2016;
    - 10.2. Coetzer, C. Determination of 1:100 year flood lines stormwater management plan and design of smaller structures to comply with the requirements of GN704: Proposed Doornhoek fluorspar mine between Zeerust and Mafikeng. CWT Consulting. CWT 722015. August 2016;
    - 10.3. De Jager, M. Noise study for environmental impact assessment – Doornhoek Fluorspar Mine, near Zeerust, North-West Province. Enviro Acoustic Research. July 2016;
    - 10.4. Durand, J F. Proposed Fluorspar Mine at Doornhoek near Zeerust, Northwest – Desktop study report – Palaeontology. August 2016;
    - 10.5. Grobler, Gildenhuys and Da Camara. Doornhoek Fluorspar Mine environmental pre-feasibility report. PFS-2015-09-10. Exigo Sustainability (Pty) Ltd. September 2015;
    - 10.6. Hansen, R N. Doornhoek Fluorspar geochemical risk assessment – Waste classification and geotechnical modelling. GDS-201606001 (version 3 – final). Geochemical Dynamic Systems. August 2016;
    - 10.7. Havenga, C. Traffic Impact Assessment – Doornhoek Fluorspar Mine. PP21224. Corli Havenga Transportation Engineers. September 2016;

10.8. Henning, B.J. An Ecological impact assessment for the Doornhoek Fluorspar Mine, Zeerust, North-West Province. Exigo Sustainability (Pty) Ltd. June 2016;

10.9. Henning, B.J. A specialist report on the soils, agricultural potential and land capability for the Doornhoek Fluorspar mining right application in the Ngaka Modiri Molema District, Northwest Province. Exigo Sustainability (Pty) Ltd. July 2015;

10.10. Henning, B J. A Wetland delineation and impact assessment report for the Doornhoek Fluorspar mining right application in the Ngaka Modiri Molema District, Northwest Province. Exigo Sustainability (Pty) Ltd. July 2016;

10.11. Kruger, N. Archaeological impact assessment (aia) of demarcated areas on the farms Rhenosterfontein 304JP and farm 306JP for the proposed Doornhoek Fluorspar Mine project, Nngaka Modiri Molema District Municipality, Northwest Province. Exigo Sustainability (Pty) Ltd. June 2016;

10.12. Mostert, J F W, Meyer, W J, Meyer, F L. Doornhoek Fluorspar: Hydrogeological Specialist Investigation. ES16/068. Exigo Sustainability (Pty) Ltd. October 2016;

10.13. Mostert, J F W, Meyer, F L. Doornhoek Fluorspar: Water Supply Options Analysis. ES16/068. Exigo Sustainability (Pty) Ltd. July 2016;

10.14. Theron, C F. Doornhoek Fluorspar Mine – Water Supply Options. SAF03_R01. REDE Engineering and Management Solutions. June 2016;

10.15. Van Staden, S and Bremner, K.J. Aquatic baseline assessment as part of the environmental assessment and authorisation process for the Doornhoek Fluorite Mine, Zeerust, North-West Province. SAS 216066. Scientific Aquatic Services cc. July 2016;

10.16. Von Gruenewaldt, R. Air quality impact assessment for the proposed fluorspar mine at Doornhoek in the North West Province: 15EX109_AQIA. Airshed Planning Professionals. September 2016;

10.17. Young, G & Martin Y. Draft Visual Impact Assessment Report - Proposed Doornhoek Fluorspar Mine Project, Zeerust, North-West Province. 1617/V15NW. Newtown Landscape Architects cc. September 2016; and

10.18. Zeeman, J D. Doornhoek Fluorspar Mine Project – Blast impact specialist assessment: Blast Management and Consulting. 160517V01Scoping. May 2016.

6 FRAMEWORK FOR CLOSURE PLANNING

REDE has developed a closure framework in line with the requirements as set by the DMR and the latest NEMA Regulations, as well as with generally accepted industry best practice principles. The associated financial provision is thus based on Legislation, Regulations and the specialist information received from the various involved parties; as listed in Section 5. Some of the information currently available is preliminary and a number of assumptions were made in developing the closure liability. The following limitations and assumptions affected the findings of this assessment:

- Physical mining will only begin in / after year 5 after mining license has been granted;
- The closure period will commence once the last ton of ore has been extracted;
- No third party use of infrastructure will be available at closure (unless otherwise negotiated) and all infrastructure will thus require decommissioning;
- Rehabilitation of topsoil and overburden dumps will be undertaken concurrently with mining activities;
- All process water will be recycled;
- As each successive lift is completed on the different dumps, rehabilitation of the dump faces will be undertaken. This includes appropriate cover material and the establishment of area specific vegetation to minimize dust and contact water generation;
- It is assumed that all dumped material not properly rehabilitated during operation will be reshaped to a 1:3 slope to be sustainable in the long term;
- It was further assumed that berms and/or storm water retention dams will be required for storm water management during operations as well as to minimize the risk associated with inadvertent access to the pit.
- No engineering and/or specific closure designs were done as part of the closure liability determination process; and
- The financial provision required was calculated according to the criteria as set out in the official Mine Closure Quantum Guideline document (DME, 2005). As per the Mine Closure Quantum Guideline, specific weighing factors have been taken into account in these calculations.

6.1 Post-closure land use

The post closure land use proposed for the project area is to return the area to wilderness/natural/agricultural area suitable for grazing land. This rehabilitation process is however challenging and it would be safe to say that, during operations, the mining process will result in some loss of the current land capability resulting some small pockets having a changed status to industrial land-use. The proposed rehabilitation process thereafter will strive to restore most areas to a level where good grazing would be available again.

The Soils, Agricultural Potential And Land Capability report conducted for the project area concluded that the agricultural potential, land capability and general characteristics of the soils on the site for the development of the Doornhoek Fluorspar Mine can be classified as having a soil potential that vary from medium to low. (Ref. 10.9). To support this, a Biodiversity Action Plan should be developed and implemented, right from the onset of the project.

6.2 Closure and Rehabilitation Vision

For the mining operation, the following closure objectives and goals are proposed:

- To rehabilitate all disturbed land to a state that is suitable for its post closure use;
- To ensure that affected areas are safe and secure for both human and animal activities;
- The physical and chemical stability of the remaining structures should be such that risk to the environment through naturally occurring forces is eliminated;
- To rehabilitate all disturbed land to a state where limited or preferably no post closure management is required;
- To rehabilitate all disturbed land to a state that facilitates compliance with current environmental quality objectives (air and water quality); and
- To limit the impact on personnel whose positions may become redundant on decommissioning of the operation.

6.3 Legal Framework for Closure

This Final Rehabilitation, Decommissioning and Mine Closure Plan is deemed to be satisfactory according to the Mine and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) as amended and Regulation 1147 of the National Environmental Management Act, 1988 (Act No. 107 of 1998). In accordance with the aforementioned legislation, the holder of a mining right must make the prescribed financial provision for the costs associated with the undertaking of the management, rehabilitation and remediation of

the negative environmental impacts due to prospecting, exploration and mining activities and the latent or residual environmental impacts that may become known in future.

6.4 Accounting Policy and Current Financial Provision for Closure

Mines are required to make provision for all costs arising from environmental damage caused by the prospecting, exploration and mining operations. This includes provision for decommissioning and rehabilitation and restoration costs as well as the management of such activities. This report aims to establish a financial estimate for activities in 3 categories:

- Activities carried out during the construction, operational and decommissioning phases of mining activities;
- Activities carried out during the rehabilitation and closure phase; and
- Activities carried out during the maintenance and aftercare phase.

7 DESCRIPTION OF OPERATION

There are several opencast mining / resource areas that will be targeted over time. Figure 1 above gives us an indication of these areas and the scheduling of the development during the 30 year LoM.

The approach to mining the deposits will be by open pit method with concurrent rehabilitation. The general sequence of conventional open pit mining will be as follows:-

- Strip Overburden: The overburden material overlying the ore will be removed by digging, pushing, scraping, drilling and blasting, followed by loading into the haul trucks for transportation to the temporary overburden dump or as partial backfill for the portion being rehabilitated.
- Ore Production: The ore will be drilled, blasted, loaded and hauled to the concentrator plant where the Run of Mine (ROM) will be directly tipped into the ROM bin for processing.
- Rehabilitation: Mining and environmental legislation will require the disturbed ground to be rehabilitated to near its original form. The rehabilitation has been integrated into the mining sequence to ensure the total disturbed area is minimized. Overburden from the mining activities will be stored in temporary overburden dumps strategically placed in close proximity to the open pit mining areas. From here, the

overburden will be transported back into the open pits proper once sufficient space is available.

Where the overburden or the ore cannot be excavated by conventional equipment, it will be required drill and blast to break up the rock. It is planned for overburden material to be used for road construction and of any stormwater dams, dirty water dams as well as the TSF required for the project.

For the purpose of this study, the following infrastructure items listed below are thus included in this closure plan.

- General Mining complex infrastructure;
- Electrical sub-station and reticulation;
- Processing plant;
- Administrative buildings including Change House;
- Workshop and fuel storage facilities;
- Ore loading facility;
- Temporary overburden dump;
- Tailings Storage Facility;
- Stormwater management infrastructure including dams;
- Water supply and distribution infrastructure;
- Water- and wastewater treatment facilities;
- Haul and access roads; and
- Perimeter and internal fencing.

The proposed detail and location of the operational infrastructure is shown in Figure 2, below. At present there are four possible site layouts considered with the main difference between them being the position / footprint of the tailings storage facility and plant. The effect of these different positions on the closure liability was not considered at this point in time as it is more an environmental than cost consideration at stake. Many of the specialist reports discuss these options and their relevant impacts in detail.

For completeness of this report the layouts are attached below as figures 3 – figure 6.

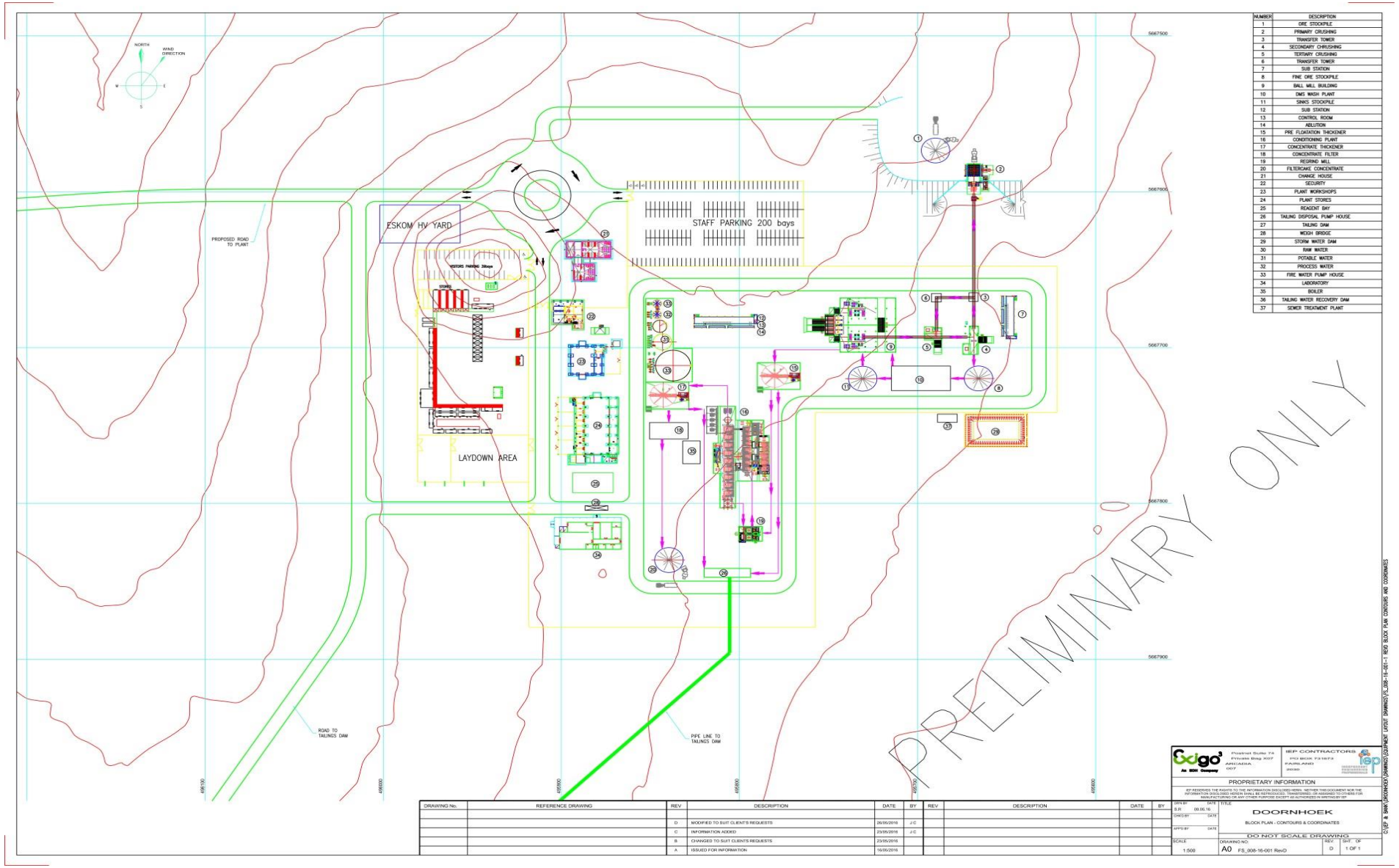


Figure 2: Doornhoek Fluorspar Mine - Site Layout Plan

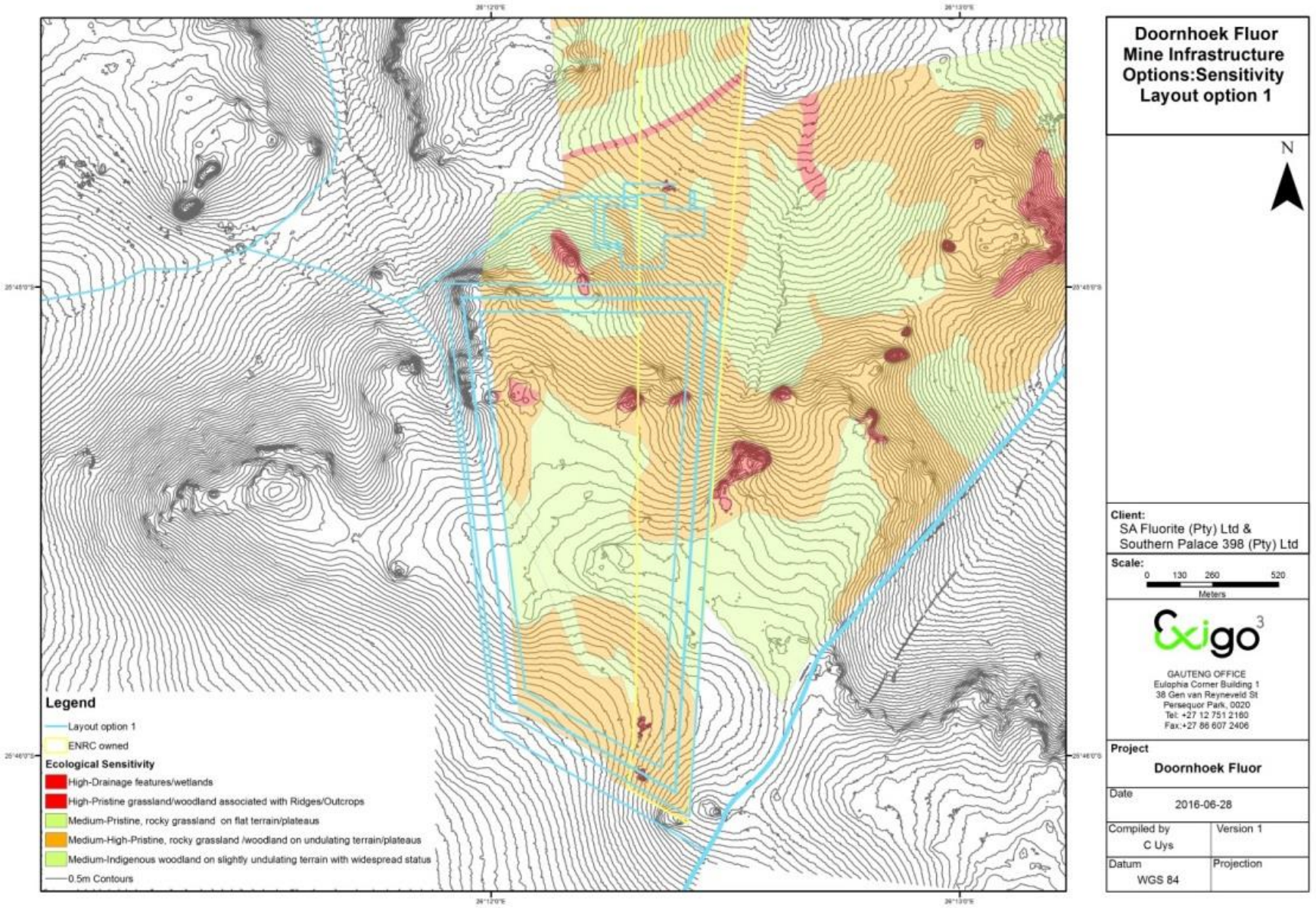


Figure 3: Tailings Storage Facility – Option 1

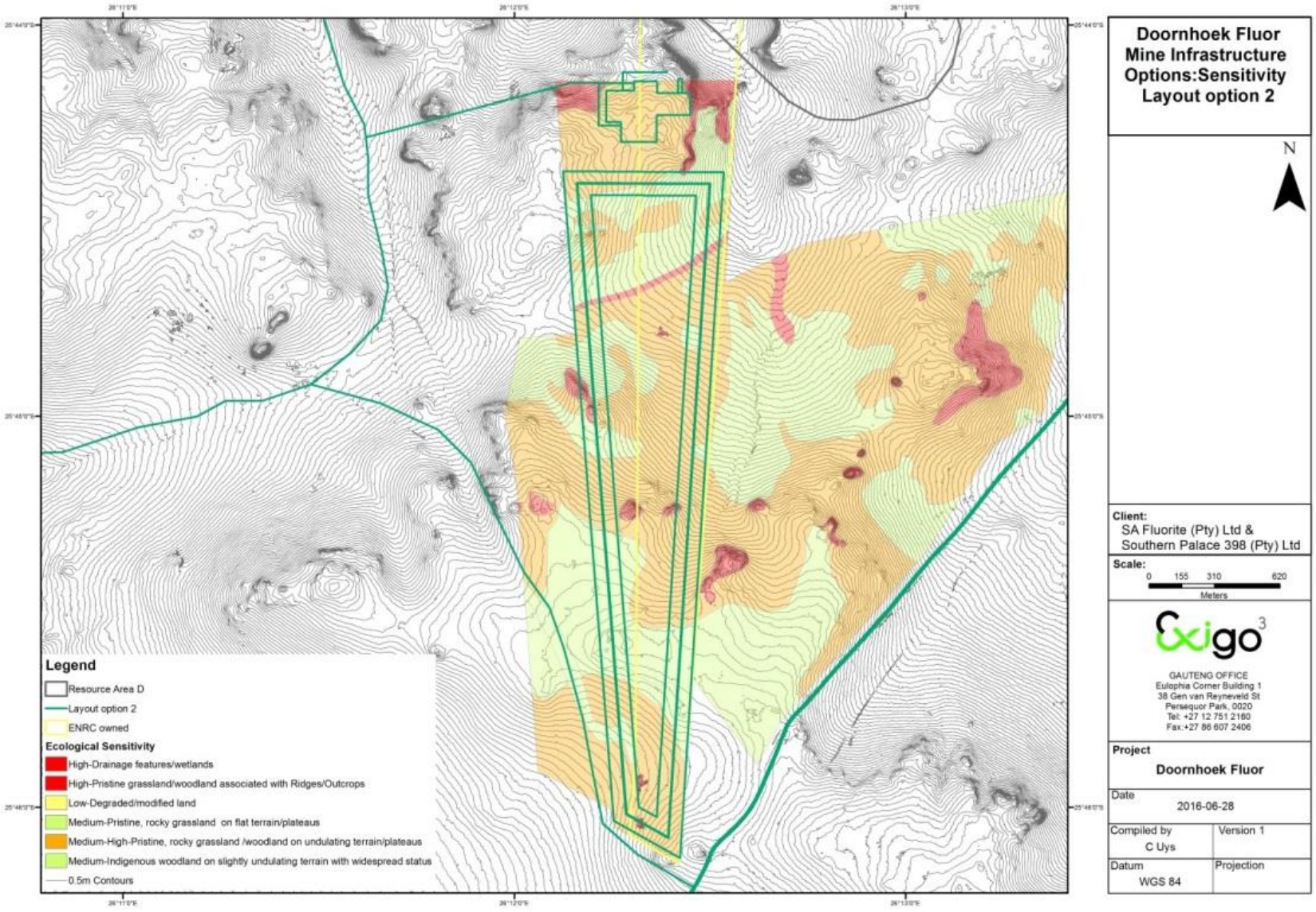


Figure 4: Tailings Storage Facility – Option 2

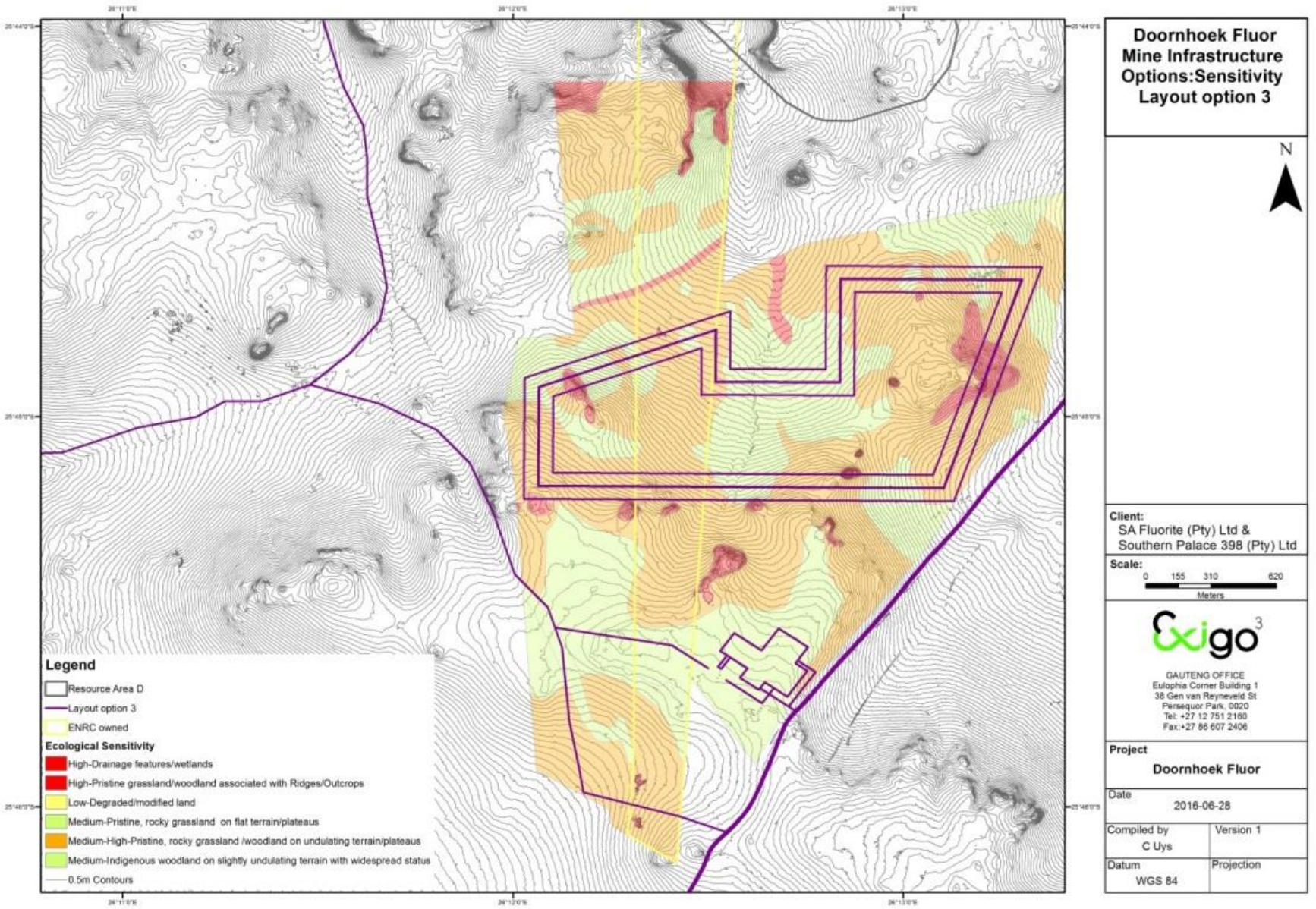


Figure 5: Tailings Storage Facility – Option 3

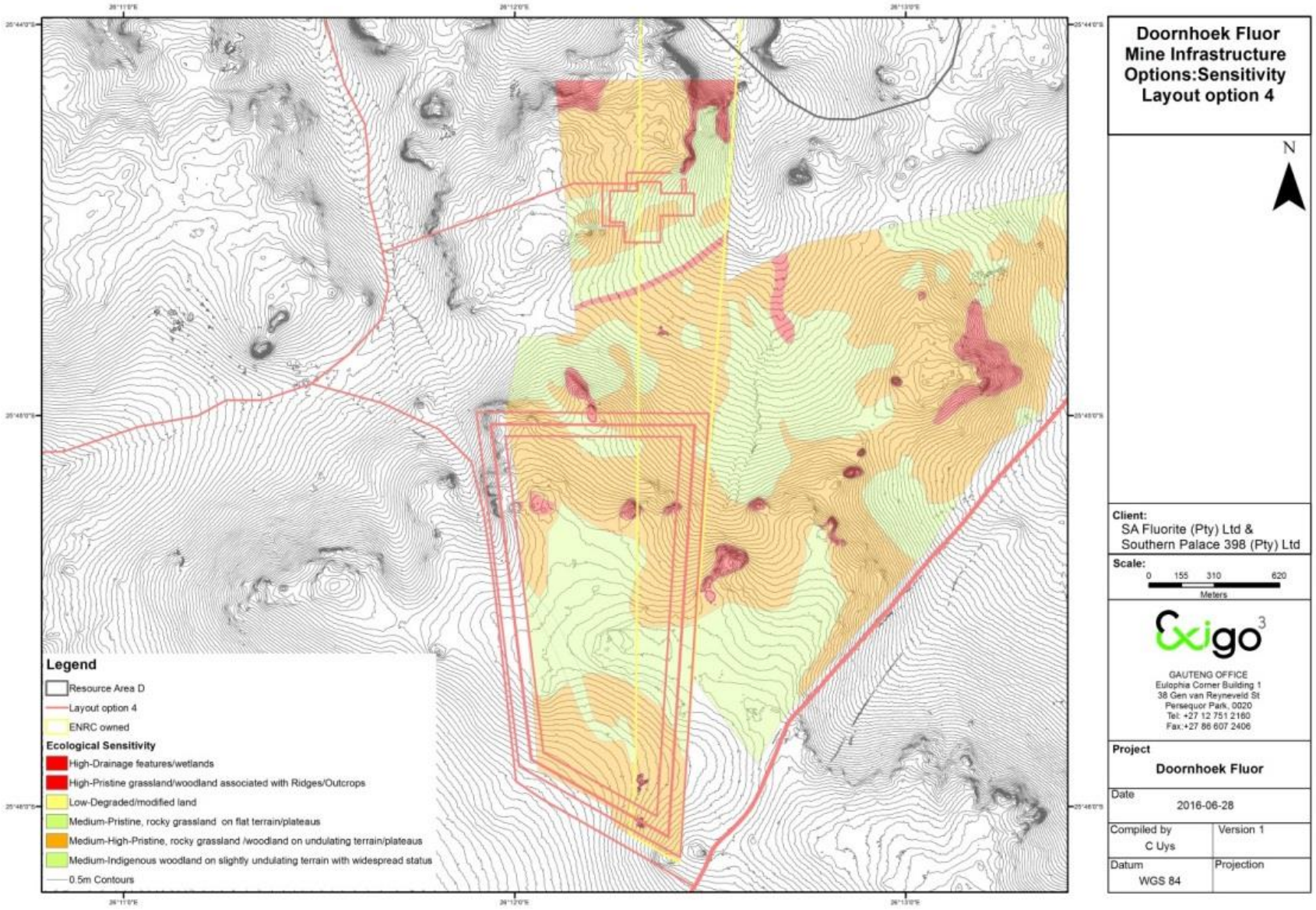


Figure 6: Tailings Storage Facility – Option 4

8 SPECIALIST STUDIES

In order to develop a suitable closure plan, any recommendations made by specialist for the project area, must be considered. The section below briefly summarizes the main specialist findings and describes any suggested specific mitigating measures.

8.1 Soil, Land Use, Land Capability and Agricultural Potential Survey

The area is expected to receive rainfall between 400mm and 500mm annually and this is generally accepted as too low for crop production under arable conditions. Soils are generally shallow and rocky in the ridges and sandy in the surrounding plains. Isolated pockets of deeper, more fertile soil do exist towards the south and west. There are also isolated pockets of moist grassland and ravines that have shallow sandy-clay or clay soils that are seasonally flooded or have a perched water table. These areas are not suitable for crop cultivation either (Ref. 10.9).

The natural vegetation in the study area has a grazing capacity that varies from low to medium. The different sections of the study area can support grazing according to the soil nutrient content as follows:

- The shallow, rocky soils associated with the slopes of outcrops have a low quality grazing and at present game species utilize these areas, especially during the early summer.
- The deep sandy and gravelly soils associated with the foot slopes, valley floors and plateaus has low quality grazing with limited potential for livestock farming. These areas are however suitable grazing for specialized grazers.
- The red-yellow apedal soils (soil of poor structure) in the area has a medium potential for livestock grazing due to the slightly higher nutrient content of the soil.
- The seasonally wet soils of the study area support palatable grass species and these areas have a medium to high suitability for livestock or game grazing.

Resulting from the above it is clear that the site should be considered valuable for grazing land with limited potential for arable agriculture considering the climatic conditions.

Direct impact of the mining activity would be mostly through excavation and soil moving. In designing the mine infrastructure, sensitive and high potential areas should be avoided. As an example, impact on the rocky areas with shallow soil and sparse vegetation will be much lower than areas with deep, nutrient rich areas. The sandy areas have a high

potential for erosion and this should be mitigated through proper methods right from the onset of the project.

Figure 3: Typical Project Area

The fist impacts will occur during stripping of topsoil for exposing the open pit area, construction of the plant, construction of haul roads and the construction of the TSF. Some areas would thus immediately lose their visual appeal and dust will be created. Dust and erosion control should thus be dealt with from the onset. If erosion is not controlled properly, sedimentation of local water courses will result.

Other impacts to be mitigated concurrently and/or at closure stage would be:

- Soil compaction on all areas where vehicle movement takes place, laydown areas, etc. This compaction process and other hardened areas also increases runoff during rainfall and will increase the possibility of erosion;
- Soil erosion and sedimentation if stormwater is not controlled correctly. This includes runoff from overburden dumps and the tailings storage facility walls;
- Soil pollution by possible oil/diesel spillage from vehicles as well as sewage produced by the administrative, washing and ablution facilities on site. Failure of the dirty water containing infrastructure also has a potential to pollute the soil, surface- and sub-surface water;
- Soil destruction through the opencast mining and removal of topsoil, even if partially backfilled and re-vegetated;

- Loss of land capability during operation is a fact. Proper rehabilitation to return this valuable resource to a state as close as possible to the pre-mining state, post mining, is crucial.

Mitigation measures to be implemented during closure and rehabilitation would, amongst others be:

- Removal of all mining infrastructure;
- Removal of all contaminated soil;
- Backfilling of mined out areas;
- Ripping and rehabilitation of all hardened areas including the plant site, access and haul roads; and seeding of ripped and rehabilitated areas with area specific species.

8.2 Archaeological Impact Assessment

The Northwest Province has a varied and rich heritage landscape. One of the primary sites is the Kaditshwene Cultural landscape and National Heritage Site, approximately 50km north of the project area.

The archaeological assessment conducted on the proposed Doornhoek Fluorspar Mine area indicate a high possibility for the existence of earlier, middle and later Stone Age material especially along the drainage lines and at sources of water on the Project properties (Ref. 10.11). Even more modern historical sites were found on the properties.

To minimize any possible effect, the following mitigation actions are proposed:

- These sites should be demarcated and 100m buffer zones created around them (non-physical);
- A full time knowledgeable person should be present throughout all construction process to identify possible undetected sites;
- Should any possible paleontological, archaeological or historical material, or burial sites be exposed, all construction should suspended to allow specialist investigation.

A desktop paleontological study was done for the area and confirmed no reports of Plio-Pleistocene fossils in the area. The overall paleontological sensitivity of the area is thus considered to be low (Ref. 10.4).

8.3 Ecological Assessment

Mining always has some impact on the environment through the modification of some of the natural vegetation and general environment. The mining operation will impact on pristine grassland and woodland areas on site, with only small pockets of degraded land in the larger area (Ref. 10.8).

A number of ecological potential impacts were identified and assessed. A few of these were assessed as having potentially medium or high significance, including the following:

- Destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular habitat;
- Impairment of the movement and/or migration of animal species resulting in genetic and/or ecological impacts (habitat fragmentation);
- Increased soil erosion causing habitat degradation;
- Establishment and spread of declared weeds and alien invader plants;
- Habitat degradation as a result of dust;
- Fauna road mortalities; and
- Spillages of harmful substances leading to soil and water pollution and ecosystem degradation.

The most important considerations for the project area are as follows (Ref 10.8):

- The mining activities should take cognizance of the red data or endemic plants in the area, as well as other sensitive habitats such as drainage channels and outcrops. The riparian and wetland areas forming part of floodlines associated with the major water courses in the area have a high sensitivity and no activities can be allowed within these areas without the necessary authorization;
- Vegetation clearing and topsoil stripping will have the most definite and permanent direct negative impact on the flora and fauna of the area. The clearance will eradicate all vegetation and displace fauna that will migrate to neighboring areas;
- The laydown areas, overburden dumps and stockpiles during the operational phase of the mine will have a direct, significant negative impact on the vegetation and fauna habitats;
- The indirect impacts such as soil erosion, fauna mortalities, spillages and establishment of alien invasive species are relevant for all mining phases, although with strict implementation of the mitigation measures and action plans for the various components, the impacts can be minimized; and

- Considering the cumulative impacts of the mining phases on the fauna and flora of the area, will cause some negative impacts, although the implementation of a rehabilitation and revegetation plan will allow the vegetation to recover over time and the fauna to return to the area.

An environmental awareness programme should be implemented during operations and on-going rehabilitation will minimize the impacts on the area.

Although concurrent rehabilitation will be done, the closure phases of the mine involve rehabilitation actions to mitigate impacts caused during the construction and operational phase of the mine. Some of the rehabilitation actions include the following:

- Removal of all infrastructure not utilized post closure;
- Ripping and rehabilitation of all compacted areas and haul roads;
- Rehabilitation of the opencast areas, overburden dumps and TSF; and
- Seeding of ripped and rehabilitated surfaces.

8.4 Aquatic Assessment

Runoff from the proposed mining area ends in the Klein-Marico River, which is a largely natural river system with a moderate ecological sensitivity. (Ref.10.15). The aquatic ecology of the area can be considered in a fair state at present.

As with any project, the Doornhoek Fluorspar Mine has a potential to impact to the aquatic resource present in the area should mitigation not take place to avoid this and minimize the impacts. One example would be monitoring of dirty water seepage and/or spillage related to the proposed infrastructure.

The cone of depression formed by the opencast mining process should be closely monitored as this will have an effect on the groundwater flow patterns which might have some impact on the flow in the river as well as surface recharge. Post closure impacts on water quality, with special mention of the groundwater resources present, are of concern – extensive mitigation measures must be employed to negate this potential disturbance.

The study suggests on-going bio-monitoring (including toxicity testing of the “dirty water” system) during all phases of the project, including the post closure period. These costs are included in both the operational, closure and rehabilitation phases of the project.

8.5 Wetland Delineation and Impact Assessment

The most prominent wetlands that bisects the proposed mining site were assessed namely the floodplains, channeled valley bottom wetlands and depressions. The embankments, existing roads, alien invasive vegetation, etc. were taken into account during the process. It was found that all of the wetlands within and around the study area have been impacted upon to some degree, causing changes in the natural flow regime (Ref. 10.10).

Impacts of the developed and mining activities can be summarized as follows:

- The construction phase of the mining development will result in loss of and damage to natural wetland habitats if the vegetation is cleared for the development of infrastructure, access and haul roads, stockpiles, overburden dumps and the tailings storage facility;
- The construction of buildings, fences and roads will inevitably result in natural movement patterns of wetland dependent fauna being disrupted;
- The construction activities associated with the developments may result in widespread soil disturbance and is usually associated with accelerated soil erosion. Soil erosion promotes a variety of terrestrial ecological changes associated with these disturbed areas, including the establishment of alien invasive plant species, altered plant community species composition and loss of habitat for indigenous flora;
- Construction or disturbance during breeding season can precipitate long-term cumulative effect on wetland dependent fauna populations;
- Impacts on water quantity (dewatering of wetlands will have an impact on the water quantity of the region potentially causing the drying of the springs;
- The spread of alien invasive plants on site is more intense during the operational phase of the mine due to the movement of vehicles over an extended area; and
- The increased hardened surfaces around infrastructure and exposed areas created alongside the open pit, as well as the roads and additional surface areas created on the slopes of the stockpiles and overburden dumps will have a definite impact on the potential erosion of exposed areas that will eventually cause sedimentation in the wetlands and streams of the area.

Amongst the more pronounced post-closure impacts on flora are landscape scarring in the form of un-rehabilitated mine facilities, discard dumps and open pits as well as continuing environmental damage from wind-blown dusts and the dispersal of contaminated solid waste. If mitigation measures are correctly implemented there should be not be any further significant impact on the surrounding natural vegetation after closure though.

8.6 Hydrogeological Assessment

The assessment of the hydrogeology of the area found the aquifer to be a dolomitic aquifer that could be defined as a sole-source. The aquifer is likely compartmentalized by diabase dykes structures which crosscut the country rocks.

A radius of influence is associated with the proposed mine dewatering during 30 year LoM which could impact neighboring groundwater users and sensitive receptors i.e. springs and the Klein Marico River (Ref.10.12 & 10.13). Simulations done showed that the average dewatering rates for the pit will be approximately 4000 m^3/d with possible peak inflows to the end of the 30 year Life of Mine of above 7000 m^3/d. Depending on the method of abstraction i.e. sumps versus pre dewatering, the mine dewatering volumes could be as much as 50% less due to evaporation losses. The groundwater levels could take a substantial time to recover post operations and this should be confirmed with monitoring for at least 12 months post closure.

There is a possibility of the possible inflow of water from the Klein Marico River into the open pit mine. Water collected in the open pit mine (or dewatering wells) should be sampled and tested with hydro-chemical and isotope finger printing on a monthly basis to verify the origin.

The overburden dumps plumes shows little migration due to the position of these facilities with regards to the zone of influence and position relative to the open pits. The possible migration of salts form the tailings storage facility (TSF) should be properly monitored as this plume migration might flow across compartments.

Additional water supply boreholes should be drilled to supplement the current wellfield to supply in the majority of mines water demand. Additional sources of groundwater should be identified and explored in the future to supply the required make up water demand.

Following is a list of possible impacts on the geohydrology during all phases of the development and mining activity:

- Supply of inadequate sanitary facilities and ablutions can result in groundwater / surface water contamination;
- The construction of roads, pipelines and the buildings on the site may impact the amount of water that infiltrates the soil, through the removal of natural vegetation and the soil layer;

- Explosives will be used in the open pit development which might contribute nitrates to the groundwater;
- Activities during the construction phase can significantly increase the risk of surface water pollution by siltation of drainage systems;
- The construction camp has the potential to contaminate both surface and sub-surface water resulting from littering or inadequate sanitation facilities;
- Over abstraction from a borehole for construction and/or operations water will lead to rapid lowering of water levels and damage to the flow towards the aquifer, potentially decreasing the sustainability of the borehole;
- Pit dewatering will have some impact on the surrounding area that need to be mitigated. Depletion of the groundwater in the aquifer and related compartment due to the proposed open pit mining dewatering is a risk;
- Increased erosion and silt loading of surface water bodies;
- Contamination of groundwater sources due to dewatering;
- Change in local drainage patterns and hence flow regimes;
- Possible groundwater seepage from the TSF and overburden dumps along the hydraulic head gradient of the groundwater regime below this facilities; and
- Additional water supply boreholes are required to supplement the current wellfield to supply in the majority of mines water demand. Additional sources of groundwater are required and should be identified and explored in the future to supply the required make up water demand.

The following are some of the mitigation measures proposed:

- Construction should preferably take place during the dry season;
- The use of all materials, fuels and chemicals which could potentially leach into underground water must be controlled;
- All materials, fuels and chemicals must be stored in a specific and secured area to prevent pollution from spillages and leakages;
- Construction vehicles and machines must be maintained properly to ensure that oil spillages are kept at a minimum;
- Spill trays must be provided if refueling of construction vehicles are done on site;
- Chemical sanitary facilities must be provided for construction workers;
- The removed soil and vegetation should be replaced once construction and mining is complete;
- Long duration aquifer tests should be conducted on any newly drilled water supply, monitoring and/or seepage capturing boreholes drilled during the LoM;

- The groundwater flow model should be updated every two years or as soon as additional groundwater exploration and/or monitoring data becomes available;
- Water pumped from the open pit mine should be pumped into a dirty water system and should not be allowed to enter any clean water system, natural drainage line, or the aquifer;
- Boreholes and related equipment should be in a fenced in area in a locked pump house for protection against theft and vandalism;
- All water retention structures, including process water dams; stormwater-, pollution control dam, etc. should be constructed to have adequate freeboard to be able to contain water from 1:50 year rain events;
- Groundwater and surface water quality information should be determined by sampling the surface water containment water (from the GN704 storm water management system) and monitoring boreholes located upstream and downstream of the mining and infrastructure;
- Flow measurements in the Klein Marico River should be taken upstream and downstream of the mine site. The flow measures should be recorded on ongoing basis to monitor possible impacts and flow reductions caused by the mine dewatering;
- Alien vegetation eradication should be implemented to off-set the possible flow reduction and increase the water balance of the local catchment;
- Real time monitoring should be installed in equipped boreholes and monthly monitoring should be conducted on water levels measurements, groundwater quality and isotope and hydro chemical. This monitoring process should continue post decommissioning;
- If the origin of water inflow into the pits is established to be from the Klein Marico River, the water should be treated to an acceptable quality and discharged back into the Klein Marico River system;
- If it is confirmed that the water seepage into the open pit mine is a diluted combination between surface water from the Klein Marico River and groundwater, then the dilution ratios should be calculated and the surface water quantities should be released back into the river system; and
- At the end of operations it is proposed to clad and isolate the TSF and remaining overburden dumps (if any) to limit ingress and recharge to these facilities and minimize potential leaching into the groundwater.

8.7 Traffic Impact Assessment

It is expected that a large portion of the employees will reside in and around Zeerust. The route from the mine via Roads D1194, D139 and R49 will thus be used for access purposes. It is expected that a bus and minibus taxis will transport employees to the mine.

As part of the mitigation of the impact of the mine on the area, several upgrades to road sections and some intersections are proposed (Ref. 10.7).

No post closure rehabilitation processes are proposed for the upgraded and/or new infrastructure created as it will be transferred to the relevant authorities and stay in use by the communities in the area. No impact post closure is expected.

8.8 Air Quality Assessment

The study (Ref. 10.16) suggests mitigation and on-going monitoring during all phases of the project. These costs are included in both the operational, closure and rehabilitation phases of the project. The following points describe information currently available:

- At present, no $PM_{2.5}$ and PM_{10} baseline data for the site exists;
- The flow field is dominated by winds from the north-easterly sector and wind speeds are normally higher during day-time;
- The closets residential areas is:
    - Zeerust – 10km north-west
    - Groot Marico – 15km north-east
    - Ottoshoop – 10km west

Possible impacts resulting from mining activities that should be mitigated through development, mining and decommissioning phases include mainly the possible dust creation from excavation, vehicle movement and crushing activities. It is thus imperative to create a dust fallout monitoring network (inclusive of PM_{10} sampling to identify and mitigate all possible sources of dust creation.

Monitoring should continue post closure to track the effects of all rehabilitation measures implemented on site.

8.9 Noise Impact Assessment

From the completed study (Ref. 10.3), noise impact potential is low. The noise projections indicate that the operations will comply with the Noise Control Regulations (GN R154). This

also includes blasting actions that will take place periodically as a very well controlled activity.

Mitigation options include:

- Proper communication with all identified receptors;
- Formation of berms/barriers at some sections along the opencast perimeter; and
- Implementation of a measurement programme during all phases up to the end of operations.

These costs are included in both the operational, closure and rehabilitation phases of the project. No post closure impacts are expected.

8.10 Blast Impact Assessment

There will be periodic blasting activity on the proposed mine. Impacts will be in the form of noise, fly rock, fumes, air wave disturbance and ground vibrations. The typical infrastructure that might be affected includes roads (Surfaced and gravel), brick and mortar structures, boreholes and heritage sites (Ref. 10.18). There are no blasting operations in the area at present.

The study (Ref. 10.18) concluded that some mitigation measures will be required to protect some structures from, especially, ground vibrations during blasting. This relates to specific heritage sites. The air blast impacts are of a lesser concern.

The above impacts can be mitigated through proper blast design and control. No post close impact is expected.

8.11 Socio Economic Assessment

Government at national, provincial and local levels acknowledges in their policies and strategies the need to develop the mining sector and promote private investment to stimulate growth in the area. Considering the impact of mining activities on the environment, they also underline the necessity to protect the ecosystem and use water resources in an efficient and sustainable way. The planned mining operations are in line with the national, provincial and local priorities and do not appear to conflict with other activities in the area.

The planned mining activities should further promote the development of an area with a small economy, a high unemployment rate (i.e. 28.4% and 36,3% of unemployed people in the Ditsobotla LM and Ramotshere Moila LM respectively), and large disparities between

urban and rural areas. The towns of Zeerust and Lichtenburg are well developed, and Zeerust is particularly well developed when focusing on indicators such as income levels and access to basic services. It was indicated that labour for the proposed project is planned to be sourced from the local community as far as possible, and be accommodated in the town of Zeerust (Ref. 10.1).

Potential impacts from the project are summarized as follows:

8.11.1 Impact ensued during Construction Phase

- Temporary Stimulation of the Local and National
- Temporary Creation of Employment in Local and National Economies
- Increased Household Income and Improved Standard of living
- Skills Development due to the creation of new Employment Opportunities
- Government Revenue Increase due to Capital Expenditure
- Change in Sense of Place
- Loss of Agricultural Production due to Agricultural Land Sterilization and Other Environmental Impacts
- Increase in Social Pathologies
- Added Pressure on Basic Services and Social and Economic infrastructure

8.11.2 Impacts Ensued during Operational Phase

- Sustainable Stimulation of the Local and National Economy
- Creation of Employment in Local and National Economies
- Skills Development due to the Creation of New Employment Opportunities
- Increase in household income and standard of living
- Increase in Government Revenue
- Export Earnings
- Change in Sense of Place
- Improved Quality of Life and Service Delivery

8.11.3 Impacts ensued during Decommissioning Phase

The Doornhoek Fluorspar Mine is planned to span for 30 years, including construction and operations. Thereafter, the termination of the project will occur.

The assessment of the current socio-economic situation in the local municipalities, the profile of the zone of influence, and the project itself revealed that the proposed mining

activity will create numerous positive impacts and will likely stimulate the local economy. It will create at least 222 sustainable employment opportunities that will be filled largely by people coming from the local communities and will increase government revenue base. Income derived during both construction and operation will also assist households in improving their standards of living. However, due to the nature of the area where the proposed mine is to be established, some negative socio-economic impacts can also be created as a result of the mine's development.

- The mine could have a negative effect on the local supply of water, which is currently a major service delivery challenge for the local government;
- It would also impact on the sense of place and transform the exclusive rural agricultural areas to include some small pockets with an industrial nature. The people who work and reside on the farms where some of the project infrastructure will be located, as well as people residing and working on the adjacent farms are likely to be the recipients of this change in the sense of place; and
- Linked to the change in the sense of place is the possibility of negative effect on the local tourism activities represented by game hunting operations. Moreover, some of the farm portions where the majority of the mine's footprint will be located are currently used for game hunting activities and are unlikely to be able to proceed if the mine is built.

Some of the above-mentioned negative effects could be mitigated or could be reduced by proper management and mitigation measures.

8.12 Visual Impact Assessment

The project area has a rolling topography which varies from slightly undulating open grasslands to deeper valleys and ridges by the Klein-Marico and associated tributaries. The vegetation is a combination of bushveld / woodlands, with medium size trees, and open grassland areas (Ref. 10.17). Manmade structures in the area are limited to a few farmsteads, agricultural activities and lodges / game farms. This infrastructure does not dominate the area.

Visual impacts by the proposed mine will be caused by activities, surface modifications and infrastructure in all project phases i.e. construction, operational, decommissioning and closure. The activities associated with the plant, will be visible (day and night), to varying degrees from varying distances (zone of potential visual influence being 10 km) around the project site during the operational phase. The visual qualities of the project site will be influenced by the success and effectiveness of rehabilitation measures implemented.

The following mitigation measures are proposed for the proposed Doornhoek Fluorspar Mine:

- As little vegetation as possible should be removed during the construction phase. Only the footprint and a small 'construction buffer zone' around the proposed Project should be exposed. In all other areas, the natural vegetation should be retained;
- Dust suppression techniques should be in place at all times during the construction, operational, and decommissioning / closure phases;
- A registered Professional Landscape Architect must be appointed to assist with the rehabilitation plan for the proposed project;
- It is suggested that if possible trees should be planted along the southern and eastern boundary of the TSF since this structure will be located close to a public road. Alternatively vegetated berms can be used along the southern and eastern boundary;
- Berms (vegetated) can also be constructed along the northern boundary of Resource Area C which will assist in mitigating the visual impact of the open cast mining areas;
- Final shaping and dumping should be engineered such that the sides of the dumps are articulated in a fashion that create areas of light and shadow interplay;
- Maintain the final landform height and slope angles for stockpiles as low as possible;
- Grass seeding of the dumps should be undertaken to emulate the groupings of natural vegetation in nearby hills;
- If possible overburden should be used for visual berms. These berms must be shaped and vegetated to blend into the landscape;
- The plant should be constructed at the lowest point (contour) possible; and
- The negative impact of night lighting, glare and spotlight effects, can be mitigated using the following methods:
    - Install light fixtures that provide precisely directed illumination to reduce light "spillage" beyond the immediate surrounds of the substation;
    - Light public movement areas (pathways and roads) with low level 'bollard' type lights and avoid post top lighting;

- Avoid high pole top security lighting along the periphery of the substation site and use only lights that are activated on movement at illegal entry to the site; and
- Use security lighting at the periphery of the site that is activated by movement and are not permanently switched on.

8.13 Geochemical

Existing laboratory data was used to classify the tailings and the overburden material of the proposed mine. The process used evaluated the medium and long term behavior of the material resulting in the classification of both the tailings material and the material from the overburden dumps as Type 3, low risk waste (Ref.10.6).

Other noteworthy results are:

- The risk for the development of acid mine drainage conditions from the tailings and overburden, is insignificant;
- The risk for the contamination of soil, surface water and groundwater resources by metals and metalloids is insignificant;
- The contamination of groundwater by fluoride and sulphate from the tailings material is significant and mitigation measures should be implemented as the dolomite groundwater is a sensitive receptor; and
- If ammonium nitrate based explosive products are to be used in the mining proses, then nitrate needs to be included as a potential groundwater and surface water contamination risk.

Mitigation actions during all phases of the project as well as post closure, should include the following:

- A monthly monitoring protocol should be implemented and fluoride and sulphate included in the parameters analyzed;
- Nitrate should be included in the monthly monitoring protocol if ammonium nitrate based explosives are to be used in the mining process;
- An annual comprehensive analysis should be included in the monitoring protocol and any contamination concerns flagged and addressed; and
- If the ore processing methodologies should change, the geochemical models will need to be updated to take these changes into consideration.

8.14 Flood Lines and Storm Water

The larger project area contains various watercourses of various extents. Some diversions and canal modifications will be required during development and operation of the proposed mine (Ref. 10.2). Preliminary designs done will be able to withstand estimated floods with a 1:100 year return period.

Storm water management infrastructure developed for the construction and operational phase of the mine will be retained for closure at the end of the life of the project as required. It could however be considered to remove some of this infrastructure once it was proven that rehabilitation processes to minimize erosion, sediment transport, etc. were successful.

All the mitigation measures are not fully designed at present as there are still some TSF establishment options (position mainly) under consideration at present. All runoff from the mining plant, parking areas, overburden dump and tailings storage facility is treated as dirty water and is separated from clean water runoff.

It is of utmost importance that all storm water management infrastructure is maintained and operated properly in accordance with the intensions of the design. Any erosion damage to embankments, canals, etc. should be repaired immediately upon discovery.

9 SUMMARY OF REHABILITATION, CLOSURE AND AFTERCARE PLAN

The following items are included in the Final Rehabilitation, Decommissioning and Mine Closure Plan for the Doornhoek Fluorspar Mine Project. In some cases cost estimates were based on the total footprint area indicated on the layout maps as described in the Guideline of the DMR. The total plant/admin area will cover an approximate 4 Ha.

With detailed design drawings, a more accurate estimate will be possible. As this closure plan is only developed for the purposes of the mining rights application, a more detailed cost estimate shall be prepared once all design aspects have been finalized, as required by the Regulations (GN R. 1147).

9.1 Dismantling of Processing Plant and Related Structures

This section relates to all infrastructure items associated with the processing facility as well as infrastructure items associated with the mining complex. All infrastructure as shown on the Block Plan (Figure 2) will have been constructed for the proposed mining activities at the end of year seven of development.

The closure plan facilitates the dismantling or demolition of all infrastructure, the disposal thereof in a suitable on-site disposal location and the landscaping and re-vegetation of the disturbed area. This will allow for this area to be returned to a state as close as possible to its intended post-closure land use.

The following criteria apply to Dismantling of Mining Related Structures:

- All equipment will be removed for salvage or resale. Any item with no salvage value to the mine, but which might have value to individuals will be sold. In all cases zero salvage is assumed in all cost estimations. All remaining items will be treated as waste and disposed of in a designated waste disposal area;
- All rubble and waste from the dismantling of the structures will be disposed of in a designated waste disposal area;
- Any fixed assets that can be profitably removed, will be removed for salvage or resale;
- All structures are to be demolished or dismantled and foundations to be removed to a minimum of 500mm below the natural ground level;
- All excavations will be filled with 400mm overburden from the stockpiled overburden material and covered by 100mm topsoil;
- Terraced areas will be cut back to a slope incline of no more than 20º;
- Additionally, the entire disturbed area will be ripped to a depth of 500mm, covered with topsoil and vegetated.

9.2 Demolition of Housing, Workshops and Administrative Facilities

The local community must be engaged to determine if any building can be used as community halls, schools or the like. All other infrastructure will be demolished and any rubble disposed of in a suitable on-site disposal location. The area will be landscaped to allow for this area to be returned to a state as close as possible to its pre-mining land use. Re-vegetation with a local seed mixture will allow the area to be suitable for its post-closure land use.

The following criteria apply to Demolition of Housing and Administrative Facilities:

- All structures are to be demolished or dismantled, and foundations to be removed to a minimum of 500mm below the natural ground level;
- Any fixed assets that can be profitably removed, will be removed for salvage or resale;
- All rubble and waste from the demolition will be disposed of in a designated waste disposal area;
- All excavation will be filled with 400mm overburden from the stockpiled overburden material and 100mm topsoil;
- Additionally, the entire disturbed area will be ripped to a depth of 500mm, re-shaped, covered with topsoil and vegetated.

9.3 Rehabilitation of Access Roads

The relevant authorities must be engaged to determine future use of the roads created and upgrading done to existing infrastructure. Roads not used by the community or during the post-closure monitoring period, will be demolished and the area returned to the post-closure land use. No detail road layouts are available as yet and therefor costs are based on a preliminary road length as indicated on the block plan and available from the preliminary designs. A total of 18km roads are currently planned (10m wide service roads, 18m wide haul roads). Haul / Site access roads left in place will be reduced to a width of no more than 8m. All haul/site roads are assumed to be gravel roads.

The following criteria apply to **Rehabilitation of Access Roads:**

- Reduce road widths to be used post closure; and
- Redundant roads will be ripped, reshaped, covered with 100mm topsoil and vegetated.

9.4 Rehabilitation of Overburden and Spoils

With the intended RoM of 125 000 tpm, approximately 475 000 tpm of overburden material will be generated and used for the construction of roads, various dams, tailings storage facility where after the remaining volume will be stored either on the temporary overburden dump and/or used for concurrent backfilling into redundant opencast areas.

The temporary overburden dump is situated adjacent to resource areas A and C – refer to Figure 1. It is assumed that the dump will be constructed to a 25° angle but this should be designed in detail as it is dependent on many factors and characteristics of the dumped material.

The overburden dump will develop over time. The footprint area of the dump will be as follows:

- Year 1 – 5 2.97 Ha
- Year 6 – 30 37.07 Ha

Temporary topsoil dumps (limited) will be constructed with topsoil stripped from areas where development takes place. These dumps must be vegetated to avoid soil erosion and dust as well as to preserve topsoil for future rehabilitation activities.

As partial backfilling is proposed as part of the mining process, the following section refers to possible rehabilitation in a lights out scenario prior to the end of the Life of Mine.

The following criteria will apply to Rehabilitation of Overburden and Spoils:

- The overburden dump will not remain post-closure;
- All dump slopes will be reshaped from 25° to an approximate 20° incline angle (To be designed in detail).
- Run-off control benches, with channels and stilling basins where required, will be constructed on dump slopes at a maximum of 25 m intervals (To be designed in detail) to prevent storm water damage on the dump slope;
- The entire dump slope surface will be covered with 100 mm topsoil and then vegetated. This will serve as both a rainwater penetration cover and a dust fallout prevention measure;
- Paddocks will be constructed on the dump top surface to assist with evaporation and ensure the prevention of rainwater overtopping;
- Any existing surface water diversions around the dump footprint will be left in place.

9.5 Rehabilitation of Processing Waste Deposits

A TSF is planned for the mine development and will have a final footprint area of 150 Ha.
The following criteria apply to the **Tailings Storage Facility:**

- The TSF at Doornhoek will remain post-closure;
- The TSF walls will be reshaped to a slope incline of 18°. Run-off control benches will be constructed at 25 m intervals to prevent storm water damage on the dump slope;
- The entire TSF dam wall surface will be covered with 100 mm topsoil and vegetated to serve as an evaporative cover and prevent dust-fallout;

- Paddocks will be constructed on the top surface to assist with evaporation and ensure the prevention of rainwater overtopping;
- Surface water diversions around the TSF footprints will be left in place; and
- Any associated equipment will be removed and disposed.

9.6 Fencing

As part of the rehabilitation process, all internal fencing must be removed. Farm boundary fencing will remain in place post-closure.

The following criteria apply to **Fencing Rehabilitation:**

- Dismantle and remove redundant fencing for salvage. Where fencing is to be installed for post-closure safety, first use dismantled fencing;
- Demolish all concrete fence foundations to 500mm below original ground level, if used;
- All fence lines are to be ripped to a depth of 500mm depth, covered with 100mm topsoil and vegetated if concrete beams were used.

9.7 Water Management

Water management needs to be addressed to ensure any potential long term negative impact on water resources is identified and mitigated. In order to mitigate the risks associated with surface and groundwater depletion and / or contamination, the following rehabilitation measures are suggested.

9.7.1 Storm water Management

All storm water management structures around rehabilitated areas are to be left in place post-closure. Provision is made for a full storm water assessment of the rehabilitated site to determine any additional storm water measures required.

9.7.2 Aquifer seepage control

Seepage capturing and monitoring boreholes should be drilled at strategic locations downstream from any overburden dumps, TSF, storm water retention facilities and admin/workshop areas. This will ensure that any contamination from these areas are identified and removed from the aquifer. Cost provision is only made for the monitoring aspect and is included under Section 9.10 below.

9.7.3 Process water control

It is the intention to recycle all process water inclusive of storm water defined as “dirty” and water from the tailings storage facility.

9.8 General Surface Rehabilitation

General surface rehabilitation will be done to all disturbed areas not specifically included in the sections listed above. This will entail reshaping any terraced slopes to a maximum angle of 20° and returning the areas to a state as close as possible to its pre-mining environment and in line with the intended post-closure use.

The following criteria apply to the **General Surface Rehabilitation:**

- Reshaping of terraced land to a maximum 20° incline angle;
- General re-shaping to resemble natural topography; and
- All disturbed areas not covered specifically in the details above will at least be ripped to a depth of 500mm where possible, covered with 100mm topsoil and vegetated.

9.9 Monitoring and Management

The suggested post-closure monitoring and management period at the site is at least 3 years. Activities during this period include, but are not limited to:

- Heritage site monitoring;
- Aquatic ecological monitoring;
- Surface and groundwater quality sampling and testing;
- Air quality / Dust monitoring;
- Ground vibration and air blast monitoring;
- Noise monitoring;
- Re-vegetation of disturbed areas where required;
- Annual bio-diversity monitoring;
- Annual third party environmental compliance monitoring;
- Annual PM10 and PM2.5 monitoring; and
- Wetland monitoring.

10 FINANCIAL PROVISION

This section summarizes the financial provision for closure calculated for the activities and infrastructure described in this document. All calculations are according to the criteria as set out in Section 9 and in line with the DMR's Mine Closure Quantum Guideline document and the latest NEMA Regulations. As per the guideline, additional weighing factors have been taken into account in the calculations. The classifications can be seen in Table 1 and Table 2 below.

In this case a first (terrain) weighting factor of 1.00 has been taken into account in the calculations as the nature of terrain varies between flat to undulating in some areas – the mining and plant area however is situated in the flat area with an even slope.

For the second weighting factor (proximity) a value of 1.05 was used, taking into account that the project is approximately 70km from the larger Lichtenburg and 55km from Mahikeng where most plant and equipment would be available. These weighting factors are added to the subtotal cost calculations before the addition of preliminary and design costs and contingencies.

Table 1: Weighting Factor 1

Weigh Factor 1	Flat	Undulating	Rugged
Nature of Terrain/Accessibility	**1.00**	1.10	1.20

Table 2: Weighting Factor 2

Weigh Factor 2	Urban	Perri-urban	Remote
Proximity from Urban Area	1.00	**1.05**	1.10

The two environmental liabilities calculated are shown in the subsequent sections. The 'Immediate Closure Provision' refers to the projected 'lights-out' closure scenario at the end of the first year of full operation (year 7). This is typically the amount that initially needs to be accounted for in the mine's closure liability fund. Once operations commence, this amount should be updated every year as part of the annual liability assessment required by the MPRDA and the latest NEMA Regulations (GN R. 1147). The 'Life-of-Mine' provision refers to the estimated final provision foreseen once all operations have seized and decommissioning and rehabilitation is due to commence.

10.1 Calculation of Immediate Closure Provision

Based on current infrastructure and the closure and rehabilitation plan and activities described in this document, the provision calculated for an immediate closure scenario after the first year of full operation is R 20 895 922. This is the suggested amount to be provided for by means of one of the funding vehicles listed in Section 2 and as stipulated in GN R. 1147 of the NEMA.

A summary of this provision is shown in Table 3 below.

Table 3: Summary of Immediate Closure Provision

Description	Rehab & Closure	Aftercare (5yrs)	TOTAL
Immediate Closure Provision – after year 1 of full operation	R 17 688 778	R 3 207 144	**R 20 895 922**

10.2 Calculation of Life-of-Mine Closure Provision

For this scenario it is foreseen that most of the rehabilitation takes place concurrent to the mining activity. This is suggested as it will help to reduce the annual immediate / lights out closure provision.

The table below gives a short summary of the calculated closure provision for the LOM scenarios for the mine which has an expected Life of Mine of 30 years.

A summary of these costs can be seen in Table 4 below.

Table 4: Summary of Life of Mine Closure Provision

Description	Operational	Rehab & Closure	Aftercare (3yrs)	TOTAL
Life-of-Mine Closure Provision	R 92 101 784	R 7 112 492	R 3 207 144	R 102 421 420
Life-of-Mine Closure Provision	R 0	R 99 214 576	R 3 207 144	R 102 421 420

The total financial liability for the 30y LoM scenario is estimated to be R 102 421 420. This is equal to an annual expenditure of R 3 414 047 on rehabilitation. Should all progressive rehabilitation be done, the remainder of the total liability will be required at closure, which is estimated at R 10 319 636 which includes the 3-year aftercare amounting of R 3 207 144. This last figure includes the post-closure maintenance, monitoring and management of external resources but does not include the involvement of the mine in the process.

11 CONCLUSION

Based on the calculations of the financial provision for closure for the mining operation proposed for the Doornhoek Fluorspar Mine Project, the following conclusions can be made:

Immediate Closure Liability

- In the event of an immediate 'lights-out' closure event at the end of the first year of full operation, the total financial provision required to successfully rehabilitate the mine is R 20 895 922 which includes 3 years of post closure monitoring

Life-of-Mine Closure Liability

- Final LoM closure liability without any progressive rehabilitation actions is estimated to be R 102 421 420;
- R 92 101 784 of the final LoM liability must be planned for during the 30 year operational phase of the mine; and
- R 10 319 636 will be required for the rehabilitation, closure and aftercare in the case of successful progressive rehabilitation during the operational period.

12 RECOMMENDATIONS

Based on the aforementioned sections above it is recommended that the following actions be taken in order to better quantify the closure provision in subsequent project stages:

- Develop an implementation-level closure plan that will incorporate final design information when construction starts – this will be the *Annual Rehabilitation Plan* as described in the Regulation;
- Develop a funding model in collaboration with a mine rehabilitation specialist and a qualified, experienced financial planner; and
- Progressive rehabilitation has been included in this closure plan and the mine must ensure that provision for progressive rehabilitation is incorporated into the operational cost of their activities.

APPENDIX A: REHABILITATION COST SUMMARY

30YEARS LIFE OF MINE

PRELIMINARY CALCULATION OF THE QUANTUM

	Mine: Proposed Doornhoek Fluor Mine				**Location: 30km South East of Zeerust - North West Province**		
	Evaluators: REDE Engineering and Management Solutions (Pty) Ltd					**Date:**	**29-Oct-16**
	Risk Class	C					
	Area Sensitivity	Medium					

No.	**Description**	**Unit**	**A**	**B**	**C**	**D**	**E=A*B*C*D**
			Quantity	**Master rate (October 2016)**	**Multiplication factor**	**Weighting factor 1**	**Amount (rands)**
CPI							
1	Dismantling of **processing plant and related structures** (including overland conveyors and powerlines)	m^3	9,365	13.54	1.00	1.00	126,755
2(A)	Demolition of **steel buildings and structures**	m^2	3,727	188.54	1.00	1.00	702,765
2(B)	Demolition of **reinforced concrete buildings and structures**	m^2	1,639	277.85	1.00	1.00	455,272
3	Rehabilitation of **access roads**	m^2	23,529	33.74	1.00	1.00	793,840
4(A)	Demolition and rehabilitation of **electrified railway lines**	m	0	327.46	1.00	1.00	0
4(B)	Demolition and rehabilitation of **non-electrified railway lines**	m	0	178.62	1.00	1.00	0
5	Demolition of **housing and/or administration facilities**	m^2	1,745	377.08	1.00	1.00	658,084
6	**Opencast rehabilitation** including final voids and ramps	ha	182.5	191,914.26	0.52	1.00	18,212,663
7	Sealing of **shafts, adits and inclines**	m^3	0	101.22	1.00	1.00	0
8(A)	Rehabilitation of **overburden and spoils**	ha	27.6	131,779.80	1.00	1.00	3,634,487
8(B)	Rehabilitation of processing waste **deposits and evaporation ponds (basic salt-producing waste)**	ha	150	164,129.36	1.00	1.00	24,619,404
8(C)	Rehabilitation of processing waste **deposits and evaporation ponds (acidic, metal-rich waste)**	ha	0	476,709.46	0.66	1.00	0
9	Rehabilitation of **subsided areas**	ha		110,345.74	1.00	1.00	0
10	**General surface rehabilitation**	ha	4.0	104,391.83	1.00	1.00	417,567
11	**River diversions**	ha	7.50	104,391.83	1.00	1.00	782,939
12	**Fencing**	m	2,156	119.08	1.00	1.00	256,732
13	**Water management**	ha	0.3	39,692.71	0.25	1.00	2,972
14	2 to 3 years of **maintenance and aftercare**	Sum	1.0	3,207,144.00	1.00	1.00	3,207,144
15A	Specialist study (and aftercare)	Sum	1	25,657,152.00	1.00	1.00	25,657,152
15B	Specialist studies (soil remediation)	ha	28	25,000.00	1.00	1.00	689,500
						SubTotal 1 (At Closure)	**80,217,278**
	Preliminary and General	6.0%	if Subtotal 1 > 100 000 000		Weighting factor 2		
		12.0%	if Subtotal 1 < 100 000 000		1.00		9,626,073
						SubTotal 2	**89,843,351**
			(Subtotal 1 plus sum of management and contingency)				
						Add Vat (14%)	12,578,069
						GRAND TOTAL	**102,421,420**
						(Subtotal 2 plus VAT)	

APPENDIX B: REHABILITATION COST SUMMARY – END YEAR 7

(LIGHTS OUT SCENARIO)

PRELIMINARY CALCULATION OF THE QUANTUM

	Mine: Proposed Doornhoek Fluor Mine				**Location: 30km South East of Zeerust - North West Province**		
	Evaluators: REDE Engineering and Management Solutions (Pty) Ltd					**Date:**	**29-Oct-16**
	Risk Class	C					
	Area Sensitivity	Medium					
No.	**Description**	**Unit**	**A**	**B**	**C**	**D**	**E=A*B*C*D**
			Quantity	**Master rate (October 2016)**	**Multiplication factor**	**Weighting factor 1**	**Amount (rands)**
CPI							
1	Dismantling of **processing plant and related structures** (including overland conveyors and powerlines)	m^3	9,365	13.54	1.00	1.00	126,755
2(A)	Demolition of **steel buildings and structures**	m^2	3,727	188.54	1.00	1.00	702,765
2(B)	Demolition of **reinforced concrete buildings and structures**	m^2	1,639	277.85	1.00	1.00	455,272
3	Rehabilitation of **access roads**	m^2	23,529	33.74	1.00	1.00	793,840
4(A)	Demolition and rehabilitation of **electrified railway lines**	m	0	327.46	1.00	1.00	0
4(B)	Demolition and rehabilitation of **non-electrified railway lines**	m	0	178.62	1.00	1.00	0
5	Demolition of **housing and/or administration facilities**	m^2	1,745	377.08	1.00	1.00	658,084
6	**Opencast rehabilitation** including final voids and ramps	ha	16.0	191,914.26	0.52	1.00	1,596,727
7	Sealing of **shafts, adits and inclines**	m^3	0	101.22	1.00	1.00	0
8(A)	Rehabilitation of **overburden and spoils**	ha	5.0	131,779.80	1.00	1.00	658,899
8(B)	Rehabilitation of processing waste **deposits and evaporation ponds (basic salt-producing waste)**	ha	13	164,129.36	1.00	1.00	2,051,617
8(C)	Rehabilitation of processing waste **deposits and evaporation ponds (acidic, metal-rich waste)**	ha	0	476,709.46	0.66	1.00	0
9	Rehabilitation of **subsided areas**	ha		110,345.74	1.00	1.00	0
10	**General surface rehabilitation**	ha	4.0	104,391.83	1.00	1.00	417,567
11	**River diversions**	ha	0	104,391.83	1.00	1.00	0
12	**Fencing**	m	2,156	119.08	1.00	1.00	256,732
13	**Water management**	ha	0.3	39,692.71	0.25	1.00	2,972
14	2 to 3 years of **maintenance and aftercare**	Sum	1.0	3,207,144.00	1.00	1.00	3,207,144
15A	Specialist study (and aftercare)	Sum	1	772,577.00	1.00	1.00	386,289
15B	Specialist studies (soil remediation)	ha	1	0.00	1.00	1.00	0
						SubTotal 1 (At Closure)	**11,314,664**
	Preliminary and General	6.0%	if Subtotal 1 > 100 000 000		Weighting factor 2		
		12.0%	if Subtotal 1 < 100 000 000		1.00		1,357,760
	Contingency	50.0%	of Subtotal 1				5,657,332
						SubTotal 2	**18,329,756**
			(Subtotal 1 plus sum of management and contingency)				
						Add Vat (14%)	2,566,166
						GRAND TOTAL	**20,895,922**
						(Subtotal 2 plus VAT)	