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Agricultural and Soil Impact Assessment and Management Plan for the alternative closure and rehabilitation project at the Tshipi Borwa Mine

Submitted by TerraAfrica Consult cc
Mariné Pienaar
(MSc. Environmental Science)
(SACNASP Agricultural and Soil Scientist)

June 2019

DEFINITIONS AND ACRONYMS

Aquaculture: Aquaculture is the farming of marine or freshwater fish or shellfish under controlled conditions.

Aquaponics: Aquaponics is the combination of aquaculture and hydroponics where both vegetables and fish are produced where both nutrients and water are recycled in a system that creates very limited waste.

Hydroponics: Hydroponics is a method of growing plants using mineral nutrient solutions, in water, without soil.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertilizer: An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land use: The use to which land is put.

Declaration of EAP

Details of practitioner

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Physical address: 57 Kruger Street, Wolmaransstad, 2630

Declaration of Independence

I, Mariné Pienaar, hereby declare that TerraAfrica Consult, an independent consulting firm, has no interest or personal gains in this project whatsoever, except receiving fair payment for rendering an independent professional service.

I further declare that I was responsible for collecting data and compiling this report. All assumptions, assessments and recommendations are made in good faith and are considered to be correct to the best of my knowledge and the information available at this stage.

TerraAfrica Consult cc represented by M Pienaar
May 2019

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1. Introduction

SLR Consulting (Africa) (Pty) Ltd appointed Terra Africa Consult cc to conduct the agricultural and soil assessment for the closure planning of the EMPr amendment for the Tshipi Borwa Mine. The project consists of the following two phases:

- Situational analysis of the agricultural and soil aspects of the four options that were considered for the mine closure which included complete backfill of the final pit void, partial backfill, in-pit dumping only and no in-pit dumping (and no backfill).
- Determination of the impacts of the option chosen (in-pit dumping) on the agricultural potential and soil properties of the mining area and compilation of mitigation and management measures to reduce negative impacts and maximise positive impacts.

The strategic objectives of the project are the following:

- To conduct a cost-benefit approach to options analysis;
- To determine whether post-closure land use can be more productive than pre-mining land use; and
- To determine whether the liability can be turned into an asset.

The report starts with an explanation of the project as well as the key background information from the situational analysis that informs the approach to the impact assessment and the development of the mitigation and management measures. The anticipated impacts are rated using the methodology provided by SLR Consulting Africa.

2. Background project information

Tshipi é Ntle Manganese Mining (Pty) Ltd (Tshipi) currently operates the Tshipi Borwa open pit manganese mine located on the farms Mamatwan 331 and Moab 700, approximately 18 km south of Hotazel in the Joe Morolong Local Municipality and the John Taolo Gaetsewe District Municipality in the Northern Cape Province. Tshipi currently holds the following authorisations:

- A mining right (NC/30/5/1/2/2/0206MR) issued by the Department of Mineral Resources (DMR);
- An Environmental Management Programme report (EMPr) approved by the DMR;
- An environmental authorisation (NC/30/5/1/2/2/206/000083 EM) issued by the DMR; and
- A Water Use Licence (IWUL) (10/D41K/AGJ/1735) issued by the Department of Water and Sanitation.

Key mine infrastructure includes an open pit, haul roads, run-of mine ore tip, a primary crusher, a secondary crushing and screening plant, various stockpiles for crushed and product ore, a train load-out facility, a private siding, offices, workshops, warehouses and ancillary buildings, an access control facility, various access roads, diesel generator house, electrical reticulation, clean and dirty water storage dams, water reticulation pipelines and drains, topsoil stockpiles and waste rock dumps. The mine has an anticipated life of mine of approximately 25 years and has been operational since 2012.

The approved EMPr commits Tshipi to restore the surface to pre-mining state of wilderness and grazing and requires that the open pit is backfilled. Recent operation optimisation investigations indicate that when considering environmental, socio-economic, technical, commercial and legal factors, and, completely backfilling the open pit is sub-optimal. An alternative closure and rehabilitation strategy offers:

- The opportunities for enhanced biodiversity habitats with a different backfill approach particularly in terms of topographic variety and access to surface water;
- The opportunities for enhanced land use increase with access to surface water; and
- An alternative closure option will allow for earlier rehabilitation of waste rock dumps.

In addition to the above, completely backfilling the open pit is likely to sterilise an underground resource located to the north of the current approved open pit. The associated loss of employment, procurement, taxes and foreign exchange earnings is significant and will be a material net loss to the region and the country;

Tshipi is therefore proposing to change the current closure commitment to achieve a more sustainable and optimised outcome. In this regard, the proposed project focusses on:

- Concurrent backfill only i.e. in-pit dumping during mining operations only;
- Sloping and rehabilitation of waste rock dumps remaining on surface concurrent with mining activities;
- Access to readily available future water supply; and
- Optimisation of the surface landforms and partially backfilled pit from a biodiversity, rehabilitation, land use and pollution prevention perspective.

3. Report compliance

This report complies with the requirements of the NEMA and environmental impact assessment (EIA) regulations (GNR 326 of 2014 as amended). The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014 as amended)

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Declaration of EAP (pg iii)
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix 1 - Curriculum Vitae of Specialist
b)	A declaration that the specialist is independent	Declaration of EAP (pg iii)
c)	An indication of the scope of, and the purpose for which, the report was prepared	Introduction (pg 5)
cA)	An indication of the quality and age of	Not applicable

No.	Requirement	Section in report
	base data used for the specialist report	
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Not applicable
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 5
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Section 4
g)	An identification of any areas to be avoided, including buffers	Not applicable
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Not applicable
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 6
j)	A description the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 7
k)	Any mitigation measures for inclusion in the EMPr	Section 8
l)	Any conditions for inclusion in the environmental authorisation	Section 9
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 9
n)	A reasoned opinion -	Section 10
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 10
(iA)	Regarding the acceptability of the proposed activity or activities	Section 10
(ii)	If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 10

No.	Requirement	Section in report
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	Not applicable
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	No comments received yet
q)	Any other information requested by the competent authority	Not applicable

4. Findings of alternatives analysis

Four alternatives were considered for the post-closure landscape at Tshipi Borwa Mine. The alternatives considered are:

- Backfill of the final pit void post mining to original ground level, before rehabilitation of the surface as per the current approved EMPr. (Figure 1)
- Backfill of the final pit void post mining to a level just above the rebound water-table level, approximately 50m below original ground level, before rehabilitation of the surface (Figure 2).
- Backfill of the pit void concurrent with mining only, also called in-pit dumping, which results in a final pit void which will be 'made safe' (profiled) before rehabilitation of the surface(Figure 3).
- No backfill of the pit either concurrent with mining or post mining i.e. all waste rock to surface dumps. The pit side-walls and end-walls will only be 'made safe' (Figure 4).

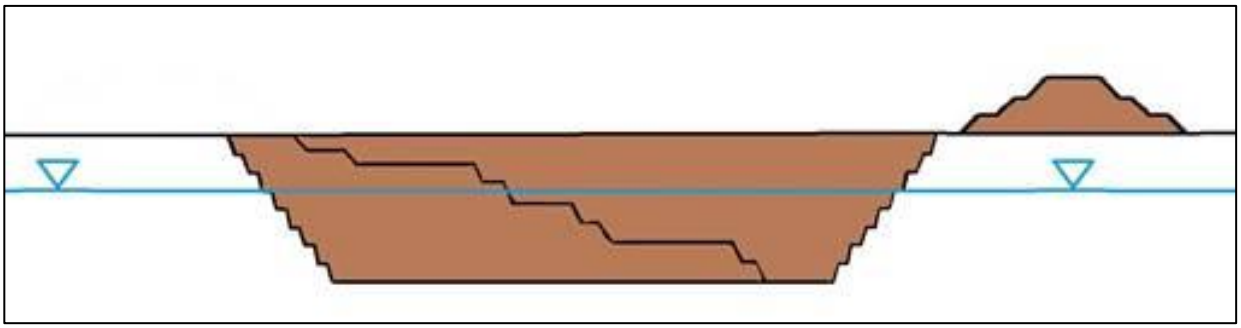

Figure 1: Backfill of the final pit void post mining to original ground level as per the original EMPr requirements

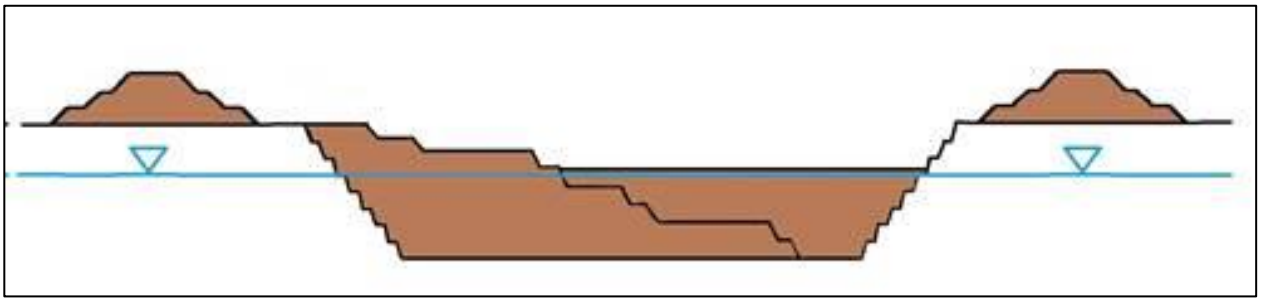

Figure 2: Partial backfill of the final pit void

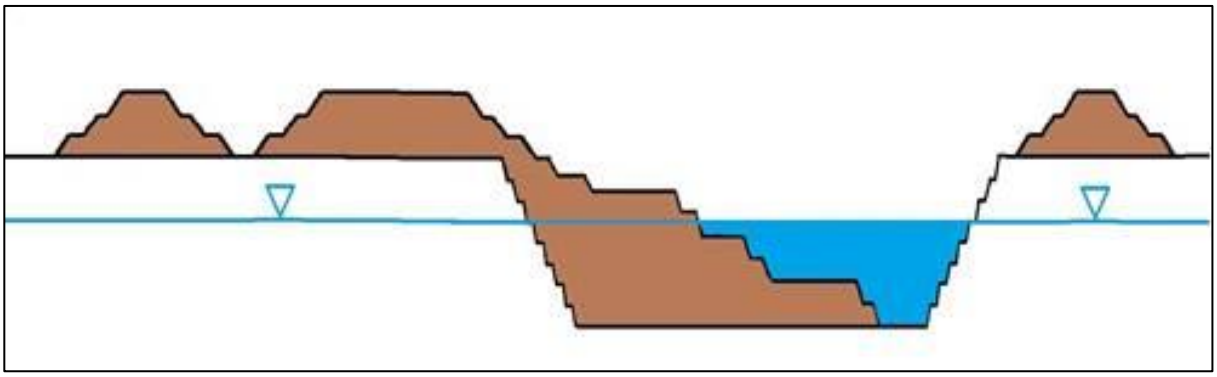

Figure 3: In-pit dumping

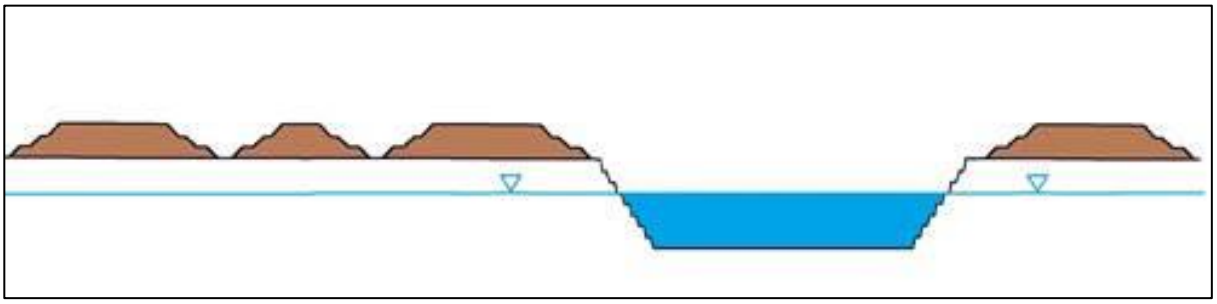

Figure 4: No backfill and no in-pit dumping

Considering the opportunities described above, the closure option that provides the most water (and aggregate for growing medium), is also the option that will provide the highest agricultural productivity per unit area. In a similar way, the higher the productivity and the more intensive the production methodology, the higher the number of direct and indirect employment and business opportunities created.

Therefore, the “No In-Pit Dumping and No Backfill” option is the most preferred option for closure at the Tshipi Borwa Mine. The second best option will be “In-pit dumping only” as it will have the second-highest volume of water available. The third option is “Partial backfill” as there will still be some water and aggregate available to set up an aquaponics unit (or a few). “Complete backfill” is the least preferred option as the land where the waste rock dumps are located will be rehabilitated to grazing at some capacity but this will not significantly contribute to the food basket of the region or increase socio-economic conditions.

With regards to the soil properties, the different closure options will have similar impact on soil properties. While topsoil may be used for rehabilitation of the pit once it has been backfilled, it can also be used for the vegetation of the waste rock dump in the case that the pit is not backfilled. The post-closure soil quality will depend on the rehabilitation techniques used and how well the nutrient cycles can re-establish itself in the soil. However, this will most likely be homogeneous for all four of the options.

5. Gaps, assumptions and limitations

The main assumption made in the assessment is that the water available at the end of the project will be of sufficient quality for use. Another assumption is that the quantity of water available is predicted accurately by the geohydrological modelling done for this project.

6. Methodology for impact assessment

The impact assessment methodology is based on the Hacking method of determination of the significance of impacts (Hacking, 1998). This method also complies with the method provided in the EIA guideline document. Part A provides the definition for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D.

PART A: DEFINITION AND CRITERIA* (*H = high, M= medium and L= low and + denotes a positive impact)		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of severity, spatial extent and duration**
Criteria for ranking of the SEVERITY of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

PART B: DETERMINING CONSEQUENCE					
SEVERITY = L					
DURATION	Long term	**H**	**Medium**	**Medium**	**Medium**
	Medium term	**M**	**Low**	**Low**	**Medium**
	Short term	**L**	**Low**	**Low**	**Medium**
SEVERITY = M					
DURATION	Long term	**H**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**
SEVERITY = H					
DURATION	Long term	**H**	**High**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Medium**	**Medium**	**High**
			L	**M**	**H**
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**H**	**Medium**	**Medium**	**High**
	Possible/ frequent	**M**	**Medium**	**Medium**	**High**
	Unlikely/ seldom	**L**	**Low**	**Low**	**Medium**
			L	**M**	**H**
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

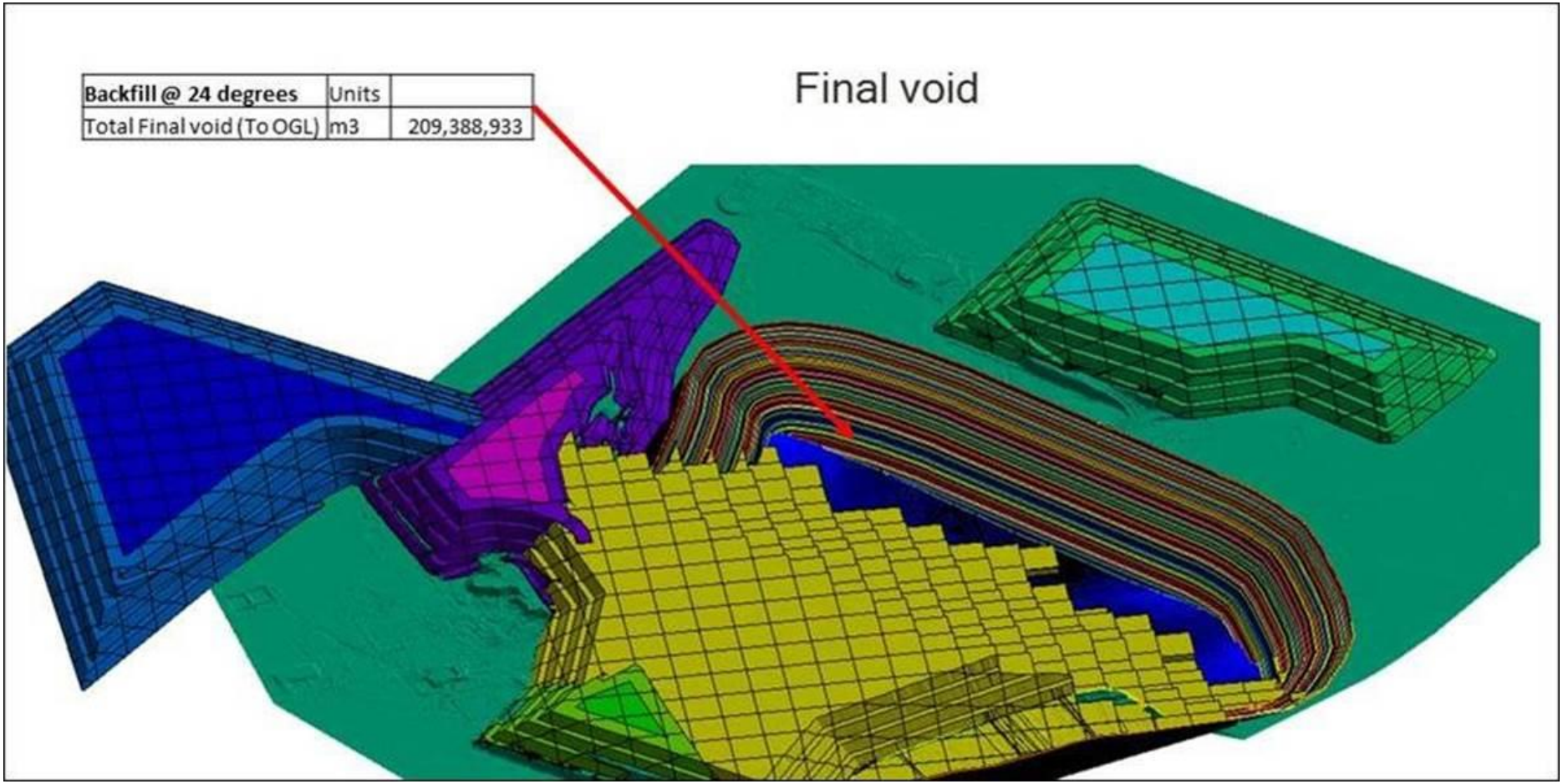

Figure 5: Layout map of the proposed final void after in-pit dumping and ready for closure

7. Impacts with traditional approach to post-mining land use (partial mitigated scenario)

7.1 Introduction

The traditional determination of post-closure land use relies heavily on the pre-mining assessment of the land capabilities of the area to be affected. The baseline soil properties are assessed which then gets translated into the different land capabilities. The pre-mining land capabilities are then used and rehabilitation objectives are usually then the same class (when there was initially grazing land capability) or a class less productive (wilderness). Closure objectives usually refrain from committing to restoring arable land capability, as it has not been possible yet in South Africa to restore this capability to a large extent with current technologies and techniques available.

In a similar way, current objectives for post-closure soil properties are rather vague. Most Soil Management Plans aim for soil that is not chemically polluted or that has eroded away during the project lifecycle. Although much emphasis is placed on maintaining the “fertility of the soil” during the mining lifecycle, the success of the practices recommended are debatable and has been shown through research projects to be of insignificance. While soil quality and soil health are more comprehensive (and better) approaches to soil management, much awareness regarding these approaches are still needed. Successful land rehabilitation that can result in mine closure is still viewed by most as land where the soil has been levelled and vegetation covers the soil surface.

7.2 Impact rating

The impacts have only been rated for closure operations as it will be the only project phase of the project. The impacts on agricultural productivity and soil are based on the following activities:

- Concurrent in-pit dumping within the open pit.
- Sloping and rehabilitation of waste rock dumps remaining on surface, concurrent with mining.
- Revegetation of bare soil surfaces with indigenous grass that are suitable for livestock grazing.
- Monitoring of revegetated soil surfaces to ensure that good quality grazing has been established and livestock grazing is allowed only at a suitable grazing capacity.

A suitable grazing capacity for land in the climatic region within which Tshipi Borwa lies will allow for just 11 units of large livestock (e.g. cattle) for the total backfill option. This will create perhaps one job opportunity or for one family to supplement their income through the sale of a few heifers once a year i.e. subsistence farming.

Impact	Severity	Duration	Spatial scale	Consequence	Significance
Covering of waste rock dumps with soil for revegetation	M+	L+	L+	L+	M+
Establishment of vegetation that will activate soil nutrient cycles (e.g. nitrogen and carbon soil cycles)	M+	M+	L+	M+	M+
Rehabilitation of surrounding areas back to grazing land capability	L+	H+	L+	M+	M+
Increase in the food production potential of the area	L+	L+	L+	L+	L+
Increase in agricultural employment opportunities	L+	L+	L+	L+	L+

8. Impacts with additional mitigation and management

8.1 Introduction

Following the water quality analysis provided in the Hydrological and Geochemical Specialist Report (SLR Ref No: 405.03471.00039, March 2019), the water available in the pit is of sufficient quality to be used for intensive agriculture for the first 100 years without the need for any treatment. After 100 years some form of passive or active or combined treatment will be needed to enable continued use of the water for agriculture

The option most highly recommended is the establishment of aquaponic farming units. Aquaponics is the combination of hydroponics (crops growing in contained spaces where alternative growing media is used and nutrients are provided in the water) and aquaculture (the production of fish and seafood). This system is extremely water efficient (uses 95 to 99% less water than conventional crop production methods) and nutrients are recycled while the water gets filtered by the crop roots. The system is becoming increasingly popular globally as a method to produce both protein and vegetables while using resources optimally.

The energy required for the operation of the system can be generated by solar PV units to make it even more sustainable. The location of the Tshipi Borwa mine is ideal for the combination of solar energy with aquaponics units since it is in a larger region where there is already several solar project developments. Aquaponics is a labour-intensive production system as there is constant inputs required and the harvesting of fish and vegetable crops occur weekly.

Small aggregate is a popular growth medium used in aquaponics. The waste rock dump at the mine may prove to be a great source of aggregate. The waste rock can be crushed in order to be the optimal size for use in aquaponics.

In addition to aquaponics units, some of the existing infrastructure (buildings) can be converted into plant factories. A plant factory produces crops but no fish. It is a highly efficient system with regards to water use and the crops grow much faster inside the plant factories than other systems. Artificial light is used inside the buildings to allow plants to grow even during the night. This system can also be powered by solar PV plants.

Since both the above methodologies are based on the principles of water recycling, excess water may be left (especially in the case of no in-pit dumping and no backfill). This water can be used for irrigation of pastures since the soil has suitability for irrigation. The pasture produced can be used for intensive grazing of sheep and/or goats or to set up a feedlot for sheep and goats. This way, the agricultural enterprises on the land will be diversified and create more employment opportunities. Several secondary businesses can also be developed from these production units.

8.2 Impact rating

Impact	Severity	Duration	Spatial scale	Consequence	Significance
Establishment of aquaponics units that produce fish and vegetables	H+	H+	L+	H+	H+
Recycling of available water through a closed-loop production system	H+	H+	L+	H+	H+
Establishment of secondary agri-businesses for processing, packaging and transport of the food produced	H+	H+	H+	H+	H+
Training and capacitation of the all personnel that will be actively involved in the aquaponics farming	H+	H+	M+	H+	H+
Improvement in soil quality of surrounding areas that can be used for biodiversity conservation instead of livestock farming	H+	H+	L+	H+	H+

9. Mitigation measures

Below follows a description of the mitigation measures that must be implemented in order for impacts to be of such high positive significance as indicated in Section 5.2 above:

- The management of Tshipi Borwa mine should commit a suitable volume of water available at the final pit void to the aquaculture project.
- A suitably qualified and experienced consultant must be appointed for the detailed planning of the construction and operation of the aquaponics unit.

- In conjunction to the planning of the aquaponics units, the construction and operation of solar PV facility or facilities must be considered in order to provide a sustainable source of energy to the aquaponics units.
- The beneficiaries of the aquaponics unit (or possible investors) should be contacted at least two years prior to the implementation of the project to ensure that they undergo proper training and capacitation to successfully construct and operate the aquaponics units.
- The aquaponics project must be marketed in advance in order to create market interest for the produce to be produced at the Tshipi Borwa mine.
- The aquaponics units must be designed with ergonomic principles in mind to ensure that both human and natural resources are conserved as far as possible.

10. A reasoned opinion

The mitigated scenario and accompanying mitigation measures provided in this report, is an important step forward from the traditional land capability approach, especially in a developing country such as South Africa with pressing social-economic needs. The availability of the water in the pit at Tshipi Borwa Mine can turn an area that is now mainly known for mining, into a productive area where novel production techniques makes sustainable agriculture in marginal climatic conditions possible. The existing infrastructure at the mine can be successfully converted into production units such as plant factories and several spin-off businesses can be developed from this.

APPENDIX 1 - CURRICULUM VITAE OF SPECIALIST (Mariné Pienaar)

- **Personal Details**

  Last name: **Pienaar**
  First name: **Mariné**
  Nationality: **South African**
  Employment: **Self-employed (Consultant)**

- **Contact Details**

  Email address: mpienaar@terraafrica.co.za
  Website: **www.terraafrica.co.za**
  Mailing address: **PO Box 433, Ottosdal, 2610**
  Telephone: **+27828283587**
  Address: **57 Kruger Street, Wolmaransstad, 2630, Republic of South Africa**
  Current Job: **Lead Consultant and Owner of Terra Africa Consult**

- **Concise biography**

Mariné Pienaar is a professionally registered soil- and agricultural scientist (SACNASP) who has consulted extensively for the past eleven years in the fields of soil, land use and agriculture in several African countries. These countries include South Africa, Liberia, Ghana, DRC, Mozambique, Botswana, Angola, Swaziland and Malawi. She has worked with mining houses, environmental consulting companies, Eskom, government departments as well as legal and engineering firms. She conducted more than three hundred specialist studies that included baseline soil assessment and rehabilitation planning for new projects or expansion of existing projects, soil quality monitoring, land rehabilitation assessment and monitoring, natural resource assessment as part of agricultural project planning, evaluation and development of sustainable agriculture practices, land use assessment and livelihood restoration planning as part of resettlement projects and land contamination risk assessments. She holds a BSc. Agriculture degree with specialisation in Plant Production and Soil Science from the University of Pretoria and a MSc in Environmental Science from the University of the Witwatersrand. In addition to this, she has attended a number of courses in Europe, the USA and Israel in addition to those attended in South Africa. Mariné is a contributing author of a report on the balance of natural resources between the mining industry and agriculture in South Africa (published by the Bureau for Food and Agricultural Policy, 2015).

- **Qualifications**

  Academic Qualifications:

  - **MSc Environmental Science**; University of Witwatersrand, South Africa, 2017
  - **BSc (Agric) Plant Production and Soil Science;** University of Pretoria, South Africa, 2004

- **Senior Certificate / Matric;** Wolmaransstad High School, South Africa, 2000

Courses Completed:

- **World Soils and their Assessment;** ISRIC – World Soil Information, Wageningen, 2015
- **Intensive Agriculture in Arid- and Semi-Arid Environments** – Gilat Research Centre, Israel, 2015
- **Hydrus Modelling of Soil-Water-Leachate Movement;** University of KwaZulu-Natal, South Africa, 2010
- **Global Sustainability Summer School 2012;** Institute for Advanced Sustainability Studies, Potsdam, Germany, 2012
- **Wetland Rehabilitation;** University of Pretoria, South Africa, 2008
- **Enviropreneurship Institute;** Property and Environment Research Centre [PERC], Montana, U.S.A., 2011
- **Youth Encounter on Sustainability;** ACTIS Education [official spin-off of ETH Zürich], Switzerland, 2011
- **Environmental Impact Assessment │Environmental Management Systems – ISO 14001:2004 │Environmental Law;** University of Potchefstroom, South Africa, 2008
- **Carbon Footprint Analyst Level 1;** Global Carbon Exchange Assessed, 2011
- **Negotiation of Financial Transactions;** United Nations Institute for Training and Research, 2011
- **Food Security: Can Trade and Investment Improve it?** United Nations Institute for Training and Research, 2011

- **Language ability**

Perfectly fluent in English and Afrikaans (native speaker of both) and conversant in French.

- **Professional Experience**

Name of firm	Terra Africa Environmental Consultants
Designation	Owner | Principal Consultant
Period of work	December 2008 to Date

- **Prior Tenures**

Integrated Development Expertise (Pty) Ltd; **Junior Land Use Consultant** [July 2006 to October 2008]
Omnia Fertilizer (Pty) Ltd; **Horticulturist and Extension Specialist** [January 2005 to June 2006]

- **Professional Affiliations**

- South African Council for Natural Scientific Professions [SACNASP]
- Soil Science Society of South Africa [SSSA]
- Soil Science Society of America
- South African Soil Surveyors' Organisation [SASSO]
- International Society for Sustainability Professionals [ISSP]

Summary of a selected number of projects completed successfully:

[Comprehensive project dossier available on request]

1. *Sekoko Railway Alignment and Siding Soil, Land Use and Capability Study* in close proximity to the Medupi Power Station in the Lephalale area, Limpopo Province.

2. *Italthai Rail and Port Projects, Mozambique* – The study included a thorough assessment of the current land use practices in the proposed development areas including subsistence crop production and fishing as well as livestock farming and forestry activities. All the land uses were mapped and intrinsically linked to the different soil types and associated land capabilities. This study was used to develop Livelihood Restoration Planning from.

3. *Bomi Hills Railway Alignment Project, Liberia:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, as well as associated infrastructure upgrades of the port, road and railway.

4. *Kingston Vale Waste Facility, Mpumalanga Province, South Africa*: Soil and vegetation monitoring to determine the risk of manganese pollution resulting from activities at the waste facility.

5. *Keaton Mining's Vanggatfontein Colliery, Mpumalanga*: Assessment of soil contamination levels in the mining area, stockpiles as well as surrounding areas as part of a long-term monitoring strategy and rehabilitation plan.

6. *Richards Bay Minerals, KwaZulu-Natal*: Contaminated land assessment of community vegetable gardens outside Richards Bay as a result of spillages from pipelines of Rio Tinto's Richards Bay Minerals Mine.

7. *Buffelsfontein Gold Mine, Northwest Province, South Africa:* Soil and land contamination risk assessment for as part of a mine closure application. Propose soil restoration strategies.

8. Glenover Phosphate Mining Project near Steenbokpan in the Lephalale area – Soil, Land Use and Land Capability Study as part of the environmental authorisation process.

9. *Waterberg Coal 3 and 4 Soil, Land Use and Land Capability Study* on 23 000 ha of land around Steenbokpan in the Lephalale area.

10. *Lesotho Highlands Development Agency, development of Phase II (Polihali Dam and associated infrastructure)*: External review and editing of the initial Soil, Land Use and Land Capability Assessment as requested by ERM Southern Africa.

11. *Tina Falls Hydropower Project, Eastern Cape , South Africa*: Soil, land use and land capability assessment as part of the ESIA for the construction of a hydropower plant at the Tina Falls.
12. *Graveyard relocation as part of Exxaro Coal's Belfast Resettlement Action Plan*: Soil assessment to determine pedohydrological properties of the relocation area in order to minimise soil pollution caused by graveyards.

13. *Rhino Oil Resources: Strategic high-level soil, land use and land capability assessment of five proposed regions to be explored for shale gas resources in the KwaZulu-Natal, Eastern Cape, North-West and Free State provinces of South Africa.*

14. *Eskom Kimberley Strengthening Phase 4 Projec*t, Northern Cape & Free State, South Africa: soil, agricultural potential and land capability assessment.

15. *Mocuba Solar Project, Mozambique* – The study included a land use assessment together with that of the soil and land capabilities of the study area. All current land uses were documented and mapped and the land productivity was determined. This study advocated the resettlement and livelihood restoration planning.

16. *Botswana (Limpopo-Lipadi Game Reserve).* Soil research study on 36 000 ha on the banks of the Limpopo River. This soil study forms part of an environmental management plan for the Limpopo-Lipadi Game Reserve situated here as well as the basis for the Environmental Impact Assessment for the development of lodges and Land Use Management in this area.

17. *TFM Mining Operations [proposed] Integrated Development Zone, Katanga, DRC* [part of mining concession between Tenke and Fungurume]: soil and agricultural impact assessment study.

18. *Closure Strategy Development for Techmina Mining Company – Lucapa, Angola.* Conducted an analysis of the natural resources (soil, water) to determine the existing environmental conditions on an opencast diamond mine in Angola. The mine currently experience severe problems with kimberlite sediment flowing into the river. A plan is currently being developed to change the mining area into a sustainable bamboo farming operation.

19. *Closure of sand mining operations, Zeerust District.* Succesfully conducted the closure application of the Roos Family Sand Mine in the Zeerust District. Land Use Management Plans for rehabilitated soil were developed. The mine has closed now and the financial provision has been paid out to the applicant.

20. *ESIA for [proposed] Musonoi Mine, Kolwezi area, Katanga, DRC:* soil, land use and land capability assessment.

21. *Bauba A Hlabirwa Moeijelik Platinum mine [proposed] project, Mpumalanga, South Africa:* soil, land use and land capability assessment and impact on agricultural potential of soil.

22. *Commissiekraal Coal Mine [proposed] project, KwaZulu*-Natal, South Africa: sustainable soil management plans, assessment of natural resource and agricultural potential and study of the possible impacts of the proposed project on current land use. Soil conservation strategies included in soil management plan.

23. *Cronimet Chrome Mine [proposed] project, Limpopo Province, South Africa:* soil, land use and land capability of project area and assessment of the impacts of the proposed project.
24. *Moonlight Iron Ore Land Use Assessment, South Africa* – Conducted a comprehensive land use assessment that included interviews with land users in the direct and indirect project zones of influence. The study considered all other anticipated social and environmental impacts such as water, air quality and noise and this was incorporated into a sensitivity analysis of all land users to the proposed project.

25. *Project Fairway Land Use Assessment, South Africa* – The study included an analysis of all land users that will directly and indirectly be influenced by the project. It analysed the components of their land uses and how this components will be affected by the proposed project. Part of the study was to develop mitigation measures to reduce the impact on the land users.

26. *Bekkersdal Urban Renewal Project – Farmer Support Programme,* Independent consultation on the farmer support programme that forms part of Bekkersdal Renewal Project. This entailed the production of short and long term business plans based on soil and water research conducted. Part of responsibilities were the evaluation of current irrigation systems and calculation of potential water needs, etc. as well as determining quantities and prices of all project items to facilitate the formalisation of tender documents.

27. *Area-based agricultural business plans for municipalities in Dr. Kenneth Kaunda Municipal District.* Evaluation of the agricultural and environmental status of the total district as well as for each municipality within the district. This included the critical evaluation of current agricultural projects in the area. The writing of sustainable, executable agricultural business plans for different agricultural enterprises to form part of the land reform plans of each Municipality within the district.

28. *Batsamaya Mmogo, Hartswater.* Conducted a soil and water assessment for the farm and compiled management and farming plans for boergoats grazing on *Sericea lespedeza* with pecan nuts and lucerne under irrigation.

29. *Anglo Platinum Twickenham Mine – Irrigated Cotton Project.* Project management of an irrigated cotton production project for Twickenham Platinum Mine. This project will ensure that the community benefit from the excess water that is available from the mine activities.

30. *Grasvally Chrome (Pty) Ltd Sylvania Platinum [proposed] Project, Limpopo Province, South Africa:* Soil, land use and agricultural potential assessment.

31. *Jeanette Gold mine project [reviving of historical mine], Free State, South Africa:* Soil, land use and agricultural potential assessment.

32. *Kangra Coal Project, Mpumalanga, South Africa:* Soil conservation strategies proposed to mitigate the impact of the project on the soil and agricultural potential.

33. *Richards Bay Integrated Development Zone Project, South Africa* [future development includes an additional 1500 ha of land into industrial areas on the fringes of Richards Bay]: natural resource and agricultural potential assessment, including soil, water and vegetation.

34. *Exxaro Belfast Coal Mine [proposed] infrastructure development projects* [linear: road and railway upgrade | site-specific coal loading facilities]: soil, land capability and agricultural potential assessment.

35. *Marikana In-Pit Rehabilitation Project of Aquarius Platinum, South Africa:* soil, land capability and land use assessment.
36. *Eskom Bighorn Substation proposed upgrades, South Africa:* soil, land capability and agricultural potential assessment.

37. *Exxaro Leeuwpan Coal Mining Right Area, South Africa:* consolidation of all existing soil and agricultural potential data. Conducted new surveys and identified and updated gaps in historic data sets.

38. *Banro Namoya Mining Operation, DRC:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, including proposed project extension areas and progressive soil and land use rehabilitation plan.

39. *Kumba Iron Ore's Sishen Mine, Northern Cape, South Africa: soil, land use and agricultural scientist* | *Western Waste Rock Dumps [proposed] Project:* soil, land use and agricultural potential assessment, including recommendations regarding stripping/stockpiling and alternative uses for the large calcrete resources available.

40. *Vetlaagte Solar Development Project, De Aar, South Africa:* soil, land use and agricultural scientist. Soil, land use and agricultural potential assessment for proposed new 1500 ha solar development project, including soil management plan.