ADDENDUM TO THE ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE GOLD FIELDS BEATRIX GOLD MINE

FOR THE INSTALLATION OF A CO-GENERATION POWER PLANT AND METHANE GAS FLARE AT THE GOLD FIELDS BEATRIX GOLD MINE – SHAFT 4, FREE STATE

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LIST OF ABBREVIATIONS

EC	**Electrical Conductivity**
EMPR	**Environmental Management Programme Report**
I&AP	**Interested and Affected Party**
MPRDA	**Mineral and Petroleum Resources and Development Act**
RDB	**Red Data Book**

1. BRIEF PROJECT DESCRIPTION

1.1. Name and address of company responsible for the Project

The project will be implemented in terms of an agreement between Gold Fields' Beatrix Gold Mine and Promethium Carbon (Pty) Ltd.

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1.2. Description of the proposed project

The project will consist of the following components:

- Extraction of the methane gas from underground at the Beatrix Shaft Four (4)
- Electrical power generation plant at Beatrix Shaft Four
- A flare to destroy any excess methane extracted at the Beatrix Mine Shaft Four that is not used in the electrical generation facility.

The electrical generation facility will combust the methane gas extracted from underground (via the shaft 4) in internal combustion engines to simultaneously generate both electricity and useful heat, which would otherwise be transferred to the atmosphere. The methane gas from underground at shaft four (4) will be flared to reduce the impact of methane, which is currently being released, on the environment. Methane is a potent greenhouse gas; having a global warming potential of 21 times that of carbon dioxide (CO_2).

The proposed development is divided into two main components:

- The electrical power generation plant
- The flare.

The flare as well as the electrical power generation plant is proposed to be operated by the Beatrix Mine. The Beatrix Mine is located between Theunissen and Virginia in the Free State (**see Figure 1 overleaf**). Access to the site is from the R30 to Bloemfontein (Theunissen/Virginia Rd). The site is located within the Masilonyana and Matjhabeng Local and Lejweleputswa District Municipalities. There are four shaft complexes located on the greater Beatrix Mine area.

The Beatrix mine currently has an Exploration Right on the gas in terms of the Minerals and Petroleum Resource Development Act (MPRDA).

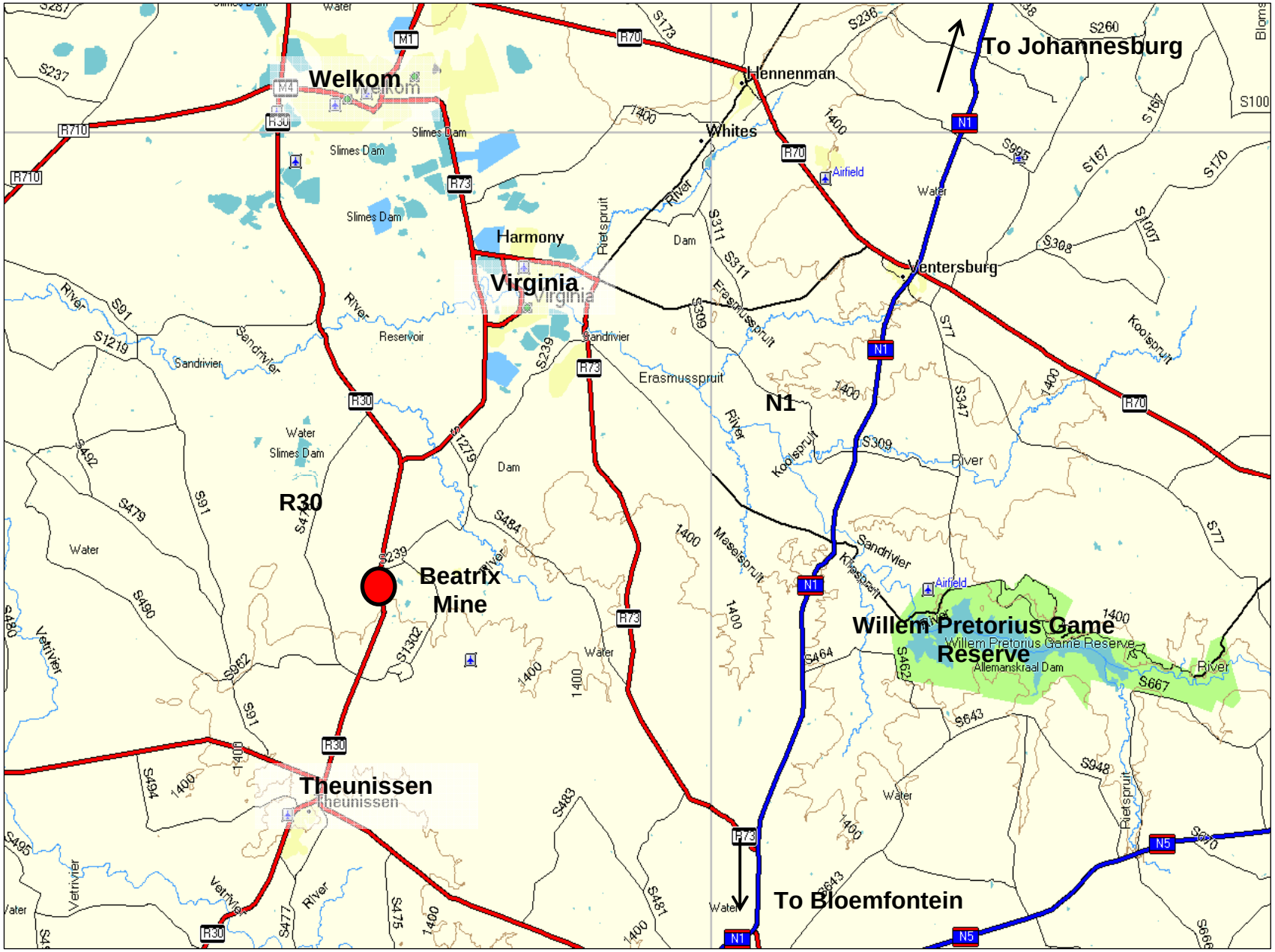

Figure 1: Location of the Gold Fields Beatrix Mine (not to scale)

1.3. Co-generation Plant at Beatrix Mine Shaft 4

Location:	The proposed location of the electrical generation plant to be located at the shaft 4. The co-ordinates of the site are as follows: 28°11'12"S and 26°43'14"E (See **Figure 2** overleaf).
Infrastructure:	• Four containerised internal combustion engines with closed circuit radiators and exhaust silencers, with a total generating capacity of 4MW will be installed. Gas fans to boost the off-gas pressure in order to meet the engine requirements; • Flares; • Absorption chillers; • Flame arrestors; • Demister; • Instrumentation and control equipment; • Piping to route the methane to the engines; • Containerised electrical switchgear and distribution cables from the engines to the electrical sub-station on site; • An oil storage facility for engine lubrication oil (not exceeding 30 cubic meters); and • A containerised control room. The engines, electrical switchgear room and control room will all be containerised to minimise the impact on the mine and be able to be removed from the mine with minimal rehabilitation requirements. The containers will be installed on concrete footings that will be removed upon decommissioning. Prior to the installation of the above-mentioned equipment, a 6-7 m high flare will be installed at the same locality where the co-generation plant equipment will be installed. The flare will be installed to ensure that the methane, a gas with a global warming potential of 21 times that of carbon dioxide, does not enter the atmosphere. The flare will burn the methane until such time as the electrical generation plant is installed. The electricity generation, chilled water generation and flaring plant will be built, owned and operated by Beatrix Gold mine The electricity and chilled water produced will be used by the Beatrix Mine.

Figure 2: Aerial photograph of the Gold Fields Beatrix Mine Indicating the Proposed Location of the Co-generation Plant (not to scale)

The proposed project will pipe the underground mine methane up the Beatrix shaft (Shaft number 4) and to the surface where it will be flared and used to generate electricity and chilled water. The project will be implemented in three phases:

1. The first phase will be the installation of the flare at shaft four (4). At this stage, all the methane extracted from underground will be flared. The first phase will occur in 2013.
2. The second phase will be the installation of the power plant. In phase two, the mine methane will be used to generate electricity and any excess methane will be flared.
3. The third phase will include electricity and chilled water generation. In this phase, excess mine methane (in addition to what will be used for electricity generation) will be used to generate chilled water in direct fired absorption chillers. Any further excess methane, remaining after power generation and chilled water production will be flared. In addition, tangible waste heat from the engine exhaust gas will be used in absorption chillers to generate additional chilled water. The chilled water generated by absorption chillers will displace chilled water generated by electric chillers and, hence, electricity from the grid.

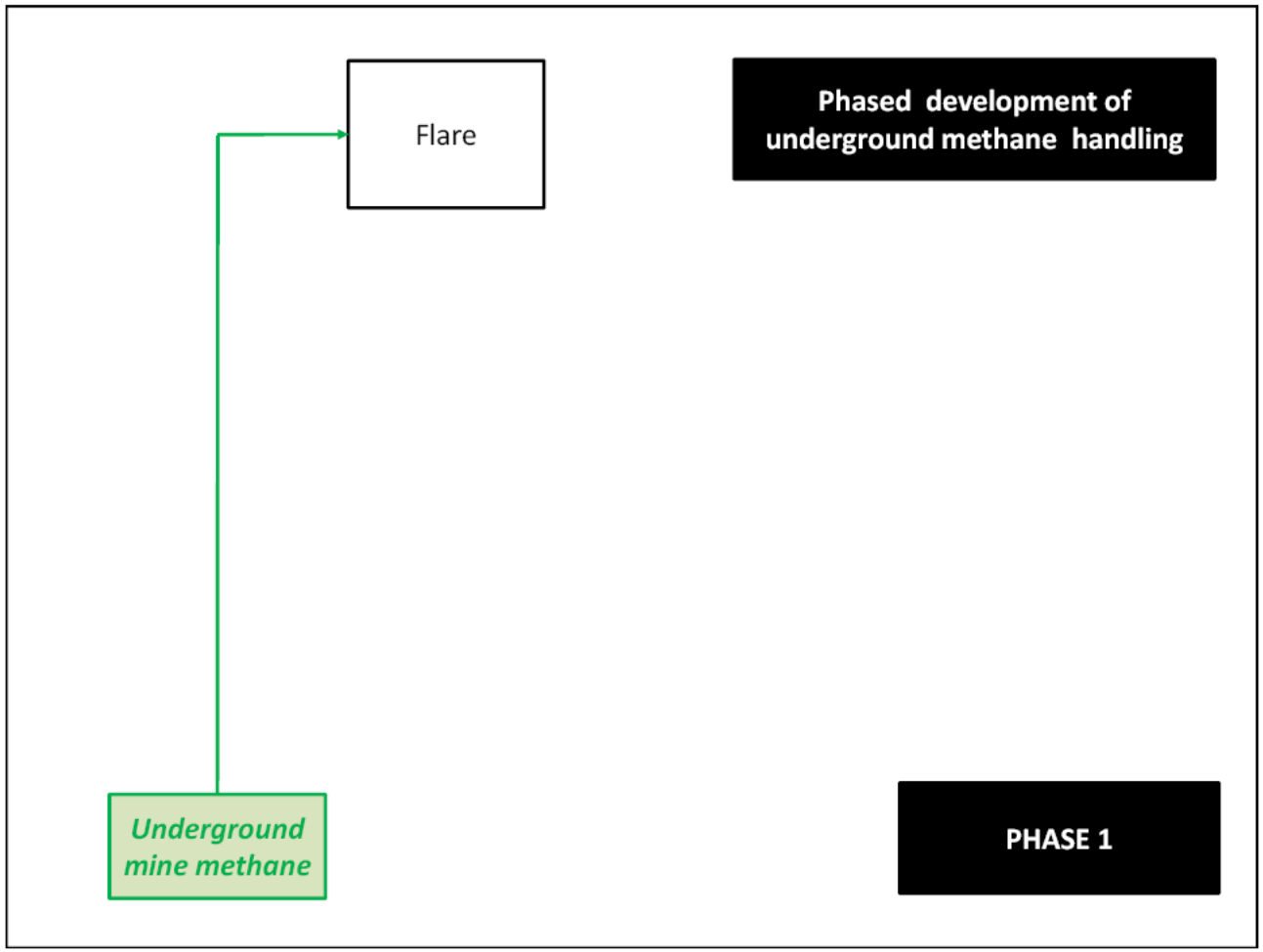

Figure 3: Phase 1 of proposed project activity

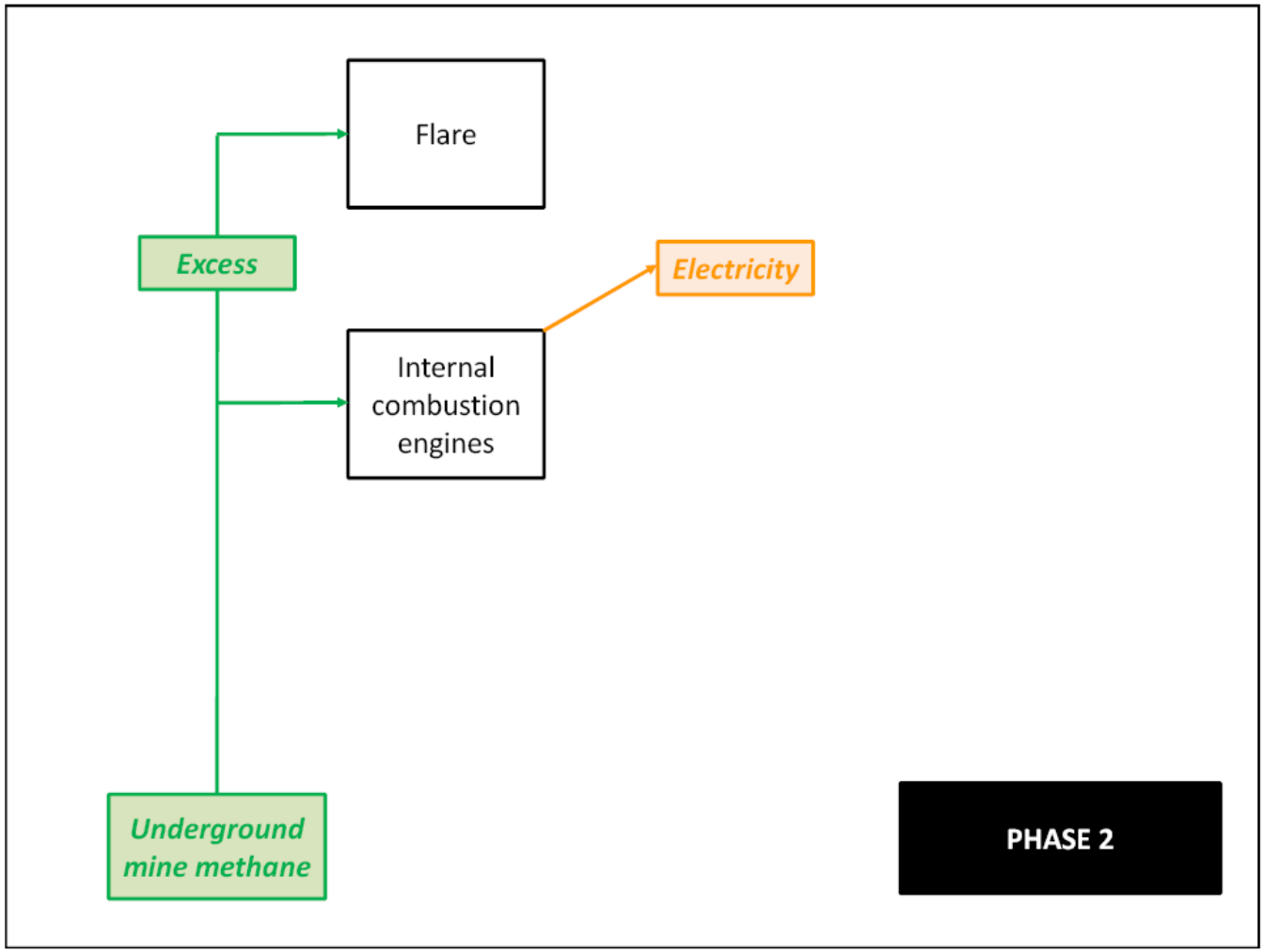

Figure 4: Phase 2 of proposed project activity

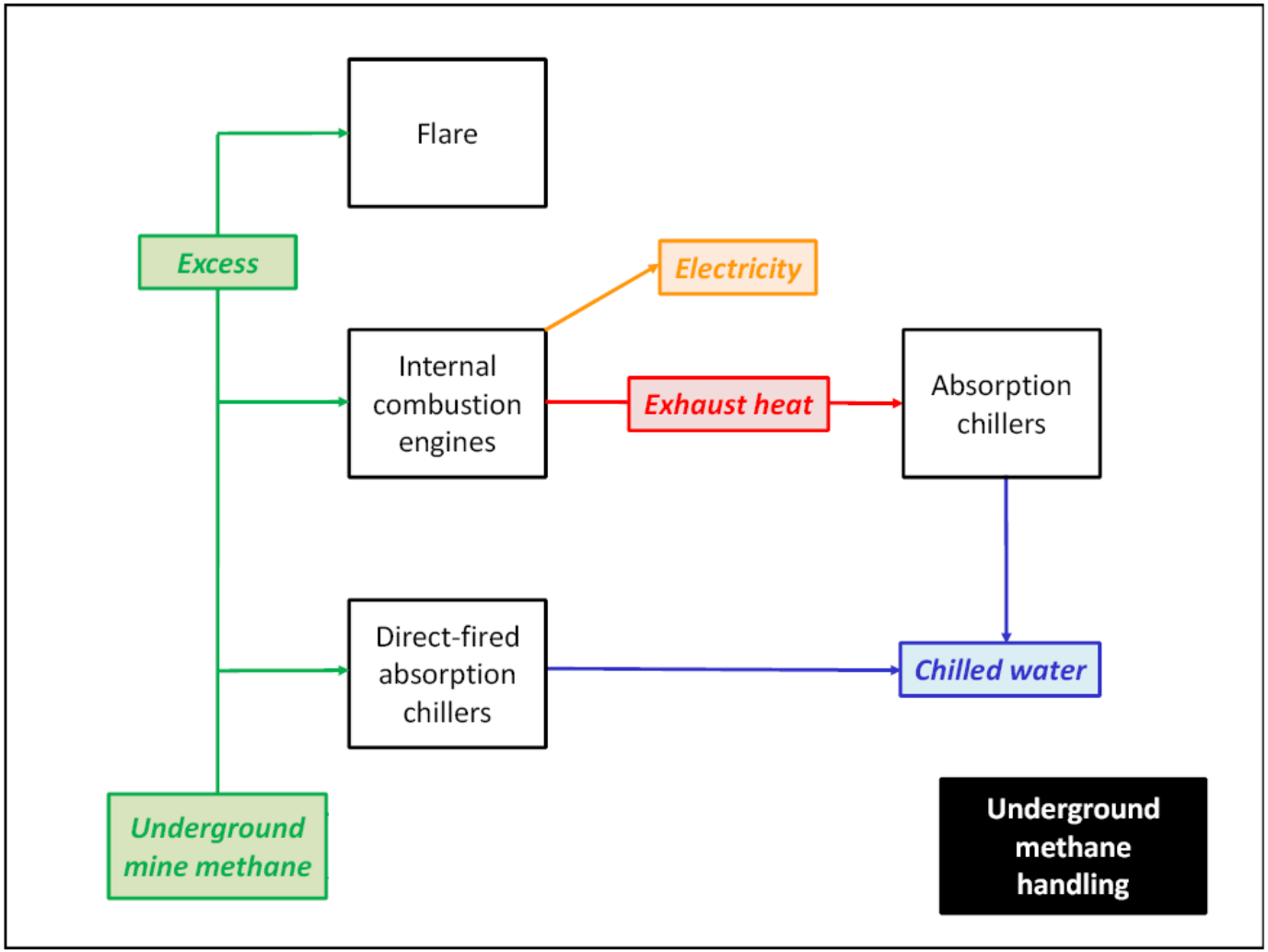

Figure 5: Phase 3 of proposed project activity

1.4. Existing Co-generation Facility in Operation on shaft the Beatrix Main Shaft

It is important to understand that there is currently an existing co-generation facility in operation on shaft (1). This proposed development will be modelled on the technology on existing facility. The existing facility consists of 5 flares have been installed at each of the five boreholes and a big flare at the Beatrix 1 shaft complex, therefore the scope of this Project only includes the installation and operation of one additional flare at Shaft 4

Background:
Small amounts of methane are released from numerous old exploration boreholes on the Beatrix property. These boreholes were drilled for exploration purposes (Not all of them before 2001). These boreholes have a low methane flowrate; making it unfeasible to use the methane to generate electricity. However, the methane poses a safety risk and contributes to climate change so the methane released from 5 of these boreholes are currently being flared as part of the electricity generation project undertaken at the Beatrix Main Shaft (1).

The only revenue from flaring this methane will come from the generation of carbon credits. The carbon credits will be used to finance this project as well as the previous ~~project~~ Electrical Generation project on the Main Shaft. The project is currently applying for registration under the Clean Development Mechanism.

These boreholes are:

Name	GPS Coordinates
DBE1	S 28 11.066 E26 45.488
EX1	S 28 16.334 E 26 44.612
ST23	S 28 11.995 E 26 44.312
1400	S 28 13.323 E 26 44.607
2264	S 28 13.908 E 26.47.078

Table 1: GPS coordinates of boreholes

Figure 6: Location of Beatrix main shaft and the five boreholes currently flared

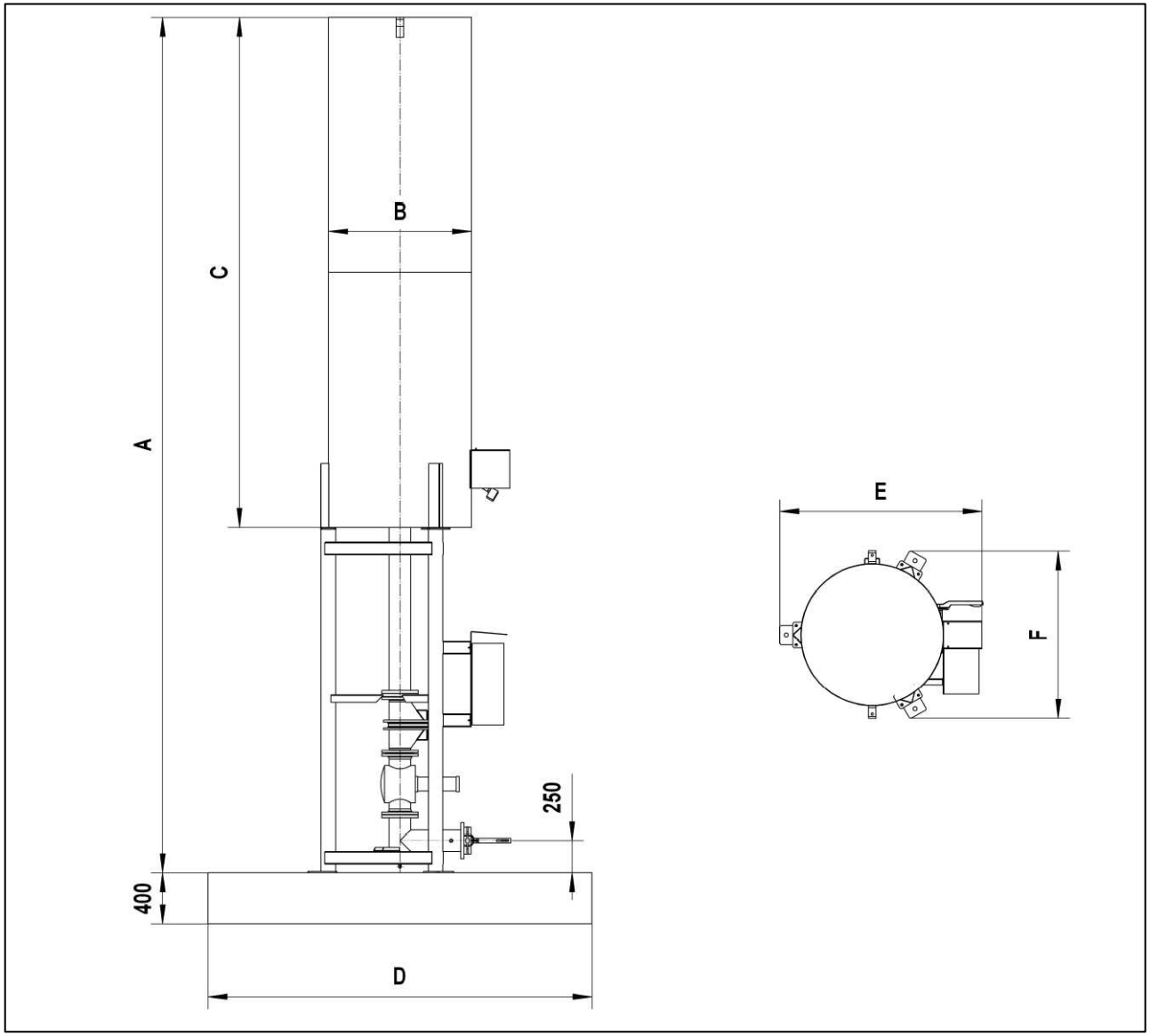

Figure 7: Example of a flare

HOF*GAS*®-	Gas flow rate (max.)	Burner capacity (max.)	Flange connection	Initial gas pressure at full load (min.)	Dimension A	Dimension B	Dimension C	Dimension D	Dimension E	Dimension F	Weight (approx.)
	Nm^3/h	kW	DN/PN	mbar	mm	mm	mm	mm	mm	mm	kg
IFL1c 60	60	450	50/16	25	6'200	Ø 640	3'500	□ 2'500	1'100	730	500
IFL1c 120	120	900	65/16	25	6'700	Ø 800	4'000	□ 3'000	1'170	1'000	500
IFL1c 180	180	1'350	80/16	25	6'700	Ø 800	4'000	□ 3'000	1'170	1'000	650
IFL1c 240	240	1'800	80/16	25	6'700	Ø 960	4'000	□ 3'000	1'330	1'160	850
IFL1c 360	360	2'700	100/16	25	7'200	Ø 1'120	4'500	□ 3'000	1'600	1'350	1'200
IFL1c 480	480	3'600	125/16	25	7'200	Ø 1'280	4'500	□ 4'000	1'730	1'480	1'400

Figure 8: Specification for standard units for a flare

2. MOTIVATION FOR THE PROPOSED PROJECT

The proposed project will use methane gas to generate electricity and produce chilled water for use by the mine. The chilled water will be produced by combusting methane in direct-fired absorption chillers and using the waste heat from the engines in absorption chillers to generate additional chilled water. The chilled water generated by absorption chillers will displace chilled water generated by electric chillers; thereby displacing electricity from the grid.

Methane occurs naturally underground at Beatrix Mine in geological faults. This methane is released when these geological faults are intersected. Methane is a significant safety risk for the mine as it has wide explosive limits in air and can lead to explosions. The Beatrix mine has safety measures in place for the responsible management of methane emissions. The methane is currently diluted with air to below its explosion limits and then vented into the atmosphere. The proposed project will utilise the underground mine methane thereby further promoting a safer working environment for the personnel at Beatrix. Methane from both the underground working areas and from the borehole will be destroyed either by flaring or by utilising it in power generation equipment or absorption chillers.

Promethium Carbon is in the process of registering the project as a carbon credit project to subsidise the cost associated with using the methane to generate electricity. The project reduces greenhouse gas emissions through:

The destruction of methane: The proposed project will destroy both the underground mine methane and the borehole methane. The destruction of this methane will result in the elimination of methane released directly into the atmosphere. Since methane has 21 times the global warming potential of carbon dioxide, the project will result in a significant reduction of greenhouse gas emissions from the mine.

The displacement of grid electricity: Methane will be extracted from underground and piped up the Shaft four to the surface. This methane will fuel internal combustion engines to produce electricity. The electricity will be used on the mine; reducing the amount of electricity that the Beatrix Mine needs to import from the national grid. The methane and the waste heat from the engines will be used to generate chilled water. This chilled water would otherwise have been generated using electricity in conventional electric chillers. Hence, the production of chilled water in this project will displace grid electricity.

The project will create jobs in both the construction and operations phase. The project will contribute to foreign reserve earnings for South Africa via the carbon credit sales revenue. The carbon credits obtained from the destruction of methane will be owned by Gold Fields. The revenue from the carbon credits will decrease the volatility of the normal earnings profile of the mine. The current earning profile of the mine changes with the fluctuating gold price and the cyclical changes associated with the South African currency.

3. PRE MINING ENVIRONMENT

The following information has been extracted for the approved EMPR for Beatrix Mine and has been provided for background purposes only in order to place the proposed project in context to the pre mining environment.

3.1 Geology

The geology of the area is dominated by sediments comprising sandstone and mudstone of the Beaufort Group (Pa), which forms part of the Karoo Sequence, and consists of an alternative of arenaceous and argillaceous sediments. These rocks were locally intruded by a cyclic event of mafic rich magmas and fluids approximately 190 – 150 Ma ago giving consequence to the associated intrusive dykes and sills in the vicinity. Detailed information regarding geology can be obtained from Section 2.1 of the main EMPR document for Beatrix Mine. This includes representative borehole logs and a section through the ore body as well as information regarding dykes, sills and faults that extend beyond the property boundary.

3.2 Climate

Beatrix Mine is situated in a semi-arid region with an annual rainfall of between 400 and 600mm. Local thunderstorms and showers are responsible for most of the precipitation during the summer from October to March and peaking in January. More than 79% of the mean Annual Precipitation occurs in the six-month period from October to March. Temperatures show large daily and seasonal variations. Mean temperatures reach a maximum in December / January and a minimum in June / July. The period during which frost can be expected lasts about 100 days from June to August.

The dominant wind direction is north easterly with average monthly wind speeds not exceeding 6 metres per second. The summer rainfall region of the Gold Fields is characterised by diurnal conventional heating, which often results in thunderstorms accompanied by lightning, heavy rain, strong winds and sometimes hail. The storms, which may occur on average 40 – 60 times per year, are highly localised and rainfall can vary markedly over short distances.

3.3 Topography

The area is flat with an overall slope away from the mine. Theronskop and Lion Hill are the only two noticeable features in the landscape. The topography rises from 1 400m in the north to 1 410m in the southern corner of the area. On a regional scale the topography of the are comprises a gently undulating, northwards sloping surface at an average elevation of 1 380 metre above mean sea level along the watershed between the Boschluis Spruit to the west of Beatrix 4 and the Theron Spruit in the east.

3.4 Soils

The soils derived from the sediments (Beaufort Group) that make up the majority of the parent material of this area are of a sandy loam nature. The Beaufort sediments returning reddish iron rich soils. In general, the deeper and better drained soils that are to be disturbed are light textured, sandy loams, implying that they can be worked at a wide range of moisture contents without structural damage, and are moderately easily rehabilitated. Detailed information regarding the description of identified soils and soil characteristics can be found in the main EMPR document.

3.5 Land Use

During the pre-mining period the land on which the mine is now situated was used for agricultural purpose and mainly for cultivation of crops and grazing purposes. See Plan E of the main EMPR document for pre-mining details at Beatrix. The agricultural production in this area consisted of maize crops in summer and wheat in winter, which was normally planted on a rotation basis. Sunflower crops are alternated with the maize crops on occasions. Apart from farmhouses and associated infrastructure, no other structures were present on the land prior to when mining operations commenced.

3.6 Natural vegetation/ plant life

The pre-mining conditions were generally that of farmlands where the natural vegetation has been removed and cultivated crops introduced .No detailed vegetation study was conducted. No Red Data Book (RDB) species are likely to occur in the area, and none were observed. The detail on the species that were identified from a survey undertaken to determine the presence of declared weeds and invader plants is appended in Appendix II of the main EMPR document for Beatrix mine.

3.7 Animal life

The wild life in the general area on and surrounding area has been severely impacted upon by the intensive agricultural development in the area. Neither of the above species identified on site are considered endangered or threatened and as such no special management or monitoring measures are proposed. According to the Red Data Book on mammals of South Africa, it is unlikely that any rare, endangered, vulnerable or indeterminate mammal species are likely to occur on site.

All bird species observed on site are common residents and are unlikely (mainly because of their mobility) to be affected by the proposed development. Given the degree of agriculture (particularly grazing) around the site, it is unlikely that any rare or endangered bird species will occur on the site.

3.8 Surface water

Refer to the EMPR for Beatrix Mine Plans F1 and F2 for the water courses, streams, rivers, dams and pans located in the vicinity of the mine. The 1:100 Floodline is also indicated. The upper part of the floodline at Beatrix has been inferred, as no such data was available.

3.8.1 Surface water quantity

Beatrix mine is located within the Vaal drainage region; the total catchment area of this region is 196 293km^2. The mine is situated in the headwaters of the Theron Spruit and Boschluis Spruit seasonal streams draining to the Doring River then into the Sand River. Locally Beatrix Mine is situated within the Doring River catchment. This catchment includes the Doring River and all its tributaries to the point of confluence with the Sand River. This is a vast area, which includes Star Diamonds, Oryx and Joel Mines. Approximately 100 km down stream from Bloudrif, the Sand River, now called the Vet River flows into the Bloemhof Dam.

Beatrix mine is located within the Theron Spruit and Boschluis Spruit sub-catchments of the Sand River catchment. A map of the catchment can be seen in EMPR plan A. Catchment areas are given in Table 2.18. The 1:100 year flood line is indicated in red on EMPR plans F1 and F2. The flood level was calculated by using the Weiss and Midgley backwater programme. (SRK 1988). The other area Beatrix uses to dispose of fissure water is the Wolvepan and Rietpan system. No well-defined water courses are near the Wolvepan complex and the system can be regarded as a closed circuit. All run-off water from St. Helena and the fissure water from Beatrix are contained in the system and no spillage has occurred to date.

3.8.2 Surface water quality

The water quality in the Theron and Boschluis Spruits is monitored weekly at the monitoring points S – S9 and S1 – S10 respectively. (See EMPR Plan F1 and F2) S is regarded as the background monitoring point at both mines. At Beatrix it is located upstream of the mine next to Star Diamonds and at 4# upstream of the mine towards Rex Diamonds. Sampling point S7 is the compliance monitoring point for Beatrix and S6 for 4#. The pH and electrical conductivity (EC) are measured and the flow estimated. Once a month a water sample is taken chemically analysed.

More detailed information regarding electrical conductivity and presence of ions can be obtained from the main EMPR document for Beatrix Mine.

3.8.3 Surface water use

The water courses in the area are very seasonal and long periods of very low to no flow is experienced along the most parts of the river reaches. The net result is that irrigation from the streams is just not feasible due to a lack of water. Therefore the water in the Theron, Boschluis Spruits and the Doorn River is used mainly by the natural environment and by farmers for stock watering purposes. The Water Management Plan of the Department of Water Affairs and Forestry (September 1997) also categorises the above mentioned water courses as category 6 water use area, specifically for livestock watering and the natural environment. The Sand/Vet irrigation scheme that obtains its water via channels from the Allemanskraal Dam affords farmers the opportunity to practice irrigation in the area. Backflows from these channels into the lower Vet River allows farmers to extract water from the river for irrigation purposes.

As there is no affected water course or receiving water body at Wolvepan/Rietpan no significant utilisation of surface water is being done. Farmers in the area are reliant on ground water for their water needs. During above average rainfall seasons the natural pans to the west of Wolvepan/Rietpan are used by farmers for stock watering. The water in the evaporation dam complex is also not being used at all

3.8.4 Water authority

Sedibeng Water supplies water to the Goldfields via their plants at Balkfontein next to the Vaal River and the Virginia Treatment Works, also receiving its water from Allemanskraal Dam.

3.9 Wetlands

Pre-mining plans show no evidence of wetlands. However, since mining started, certain areas have developed wetland characteristics due to the significant impoundment of water. The shallow, warm water of the evaporation dams is highly conducive for aquatic plant growth and over the years substantial plant growth has taken place in certain dams. Dominant species are Typha Capensis (bulrush or papkuil), Phragmites Australis (common reed or fluitjiesriet) and Schoenoplectus Tabernam Ontanum (Steekbiesie). Several species of water grass are also present.

The artificial wetlands at Beatrix Mine exhibit a medium biological diversity and are not unique nor declared wetlands. All the areas were created due to mining activities and will cease to exist when mining stops.

3.10 Ground water

Two main aquifers exist in the area.

- A shallow aquifer, which lies within the weathered and fractured zone of the Karoo sediments; and
- A deep aquifer, which has developed in the fractured and faulted Ventersdorp and Witwatersrand, rocks.

These two are discussed separately and in more detail in the main EMPR document. This includes Information regarding the depth of the water tables, the presence of water boreholes and springs and their estimated yields. .

Boreholes drilled in the Beaufort sediments generally yield ground water of a better quality compared to those boreholes in the Ecca sediments. (Pretorius, 1989). Beatrix is situated on the Beaufort sediments and Wolvepan/Rietpan on the Ecca sediments.

Extensive monitoring of ground water is done by Beatrix Mine according to the approved EMPR (Nov 2000). The chemical analysis of underground water is displayed in Appendix III of the EMPR document. Approximately 100 boreholes are monitored in the areas of responsibility. The details on these are depicted in Chapter 6 of the main EMPR document.

Most of the ground water in the area is used for domestic and stock watering purposes.

More detailed information regarding ground water can be obtained from the EMPR document for Beatrix Mine.

3.11 Air quality

No air quality survey was done prior to the commencement of mining operations. Aspects may contribute to potential air pollution include dust from the slimes dam and waste rock dumps and gas, for which the main sources of air pollution are stack emissions from the boilers (not a scheduled process), the metallurgical plant and diesel emissions from mechanically driven equipment. Methane gas has commonly been intersected in surface boreholes drilled in the area. Methane gas will be strongly associated with fissure water intersections.
The mine is monitoring fall out dust by using the Dustwatch multidirectional bucket monitoring system. The AEL application is currently being prepared and will be submitted early in 2013.

3.12 Noise

No noise survey was done prior to the commencement of mining operations. Pre-mining noise levels existed due to normal agricultural activities. Personal noise exposure levels are monitored on the mine area and where necessary, protective equipment is used. The following activities/areas are the main sources of noise: destroying of old explosives, hauling and transporting of ore, crushing, milling and tipping of ore in the metallurgical plant. No further extensions to mining operations are envisaged and the noise level should reduce to normal as the mine reduces production and finally closes completely. Mining operations has no effect on neighbouring farms, which are the only impact sites close to the mine.

3.13 Sites of archaeological or cultural interest

No known sites of archaeological or cultural interest exist on or near the mine property. There are no sensitive landscapes on mine property.

3.14 Visual aspects

Shaft head gear, waste rock dumps and slimes dams are visible from the national road (R30) running between Welkom and Theunissen. Dust from slimes dams is not noticeable due to the magnitude of the dust from farmlands during dust storms in the area and the majority of the slimes dams are still operational. Beatrix Mine forms part of the mining operations in the Gold Fields, with the result that these features are common in the region.

3.15 Regional socio-economic structure

3.15.1 Population density, growth and location

The Matjhabeng Local Municipality consists of numerous towns in the area, including Welkom, Thabong, Virginia and Meloding.Masilonyana Local Municipality consists of inter alia Theunissen and Masilo. Both these regions are developed areas with fairly high population densities. The region is home to approximately 800 000 people. Due to the rationalisation and closures on the gold mines in the area, the population growth rate of the area has declined in the past years. A detailed assessment for the existing population density for this amendment to the EMPR was considered unnecessary.

3.15.2 Major economic activities and sources of employment

The major economic activities for the region consist of the following; Farming, mining, light engineering works, construction and the normal retail trade associated with an area of similar population density. See Section 5.2.15 for a graph.

3.15.3 Unemployment estimate for the area

There was a very low unemployment rate prior to mining activities and during the build up period. Due to cut-backs and lack of growth on the surrounding mines, the level of unemployment in the Free State Gold Fields area has risen over the past number of years and is currently standing at an estimated 45%.

3.15.4 Housing demand and availability

No housing was available prior to mining and the mine established its own housing. The housing situation has altered in line with the decline in employment opportunities in the area in the past few years. For labourers the mine supplies hostel accommodation available well in excess of present utilisation. These Hostels are for single employees only. Only a few units are being utilised as married quarters. Currently the majority of the employees reside in Welkom and the Masilo and Meloding townships adjoining Theunissen and Virginia. These employees are transported to work by busses.

3.15.5 Social infrastructure

The mine is very well served by the social infrastructure of the surrounding towns, which includes the following: schools, hospitals, sporting and recreational facilities, shops, police force and civil administration.

3.15.6 Water supply

The water is supplied to the mine and surrounding towns by Sedibeng Water.

3.15.7 Power supply

The mine is supplied through power transmission lines. Eskom feeds these lines via the national distribution grid.

3.16 Site photographs

Figure 9: Shaft 1: Existing Facility at Beatrix

Figure 10: Existing Shaft 1: Generators, Flare & water cooling systems

Figure 11: Shaft Four

Figure 12: Area surrounding Shaft four

ENVIRONMENTAL IMPACTS OF THE PROPOSED PROJECT

Negative impacts are mostly limited to the construction phase. During the construction phase, the environmental impacts of installing the gas flaring system and co-generation facility include noise, generated from the transportation and installation activities, and dust generated from transportation activities. These impacts as well as minimization measures are detailed in section 5.1. Impacts expected during the operation phase and mitigation measures are detailed in section 5.2. The greater positive environmental impacts of the proposed project include an improved air quality, a safer working environment and economic benefits. These are elaborated on below.

4.1 Improved Air quality

On escaping to the atmosphere, methane is a major component of global greenhouse gas emissions second only to carbon dioxide in its effects. The proposed co-generation plant will reduce greenhouse gas emissions and improve the energy efficiency of the mine. Greenhouse gas emissions will be reduced. The first is the destruction of the methane and the second in the reduction of emissions related to the generation of Eskom power. Furthermore, the project will reduce the mine's reliance on Eskom power. Promethium Carbon (Pty) Ltd is in the process of registering the project as a carbon credit project to subsidise the cost associated with using the methane to generate electricity.

4.2 Safer working environment

Mine methane is a hazardous gas as it has wide explosion limits in air and has the potential to cause explosions if not efficiently and safely managed through safe mine ventilation systems underground. Methane gas is a recognised, significant safety risks for underground mine workings. Although methane awareness and safety is improving, it is still a deadly and justifiably feared hazard of the mining industry.

The problem is that methane is unavoidable and unlike coal mine methane, it is not a direct result of mining. In coal mines, the methane production is a function of the coal mined. In gold mines, the methane is in geological faults and when these faults are intersected, this methane is released. Hence, methane emits continuously from certain areas in the mine. The properties of methane make it as difficult to detect. It is colourless, odourless and non-toxic, so there are no obvious physical signs such as coughing or streaming eyes to warn of its proximity (it will cause suffocation if it builds up in a badly ventilated space). Once present in the atmosphere of the mine, methane can be easily ignited. Mine operators must ventilate or drain methane gas away from the face of the mine to keep levels well below the explosive range. It is a hazard to miners.

The extraction of the methane will result in a safer working environment for the personnel at Beatrix. Methane from both the underground working areas and from the boreholes will be destroyed either by flaring or by utilising it in power generation equipment or absorption chillers.

4.3 Economic benefits

By improving efficiency, the co-generation plant can reduce costs associated with providing chilled water and electricity to the mine. The project will create jobs in both the construction and operations phase. The project will contribute to foreign reserve earnings for South Africa via the carbon credit sales revenue. The carbon credits obtained from the destruction of methane will be owned by Gold Fields. The revenue from the carbon credits will decrease the volatility of the normal earnings profile of the mine. The current earning profile of the mine changes with the fluctuating gold price and the cyclical changes associated with the South African currency.

4. ENVIRONMENTAL MANAGEMENT PROGRAMME

5.1 Construction phase

5.1.1. Soil

Comment				
Beatrix Gold Mine will return the soil to the same condition it was in prior to the establishment of the electrical generation plant on site.				
Construction objectives				
• Minimise soil loss during the construction phase				
Management Standards				
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Environmental Management Act, 1998 (Act No. 107 of 1998) • Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) • Conservation of Agricultural Resources Act, 1983 (Act 43 No. of 1983)				
Activity	**Aspect**	**Impact**	**Management actions**	**Responsibility**
Concrete footing for containers	Covering of soil	Reduction of available soil due to covering.	Topsoil will be stripped and stockpiled	Environmental Co-ordinator
Disposal of waste	Seepage or spillage	Contamination of soil	Storm water diversion and seepage collection measures.	Outside Section Foreman
			Appropriate remedial measures will be instituted if necessary. If soil is contaminated, it will either be removed and disposed of as hazardous waste to the appropriate permitted landfill or remediated on site.	Environmental Co-ordinator

5.1.2 Land capability and land use

Comment
The proposed electrical generation facility is located within the existing mine. Land capability has been permanently changed by mining operations.

Construction objectives
• To minimise the alteration of land capability • To return the capability of the land to the same condition it was in prior to development

Management Standards
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Environmental Management Act, 1998 (Act No. 107 of1998) • Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) • Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)

Activity	Aspect	Impact	Management actions	Responsibility
Transfer of land	Infrastructure	Occupation of unused space	Disturbed areas to be rehabilitated to the same condition as prior to the installation	Environmental Co-ordinator

5.1.3 Vegetation and animal life

Comment
No endangered or threatened species are known to occur on the mine. No large animal species occur at the co-generation plant site, since it is a heavily developed and unvegetated “brownfields” site. the footprint of the the flare will be insignificant..

Construction objectives
• To minimise the disturbance of natural vegetation. • Return the disturbed areas to the same condition as they were prior to construction with respect to vegetation and habitat for animal life.

Management Standards				
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Environmental Management Act, 1998 (Act No. 107 of1998) • Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) • Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)				
Activity	**Aspect**	**Impact**	**Management actions**	**Responsibility**
Clearing of land for installation of infrastructure	Disturbance of natural vegetation cover	Dust and erosion	The site of the co-generation facility will be rehabilitated together with the rest of the site to the same end-use objectives as the rest of the main plant area.	Environmental Co-ordinator
Clearing of land for installation of infrastructure	Disturbance of natural vegetation cover	Invasion by invasive plants and declared weeds	Periodic inspections will be carried out to establish the occurrence of declared weeds and invader plants.	Environmental Co-ordinator
			Appropriate action will be taken to control and or remove invader plants and declared weeds. This will include chemical or mechanical control measures as appropriate to the type of species encountered.	

5.1.4 Surface water

All surface water at the co-generation plant will be routed into the mine's existing stormwater management system. The mine's dirty and clean water drainage systems are separated. The only activity at the co-generation plant that could cause significant impacts (storage of oil) will be properly bunded to prevent surface water pollution.

5.1.5 Storm water

Comment
The Beatrix mine's dirty and clean water drainage systems are separated.
Construction objectives
• To minimise the disturbance of natural vegetation. • Return the disturbed areas to the same condition as they were prior to construction with respect to vegetation and habitat for animal life.
Management Standards
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Environmental Management Act, 1998 (Act No. 107 of1998) • National Water Act 1998 (Act No. 36 of 1998). • Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) • Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)

Activity	Aspect	Impact	Management actions	Responsibility
Construction of co-generation plant and borehole flares	Polluted run-off during construction	Pollution of surface water and groundwater	Operate, inspect and maintain the storm water maintenance and/or remedial measures will be initiated if necessary and will be reported to the Surface Engineer/Environmental Co-ordinator.	Outside section foreman
			Vehicles used by contractors may not be services or washed at the construction sites. They may only be washed at designated washbays equipped with oil traps, as indicated by Beatrix Mine.	Outside section foreman
			Investigate non-compliance to water quality objectives and institute action plans.	Environmental Co-ordinator
			Water samples will be taken at any point where seepage or spillage may result in non-compliance.	Environmental Co-ordinator

5.1.6 Ground Water

Comment				
Beatrix Gold Mine will return the groundwater to the same condition it was in prior to the establishment of the co-generation plant on site				
Construction objectives				
• Prevent contamination of groundwater. • Conduct due diligence assessment of groundwater quality prior to construction to ensure that the soil is returned to the same condition at the end of the life cycle of the facility.				
Management Standards				
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • All permits issued in terms of the Water Act (Act No. 54 of 1956). • National Environmental Management Act, 1998 (Act No. 107 of1998) • National Water Act, 1998 (Act No. 36 of 1998)				
Activity	**Aspect**	**Impact**	**Management actions**	**Responsibility**
Water Management	Spillage or Seepage	Pollution of ground water or near ground water (perched water table)	Monitor the water quality and water levels of the boreholes.	Environmental Officer
			Any deterioration in the water quality will be discussed with the landowner. Appropriate remedial measures will be implemented	Environmental Co-ordinator

5.1.7 Air quality

Comment
Dust generated from the from transportation and installation activities during the construction phase
Construction objectives

• Dust emanating from construction activities should be minimized.				
Management Standards				
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Environmental Management Act, 1998 (Act No. 107 of1998) • Air Quality Act, 2004 (Act No. 39 of 2004) • Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) • Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)				
Activity	**Aspect**	**Impact**	**Management actions**	**Responsibility**
Construction activities	Transportation and installation	Generation of dust	Place suitable wearing course on the access roads to reduce dust levels. Regular dust suppression will be undertaken on site.	Occupational Environment

5.1.8 Noise

Noise pollution may increase as a result of the transportation and installation activities during the construction phase. A noise-monitoring program is in place on the Beatrix mine and will be maintained. Appropriate action will be taken if any area of concern is identified. Management actions include conducting routine equipment maintenance and using self protector appliances such as earmuffs or earplugs.

5.1.9 Sensitive landscapes

No sites of archaeological or cultural interests exist on the sites. The site of the co-generation facility is in an already impacted brownfields area. No management plan is needed for this aspect.

5.1.10 Visual aspects

The flare adjacent to the Main Shaft would be unlikely to cause a significant visual impact since it is in an existing built-up area. There are tall buildings all around the location of the flare and it is unlikely that the flare would be visible from adjacent properties around the mine. No flame will be visible from the flare as it is an enclosed flare.

5.2 Operational phase

5.2.1 Geology

There will be no impact on geological conditions, therefore there is no management plan.

5.2.2 Topography

Topography will not be changed by the installation of the co-generation plant or the borehole flares. Therefore no management plan is required.

5.2.3 Soil

Comment	
Beatrix Gold Mine will return the soil to the same condition it was in prior to the establishment of the co-generation plant on site.	
Operational objectives	**Closure objectives**
• Minimise soil loss during the construction phase	• Minimise soil loss during the decommissioning phase. • Reinstate soil to the same condition as it was prior to installation of the co-generation facility.
Management Standards	
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Environmental Management Act, 1998 (Act No. 107 of 1998) • Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) • Conservation of Agricultural Resources Act, 1983 (Act 43 No. of 1983)	

Activity	Aspect	Impact	Management actions	Responsibility
Storage of lubrication oil on site	Possible spillage of engine oil	Soil pollution	The oil storage container will be bunded with an impermeable concrete floor to contain any possible spillages. The capacity of the bunding will be 110% of the capacity of the oil container.	Environmental Co-ordinator
Concrete footing for containers	Covering of soil	Reduction of available soil due to covering.	Topsoil will be stripped and stockpiled	Environmental Co-ordinator
Disposal of waste	Seepage or spillage	Contamination of soil	Storm water diversion and seepage collection measures.	Outside Section Foreman
			Appropriate remedial measures will be instituted if necessary. If soil is contaminated, it will either be removed and disposed of as hazardous waste or remediated on site.	Environmental Co-ordinator

5.2.4 Land capability and land use

Comment	
The proposed electrical generation facility is located within the existing mine. Land capability has been permanently changed by mining operations. The boreholes are existing and have a negligible impact on land capability due to their small size. The installation of the flares at the boreholes will not significantly affect the size of their footprints.	
Operational objectives	**Closure objectives**
• To minimise the alteration of land capability	• To return the capability of the land to the same condition it was in prior to development.
Management Standards	

• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Environmental Management Act, 1998 (Act No. 107 of1998) • Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) • Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)				
Activity	**Aspect**	**Impact**	**Management actions**	**Responsibility**
Transfer of land	Infrastructure	Occupation of unused space	Investigate re-use of infrastructure upon decommissioning (depending on the needs of the mine or other end users)	Environmental Co-ordinator
			Disturbed areas to be rehabilitated to the same condition as prior to the installation	Environmental Co-ordinator

5.2.5 Vegetation and animal life

Comment	
No endangered or threatened species are known to occur on the mine. No large animal species occur at the electrical generation plant site, since it is a heavily developed and unvegetated “brownfields” site.	
Operational objectives	**Closure objectives**
• To minimise the disturbance of natural vegetation.	• Return the disturbed areas to the same condition as they were prior to development with respect to vegetation and habitat for animal life.

Management Standards				
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Environmental Management Act, 1998 (Act No. 107 of1998) • Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) • Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)				
Activity	**Aspect**	**Impact**	**Management actions**	**Responsibility**
Clearing of land for installation of infrastructure	Disturbance of natural vegetation cover	Dust and erosion	The site of the co-generation facility will be rehabilitated together with the rest of the site to the same end-use objectives as the rest of the main plant area.	Environmental Co-ordinator
Clearing of land for installation of infrastructure	Disturbance of natural vegetation cover	Invasion by invasive plants and declared weeds	Periodic inspections will be carried out to establish the occurrence of declared weeds and invader plants.	Environmental Co-ordinator
			Appropriate action will be taken to control and or remove invader plants and declared weeds. This will include chemical or mechanical control measures as appropriate to the type of species encountered.	

5.2.6 Surface water

The activities of Beatrix Mine directly impact on the surface water of the Theron Spruit, Boschluis Spruit and the Doring River. These are located a significant distance from the proposed site and are unlikely to be impacted upon by the proposed co-generation facility. No impacts will be caused by the borehole flares as there will be no hazardous chemicals in use at the flares. All surface water at the co-generation plant will be routed into the mine's existing stormwater management system. The mine's dirty and clean water drainage systems are separated. The only activity at the co-generation plant that could cause significant impacts (storage of oil) will be properly bunded to prevent surface water pollution.

5.2.7 Storm water

Comment				
The Beatrix mine's dirty and clean water drainage systems are separated.				
Construction objectives				
• To minimise the disturbance of natural vegetation. • Return the disturbed areas to the same condition as they were prior to construction with respect to vegetation and habitat for animal life.				
Management Standards				
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Environmental Management Act, 1998 (Act No. 107 of1998) • National Water Act 1998 (Act No. 36 of 1998). • Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) • Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)				
Activity	**Aspect**	**Impact**	**Management actions**	**Responsibility**
Management of storm water	Polluted run-off	Pollution of surface water and groundwater	Operate, inspect and maintain the storm water maintenance and/or remedial measures will be initiated if necessary and will be reported to the Surface Engineer/Environmental Co-ordinator.	Outside Section Foreman

			Vehicles used by contractors may not be services or washed at the construction sites. They may only be washed at designated washbays equipped with oil traps, as indicated by Beatrix Mine.	Outside Section Foreman
			Investigate non-compliance to water quality objectives and institute action plans.	Environmental Co-ordinator
			Water samples will be taken at any point where seepage or spillage may result in non-compliance.	Environmental Co-ordinator

5.2.8 Ground Water

Comment	
Beatrix Gold Mine will return the groundwater to the same condition it was in prior to the establishment of the co-generation plant on site	
Operational objectives	**Closure objectives**
• Prevent contamination of groundwater. • Conduct due diligence assessment of groundwater quality prior to construction to ensure that the soil is returned to the same condition at the end of the life cycle of the facility. • Continue with the ground water monitoring programme.	• Mitigates the residual impact of the pollution on the ground water to ensure sustainable use of the ground water.
Management Standards	
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Water Act 1998 (Act No. 36 of 1998). • All permits issued in terms of the Water Act (Act No. 54 of 1956). • National Environmental Management Act, 1998 (Act No. 107 of1998) • National Water Act, 1998 (Act No. 36 of 1998)	

Activity	Aspect	Impact	Management actions	Responsibility
Water Management	Spillage or Seepage	Pollution of ground water or near ground water (perched water table)	Monitor the water quality and water levels of the boreholes.	
			Any deterioration in the water quality will be discussed with the landowner. Appropriate remedial measures will be implemented	Environmental Co-ordinator

5.2.9 Air quality

Comment	
Some environmental impacts are expected to occur due to the emission of gases from flaring as a result of the combustion of the methane. Carbon Dioxide (CO_2) and water vapor (H_2O) are the primary gaseous emissions from the flaring. In addition there will be emission of oxides of nitrogen (NO_x) as a product of combustion. Emissions of Carbon Monoxide (CO), Hydrogen (H_2) and Methane (CH_4) may occur due to incomplete combustion during flaring. All emissions from the flares and engines chillers will be in line with European standards.	
Operational objectives	**Closure objectives**
• Eliminate health and nuisance problems associated with air quality • Minimise dust pollution from slimes dams	• Dust emanating from the closed mining area should not exceed back ground levels associated with the adjacent agricultural activities.
Management Standards	
• Constitution of the Republic of South Africa (Act No. 108 of 1996) Section 24. • National Environmental Management Act, 1998 (Act No. 107 of1998) • Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) • Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)	

Activity	Aspect	Impact	Management actions	Responsibility
Emissions from co-generation plant	Airborne pollutants	Air quality	Visual monitoring of dust during construction of the borehole flares and co-generation plant.	Environmental Co-ordinator
Emissions from borehole flares	Airborne pollutants	Air quality	Quantification of the impacts from the emissions of the flaring activities	Environmental Co-ordinator

5.2.10 Noise

Noise pollution may increase as a result of the co-generation plant. The engines will be housed in individual insulated containers and have exhaust silencers. Noise impacts are not expected to be significant as the site is already built up. No significant noise impacts, apart from occupational noise inside the engine containers, are expected. Appropriate noise warning signs will be in place at the entrance to the engine containers.

A noise-monitoring program is in place on the Beatrix mine and will be maintained. Appropriate action will be taken if any area of concern is identified. Management actions include conducting routine equipment maintenance and using self protector appliances such as earmuffs or earplugs.

5.2.11 Sensitive landscapes

No sites of archaeological or cultural interests exist on the sites. The site of the co-generation facility is in an already impacted brownfields area. No management plan is needed for this aspect.

5.2.12 Visual aspects

The flare adjacent to the Main Shaft would be unlikely to cause a significant visual impact since it is in an existing built-up area. There are tall buildings all around the location of the flare and it is unlikely that the flare would be visible from adjacent properties around the mine.

5.3 Interested and affected parties

The draft addendum to EMPR document was made available for public review for a period of 40 days for comment and formal stakeholder consultation meetings have been held as part of the EMPR consultative process.

5.4 Maintenance

Maintenance will be conducted as and when required. Maintenance will consist of the following tasks:

- A maintenance service place containing an equipment list and operating and maintenance tasks for all equipment, along with a service schedule. A list of important data to be tracked over time should be drawn up, including performance, fuel consumption (a measure of engine thermal efficiency), exhaust emissions, all temperatures and pressures, electrical and thermal parameters and chiller performance.
- Annual checks must be carried out on all major engine components following installation. Permanent maintenance records must be kept and all work should be tested to required regulations.
- Establishment of clear lines of communication, feedback and protocols regarding emergency service, after hours service and regular planned maintenance visits is required.

5.5 Decommissioning phase and closure

5.5.1 Closure Objectives

The containerised engines, electrical switchgear room and control room would be removed at the end of the project life cycle.

Concrete slabs on which the containers would be placed would also be removed upon decommissioning.

Ground water quality in boreholes in the affected areas should not deteriorate from the present quality.

Certain pollution control measures will be retained to ensure that surface water resources will be protected by the separation of clean and contaminated run off. After closure monitoring will determine when these structures can be removed.

All infrastructures suitable for an alternative use should be made available for that use.

A detailed closure and rehabilitation plan will be developed when the facility starts approaching the end of its life.