REPORT

Gamsberg Mine Additional Infrastructure Project - Desktop Soil Assessment

Black Mountain Mining (Pty) Ltd

Submitted to:

Black Mountain Mining (Pty) Ltd

1 Penge Road
Aggeneys
8893

Submitted by:

Golder Associates Africa (Pty) Ltd.

Building 1, Maxwell Office Park, Magwa Crescent West, Waterfall City, Midrand, 1685, South Africa

P.O. Box 6001, Halfway House, 1685

+27 11 254 4800

21466019-351901-4

April 2022

Distribution List

1 Electronic Copy to Black Mountain Mining (Pty) Ltd

1 Electronic Copy to projectreports@golder.co.za

1 Electronic Copy to Golder SharePoint Site for 21466019

Table of Contents

TABLES

FIGURES

APPENDICES

APPENDIX A
Soils Map (SRK, 2009)

1.0 INTRODUCTION

Black Mountain Mining (Pty) Ltd. (BMM), a subsidiary of Vedanta Zinc International (VZI), operates the Black Mountain Complex consisting of the underground Black Mountain Mine operations, Deeps and Swartberg, and the opencast Gamsberg Zinc Mine. The Black Mountain Mine complex mines zinc, lead, silver and copper and hoists 1.7 million tonnes (mt) of ore a year with a current production capacity of 90 000 tonnes per annum (tpa) metal-in-concentrate.

The Gamsberg Zinc Mine came into operation in June 2016 and mines approximately 4 million tonnes per annum (Mtpa) and produces 250-300 tpa of zinc concentrate.

The mine is situated in the Namakwa District, Northern Cape and is approximately 120 km east of Springbok and approximately 270 km from Upington, between the towns of Aggeneys and Pofadder. The Gamsberg Zinc Mine is located over three properties namely, Portion 1 of the farm Bloemhoek 61, Portion 1 of the farm Gams 60 and Portion 0 of farm Aroams 57.

Gamsberg Mine currently requires further environmental related applications to authorise additional infrastructure and activities that are required for ongoing operations and which were not included in the previous authorisations, and to authorise changes required in infrastructure layout as a result of optimised planning. As part of the Basic Assessment process, a specialist soil, land capability and land use assessment are required.

WSP in Africa (WSP), a wholly owned affiliate of WSP Global Inc., was commissioned to undertake a desktop soils assessment for the proposed project. The objective of this study is to identify and assess the potential impacts of the proposed infrastructure and associated activities on the soils and to provide recommended mitigation measures, monitoring requirements and rehabilitation guidelines for the identified impacts.

2.0 PROPOSED INFRASTRUCTURE DEVELOPMENT AND CHANGES

Gamsberg Mine is applying for environmental authorisation for the proposed infrastructure and activities described in the sections below and illustrated in Figure 1.

2.1 New potable water pipeline

A new above-ground potable water pipeline is proposed to run from the Horseshoe dam to the processing plant. This pipeline will be developed in an existing servitude already use for pipelines transporting water from Sedibeng Water to the mine. The location where the pipeline is proposed to be developed has already been cleared of vegetation as it is within a road reserve. The proposed pipeline will be installed above-ground and will have an inside diameter of 400 mm, an outside diameter of 460 mm, a throughput of 460 m3/hour and will be approximately 7 km in length. The entire pipeline will belong to Gamsberg Mine.

2.2 Expansion of dangerous goods storage facilities

To support the ongoing operations at Gamsberg Mine, an increase in storage capacity will be required for the following dangerous goods storage facilities:

- Fuel storage capacity which is proposed to increase from 600 m3 to 1 200 m3.
- Emulsion storage is proposed to be increased from 2 x 85t silos and 2 x 50t silos to 2 x 100t and 2 x 200t silos respectively.

The proposed expansion of the above-mentioned facilities will be adjacent to the existing storage facilities, located at the existing mine office and workshop area.

2.3 River diversion

To minimise pollution from the waste rock dump, ROM pad and crushers and conveyer infrastructure associated with the phase 1 and 2 plant infrastructure, it is proposed that the ephemeral riverbed that passes between the processing plant and the mining operations, be altered.

The diversion will include the construction of an attenuation weir, diversion berms, two above-ground pipelines for conveying any upstream runoff past the impacted area (processing plant and the mining operations) and an energy dispersion outlet structure. The altered section will be approximately 2.5 km in length.

The alteration will be in place for the duration of the operational phase of the mine and will be rehabilitated during the decommissioning and closure phase.

2.4 Refined layout of the waste rock dump and quartzite rock dump/berm

A waste rock dump facility, with a capacity to store 1.5 billion tons of waste rock on an area of 490 ha, is approved in the Environmental and Social Impact Assessment Report for the Gamsberg Zinc Mine and Associated Infrastructure in the Northern Cape (June 2013).

In addition to the main waste rock dump facility and in order to mitigate the impacts on biodiversity as a result of the basin/crater mining activities, it was recommended that a rock dump / berm, comprising only quartzite rock, be designed and constructed to shield the remainder of the basin / crater from mining activities. It is detailed in the Environmental Management Programme for the Gamsberg Zinc Mine and Associated Infrastructure in the Northern Cape (May 2013), that the berm should be constructed to the same elevation as the plateau comprising a non-acid leaching rock core and a quartzite rock outer layer. It is further stated that the placement of the barrier must be defined with input from a qualified botanist and the engineering team prior to the placement of the rock.

The Gamsberg Mine engineering team has refined the layout of the current waste rock to optimise the placement of waste rock and to avoid current mine infrastructure and to ensure safe operation of the facility. The updated waste rock dump layout is based on the storage capacity and footprint as approved in the 2013 EIA and EMPr.

The 2013 EMPr does not include a final position and layout of the biodiversity protection rock dump / berm. The engineering team, in consultation with the biodiversity specialist has defined the final layout and position.

The updated waste rock dump layout and layout and position of the biodiversity rock dump / berm will be included in the Basic Assessment Report.

2.5 Defined layout for the crusher and coarse ore stockpile for the 2nd phase of the plant

The 2013 EIA states that the full production capacity of the mine will be 10 Mtpa ore. This capacity will be reached in a modular approach following the mine ramp up plan as described in the report. It is stated that the current concentrator plant will be ramped up in three modules to full capacity. It is indicated that the three phases of the concentrator plant will each consist of a concentrator stream with supporting utility and supporting infrastructure.

An amended concentrator plant boundary and shortened conveyor route was approved in the Gamsberg Mine Environmental Management Programme Amendment (December 2016). The information was presented at a high level and did not differentiate between the infrastructure components required for the three plant modules.

The Gamsberg Mine engineering team has defined the phase 2 plant components in preparation for construction. The updated conveyor and phase 2 concentrator plant layout will be included in the Basic Assessment Report.

3.0 SPECIALIST STUDY INTRODUCTION

The report provides, at a desktop level, the soil characteristics, land capability and land use of the project area. The study provides an input into the Basic Assessment Report as required in terms of the Mineral and Petroleum Resources Development Act (MPRDA), Act 28 of 2002 and the National Environmental Management Act (NEMA), Act 107 of 1998. These Acts require the avoidance of pollution and/or degradation of the environment or where neither can be avoided, it is required that the pollution or degradation thereof be minimised or remediated.

3.1 Study Objectives

The objectives of the study were therefore to do the following:

- Conduct a desktop soil assessment based on the available literature and specialist studies and reports conducted for the Gamsberg Mine and surrounding areas.
- Determine the impacts on soil, land use and land capability associated with the project.
- Propose environmental management actions required for the preservation of local soils (mitigation measures and monitoring requirements).

3.2 Study Limitations

The content of this report is based on existing specialist studies and reports available for the Gamsberg Mine and surrounding area. The author of this report did not visit the study site.

The assessment rating of impacts is not an absolute measure. It is based on the subjective considerations and experience of the specialist but is done with due regard and as accurately as possible within these constraints.

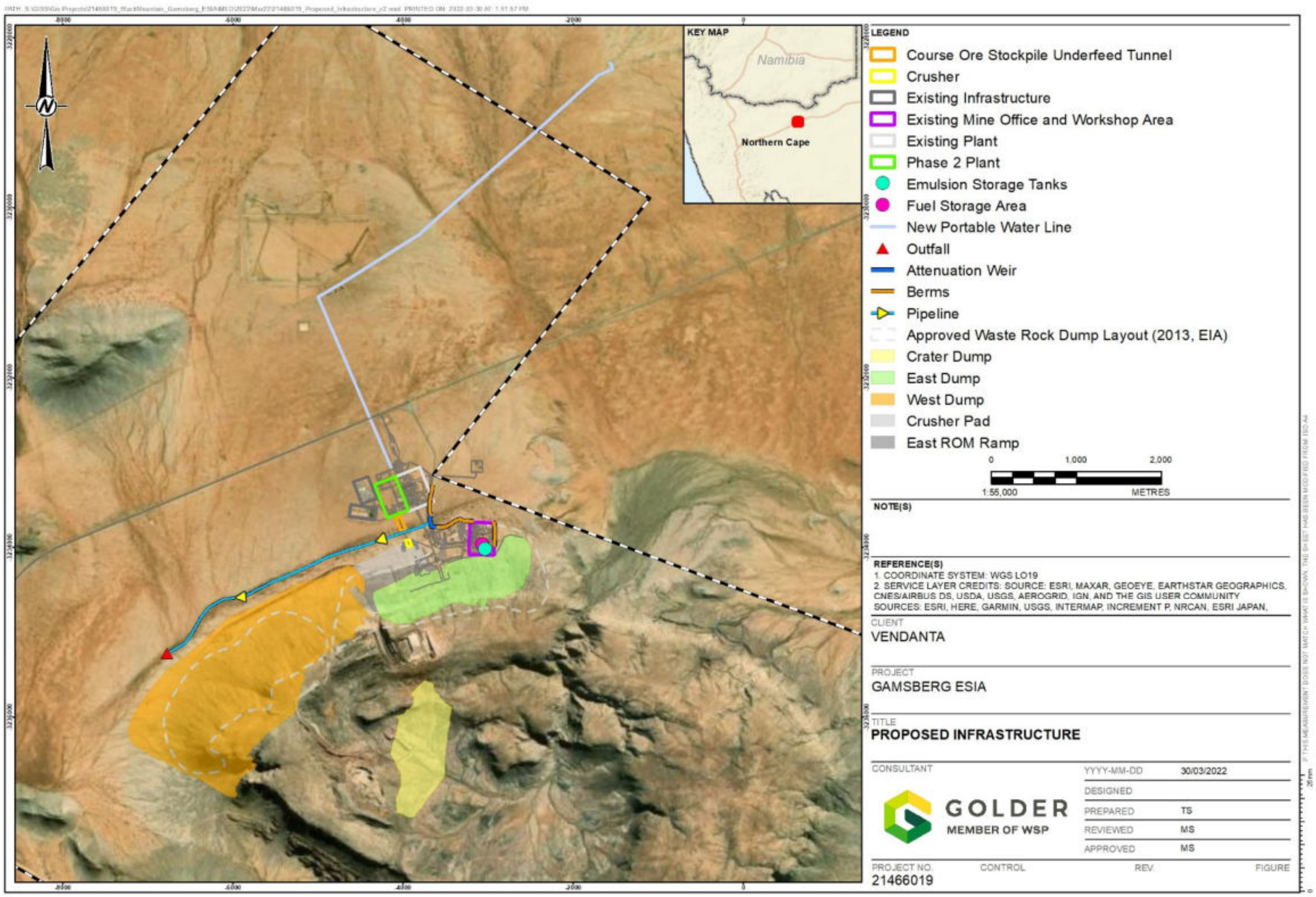


Figure 1: Gamsberg Mine study site and proposed infrastructure

4.0 POLICY AND LEGAL AND ADMINISTRATIVE FRAMEWORK

The following section outlines a summary of South African Environmental Legislation that needs to be considered for the proposed Gamsberg Mine infrastructure project with regards to management of soil:

- The law on Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal.
- The Bill of Rights states that environmental rights exist primarily to ensure good health and well-being, and secondarily to protect the environment through reasonable legislation, ensuring the prevention of the degradation of resources.
- The Environmental right is furthered in the National Environmental Management Act (No. 107 of 1998), which prescribes three principles, namely the precautionary principle, the “polluter pays” principle and the preventive principle.
- It is stated in the above-mentioned Act that the individual/group responsible for the degradation/pollution of natural resources is required to rehabilitate the polluted source; Soils and land capability are protected under the National Environmental Management Act 107 of 1998, the Environment Conservation Act 73 of 1989, and the Conservation of Agricultural Resources Act 43 of 1983.
- The National Veld and Forest Fire Bill of 10 July 1998 and the Fertiliser, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36 of 1947 can also be applicable in some cases.
- The National Environmental Management Act 107 of 1998 requires that pollution and degradation of the environment be avoided or, where it cannot be avoided, be minimized and remedied.
- The Conservation of Agriculture Resources Act 43 of 1983 requires the protection of land against soil erosion and the prevention of water logging and salinisation of soils by means of suitable soil conservation works to be constructed and maintained.

5.0 METHODOLOGY

5.1 Data Gathering

A desktop soil assessment was undertaken for the Gamsberg Mine site. This included accessing the ISRIC World Soils Database, based on the World Reference Base Classification System (WRB, 2014), the Soil and Terrain Database for South Africa (ISRIC, 2008) and a previous soils report undertaken in the area by SRK Consulting (Pty) Ltd (SRK, 2009). These sources, most notably the previous SRK study, cover the majority of the proposed infrastructure study area. The soils underlying the 1.2km long northern-most section of the proposed potable water line, located outside the Gamsberg Mine mining right area (MRA) have not previously been classified (refer to Figure 1). The proposed potable water line will be located within an existing servitude already used for pipelines transporting water from Sedibeng Water to the mine.

5.2 Available literature and studies

Documents appraised as part of the desktop study included the following:

- SRK Consulting (2009). Gamsberg Zinc Project Soils and Land Capability Baseline Report. Report No. 396036/Soils.

- ERM (2013). Environmental and Social Impact Assessment Report for the Gamsberg Zinc Mine and Associated Infrastructure in the Northern Cape. Final Report. June 2013.
- SLR. (2020). Gamsberg Smelter Project: Environmental Impact Assessment and Environmental Management Programme.
- International Soil Reference and Information Centre (2008). The Soil and Terrain Database for South Africa.
- World Resource Base (previous FAO system) (2014). The World Reference Base Classification System 2008.

6.0 ENVIRONMENTAL CONTEXT

6.1 Climate

The Gamsberg Mine is located in an area that is classified as a desert region with very low rainfall and very high evaporation rates. The mean annual precipitation is estimated at 92.4 mm and rainfall can occur in both summer and winter as the area lies in a transition zone between winter and rainfall areas and average summer temperatures range between 30°C and 35°C while in winter the maximum temperatures range between 17°C and 20°C.

6.2 Geology

6.2.1 Regional Geology

ERM (2013) states that the Gamsberg zinc deposit is developed in a medium to high grade metamorphic volcano-sedimentary succession belonging to the Aggeneys Sub-Group of the Bushmanland Group. This group is bordered to the east by the Hartbees River Thrust, to the north by the Groothoek Thrust and Wortel Belt, and it is overlain by Karoo-age rocks to the south. Together these Groups occur within the Namaqualand Metamorphic Complex, which, as stated by ERM (2013), consist of Precambrian metamorphic rocks and intrusives formed or metamorphosed during the Namaqua Orogeny.

The Bushmanland Group is composed of basement granitic rocks (1 700 to 2 050 mega annum (Ma)), supra-crustal sequences of sedimentary and volcanic origin (1 200, 1 600 and 1 900 Ma) and intrusive charnockite to granitic rocks (950, 1 030 to 1 060, and 1 200 Ma) (ERM, 2013).

6.2.2 Local Geology

ERM (2013) describes the local geology of the Gamsberg Mine area as a succession of basal quartzo-feldspathic gneiss overlain progressively upwards by sillimanite-bearing pelitic schist and metaquartzites of up to 450 m thickness; the Gams Iron Formation (GIF) of 0 to 80 m thickness; and Koeris Formation rocks consisting of quartz-muscovite schist, lenses of conglomerate and amphibolite to a thickness of 400 to 500 m.

6.3 Topography

The local topography is characterized with undulating plains, containing low growing shrubby vegetation and grasses. The surrounding plains are approximately 750 – 900 meters above mean sea level (mamsl), with the highest areas of the Gamsberg inselberg varying between 1 100 – 1 150 mamsl. The Gamsberg inselberg measures approximately 7.5 km east-west and approximately 4.6 km north-south. A basin, varying between 60 to 70 m below the rim, has developed at the top of the inselberg as a result of erosion (SLR, 2020).

6.4 Regional Soils and Land Use

The Gamsberg Mine area is described by ERM (2013) as being characterised by extensive peneplain[1]. It is explained that the soils present in the peneplain are predominantly shallow and stony. However, soils found within the inselberg are characterised with boulder and stony scree slope soils (SRK Consulting, 2010 as cited by SRK, 2013). The scarps and crest of the inselberg are characterised with bare rocks, while the Gamsberg Basin itself is characterised with shallow gravelly soils.

It is further stated by ERM (2013) that the soils present on the peneplain are generally characterised with reddish sandy topsoil that is shallow in nature. It is however noted that this layer of red sandy soils varies between being 10 cm to up to 60 cm across the Gamsberg Mine area.

The area is unsuitable for crop production due to the dry climate and low rainfall and therefore livestock farming is the dominant form of land use in the region.

The proposed project area falls within the existing Gamsberg MRA except for a short section of the proposed potable water pipeline that will be constructed within an existing pipeline servitude. Therefore, no agricultural land will be transformed for this project.

7.0 SOILS IDENTIFIED

The soils identified at the site that coincide with the abovementioned proposed new infrastructure areas are described in the previous SRK soils study of the site (SRK, 2009) and are listed in Table 1 below (refer to APPENDIX A for the soil type distribution map compiled by SRK).

The area closest to the previously unclassified northern-most section of the proposed water line has been classified as Knersvlakte soil (SRK, 2009), and because there are no significant differences between this area and the unclassified area, it has been assumed that that the unclassified area is also underlain by Knersvlakte soil.

7.1 Knersvlakte Soil Form

Knersvlakte consists of red sand that forms an Orthic topsoil underlain by a Dorbank. The Dorbank can be several centimetres to several metres deep, underlain by hard carbonate and then soft carbonate. In other areas the carbonate sequence is reversed, where soft carbonate is above hard carbonate. During the SRK study site visit, the topsoil was moist in most areas due to rain earlier in the week of sampling, and was described as red in colour, friable to slightly firm, clay sand and wind deposited. Given the arid climate of the region, the moisture observed is likely to be associated with conditions that prevail after rainfall. The Dorbank is a hard to very hard red layer, comprising of sand, gravel and in some places fines stones cemented together. There was visual evidence of precipitated salts in the Dorbank.

7.2 Coega Soil Form

Coega is composed of an Orthic A horizon, underlain by hard carbonate. The thin topsoil cover of red sand was absent in places, exposing the underlying hard carbonate on the surface. The thickness of the hard carbonate varied (0.4 – 1.5 m) across the site.

[1] A more or less level land surface produced by erosion over a long period, undisturbed by crustal movement.

7.3 Prieska Soil Form

Prieska is composed of a thin topsoil overlying a red sand soil with carbonate. This soil layer is underlain by hard carbonate starting from a depth of about 40 cm in places.

7.4 Glenrosa Soil Form

The Glenrosa soils identified at the site were composed of red sandy topsoil overlying weathered rock. The weathered rock was about 40 cm thick and merged into a hard rock.

7.5 Mispah Soil Form

Mispah is comprised of a very thin topsoil horizon directly on hard rock. These shallow, sandy, stony and /or rocky soils do not have a clear profile, overlying hard rock.

7.6 Oakleaf Soil Form

The Oakleaf soils identified comprised moderately shallow red sand over rock or gravelly material. Most of these soils had an effective soil depth about 60 cm, but the water holding capacity was reduced by the low clay and fairly high gravel contents.

Table 1: Soil forms identified in proposed development areas

	Soil Forms Identified						
Proposed Development Areas	**Shallow Oakleaf**	**Deep Oakleaf**	**Knersvlakte**	**Mispah**	**Glenrosa**	**Prieska**	**Coega**
Potable water pipeline			X			X	X
Potable water pipeline area outside mining rights area			X				
Expansion of dangerous goods storage areas		X	X				
River diversion/alteration		X					
Waste rock dump area	X	X	X	X	X		
Crusher and coarse ore stockpile for plant phase 2	X	X	X				X

8.0 ENVIRONMENTAL IMPACT ASSESSMENT

8.1 Methodology for assessing impact significance

The significance of identified impacts was determined using the approach outlined below (terminology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998).

This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

Table 2: Impact assessment factors

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Scale/extent of impact	Magnitude of impact

To assess these factors for each impact, the following four ranking scales were used:

Table 3: Impact assessment scoring methodology

Magnitude	Duration
10- Very high/unknown	5- Permanent (>10 years)
8- High	4- Long term (7 - 10 years, impact ceases after site closure has been obtained)
6- Moderate	3- Medium-term (3 months- 7 years, impact ceases after the operational life of the activity)
4- Low	2- Short-term (0 - 3 months, impact ceases after the construction phase)
2- Minor	1- Immediate
Scale	**Probability**
5- International	5- Definite/Unknown
4- National	4- Highly Probable
3- Regional	3- Medium Probability
2- Local	2- Low Probability
1- Site Only	1- Improbable
0- None	0- None

Significance Points= (Magnitude + Duration + Scale) x Probability.

Table 4: Significance of impact based on point allocation

Points	Significance	Description
SP>60	High environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30 - 60	Moderate environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP<30	Low environmental significance	Impacts with little real effect and which will not have an influence on or require modification of the project design.
+	Positive impact	An impact that is likely to result in positive consequences/effects.

For the methodology outlined above, the following definitions were used:

- Magnitude is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely recognised standards are to be used as a measure of the level of impact;
- Scale/Geographic extent refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international;
- Duration refers to the length of time over which an environmental impact may occur: i.e. immediate/transient, short-term (0 to 7 years), medium term (8 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project), or permanent; and
- Probability of occurrence is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).

8.2 Project Phases

The environmental impacts were considered with respect to the Project Description detailed in Section 2.0 with the understanding that the following project activities are anticipated:

- Constructing and operating of the above ground potable water pipeline within the existing pipeline servitude.

- Constructing and operating the infrastructure required for the diversion / alteration of the ephemeral riverbed. These will include berms, an attenuation weir, above-ground pipelines and an energy dispersion outlet structure
- Constructing and operating the additional fuel and emulsion storage infrastructure adjacent to the existing storage facilities.
- Continued deposition of waste rock dump on the refined layout footprint and construction of the approved quartzite crater dump/berm (biodiversity mitigation measure).
- Construction and operation of the crusher and coarse ore stockpile (associated infrastructure of the approved 2nd phase of the concentrator plant).
- Removal of all infrastructure during the closure and rehabilitation phase and rehabilitation of the areas to a state of physical and chemical stability to ensure safety and to prevent further degradation of the ecological environment.

9.0 POTENTIAL SOIL IMPACTS

The following impacts are potentially significant across the site in respect of soil, land use and land capability.

9.1 Erosion and Sedimentation

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE Before mitigation						MITIGATION AND MANAGEMENT MEASURES	ENVIRONMENTAL SIGNIFICANCE After mitigation					
	M	D	S	P	SP	R		M	D	S	P	SP	R
Construction, Operational and Decommissioning Phases													
Development of the proposed infrastructure will lead to some erosion during the construction and decommissioning phases of development, and potentially the operational phase of the development as measures will need to be put in place to prevent eroded areas from spreading. The sandy soils identified in the study area are less resilient to wind erosion than the coarse rocky soils. Furthermore, as the hydraulic characteristics of the area are likely to be significantly altered as a result of channelling of runoff or increased water velocity from artificial slopes, there is the potential that the soils may be subjected to increased water erosion. The risk of sedimentation is directly linked to the risk of erosion, as eroded soil particles will end up in the very	2	2	1	3	15	Low	■ Implement an effective system of run-off control, where it is required, that collects and safely disseminates run-off water from all hardened surfaces and prevents potential down slope erosion. ■ Periodic erosion monitoring to be undertaken in cleared areas. ■ Any occurrence of erosion must be attended to immediately and the integrity of the erosion control system at that point must be amended to prevent further erosion form occurring there.	2	2	1	2	10	Low

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE Before mitigation						MITIGATION AND MANAGEMENT MEASURES	ENVIRONMENTAL SIGNIFICANCE After mitigation					
	M	D	S	P	SP	R		M	D	S	P	SP	R
nearby surrounding watercourses as sedimentation.							■ Retain as much vegetation cover over as much of the site as possible to protect soil from water and wind erosion. ■ Work should be stopped in land clearance areas during heavy rainfall periods.						

9.2 Loss of Topsoil

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE Before mitigation						MITIGATION AND MANAGEMENT MEASURES	ENVIRONMENTAL SIGNIFICANCE After mitigation					
	M	D	S	P	SP	R		M	D	S	P	SP	R
Construction, Operational and Decommissioning Phases													
Loss of topsoil from site during the construction phase. Although topsoil will be lost from the site during the construction phase, it can potentially be transferred to an alternative area for cultivation or stockpiled and reused in accordance with a site-specific soil management plan, where possible.	4	4	1	3	27	**Low**	• Any available topsoil should first be stripped from the entire surface to be disturbed and stockpiled for re-spreading during rehabilitation. The depth of topsoil stripping will be dependent on the specific field conditions. • It is only in areas where topsoil cannot be retained on the surface during the operational phase, and where the area will be rehabilitated back to veld after decommissioning, that it should be stripped and stockpiled for the duration of the operational phase for re-spreading during de-commissioning. • Topsoil stockpiles must be conserved against losses through erosion by establishing vegetation cover on them. • During rehabilitation, the stockpiled topsoil must be	2	4	1	2	14	**Low**

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE Before mitigation						MITIGATION AND MANAGEMENT MEASURES	ENVIRONMENTAL SIGNIFICANCE After mitigation					
	M	D	S	P	SP	R		M	D	S	P	SP	R
							evenly spread over the entire disturbed surface. • If there is compaction, either in re-spread topsoil or in areas where topsoil was retained during the operational phase, it must be loosened using appropriate decompaction (ripping) equipment. • If topsoil has been stockpiled for the duration of the operational phase, re-vegetation is likely to require seeding and / or planting. • Erosion must be carefully controlled where necessary on topsoiled areas.						

9.3 Soil compaction

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE Before mitigation						MITIGATION AND MANAGEMENT MEASURES	ENVIRONMENTAL SIGNIFICANCE After mitigation					
	M	D	S	P	SP	R		M	D	S	P	SP	R
Construction, Construction and Decommissioning Phases													
Soil compaction is likely to occur in some areas of the site during the construction phase. Compaction of a proportion of the site will occur during the operational phase. Although soils could be ripped after decommissioning of the site, the soils will not regain their original structure so this cannot be fully mitigated against. Having said this, the low clay content and sandy nature of the soils found throughout most of the study area is beneficial as sandy soils are less likely to be compacted than soils with a higher clay content.	6	5	1	3	36	**Moderate**	• Soil compaction during construction and decommissioning phases cannot be avoided as heavy machinery will be operational in all areas where disturbance is anticipated. • Contractors (in particular heavy machinery) will be restricted to designated areas as defined by the Environmental Department. • Tracked vehicles will be utilised in soil clearance activities as per soil stripping and handling procedures. • Limit traffic to designated roads.	4	5	1	3	30	**Moderate**

9.4 Change in surface profile

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE Before mitigation						MITIGATION AND MANAGEMENT MEASURES	ENVIRONMENTAL SIGNIFICANCE After mitigation					
	M	D	S	P	SP	R		M	D	S	P	SP	R
Construction Phase													
In order to create platforms/foundations for development of the proposed infrastructure, the surface profile of the sites will be changed during the construction phase. This will affect water flow, sedimentation and erosion patterns.	6	5	1	3	36	**Moderate**	• No mitigation possible.	6	5	1	3	36	**Moderate**

9.5 Change in land use

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE Before mitigation						MITIGATION AND MANAGEMENT MEASURE	ENVIRONMENTAL SIGNIFICANCE After mitigation					
	M	D	S	P	SP	R		M	D	S	P	SP	R
Construction and Operational Phase													
The proposed development activities will result in a temporary change of land use during the construction and operational phases. The areas will be rehabilitated during the closure and rehabilitation phase.	6	4	1	5	55	**Moderate**	• Minimise the infrastructure footprint and therefore disturbance to the minimum area necessary by forward planning (clearing land during the dry season rather than wet season) and clear demarcation of the areas to be disturbed. • Avoid permanently impacting topsoil and subsoil, but salvaging the maximum depth of these when clearing areas for infrastructure. • Avoid mixing topsoil (A-horizon) with subsoil (B-horizon) during stripping and storing of soil (where applicable). • Ensuring that the overall thickness of the soils utilised for rehabilitation is consistent with surrounding undisturbed areas and future land use (at least gazing land use).	4	4	1	5	45	**Moderate**

9.6 Change in Land Capability

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE Before mitigation						MITIGATION AND MANAGEMENT MEASURES	ENVIRONMENTAL SIGNIFICANCE After mitigation					
	M	D	S	P	SP	R		M	D	S	P	SP	R
Construction, Operational Phases													
The proposed development activities will result in a temporary loss of land capability under surface infrastructure during the construction and operational phases. At closure, when the infrastructure is demolished and the area is rehabilitated, there will be a return of land capability in the infrastructure areas.	6	5	1	3	36	**Moderate**	• No mitigation possible.	6	5	1	3	36	**Moderate**

9.7 Soil Contamination

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE Before mitigation						MITIGATION AND MANAGEMENT MEASURES	ENVIRONMENTAL SIGNIFICANCE After mitigation					
	M	D	S	P	SP	R		M	D	S	P	SP	R
Construction, Operational and Decommissioning Phases													
Soil is likely to be contaminated during the construction and decommissioning phases of the development as large vehicles will be on site, thus on-site pollutants' contact with the soils will need to be limited. There is also a risk of soil contamination during the operational phase, although these will largely be different kinds of pollutants. In all phases soil contamination can and should be prevented, especially as these contaminants will likely quickly enter the surrounding watercourses. The rocky soils on the slopes are very thin, thus it is unlikely that they will be resilient to salt and metal contamination. However, the thinness of the soils would result in the contaminants being rapidly leached from the soil profile, taking cognisance of the fact that there is	4	4	1	3	27	**Low**	• All vehicles and machinery shall be kept in good working order and inspected on a regular basis for possible leaks and shall be repaired as soon as possible if required. • Repairs shall be carried out in a dedicated repair area only, unless in-situ repair is necessary as a result of a breakdown. • Drip trays shall at all times be placed under vehicles that require in-situ repairs. • Drip trays shall be emptied into designated containers only and the contents disposed of at a licenced hazardous material disposal facility. • Ensure proper handling of hazardous chemicals and materials (e.g. fuel, oil, cement, concrete, reagents, emulsion etc.) as per their corresponding Safety Data Sheets (SDS) and the	4	2	1	2	14	**Low**

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE Before mitigation						MITIGATION AND MANAGEMENT MEASURES	ENVIRONMENTAL SIGNIFICANCE After mitigation					
	M	D	S	P	SP	R		M	D	S	P	SP	R
limited rainfall to drive the leaching process.							Gamsberg Mine spill response procedures. • Accidental spills (concrete, chemicals, process water, hydrocarbons, ore, waste) need to be reported immediately so that effective remediation and clean-up strategies and procedures can be implemented. • Soil that is contaminated by fuel, chemical or oil spills, for example, from vehicles, or ore spillage at the crusher and coarse ore stockpile area will either be collected to be treated at a pre-determined and dedicated location, or will be cleaned up and treated in situ, using sand, soil or a suitable absorption medium.						

9.8 Residual Impacts

It is not anticipated that any residual impacts will remain in the areas where the proposed additional infrastructure will be constructed as the infrastructure platforms will be lifted at closure and the areas topsoiled and rehabilitated back to the at least grazing land capability and grazing land use.

9.9 Cumulative Impacts

With expected soil degradation occurring, a decline in the overall soil quality and health, may hinder the soil suitability for the end land use.

10.0 COMPLIANCE MONITORING

The mechanisms for compliance monitoring and performance assessment against the environmental management programme and reporting thereof, include:

- Monitoring of impact management actions.
- Monitoring and reporting frequency.
- Responsible persons
- Time period for implementing impact management actions.
- Mechanisms for monitoring compliance.

The potential impacts of the proposed infrastructure project on soil, land use and land capability can be monitored by the following methods (Table 5).

Table 5: Soil, Land Use and Land Capability Monitoring Program

Type	Objective	Detailed Actions	Monitoring Location	Parameters	Timeframe/Frequency	Responsibility
Soil quality	Maintain the soil quality along areas that will be developed for the proposed infrastructure as well as areas adjacent to the fuel and emulsion storage areas.	Collection of at least one sample per hectare for developed areas or where visible signs of contamination are noted (spillage or seepage areas/zones)	All areas that will be developed for infrastructure	■ pH and salinity (EC) ■ Major anions and cations ■ Organic matter content for the topsoil ■ Texture and CEC ■ Content of major plant nutrients (P and K) ■ Heavy metals and hydrocarbons	Annually	Environmental Department
Soil stockpiles (if applicable)	Maintain soil quality and minimise the degradation of soil stockpiles	Collection of at least one composite sample per stockpile	Soil stockpiles	■ pH and Salinity (EC) ■ Major anions and cations ■ Organic matter content for the topsoil	Annually	Environmental Department

Type	Objective	Detailed Actions	Monitoring Location	Parameters	Timeframe/Frequency	Responsibility
				■ Texture and CEC ■ Content of major plant nutrients (P, K, and S) ■ Content of major plant nutrients (P and K) ■ Metal and hydrocarbons; ■ Stockpile height (<2 m).		
Soil erosion	Mitigate and minimise soil erosion	Infrastructure and drainage lines to be maintained in accordance with the surface water management plan	Soil stockpiles Developed areas Ephemeral drainage line	■ Assess soil stockpile heights and conditions (i.e. gullies and rills). ■ Assess the condition and effectiveness of vegetation	Annually, after rainy season	Environmental Department

Type	Objective	Detailed Actions	Monitoring Location	Parameters	Timeframe/Frequency	Responsibility
				on the stockpiles. ■ Include periodic site inspection in environmental performance reporting that inspects the effectiveness of the run-off control system and specifically records occurrence or not of any erosion on site or downstream. ■ Assess the effectiveness of water versus other dust suppression substances		

Type	Objective	Detailed Actions	Monitoring Location	Parameters	Timeframe/Frequency	Responsibility
				(e.g. molasses or bitumen)		
Rehabilitated Areas	Maintain the quality and condition of rehabilitated areas	Continuous monitoring of rehabilitated areas for closure compliance	Disturbed areas	■ pH and Salinity (EC) ■ Major anions and cations ■ Texture and CEC ■ Organic content of topsoil. ■ Content of major plant nutrients (P and K). ■ Contamination assessment (pH, metals, hydrocarbons). ■ Volume and depth of soil replaced.	Annually	Environmental Department

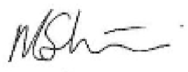
11.0 CONCLUSION

The proposed infrastructure will be developed within the existing Gamsberg Mine MRA, with a short section of the potable water pipeline outside the MRA but within an existing pipeline servitude. The proposed project will therefore not impact on any agricultural land or previously undeveloped areas outside the Gamsberg Mine MRA.

There are no conditions resulting from this assessment that need to be included in the environmental authorisation.

Signature Page

Golder Associates Africa (Pty) Ltd.



Marié Schlechter
Environmental Assessment Practitioner

Mark Aken
Land Use and Closure Consultant

MS/MA/ms

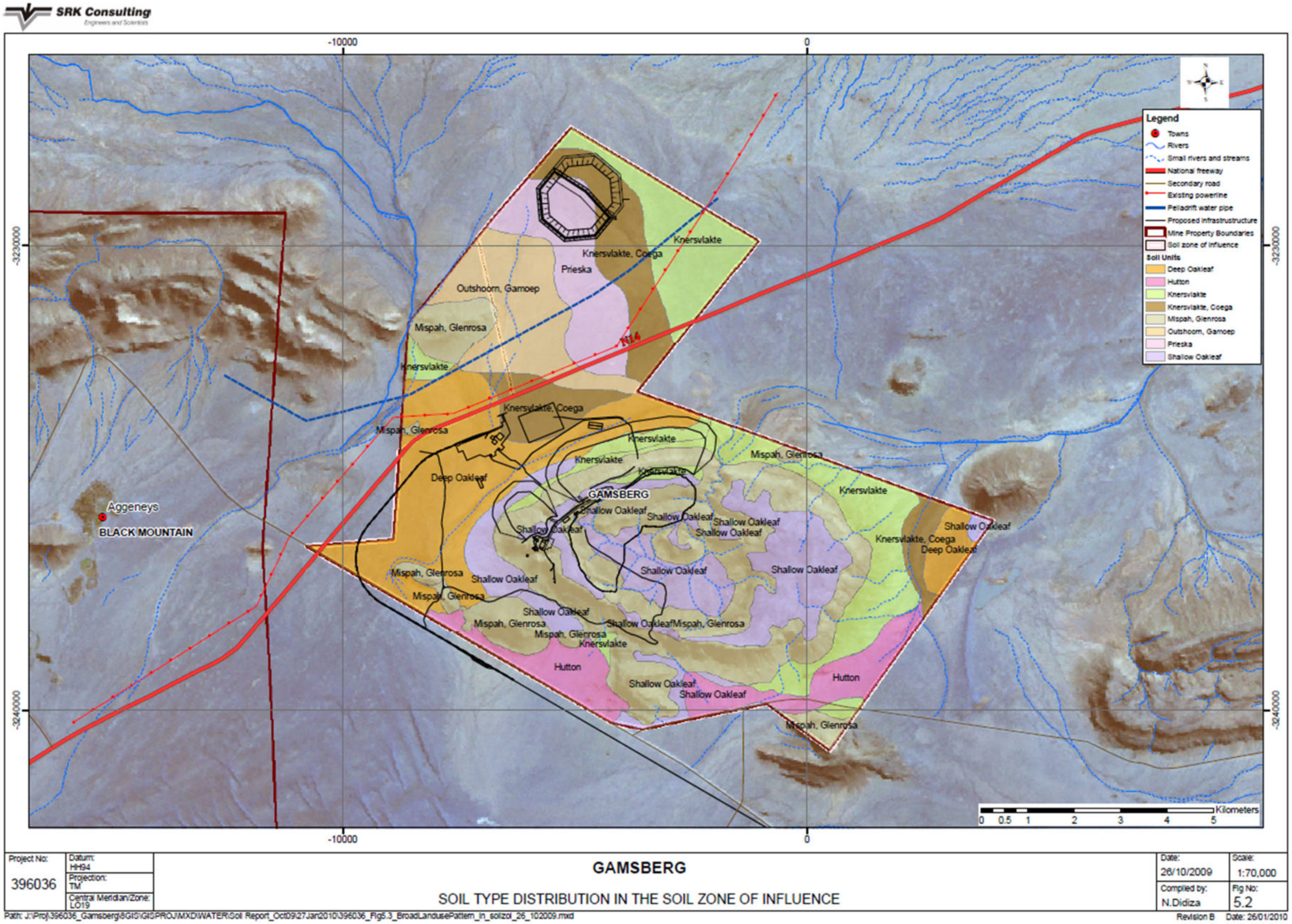
Reg. No. 2002/007104/07

Golder and the G logo are trademarks of Golder Associates Corporation

https://golderassociates.sharepoint.com/sites/145886/project files/6 deliverables/final client deliverables/specialist studies/soil assessment/21466019_desktopsoilassessment_final_13apr2022.docx

APPENDIX A

Soils Map (SRK, 2009)


SRK Consulting
Engineers and Scientists
-10000
0
-3230000
-3240000
Legend
Towns
Rivers
Small rivers and streams
National freeway
Secondary road
Existing powerline
Pelladrift water pipe
Proposed infrastructure
Mine Property Boundaries
Soil zone of influence
Soil Units
Deep Oakleaf
Hutton
Knersvlakte
Knersvlakte, Coega
Mispah, Glenrosa
Outshoorn, Gamoep
Prieska
Shallow Oakleaf
Knersvlakte, Coega
Knersvlakte
Prieska
Outshoorn, Gamoep
Mispah, Glenrosa
N14
Knersvlakte, Coega
Mispah, Glenrosa
Deep Oakleaf
GAMSBERG
Shallow Oakleaf
Hutton
Agggeneys
BLACK MOUNTAIN
Kilometers
0 0.5 1 2 3 4 5
Project No: 396036
Datum: HH94
Projection: TM
Central Meridian/Zone: LO19
GAMSBERG
SOIL TYPE DISTRIBUTION IN THE SOIL ZONE OF INFLUENCE
Date: 26/10/2009
Scale: 1:70,000
Compiled by: N.Didiza
Fig No: 5.2
Path: J:\Proj\396036_Gamsberg\8GIS\GISPROJ\MXD\WATER\Soil Report_Oct09\27Jan2010\396036_Fig5.3_BroadLandusePattern_in_solizol_26_102009.mxd
Revision B Date: 26/01/2010

GOLDER

MEMBER OF WSP

golder.com