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OPERATIONAL ENVIRONMENTAL MANAGEMENT PROGRAMME

HARMONY MOAB KHOTSONG OPERATIONS

NW 30/5/1/2/2/15 & 16MR

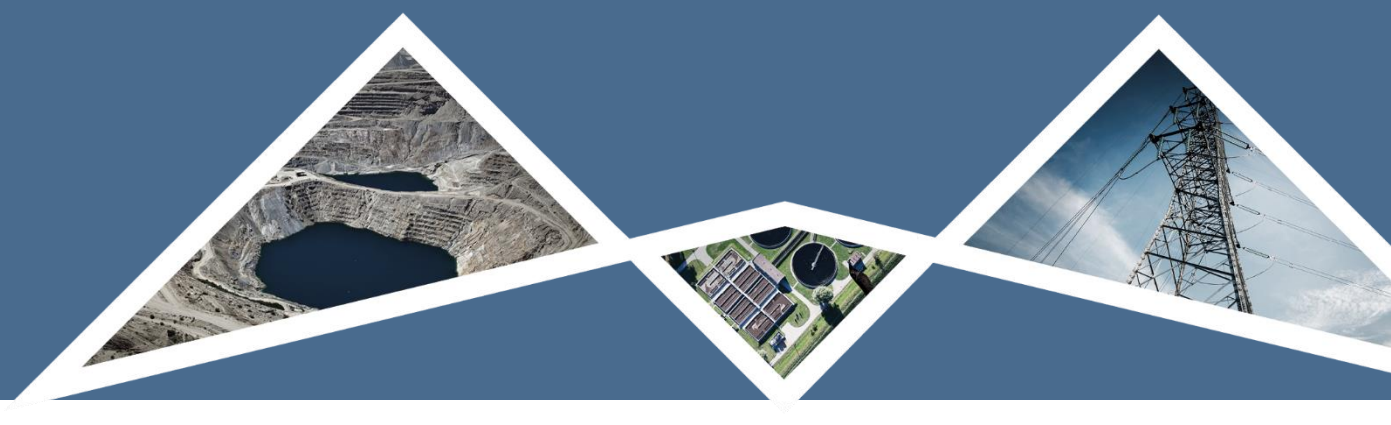

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Table of Contents

Contents

List of Figures

List of Tables

Appendices

Appendix 1 : Code of Practice for Mine Residue Deposits

Appendix 2 : Biodiversity Management Plan: AngloGold Ashanti – Vaal River Operations

Appendix 3: Moab Khotsong Alien Management Plan

Appendix 4: Dolomitic Risk Management Report

Appendix 5: Water Use License

Appendix 6: Air Emission License

Appendix 7: Harmony Guidelines for Tailings Management

Appendix 8: Emergency Preparedness and Response Plan

Appendix 9: Harmony Moab Baseline AQ Assessment

List of Abbreviations

Abbreviation	Item
AGA	Anglo Gold Ashanti
AMD	Acid Mine Drainage
ARD	Acid Mine Drainage
BMP	Biodiversity Management Plan
COP	Code of Practice
DMRE	Department of Mineral and Energy
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EMP	Environmental Management Programme
EMPr	Environmental Management Programme Report
IRWQO	Interim Resource Water Quality Objectives
MPRDA	Mineral and Petroleum Resources Development Act
MRS	Mine residue stockpiles
NEM:AQA	National Environmental Management Air Quality Act
NEM:BA	National Environmental Management: Biodiversity Act
NEM:WA	National Environmental Management: Waste Act
NEMA	National Environmental Management Act
NGO	Non-Governmental Organisation
NGP	Noligwa Gold Plant

Abbreviation	Item
NNRA	National Nuclear Regulator Act
NWA	National Water Act
OEMPr	Operational Environmental Management Programme Report
PES	Present Ecological State
PCD	Pollution Control Dam
Pr.Sci.Nat	Profession Scientist of Nature
READ	Department of Rural, Environment and Agricultural Development
RWD	Return Water Dam
RWQO	Resource Water Quality Objectives
SACNASP	South African Council for Natural Scientific Professions
SASS	South African Scoring System
SUP	South Uranium Plant
TSF	Tailings Storage Facility
VRO	Vaal River Operations
VR	Vaal Reef
WRD	Waste Rock Dump
WUL	Water Use Licence
WULA	Water Use Licence

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Harmony Gold Mining Company Limited (Harmony) is the Minerals Rights holder of all gold bearing minerals within the Moab Khotsong Mining Rights area. Harmony has acquired various assets previously held by Anglo Gold Ashanti Limited (Anglo). Amongst these assets was the existing Moab Khotsong Mine and the Great Noligwa Mine (including the gold processing plant, South Uranium Plant, and the Noligwa shaft).

The Vaal River Operations have been in operation since 1936. AGA updated and reviewed its approved Environmental Management Programme Report (EMPr) in terms of the Minerals Act (Act No. 50 of 1991) for its Vaal River Operations in line with the Regulations of the Mineral and Petroleum Resources Development Act, No. 28 of 2002 (MPRDA) in 2009. The EMPr update and review process involved the compilation of a Scoping, Environmental Impact Assessment (EIA) and Environmental Management Programme (EMP) Reports which were submitted for approval to the North West Department of Mineral Resources (DMRE). An EMPr was developed to mitigate and manage identified environmental impacts. The EMPr was approved by the DMRE on 14 February 2014. For the purposes of this report, that EMPr will be referred to as the 2009 AGA EMPr.

As part of concluding the acquisition, Harmony applied to the Department of Mineral Resources (DMR) to separate the abovementioned assets and transfer the mineral right to Harmony. An amended EMPR, which reflected the acquired assets was prepared in 2017 and accompanied the application (MPRDA Section 102 and Section 11). The MPRDA Section 11 and associated Section 102 was issued in February 2018. In May 2018 the DMR issued an addendum to the Environmental Authorisation (EA) reflecting the transfer to Harmony. SRK Consulting complied an EMPr in 2017 on which the update EMPr is based. For the purposes of this report, that EMPr will be referred to as the 2017 SRK EMPr. The purpose of the 2017 SRK EMPr was to separate out Harmony's proposed assets from AGA's Vaal River Operations into a separate EMPr. This EMPr contains updated environmental and social information and updated project information. The EA Amendment with reference numbers NW30/5/1/2/2/15 MR and NW305/1/2/2/16 MR dated 24 May 2018 serves as an addendum to the EA issued on the 14th of February 2014.

Harmony Gold Mining Company - Moab Khotsong Operations are located within the Fezile Dabi District Municipality, approximately 12 km north and 10 km south-east of Vierfontein and Klerksdorp, respectively, in the Free State Province. The land use in the area comprises primarily of mining and agriculture. Harmony Moab Operations are the main mining operation in the area. No environmentally sensitive areas have been identified.

The operations comprise of gold and uranium plants, a tailings storage complex, a waste rock dump, and two mine shafts as follows:

- Noligwa and Mispah Gold Plants;
- South Uranium Plant;
- Great Noligwa Shaft;
- Moab Shaft + Waste Rock Dump;
- Mispah and Kopanang Pay Dam Tailings Storage Facilities; and
- Moab Waste Disposal Site and residential villages.

Administration buildings, workshops and site roads also form part of Harmony Gold – Moab Khotsong Operations.

EIMS has now been appointed by Harmony Moab Khotsong Operations as the independent EAP to assist in preparing this updated operational EMPr for the Moab Khotsong operations. The purpose of this 2022 EMPr update is based on previous audit findings as well as Harmony's own action plan which identified various management measures and management outcomes that are to be amended and updated. Details of the exact amendment proposed are listed in the table below.

Refer to Figure 1 for a map of Harmony Moab Khotsong Operations in relation to surrounding land use within a 5km radius.

1.1.1 DESSCRIPTION OF THE PROPERTY

Table 1: Description of property

Farm Name:	Chrystalkop 69 portion 0 Doornkom-West 446 portion 0 Moab 279 portion 0 Zuiping 394 portions 1, 3, 4, 5 and 0 Nooitgedacht 434 portion 200 Vaalkop 439 portion 0 Witkop 438 portion 2 Modderfontein 440 portion 4 Vaalkop 439 portion 3, 4, 6, and 12 Mispah 274 portion 0 Hoekplaats 598 portion 0 Anglo 593 portion 0
Application area (ha)	Great Noligwa mine: 76 ha Moab Khotsong mine: 53 ha Noligwa Gold plant: 26 ha South Uranium plant: 27 ha Mispah 1 & 2 TSF: 306 ha Kopanang Paydam: 46 ha Great Noligwa Primary Healthcare Centre (Gateway): 25 ha Moab Khotsong Primary Healthcare Centre Vaal River Village: 120 ha Umuzimuhle Village: 102 ha SAMTS (Off-Mine Services) office: 3 ha Domestic waste disposal site: 10 ha 3 x Sewage Treatment Plants:: 2 ha Reservoirs: 2 ha
Magisterial district:	**Free State Province:** Fezile Dabi District Municipality Moqhaka Local Municipality

	<u>North West Province:</u> Southern District Municipality City of Matlosana Local Municipality
Distance and direction from nearest town	The Harmony Moab Khotsong Operations lie in close proximity to the following towns: • Orkney: 11km west • Klerksdorp: 19 km north-west • Stilfontein 16 km north
21 digit Surveyor General Code for each farm portion	F03600000000006900000 F03600000000044600000 F03600000000027900000 F03600000000039400001 F03600000000039400003 F03600000000039400004 F03600000000039400005 F03600000000039400000 F03600000000027400000 F03600000000059800000 F03600000000059300000 T0IP00000000043400200 T0IP00000000043900000 T0IP00000000043800002 T0IP00000000044000004 T0IP00000000043900003 T0IP00000000043900012 T0IP00000000043900004 T0IP00000000043900006

1.1.2 LISTED AND SPECIFIED ACTIVITIES

All the activities and associated surface infrastructure described in this EMP are already constructed and in use. All the infrastructure and activities have been approved in the 2009 AGA EMP, therefore no new listed activities are triggered.

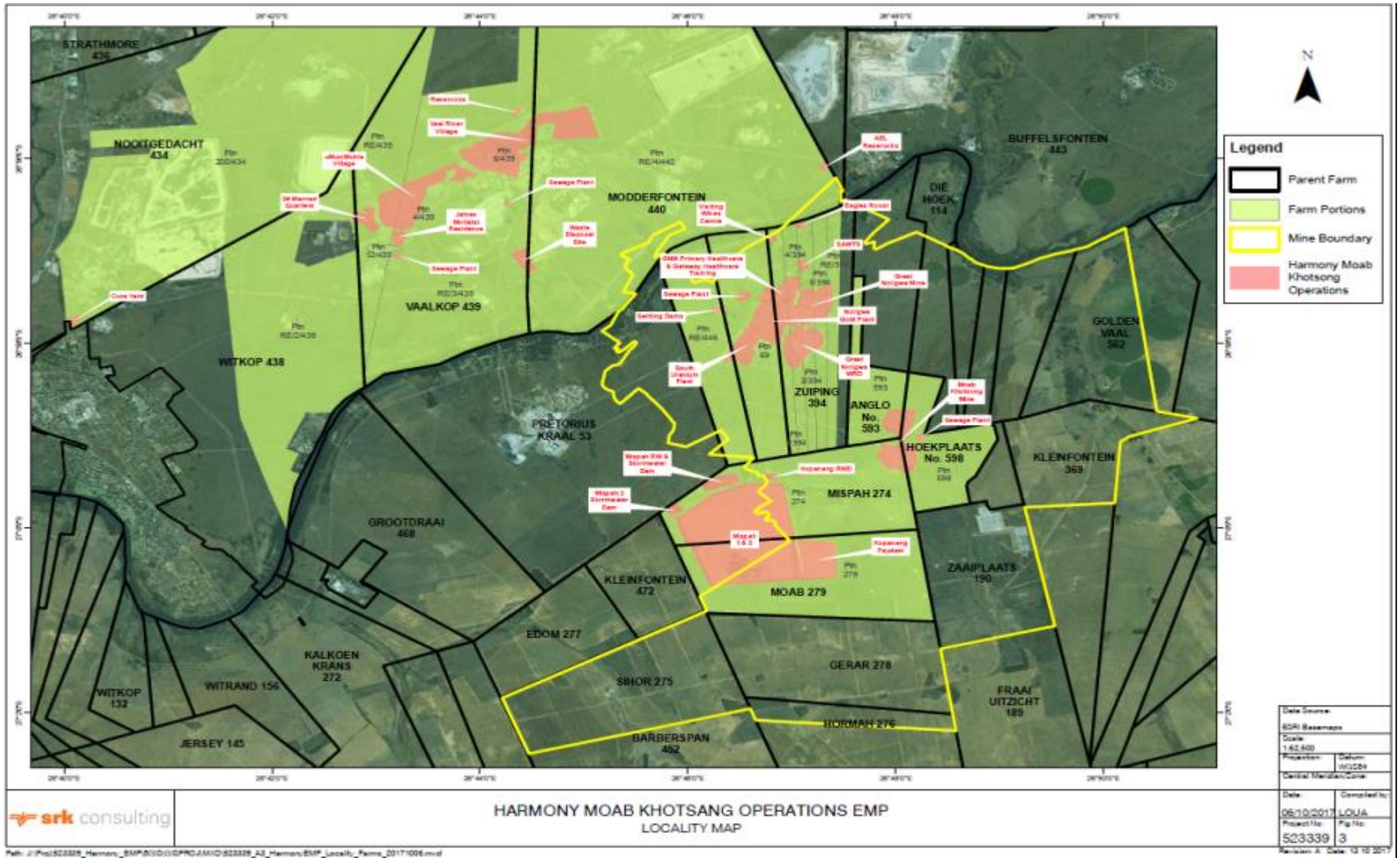

Figure 1: Harmony Moab Khotsong Operations in relation to surrounding land use within 5km radius.

1.2 DESCRIPTION OF ACTIVITIES UNDERTAKEN

1.2.1 MOAB KHOTSONG MINE

The Moab Project was approved in 1997 to exploit two distinct portions of the Moab Lease area, namely the Middle Mine (85 Level to 101 Level) and the Lower Mine (101 Level to 118 Level). During 2008, the SV4 section of Great Noligwa was incorporated into Moab Khotsong and this section is now termed the Top Mine. The orebody of interest in the Moab Khotsong lease area is the Vaal Reef (VR), the principal reef in the Klerksdorp goldfield. The VR has been extensively mined on the adjacent Kopanang and Great Noligwa mines.

Stratigraphically, it is located within the Johannesburg Subgroup of the Central Rand Group (Witwatersrand Supergroup). It is a thin (up to 4m thick), persistent stratigraphic unit that marks the base of the Strathmore Formation. Over much of the Klerksdorp mining area, the VR unconformable overlies the Mapaiskraal Member of the Stilfontein Formation (MB5). Towards the south of Kopanang and Great Noligwa, the VR oversteps onto the Mizpah Member.

The Mineral Resource at Moab Khotsong is structurally complex and highly faulted, with large fault-loss areas. Mining is based on a fill system combined with bracket pillars. The raise lines are spaced 200m apart on the dip of the reef, with 25m-long panels. Backfill is carried to within four metres of the advancing stope faces and 75% of the total area extracted is likely to be backfilled.

The geological setting of Moab Khotsong is one of crystal extension, bounded in the north-west and south-east by major south-dipping fault systems with north-dipping Zuiping faults sandwiched between them. The Die Hoek and Buffels East faults structurally bound the reef blocks of the 'Moab Upper Mine' to the north-west and south-east respectively. The northern boundary is a Zuiping-type fault. The southern boundary fault of the 'Moab Upper Mine' is currently not defined.

Due to the magnitude of throw across the Die Hoek fault, more than 700m down to the south, geological structures encountered on the up-thrown side of the fault cannot be projected to the down-thrown side and vice versa. No information pertaining to the reef blocks being accessed can be gleaned from the mapping of the access development. Only once the development is through the Die Hoek fault, does mapping thereof have any bearing on the reef blocks, and even then a great amount of exploration drilling is required to accurately delineate these blocks.

The C Reef is preserved in the northern part of the mine where the reef has been intersected by a number of boreholes. No development or stopping has taken place on the C Reef at Moab Khotsong.

Project Zaaiplaats is situated at Moab Khotsong Mine in the Free State Province of the Moab Khotsong Operations. Zaaiplaats is an underground mining project that consists of 2 phases. Phase 1 is the deepening of the shaft (underground only). Phase 1 will last till 2028. Phase 2 will extend the life of mine of the Moab Khotsong Operations to 2044. Initially trackless mining methods will be used, which will later be converted to Battery Equipped Vehicles due to the air density at the depth of planned underground mining activities. Current surface infrastructure will be utilized e.g. capital yard or laydown areas; thus no new surface infrastructure is planned.

The orebody is accessed via twin double-declines angled at 8º, the upper and lower declines, from which five production levels will originate. These will allow two attacking points into the orebody, as well as providing sufficient ventilation capacity. One of the lower declines will be a dedicated ore-handling system via a conveyor belt; each of the decline sets will have dedicated men (using chairlifts and a monorail) and material decline; the remaining upper decline will carry the majority of the services into the orebody. Shaft bottom will be 4,027m below datum (3,509m below collar).

Brownfields exploration is currently focused on improving geological confidence in the Vaal River area. Figure 2 indicate the main working areas and facilities within Moab Khotsong and Figure 3 indicates the area of responsibility.

Table 2: Main working areas and facilities of Moab Khotsong Mine

Activity	Description
Underground Mining	The underground mining comprises of the following activities: • Development which involves driving openings to ore bodies to facilitate access and transport of materials to and from the body, so that the ore body can be exploited; • Stopping which involves excavating rock by means of horizontal, vertical and inclined workings in veins or large irregular bodies of ore. The ore body is excavated by controlled blasting with explosives; and • Equipping involves preparing the development ends and stopping areas with the infrastructure required to start mining (e.g. water pipes, compressed air pipes, rails, drains). Personnel, materials and ore are transported to and from the working areas by various means including an electrically powered rail transport network, chair-lifts and conveyors. • Zaaiplaats underground mining consists of 2 phases. Phase 1 – is the deepening of the shaft (underground only). This phase will last till 2028. Phase 2 will then commence and will extend the life of mine of the Moab Khotsong Operations to 2044. Initially trackless mining methods will be used, which will later be converted to Battery Equipped Vehicles due to the air density at the depth of planned underground mining activities. Current surface infrastructure will be utilized e.g. capital yard or laydown areas; thus no new surface infrastructure is planned.
Winder House and Head Gear	The winder house is used to control and drive vertical transport network to and from underground workings. Head gear is a concrete and steel structure directly above each shaft that carries the sheave and pulley for the hoisting rope.
Surface Bank	This is the area around the shaft where loaded material cars/hoppers are temporarily stored prior to being sent underground.
Offices	The office complex is used for administrative duties by the management as well as contractors. The complex includes mobile offices, asset protection offices, the communication hall and time and attendance centre.

Activity	Description
Training Centres	This facility is used for training purposes. It is used for various courses provided by the mine for employees including the mandatory employees' induction.
Parking Areas	These are dedicated tarred/ concreted areas where cars and motorcycles are parked.
Canteen and Lapa (recreational area)	These are area where food and drinks are stored and prepared for sale to mine employees, contractors and visitors. The Lapa area is used for mine functions and meetings.
Change Houses	The change house includes change rooms, with lockers, where staff and contractors can change into working clothes; showering facilities; toilet facilities; laundry facilities, where working clothes are washed and dried and boot washing facilities.
Lamp Room/PPE Store	The lamp-room is a facility provided for the storage of underground lamps, self-rescuers and other electronic monitoring equipment. Lamps and other electronic equipment are stored there when not being used underground. During storage, the batteries that supply power to the equipment get charged. The PPE store is an area where the mine employees are issued with PPE.
Fire Response Area	This facility serves as a central office and storage facility for the fire management and emergency response equipment.
Emergency Generator	The emergency generator provides power for essential services (such as the Maryanne cage) on the shaft in the event of power failure.
Fueling Station/Diesel Tank	The fuelingstation/diesel tank provide diesel for surface and underground diesel powered machinery.
Silo	These serve for temporary storage of mined ore body once it has been hoisted up surface. There are separate silos for the ore bearing and the non-ore bearing rock.
Workshops - Mechanical, Electrical, Boiler Maker, Battery, Rock Drill	There are a number of workshop facilities both above and below ground which are used for the maintenance of underground and surface equipment.
Liquid Explosive and Hydrocarbon Stores	This is an enclosed area where liquid explosive material and hydrocarbons are stored prior use. These storage areas are designed and managed in accordance with the Material Safety Data Sheet (MSDS) for each type of material or solution.
Decontamination Yard and Wash Bay	This facility is provided for the separation of waste material received from underground activities. Waste is

Activity	Description
	separated into mantles provided for that particular waste. Some materials are recycled and the rest is disposed of. There is also a facility for washing of contaminated materials to ensure decontamination prior to disposal.
Refrigeration Plant	The refrigeration plant is used to cool water for use in the bulk air cooling towers and for underground use.
Waste Rock Dump (WRD)	Waste rock from mining operations is transported via conveyor belts and disposed at the waste rock dump. The Moab rock dump is situated on Zuiping 349, portions 3, 4 and 5. Its estimated gold value is 0.8g/t, and 70% of the dump has been reclaimed.

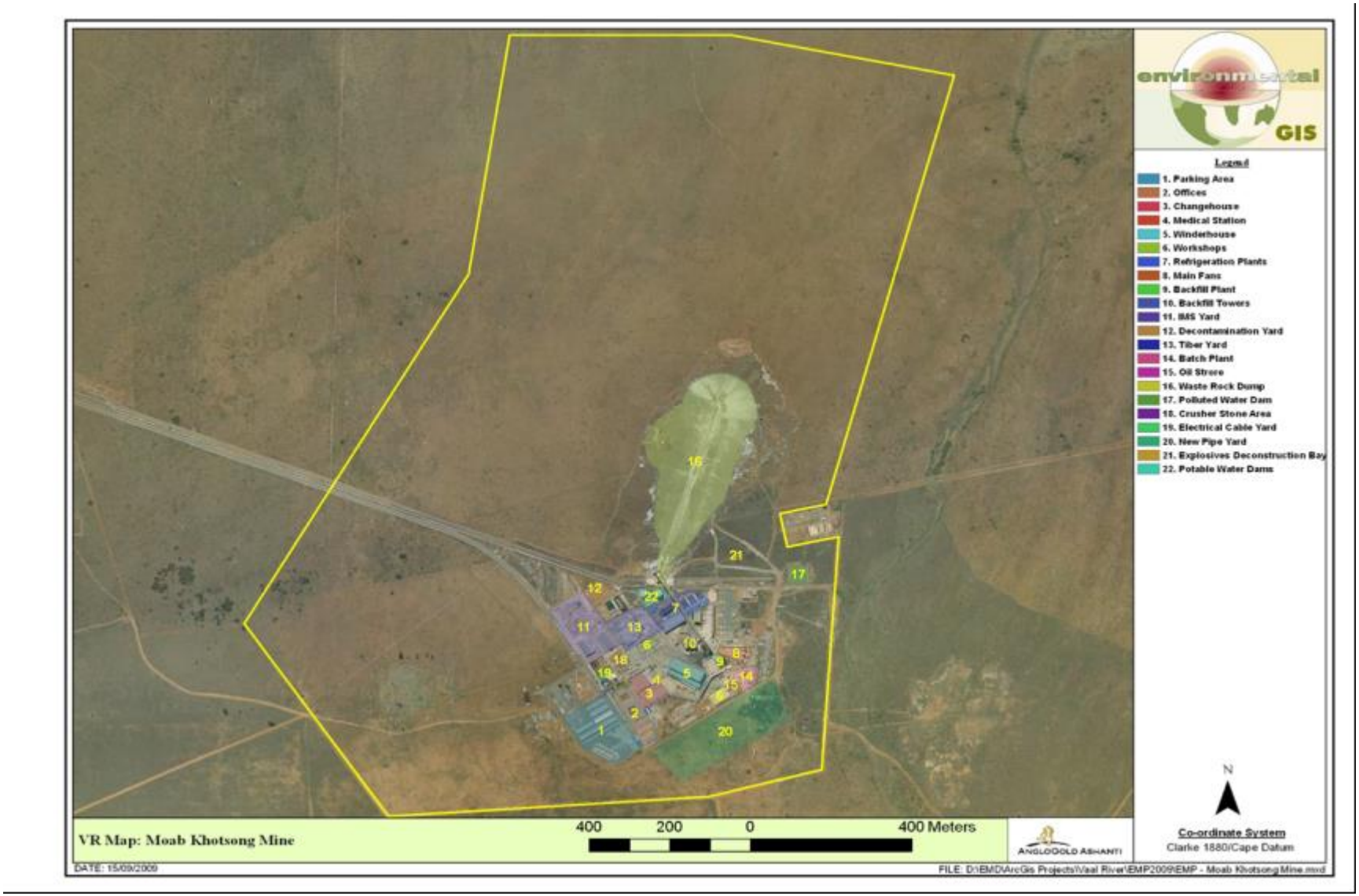

Figure 2: Moab Khotsong mine area responsibility

1.2.2 GREAT NOLIGWA MINE

Great Noligwa is located about 15km south-east of the town of Orkney, in the southern part of the Klerksdorp goldfield. The mine exploits the VR at depths varying between 1,500m and 2,600m below surface. Scattered mining methods are employed where access to the reef is from the footwall haulage and return airway development, with cross-cuts developed every 180m to the reef horizon. Raises are then developed on-reef to the level above, and the reef is stoped out on-strike. The Great Noligwa lease area is constrained to the north by Pamodzi Gold Mine, to the east by Buffelsfontein Gold Mine, to the south by the Jersey and Die Hoek faults, which displace the reef down by approximately 1,000m and 900m respectively, and to the west by Kopanang Mine.

The VR is the principal economic horizon at Great Noligwa, accounting for over 90% of the gold produced at the mine. The VR is part of the Witwatersrand Supergroup and is stratigraphically located near the middle of the Central Rand Group in the Johannesburg Subgroup on an unconformity below the Krugersdorp Formation. The VR unit can reach a maximum thickness of more than two (2) metres and consists of a thin basal conglomerate (the C Facies) and a thicker sequence of upper conglomerates (the A Facies), separated by internal quartzite (the B Facies). Across most of the Great Noligwa lease area, the A Facies is the principal economic horizon within the VR, although sporadic remnants of C Facies may be preserved below the A Facies. The high gold values in the VR are often associated with high uranium values. Uranium is a very important by-product of Great Noligwa.

The C Reef has been mined on a limited scale in the central part of Great Noligwa, where a high-grade, north-south orientated channel containing two economic horizons has been exposed. To the east and west of this channel the C Reef is poorly developed with relatively small areas of economic interest. High uranium values in the C Reef are also often associated with high gold values. To the north, the C Reef sub-crops against the Gold Estates Conglomerates and in the extreme south of the mine the C Reef has been eliminated by a deeply eroded Kimberley Channel and the Jersey fault.

Figure 3 below shows the underground cross section for the Great Noligwa mine. Ore Reception

Reef and Waste are hoisted at Great Noligwa Mine using two 23.5-ton ore skips. The reef is tipped into two silos with a capacity of 4500 tons each. The reef is drawn from the ROM Silos via Brute Force Vibrators onto the ROM mill feed conveyors. Great Noligwa Mine hoists around 200 000 ton reef a month. Reef can also be received from Moab Khotsong shaft via a rail transport system. There are normally seven 55 ton hoppers per locomotive that tip into the Rail Bin with a capacity of 500 tons. C1 conveyor then transfers the rock to the ROM Silos. Rock dump waste is also delivered to Noligwa Gold Plant via road (trucks) and/or the rail transport system. The ore received from underground varies in size from rocks of 500mm to particles smaller than 1mm.

Milling

Two conveyors withdraw ore from the base of the ROM Silos and feed the two 6.71m diameter $\times$ 10.06m long, trunnion supported ROM mills. The mills operate in closed circuit with a two-stage cyclone circuit. The solids are diluted to an RD of 1.1kg/l during the milling process. The main water source is the return water from the thickener section that circulates between the mills and thickeners. The milled product is extremely fine with 80% passing 75μm and less than 3% larger than 150 μm. The milled product is pumped to the Thickener section where it passes over two linear screens (to remove wood-chips) before gravitating to the thickeners.

Thickeners

The milling product, with 85% to 90% moisture content, is pumped to the two Woodchip linear screens to remove woodchips. The underflow of the screens gravitates to the Thickeners where solid-liquid separation takes place. Once separated, the water is returned to the Milling Plant to be used in the grinding process, and the thickened slurry is pumped to the Uranium Plant for uranium extraction.

The Thickener Plant has six 45m diameter Thickeners. A slow-moving rake mechanism moves the settled slurry to the centre of the conical base from where it is pumped to the Uranium Plant. Around the top of the Thickener, an overflow launder collects and removes the overflow water. Flocculent is added to the slurry to aid in the settling of the solid particles.

Neutralizing

Once the Uranium has been extracted from the pulp, it is returned to the Gold Plant. This pulp has an acidic pH of 1.5 to 2.5. If Cyanide is added to slurry with a pH below 9.3, HCN gas formation will occur. This gas is known to be extremely toxic, thus resulting in a serious health and safety issue. To overcome this pH problem, slaked lime (Ca(OH)2) is added. The pH is increased in three stages from 1.5 to 7.5 in the first tank, 7.5 to 9.5 in the second tank and 9.5 to 10.5 in the third tank. Auto pH control is used to control the amount of lime added to effect Neutralization. The liquid Sodium Cyanide is added to the pulp in the overflow launder of the fourth Neutralizing pachuca. Oxygen is injected at No.2 Neutralizing tanks via a circulation system. This is done to oxidize cyanide (mainly Ferrous) to reduce cyanide consumption. From here the slurry overflows into a tank from where it is pumped to the Safety Screening Plant.

Safety Screening

The Safety Screening Plant is an intermediate screening plant between the neutralizing and the leach section. Two 12m2 Delkor Linear Screens and one Vibrator Screen are used to remove any woodchips and fibre that was not removed by the woodchip screens in the thickener section. The efficiency of the Kambalda Screens in the CIP and the Elution Column Strainers are severely hampered any woodchips and fibre.

Leaching

From the safety screens, the slurry is pumped to six flat bottomed mechanically agitated leach tanks. The cyanide concentration in the first tank is controlled by an on-line Cyanide analyser (TAC 2000) by controlling the cyanide addition in the Neutralizing section. Liquid oxygen is injected via a circulation system into the first flat bottomed tank to increase the rate of leaching over the initial leaching stage. Oxygen is also injected at No.3 and No.5 flat-bottomed leach tanks via lances. From here the slurry is pumped to 16 air-agitated pachuca tanks to extend the leach process. The overall leach residence time is approximately 30 hrs. The leach tail is pumped to the CIP circuit.

Adsorption (CIP)

The Carbon in Pulp (CIP) section consists of 8 flat-bottomed Adsorption vessels containing Activated Carbon Granules onto which the dissolved Gold adsorbs. The slurry gravitates down the circuit from No.1 to No.8 tank. The carbon is pumped counter-current from No.8 to No.1 tank to increase the Gold adsorbed from the pulp. The carbon from No.1 CIP tank is pumped onto a vibrator screen to screen out the slurry before the Elution process. Regenerated carbon is pumped from the Elution circuit back to No.8 CIP tank. To prevent the carbon from moving down-stream with the slurry, Kambalda screens are installed in the tanks. The CIP Residue gravitates from the last CIP tank on to two 12m2 Linear screens to recover fine carbon from the circuit. The overflow of the screens drops onto a vibrator screen where the overflow is bagged and the underflow is pumped to a drying tank. The underflow of the linear screens (Residue slurry) is pumped to the backfill and flotation plant to produce backfill and recover pyrite.

Elution and Carbon circuit

The loaded carbon from No.1 CIP tank is dropped into two Elution Columns. A hot Caustic solution (called Eluant) is passed through the column to strip the gold from the carbon. This pregnant solution is now known as Eluate and passes through electro-winning cells where the gold is electroplated onto stainless steel cathodes. A Zadra Elution Process is used where the Caustic solution passes continuously through the column and the electro-winning cells. The barren eluant from the electrowinning cells is pumped back to the eluant tank from where it is re-circulated through the elution column. This process continues for the entire duration of the elution sequence, which is normally around 18 hours.

Strainers on the elution column prevent the carbon from leaving the elution column. After each sequence, the caustic solution is forced out of the Elution Column using compressed air. The carbon is flushed with fresh water for 30 minutes after which it is transferred to either one of the two Eluted Carbon Tanks. This Carbon is dewatered using vibrator screens and fed into two Electrically Heated Rotating Kilns where the Volatiles are driven off and the Carbon reactivated by bringing the Carbon temperature up to 600°C. The Carbon then discharges from the Kilns into Quench Tanks, which cools the Carbon down. The thermal shock of the Carbon

entering the Quench Tanks assists with the removal of Calcium precipitated on the surface of the Carbon. The Carbon is then pumped to the Acid Treatment Section, where it first passes over a Vibrating Screen for dewatering and the removal of Fine Carbon (-0.8mm). The Carbon then discharges into a vessel containing 10% to 12% Hydrochloric Acid (HCl). After Acid Treating the Carbon is pumped back into the last Adsorption vessel to renew the sequence. Approximately 10 tons of Virgin Carbon is added to the circuit every month to make up for Carbon losses.

Recovery Section

The Electrowinning Section contains twelve Mintek type cells. Each cell has six Cathodes and seven Anodes. The Cathodes consists of stainless steel wire mesh packed in a stainless-steel frame. The Anodes consist of a framework of Stainless Steel Flat Bars. Six Rectifiers are used to control the current at 600 amps and the voltage at 12 Volts.

The Eluate from the Elution column passes through a Flash Tank and then a Distribution Manifold providing equal flow to each of the twelve cells. The dissolved Gold in the Eluate is electrowon onto the cathodes. The spent electrolyte then flows through to the Eluant Tank to be re-circulated to the Elution Column.

The Gold sludge plated onto the Cathodes is washed off using high pressure water. The Gold sludge accumulates in a Water Decanting Vessel and the underflow is drained into Steel Pans for Calcining. The pans are then placed in the Calcine Furnaces at 600°C overnight to dry and to oxidize any impurities remaining in the Gold sludge. The Gold material is then mixed with a Flux consisting of Silica, Borax and Manganese and charged into the Arc Furnace. To start the smelt, graphite particles are laid between the three Graphite Electrodes. A current is applied and the Arc starts the smelting process. The smelt temperature is approximately 1300°C (The melting point of Gold is 1060°C) and the time is around 1.5 hours.

Backfill

The CIP Residue is pumped from the CIP residue tank to two Feed Tanks in the Backfill section that feeds the primary cluster cyclone feed-boxes. Here the density of the slurry is kept at 1.2 kg/l and pumped through two cluster cyclones for upgrading purposes. The underflow of the cyclones is pumped to the Feed to Float tank and this product goes to the flotation plant. The overflow of these cyclones is fed to the three backfill thickeners, where the RD is increased to about 1.5 kg/l. Flocculent is added here. The underflow of the backfill thickeners is pumped to the two Reject tanks, and the thickener overflow is pumped to the water thickener. The overflow of the water thickener is used as process water.

Slurry is received from the neutralizing tanks in the flotation plant and is pumped through the secondary-cluster-cyclones. The overflow goes via a launder to the distribution box for the three backfill thickeners, and the underflow flows into one of the three product tanks. When the tank reaches 80% full, the permeability, RD and grading are tested to see if the backfill product is up to standard. The permeability should be greater than 180mm/hr; RD 1.7kg/l and the grading should be 7 - 9% -10µm. If one of the parameters is not met, the whole batch is rejected and is pumped to the reject tanks. From the reject tanks, the slurry is pumped to two slimes residue tanks and then pumped to the Mispah Tailings Storage Facilities.

Table 3: Main working areas, facilities and activities of Great Noligwa Mine

Activity	Description
Underground Mining	The underground mining comprises of three major activities: • Development which involves driving openings to ore bodies to facilitate access and transport of materials to and from the body, so that the ore body can be exploited; • Stoping which involves excavating rock by means of horizontal, vertical and inclined workings in veins or large irregular bodies of ore.

Activity	Description
	The ore body is excavated by controlled blasting with explosives; and • Equipping involves preparing the development ends and stoping areas with the infrastructure required to start mining (e.g. water pipes, compressed air pipes, rails, drains). Personnel, materials and ore are transported to and from the working areas by various means including an electrically-powered rail transport network, chair-lifts and conveyors.
Winder House and Head Gear	The winder house is used to control and drive vertical transport network to and from underground workings. Head gear is a concrete and steel structure directly above each shaft which carries the sheave and pulley for the hoisting rope.
Surface Bank	This is the area around the shaft where loaded material cars/hoppers are temporarily stored prior to being sent underground.
Offices (8 Offices and Control Room)	The office complex is used for administrative duties by the management as well as contractors. The complex includes mobile offices, asset protection offices, the communication hall and time and attendance centre.
Training Centres	This facility is used for training purposes. It is used for various courses provided by the mine for employees including the mandatory employees' induction.
Parking Areas	These are dedicated tarred/ concreted areas where cars and motorcycles are parked.
Lapa (recreational area)	The Lapa area is used for mine functions and meetings.
Change Houses	The change house includes change rooms, with lockers, where staff and contractors can change into working clothes; showering facilities; toilet facilities; laundry facilities, where working clothes are washed and dried and boot washing facilities.
Lamp Room	The lamp-room is a facility provided for the storage of underground lamps, self-rescuers and other electronic monitoring equipment. Lamps and other electronic equipment are stored there when not being used underground. During storage the batteries which supply power to the equipment get charged. This facility is also used for issuing and storage of PPE material.
Fire Response Area	This facility serves as a central office and storage facility for the fire management and emergency response equipment.

Activity	Description
Emergency Generator	The emergency generator provides power for essential services (such as the Maryanne cage) on the shaft in the event of power failure.
Fueling Station/Diesel Tank	The fueling station/diesel tank provide diesel for surface and underground diesel powered machinery.
Mine Garage	This facility is being used as storage area for redundant mine equipment.
Silo	These serve for temporary storage of mined ore body once it has been hoisted up surface. There are separate silos for the ore bearing and the non-ore bearing rock.
Workshops - Mechanical, Electrical, Boiler Maker, Battery, Rock Drill	There are a number of workshop facilities both above and below ground which are used for the maintenance of underground and surface equipment.
Liquid Explosive and Hydrocarbon Stores	This is an enclosed area where liquid explosive material and hydrocarbons are stored prior use. These storage areas are designed and managed in accordance with the Material Safety Data Sheet (MSDS) for each type of material or solution.
Salvage Yard and Contamination Wash Bay	This facility is provided for the separation of waste material received from underground activities. Waste is separated into mantles provided for that particular waste. Some materials are recycled and the rest is disposed of. There is also a facility for washing of contaminated materials to ensure decontamination prior to disposal.
Refrigeration Plant	The refrigeration plant is used to cool water for use in the bulk air cooling towers and for underground use.
Waste Rock Dump	Waste rock from mining operations is transported via conveyor belts and disposed at the waste rock dump. The Moab Khotsong (11#) Waste rock dump is situated on: De Hoek 114, Portion 1 and Remaining extent; Zaaiplaats 190, Portion1 and Mispah 274. The dump is operating at present. Currently, the mine places 40 000t of waste per month onto the dump.

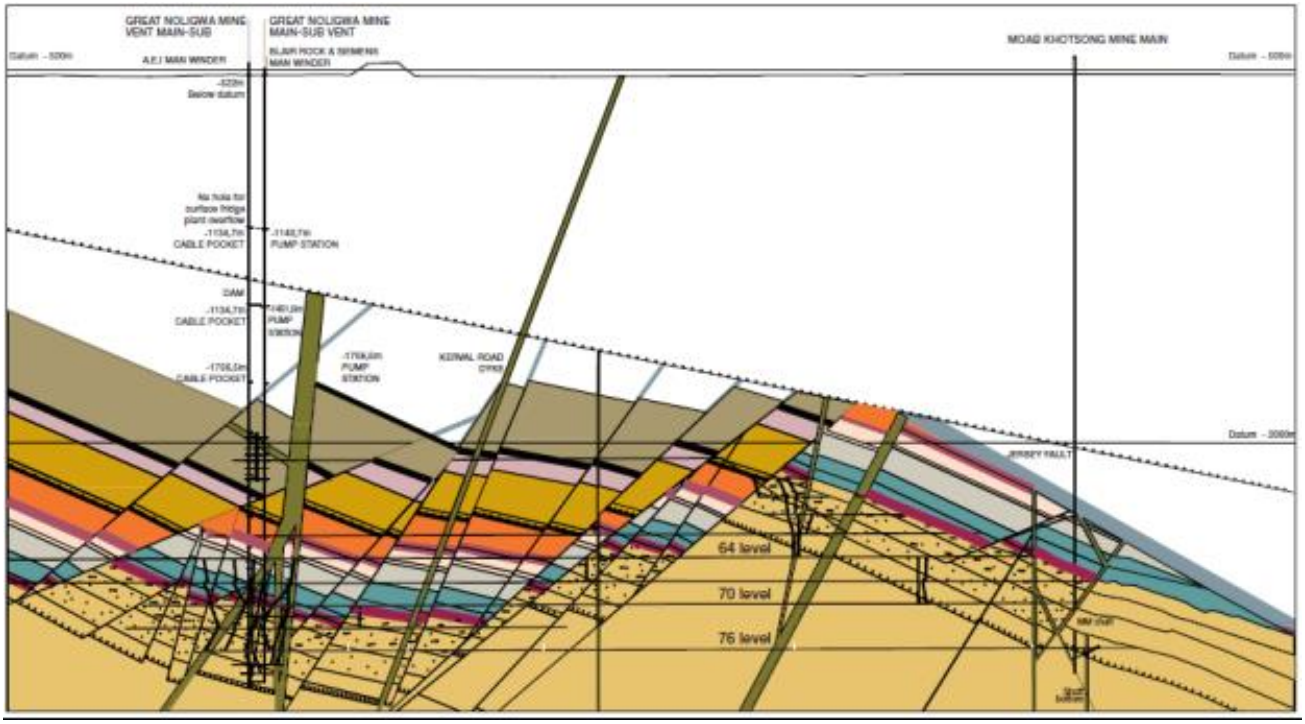

Figure 3: Great Noligwa Mine - underground cross section

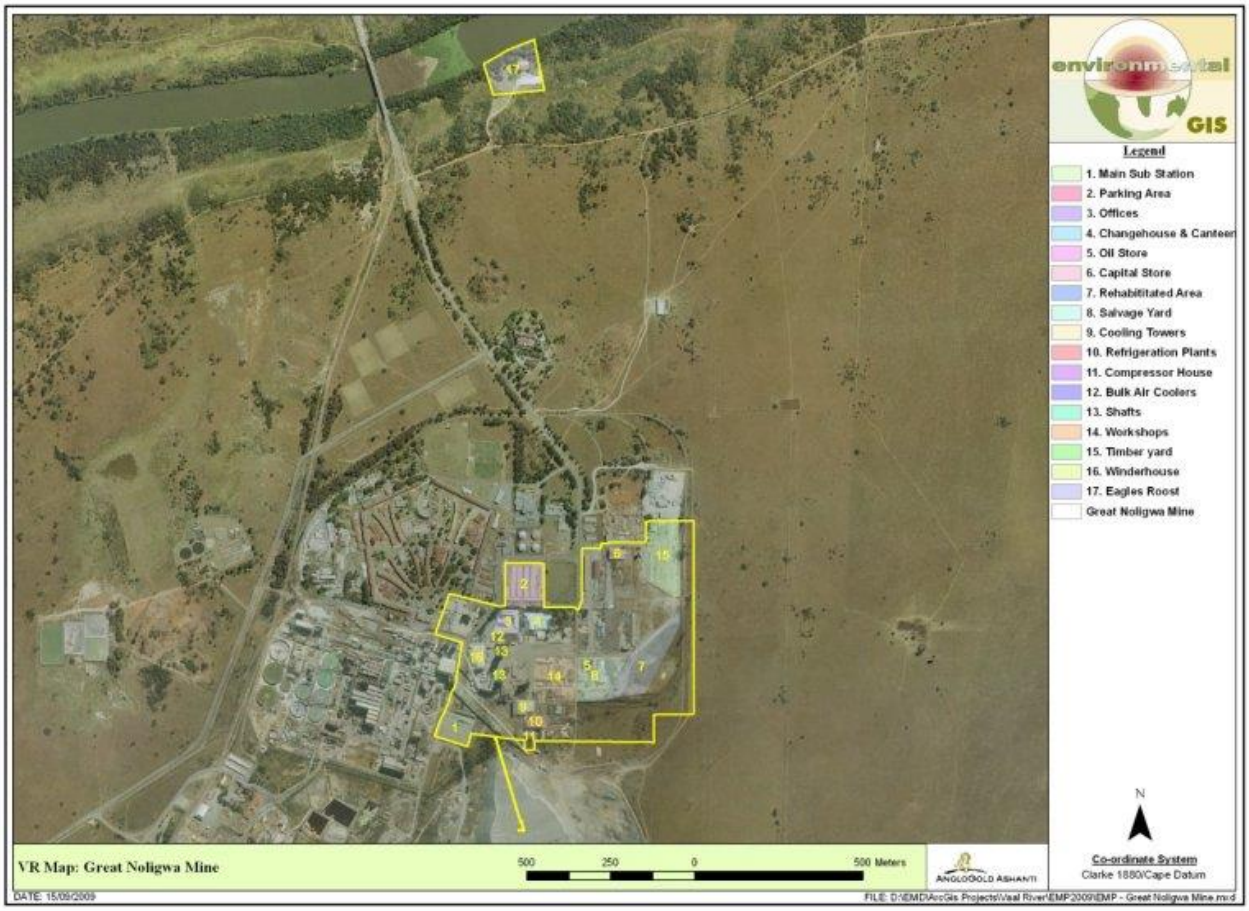

Figure 4: Great Noligwa Mine area of responsibility

1.2.3 NOLIGWA GOLD PLANT

Ore Reception

Reef and Waste are hoisted at Great Noligwa Mine using two 23.5-ton ore skips. The reef is tipped into two silos with a capacity of 4500 tons each. The reef is drawn from the ROM Silos via Brute Force Vibrators onto the ROM mill feed conveyors. Great Noligwa Mine hoists around 200 000 ton reef a month. Reef can also be received from Moab Khotsong shaft via a rail transport system. There are normally seven 55 ton hoppers per locomotive that tip into the Rail Bin with a capacity of 500 tons. C1 conveyor then transfers the rock to the ROM Silos. Rock dump waste is also delivered to Noligwa Gold Plant via road (trucks) and/or the rail transport system. The ore received from underground varies in size from rocks of 500mm to particles smaller than 1mm.

Milling

Two conveyors withdraw ore from the base of the ROM Silos and feed the two 6.71m diameter $\times$ 10.06m long, trunnion supported ROM mills. The mills operate in closed circuit with a two-stage cyclone circuit. The solids are diluted to an RD of 1.1kg/l during the milling process. The main water source is the return water from the thickener section that circulates between the mills and thickeners. The milled product is extremely fine with 80% passing 75μm and less than 3% larger than 150 μm. The milled product is pumped to the Thickener section where it passes over two linear screens (to remove wood-chips) before gravitating to the thickeners.

Thickeners

The milling product, with 85% to 90% moisture content, is pumped to the two Woodchip linear screens to remove woodchips. The underflow of the screens gravitates to the Thickeners where solid-liquid separation takes place. Once separated, the water is returned to the Milling Plant to be used in the grinding process, and the thickened slurry is pumped to the Uranium Plant for uranium extraction.

The Thickener Plant has six 45m diameter Thickeners. A slow-moving rake mechanism moves the settled slurry to the centre of the conical base from where it is pumped to the Uranium Plant. Around the top of the Thickener, an overflow launder collects and removes the overflow water. Flocculent is added to the slurry to aid in the settling of the solid particles.

Neutralizing

Once the Uranium has been extracted from the pulp, it is returned to the Gold Plant. This pulp has an acidic pH of 1.5 to 2.5. If Cyanide is added to slurry with a pH below 9.3, HCN gas formation will occur. This gas is known to be extremely toxic, thus resulting in a serious health and safety issue. To overcome this pH problem, slaked lime (Ca(OH)2) is added. The pH is increased in three stages from 1.5 to 7.5 in the first tank, 7.5 to 9.5 in the second tank and 9.5 to 10.5 in the third tank. Auto pH control is used to control the amount of lime added to effect Neutralization. The liquid Sodium Cyanide is added to the pulp in the overflow launder of the fourth Neutralizing pachuca. Oxygen is injected at No.2 Neutralizing tanks via a circulation system. This is done to oxidize cyanide (mainly Ferrous) to reduce cyanide consumption. From here the slurry overflows into a tank from where it is pumped to the Safety Screening Plant.

Safety Screening

The Safety Screening Plant is an intermediate screening plant between the neutralizing and the leach section. Two 12m^2 Delkor Linear Screens and one Vibrator Screen are used to remove any woodchips and fibre that was not removed by the woodchip screens in the thickener section. The efficiency of the Kambalda Screens in the CIP and the Elution Column Strainers are severely hampered any woodchips and fibre.

Leaching

From the safety screens, the slurry is pumped to six flat bottomed mechanically agitated leach tanks. The cyanide concentration in the first tank is controlled by an on-line Cyanide analyser (TAC 2000) by controlling the cyanide addition in the Neutralizing section. Liquid oxygen is injected via a circulation system into the first flat bottomed tank to increase the rate of leaching over the initial leaching stage. Oxygen is also injected at No.3 and No.5 flat-bottomed leach tanks via lances. From here the slurry is pumped to 16 air-agitated pachuca tanks to extend the

leach process. The overall leach residence time is approximately 30 hrs. The leach tail is pumped to the CIP circuit.

Adsorption (CIP)

The Carbon in Pulp (CIP) section consists of 8 flat-bottomed Adsorption vessels containing Activated Carbon Granules onto which the dissolved Gold adsorbs. The slurry gravitates down the circuit from No.1 to No.8 tank. The carbon is pumped counter-current from No.8 to No.1 tank to increase the Gold adsorbed from the pulp. The carbon from No.1 CIP tank is pumped onto a vibrator screen to screen out the slurry before the Elution process. Regenerated carbon is pumped from the Elution circuit back to No.8 CIP tank. To prevent the carbon from moving down-stream with the slurry, Kambalda screens are installed in the tanks. The CIP Residue gravitates from the last CIP tank on to two 12m^2 Linear screens to recover fine carbon from the circuit. The overflow of the screens drops onto a vibrator screen where the overflow is bagged and the underflow is pumped to a drying tank. The underflow of the linear screens (Residue slurry) is pumped to the backfill and flotation plant to produce backfill and recover pyrite.

Elution and Carbon circuit

The loaded carbon from No.1 CIP tank is dropped into two Elution Columns. A hot Caustic solution (called Eluant) is passed through the column to strip the gold from the carbon. This pregnant solution is now known as Eluate and passes through electro-winning cells where the gold is electroplated onto stainless steel cathodes. A Zadra Elution Process is used where the Caustic solution passes continuously through the column and the electro-winning cells. The barren eluant from the electrowinning cells is pumped back to the eluant tank from where it is re-circulated through the elution column. This process continues for the entire duration of the elution sequence, which is normally around 18 hours.

Strainers on the elution column prevent the carbon from leaving the elution column. After each sequence, the caustic solution is forced out of the Elution Column using compressed air. The carbon is flushed with fresh water for 30 minutes after which it is transferred to either one of the two Eluted Carbon Tanks. This Carbon is dewatered using vibrator screens and fed into two Electrically Heated Rotating Kilns where the Volatiles are driven off and the Carbon reactivated by bringing the Carbon temperature up to 600°C. The Carbon then discharges from the Kilns into Quench Tanks, which cools the Carbon down. The thermal shock of the Carbon entering the Quench Tanks assists with the removal of Calcium precipitated on the surface of the Carbon. The Carbon is then pumped to the Acid Treatment Section, where it first passes over a Vibrating Screen for dewatering and the removal of Fine Carbon (-0.8mm). The Carbon then discharges into a vessel containing 10% to 12% Hydrochloric Acid (HCl). After Acid Treating the Carbon is pumped back into the last Adsorption vessel to renew the sequence. Approximately 10 tons of Virgin Carbon is added to the circuit every month to make up for Carbon losses.

Recovery Section

The Electrowinning Section contains twelve Mintek type cells. Each cell has six Cathodes and seven Anodes. The Cathodes consists of stainless steel wire mesh packed in a stainless-steel frame. The Anodes consist of a framework of Stainless Steel Flat Bars. Six Rectifiers are used to control the current at 600 amps and the voltage at 12 Volts.

The Eluate from the Elution column passes through a Flash Tank and then a Distribution Manifold providing equal flow to each of the twelve cells. The dissolved Gold in the Eluate is electrowon onto the cathodes. The spent electrolyte then flows through to the Eluant Tank to be re-circulated to the Elution Column.

The Gold sludge plated onto the Cathodes is washed off using high pressure water. The Gold sludge accumulates in a Water Decanting Vessel and the underflow is drained into Steel Pans for Calcining. The pans are then placed in the Calcine Furnaces at 600°C overnight to dry and to oxidize any impurities remaining in the Gold sludge. The Gold material is then mixed with a Flux consisting of Silica, Borax and Manganese and charged into the Arc Furnace. To start the smelt, graphite particles are laid between the three Graphite Electrodes. A current is applied and the Arc starts the smelting process. The smelt temperature is approximately 1300°C (The melting point of Gold is 1060°C) and the time is around 1.5 hours.

Backfill

The CIP Residue is pumped from the CIP residue tank to two Feed Tanks in the Backfill section that feeds the primary cluster cyclone feed-boxes. Here the density of the slurry is kept at 1.2 kg/l and pumped through two cluster cyclones for upgrading purposes. The underflow of the cyclones is pumped to the Feed to Float tank and this product goes to the flotation plant. The overflow of these cyclones is fed to the three backfill thickeners, where the RD is increased to about 1.5 kg/l. Flocculent is added here. The underflow of the backfill thickeners is pumped to the two Reject tanks, and the thickener overflow is pumped to the water thickener. The overflow of the water thickener is used as process water.

Slurry is received from the neutralizing tanks in the flotation plant and is pumped through the secondary-cluster-cyclones. The overflow goes via a launder to the distribution box for the three backfill thickeners, and the underflow flows into one of the three product tanks. When the tank reaches 80% full, the permeability, RD and grading are tested to see if the backfill product is up to standard. The permeability should be greater than 180mm/hr; RD 1.7kg/l and the grading should be 7 - 9% -10µm. If one of the parameters is not met, the whole batch is rejected and is pumped to the reject tanks. From the reject tanks, the slurry is pumped to two slimes residue tanks and then pumped to the Mispah Tailings Storage Facilities.

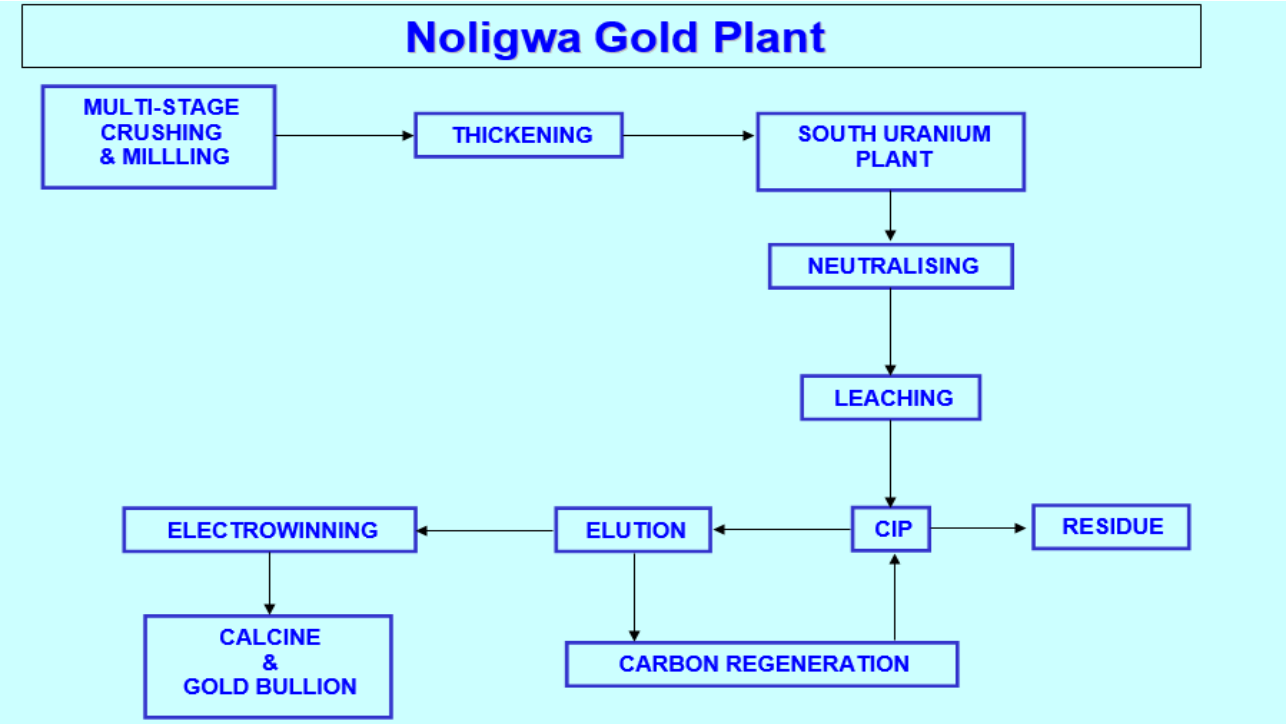

Figure 5: Overflow in quench tank recycle process

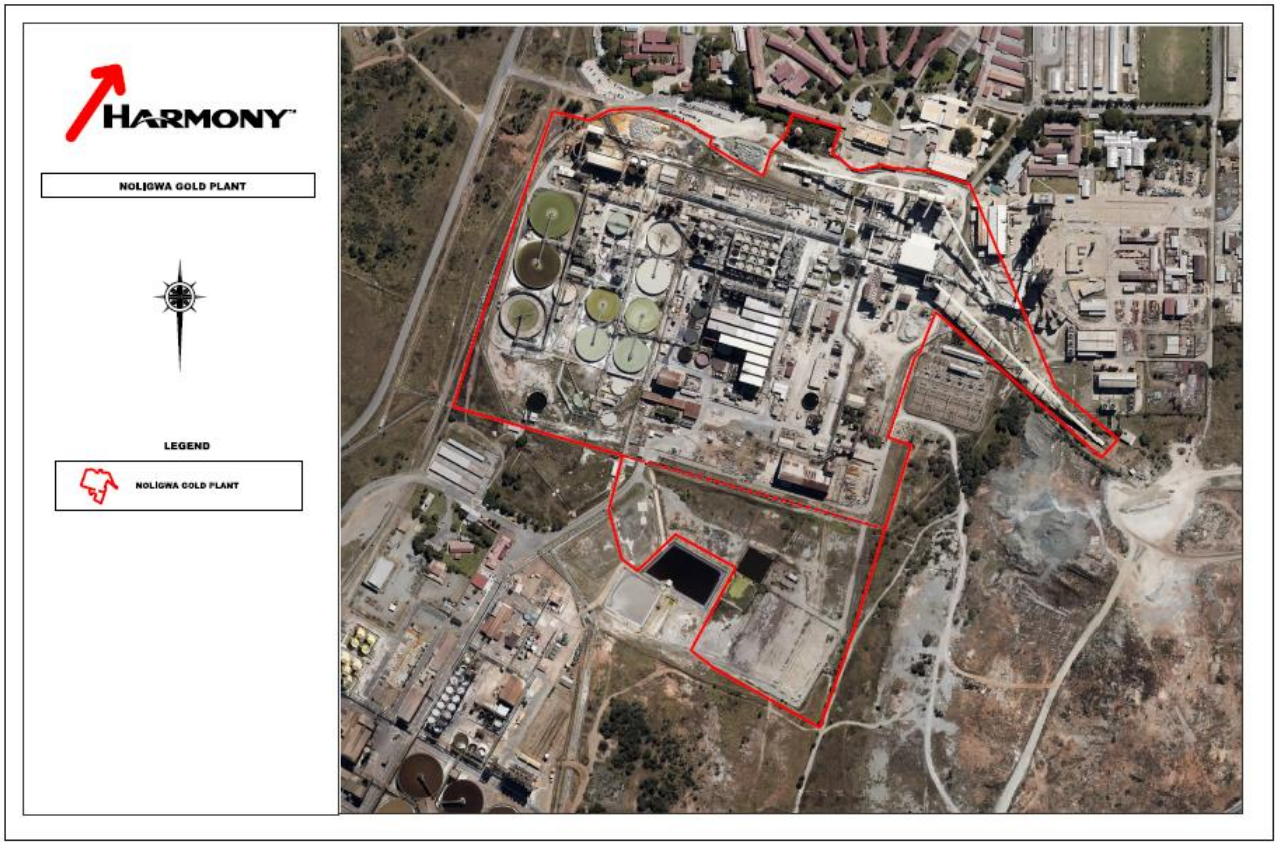

Figure 6: Noligwa Gold Plant area of responsibility

1.2.4 MISPAH PLANT

Ore Reception

The ore reception section receives ore from rail, truck or grasshopper conveyor and conveys it to the 3B bin. Level of ore in the bin is measured by a laser level measurement device. This is provided to allow control to be implemented to prevent the bin being pulled completely empty.

From the bin, ore is fed by a vibrating feeder onto CV01 conveyor to thee 3B Bin. The weight of ore conveyed from the bin is measured by a weight meter. Dust extraction is provided to remove dust generated as ore is tipped from the feeder onto the conveyor. To ensure adequate ventilation air is blown into the tunnel under the rail bin by a forced ventilation fan. Provision is also made for spraying water at the tipping point into the rail bin, at the tipping point from the feeder onto the belt and at the discharge from the head of the belt. Under condition where dry dusty ore is being handled the dust suppression sprays can be manually opened. No.3B bin, which gives surge capacity between ore reception and milling sections. Water is sprayed at the discharge of the feeders to suppress dust.

Milling

Ore is fed from 3 B bin conveyor onto the mill feed conveyor and from there into the mill. Milled product exits via the grates at the end of the mill. Oversize material in the mill discharge is removed by the trommel screen and routed to the recycle conveyor system. Trommel screen undersize flows

into the mill discharge where it is diluted by mill return water and pumped to the primary cyclones. The primary cyclone underflow is recycled to the mill for further comminution. Primary cyclone overflow gravitates to the secondary cyclone for further classification. Secondary cyclone underflow is routed to the mill discharge sump and overflow to the O/F pump box from where it is pumped to the woodchip screening section.

Woodchip screening and Thickeners

Cyclone overflow is pumped to the woodchip screen. Lime is added prior to screening to allow coarse material in the lime to be screened. On the screen material (woodchips, grit, plastic etc.) is removed. Screened slurry gravitates to the thickeners. Oversize is washed by sprays on the screen and washed off the screen by further sprays. The oversize drops onto a vibrating screen; coarse material screened out on the high-grade woodchip screens is also pumped to the same vibrating screen, where it is dewatered. De-watered oversize drops onto a conveyor to be deposited on a stockpile. Water is pumped to the high-grade woodchip screens distribution box. Scale forming in the apertures of the woodchip screen is periodically removed by spraying with high pressure water.

Leaching

Thickened slurry is pumped to the first leach tank at a controlled RD. RD control is achieved by adding dilution water to the leach feed pump box to achieve a set RD as measured by a densitometer on the leach feed line.

Prior to flowing into the first tank, the slurry is sampled by passing through a primary cross cut sampler. The sample is further sub-divided by a secondary vezin sampler. In the first tank, the pH is raised to >10.5 by addition of lime from a ring main.

Cyanide is added to the second tank; cyanide addition rate is controlled to achieve a set cyanide concentration. Addition rate is determined both by measurement of the actual concentration and the mass flow into the circuit.

Oxygen is added to the first two tanks by means of injecting oxygen into a side stream pumped out of the bottom of the tank and back into the bottom of the tank. Oxygen concentration in solution is measured and the rate of oxygen addition is controlled to achieve a set point.

Slurry cascades through the train till the last tank. From there slurry is pumped to the CIP. Rate of pumping is varied to achieve a set level in the last leach tank.

Carbon in Pulp

Slurry is received from the leach via the CIP feed pump. The slurry exposed to cyanidation meets activated carbon and the dissolved mineral absorbs onto the carbon. The slurry cascades down the CIP tanks. Carbon enters the CIP circuit at the last CIP tank on-line from the elution building via the acid washed carbon transfer pump. The carbon migrates upstream with the use of carbon transfer pumps. The inter stage MPSP screens prevent the coarse carbon particles to short circuit with the slurry stream. Loaded carbon is returned from the first CIP tank with the carbon transfer pump to the loaded carbon screen.

The carbon concentration as measured by the carbon analysers in each CIP tank is controlled by the carbon transfer pump. For example, if the carbon concentration in CIP tank No.3 is below the limit, the carbon transfer pump in CIP tank No.4 starts and runs until the required carbon concentration in CIP tank No.3 is achieved. If the carbon concentration in the last CIP tank is below the lower limit, an alarm must signal for the operator to transfer acid washed carbon or fresh carbon to this tank. Level sensors in the CIP tanks indicate high slurry levels that will alarm the operator to clean the MPSP screen in the tank.

Each CIP tank has an on-line/off-line selection switch that enables the operator to take a tank off line without impacting on the normal operation of the circuit. I.e. if CIP tank No.2 is off line and the carbon concentration in CIP tank No.1 is below the low limit, the carbon transfer pump in CIP tank no. 3 must start and run until the required carbon concentration in tank No.1 is achieved. Slurry and carbon is suspended by agitators in the CIP tanks.

Elution and Regeneration

Eluted carbon from the elution column is sent to the Regeneration kiln feed bin where process water is added. The underflow is discharged to the screw feeder for dewatering and feed to the regeneration kiln. The quench tank receives the overflow from the Regeneration Kiln Feed Bin and hot carbon from the Regeneration Kiln. Regenerated carbon is quenched in the quench tank, and then pumped to the existing Carbon Acid Wash Screen. The overflow in the quench tank is recycled to the process.

1.2.5 SOUTH URANIUM PLANT

Table 4 indicates the main working areas, facilities and activities within the Plant and Figure 7 indicates the area of responsibility.

Table 4: Main working areas, facilities and activities of South Uranium

Activity	Description
Leach	The leaching section is the first stage of the treatment of pulp at the Vaal River Operations South Uranium Plant. The purpose of this section is to dissolve the uranium in the pulp. Sulphuric acid is added first in the process to neutralize carbonate minerals and to dissolve uranium. Manganese Dioxide is added to oxidise ferrous to ferric ion. Ferric ion then oxidises tetravalent uranium to hexavalent form. Hexavalent uranium is soluble in acid. Iron is present, either as a constituent in the ore or introduced as metallic iron by wear and abrasion of equipment in the milling section.
Continuous Counter-current Decantation (CCD) (Include emergency generator)	There are six CCD Thickeners (1 × 60m dia and 5 × 55m dia). The underflow from No.2 CCD and the overflow from No.4 CCD pass into a mixing tank then pumped to No.3 CCD. The underflow from No.3 CCD and the overflow from No.5 CCD pass into a mixing tank then pumped to No.4 CCD. The underflow from No.4 CCD and the overflow from No.6 CCD pass into a mixing tank then pumped to No.5 CCD. The underflow from No.5 CCD and the barren solution from the CCIX-Section is passed into a mixing tank then pumped to No.6 CCD. The underflow from No.6 CCD is pumped to the neutralizing pachucas at the Gold Plant. The overflow from No.1 CCD gravitates to the pregnant transfer tank then pumped to two pregnant storage tanks at the counter current ion exchange section (CCIX). Flocculent is added at a controlled rate to the thickener where 50% of the volume is added to thickener No.2 and the remaining 50% added to the other four thickeners.

Activity	Description
	This 50% distribution will be changed from time to time depending on plant conditions. It is important to keep thickener No.1 overflow solution clear as this pregnant solution is pumped to the CCIX adsorption columns. High solids content can cause excessive resin loss.
Counter Current Ion Exchange (CCIX)	The main purpose of the CCIX process is to concentrate the uranium on resin, thereby reducing the subsequent volume of solution to be treated in the solvent extraction section from 1000 m^3/hr to 30 m^3/hr. The CCIX section comprises of five units each consisting of one adsorption column, one adsorption measuring chamber, one regeneration chamber, one elution column and one elution measuring chamber. Overflow from thickener No.1 is pumped to two storage tanks from where it is pumped at a controlled rate through the adsorption columns. In these columns, the uranium transfers from the solution to resin, the process being known as ion exchange. There are fourteen chambers in each adsorption column. Each of the fourteen chambers contains approximately 6m^3 of resin. The solution flows in an upward direction from chamber 1 to 14. The solution entering chamber 1 is referred to as pregnant solution and is rich in uranium, while the solution leaving chamber 14 is referred to as barren solution because the valuable uranium has been transferred to the resin. The resin transferred from chamber 1 to the measuring chamber is referred to as loaded resin. The loaded resin is transferred to the measuring chamber to ensure that the correct quantity reaches the elution column where the uranium is removed from the resin to form a solution fifty times less in volume. Fresh effluent containing ±130g/l sulphuric acid is pumped into the bottom of the elution column up through the resin, finally leaving the top of the column as concentrated eluate. This concentrated eluate is pumped to the solvent extraction plant for further processing. To replace the resin transferred out of the adsorption column, resin is transferred out of the bottom of the elution column via the elution column measuring chamber into the top of the adsorption column. The resin transferred from the bottom of the elution column is known as stripped resin. Periodically stripped resin is treated in the regeneration chamber for silica removal with 6% sodium hydroxide solution. The silica is removed from the resin as it reduces the loading capacity of the resin for adsorbing uranium. The silica level of the resin must be kept below 1.5 %.
Solvent Extraction (SX) and Ammonium Di-Uranate (ADU)	In the solvent extraction process the eluate is purified and converted into a suitable form for treatment in the ammonia precipitation plant. The solvent extraction process comprises five units: the extraction, scrub, strip regeneration and after settlers. Uranium is transferred to a solvent phase in the extractors; the solvent washed with water in the scrub and through hydrolysis the uranyl sulphate is then stripped from solvent and transferred to an aqueous phase. This aqueous phase is known as OK liquor and is processed at the ammonia precipitation plant. The after settler minimises solvent loss, while the re- generation settler cleans the solvent before being recycled for further use. The solvent extraction section is a Lurgi design from Germany. The purpose of the section is to purify/concentrate and convert the uranium bearing solution into a Suitable form for treatment in the ammonia precipitation plant. There are five major areas to the solvent extraction section. They are: Extraction, Scrubbing, Stripping, Regeneration and Solvent recovery.
Uranium Precipitation	The uranium precipitates out in the form of ammonium di-uranate (ADU) or $(NH_4)_2U_2O_7$. Together with the ammonium sulphate solution, the precipitate is pumped to a thickener

Activity	Description
	where the underflow passes through a two stage centrifuging system, firstly to wash out any impurities, and secondly to increase the relative density so that it's bulk is reduced for transport to Nufcor.
Miscellaneous (Includes Toilets and change houses plus Laundry, Offices - tea rooms, security control rooms, 2 weigh bridges, first aid station, Acid off loading and Storage), Workshops and Stores,	Change-house has change-rooms, with lockers, where staff and contractors can change into working clothes. They contain showering facilities, toilet facilities, laundry facilities where working clothes are washed and dried and boot washing facilities. The office complex is used for administrative duties by the management of the plant and contractors. The complex includes tearooms, boardrooms, cleaning equipment and storerooms as well as office spaces or control rooms for Asset Protection employees. All office blocks are air-conditioned and are equipped with ablution facilities. Workshops provide services to the plant and these include boiler, electrical and plumber workshops, where electricians conduct fixing and maintenance of equipment. Storage areas for chemical, solutions, clothing and cleaning equipment.
Main substation and transformers	The main substation is where transformers are installed to reduce the power current from the main grid for use at the plant.

Figure 7: South Uranium Plant area of responsibility

1.2.6 MISPAH TSF COMPLEX

The Mispah TSF complex comprises of the Mispah 1 & 2 TSF and Kopanang Paydam TSF.

Final treated pulp residue from Noligwa Gold Plant and Kopanang Gold Plant is pumped to the Mispah TSF where the solid particles settle out on to the dam and the water drawn off. The penstocks decant the drawn off water, that collects in a central pond, into return water dams. The water in the return water dam is pumped back to the plant as process water. The delivery pipelines to the TSF are open end discharge and the tipping area is controlled by manual operation of the discharge valves. The side walls are constructed by conventional hand packing and mechanical ditching methods.

Opportunities have been identified by Harmony for the reclamation of the Mispah TSFs. However, this project is still in the concept phase and a separate Environmental Authorisation application will be submitted once the project is in the pre-feasibility stage.

Supporting infrastructure

Supporting infrastructure includes

- Moab Khotsong Primary Healthcare Centre
- Great Noligwa Primary Healthcare Centre (Gateway);
- Vaal River Village, Umuzimuhle Village as well properties located in the towns of Orkney and Klerksdorp housing people working at Moab Khotsong and Great Noligwa Mines;
- Vaal River Region Compulsory Training including the Gateway Training Centre and the Trackless Mining Training Centre;
- The entire South African Metallurgical Technical Services (SAMTS/Off-Mine Services) office; and
- Domestic waste disposal site.

Properties and residences comprises of:

- Residential housing units;
- Schools; and
- Vacant stands.

These are situated in the villages and local town councils as well as offices and buildings utilised by employees for administration and mining related activities. The housing units and single quarters are used to accommodate employees and their families.

Commercial properties comprise of:

- Workshops;
- Offices and Training centres;
- Accommodation;
- Sports and Recreational centres;
- Canteens/Kitchens;
- Stores/Shops; and
- Farms

1.3 LEGAL REQUIREMENTS OF THE EMPR

This Operational EMPr has been compiled in terms of the provisions of Appendix 3 and 4 of December 2014 Regulation GNR. 982 of the National Environmental Management Act (NEMA). These requirements are cross-referenced to the various sections in this report where these requirements are addressed in the table below:

Table 5: Structure of the EMPr

EMPr regulation requirement	Section number
Details of – • The EAP who prepared the EMPr; and • The expertise of the EAP to prepare an EMPr, including a curriculum vitae	Section 1.4
A detailed description of the aspects of the activity that are covered by the EMPr as identified by the project description;	Section 1
A map at an appropriate scale which superimposes the proposed activity, its associated structures, and infrastructure on the environmental sensitivities of the preferred site, indicating any areas that any areas that should be avoided, including buffers;	Figure 1
A description of the impact management objectives, including management statements, identifying the impacts and risks that need to be avoided, managed and mitigated as identified through the environmental impact assessment process for all phases of the development including-	Section 4
(i) planning and design;	
(ii) pre-construction activities; (iii) construction activities;	
(iv) rehabilitation of the environment after construction and where applicable post closure; and	
(v) where relevant, operation activities;	
A description and identification of impact management outcomes required for the aspects contemplated in paragraph (d);	Section 4
A description of proposed impact management actions, identifying the manner in which the impact management objectives and outcomes contemplated in paragraphs (d) and (e) will be achieved, and must, where applicable, include actions to-	Section 4
(i) avoid, modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation;	
(ii) comply with any prescribed environmental management standards or practices;	
(iii) comply with any applicable provisions of the Act regarding closure, where applicable; and	
(iv) comply with any provisions of the Act regarding financial provisions for rehabilitation, where applicable;	
The method of monitoring the implementation of the impact management actions contemplated in paragraph	Section 2

EMPr regulation requirement	Section number
The frequency of monitoring the implementation of the impact management actions contemplated in paragraph	Section 5.2
An indication of the persons who will be responsible for the implementation of the impact management actions;	Section 5.3
The time periods within which the impact management actions contemplated in paragraph	Section 5.4
The mechanism for monitoring compliance with the impact management actions contemplated in paragraph	Section 5.5
A program for reporting on compliance, taking into account the requirements as prescribed by the Regulations;	Section 5.6
An environmental awareness plan describing the manner in which-	Section 5.7
(i) the applicant intends to inform his or her employees of any environmental risk which may result from their work; and	
(ii) risks must be dealt with in order to avoid pollution or the degradation of the environment; and	
Any specific information that may be required by the competent authority.	Section 6

1.4 DETAILS OF THE EAP

SRK Consulting complied the existing EMPr in 2017 which the update EMPr is based. EIMS has been appointed by Harmony Moab Khotsong Operations as the independent EAP to assist in preparing the updated EMPr in respect to the acquisition of various of Anglo Gold Ashanti's (AGA) Vaal River Operations' assets. This report supersedes the previous EMPr and relates specifically to the current operations at Harmony Moab Khotsong Operations. The contact details of the EIMS who complied this EMPr are as follows:

- Name of the Consultant: John von Mayer and Ayabulela Manjezi
- Tel No.: 011 789 7170
- Fax No.: 011 787 3059
- Email address: john@eims.co.za or aya@eims.co.za

1.5 EXPERTISE OF THE EAP

1.5.1 QUALIFICATION OF EAP

In terms of Regulation 1 of the IA Regulations (GN R. 982) as amended, an independent EAP, must be appointed by the applicant to manage the application. EIMS has been appointed by the Applicant as the EAP to assist with compiling the necessary reports and undertaking the statutory consultation processes. EIMS is compliant with the definition of an EAP as defined in Regulations 1 and 13 of the EIA Regulations, as well as Section 1 of the NEMA. This includes, inter alia, the requirement that EIMS is:

- Objective and independent;
- Has expertise in conducting EIA's;
- Takes into account all relevant factors relating to the application; and
- Provides full disclosure to the applicant and the relevant environmental authority.

1.5.2 SUMMARY OF EAP'S PAST EXPERIENCES

EIMS is a private and independent environmental management-consulting firm that was founded in 1993. EIMS has in excess of 27 years' experience in conducting EIA's, including many EIA's for mines and mining related projects. Please refer to the EIMS website (www.eims.co.za) for examples of EIA documentation currently available. John von Mayer is a senior consultant at EIMS and has been involved in numerous significant projects the past 13 years. He has experience in Project Management, small to large scale Environmental Impact Assessments, Environmental Auditing, Water Use Licensing, and Public Participation. Ayabulela Manjezi is a junior consultant with 2.5 years' experience working on a variety of environmental management projects.

2 SCOPE OF THIS DOCUMENT

The existing approved EMPr was prepared by SRK Consulting in 2017 and the EMPr contains management actions relevant to the existing Harmony Moab Khotsong operations. Harmony has drafted an EMPr Performance Audit – Action Plan, representing the Environmental Compliance Audit findings (2021) and actions. The plan contains actions that will form part of the updated EMPr management commitments that will be submitted to the DMRE through an EMPr Amendment Application process.

Details of the main significant amendments are listed in Table 6 below:

Table 6: Detailed description of the main significant amendments to the Harmony Moab Khotsong Operation EMPr

Environmental Aspect	Wording in Original 2017 EMPr	Amended/New Wording (underlined text is new, strike-out text has been removed)
Exotic Fish Programme	• Awareness campaigns will be implemented to inform people and local community to report and to discourage the presence of predators such as cats and dogs in the natural environment. Catch and release is to be encouraged for all indigenous fish species and the utilization of exotic fishes to be promoted by awareness campaigns (including information boards); • Management program must be drawn-up and implemented to eradicate introduced exotic fish species in dams Harmony's area. Hunting of *Redunca arundicum* a Protected species must not take place without a permit under National Environmental Management; Biodiversity Act 10 of 2004 Threatened or Protected species regulations.	This programme was the responsibility of AngloGold Ashanti and was stopped years ago and is no longer necessary for Harmony. • ~~Awareness campaigns will be implemented to inform people and local community to report and to discourage the presence of predators such as cats and dogs in the natural environment. Catch and release is to be encouraged for all indigenous fish species and the utilization of exotic fishes to be promoted by awareness campaigns (including information boards);~~ • ~~Management program must be drawn-up and implemented to eradicate introduced exotic fish species in dams Harmony's area. Hunting of *Redunca arundicum* a Protected species must not take place without a permit under National Environmental Management; Biodiversity Act 10 of 2004 Threatened or Protected species regulations.~~
Landscape function Analysis	• A landscape function analysis monitoring programme (Tongway and Ludwig, 1995; Tongway, 2008) is being implemented to identify areas prone to soil erosion, and inform soil conservation and restoration measures;	No longer required for Harmony Moab Operations. This was an AngloGold initiative. These recommendations have therefore been removed from the EMPr: • ~~A landscape function analysis monitoring programme (Tongway and Ludwig, 1995; Tongway, 2008) is being implemented to identify areas prone to soil erosion, and inform soil conservation and restoration measures;~~
Code of Practice for Residue Deposits (COP)	• Not included in original EMPr.	A COP was drawn up in accordance with guideline DMRE 16/3/2/5-A1 issued by the Chief Inspector of Mines valid till November 2024. The COP is used during accident investigation/inquiry to

Environmental Aspect	Wording in Original 2017 EMPr	Amended/New Wording (underlined text is new, strike-out text has been removed)
		ascertain compliance and also to establish whether the COP is effective and fit for purpose (Appendix 1).
Restrictions on locality/ 1:100 year flood line	• Applicant will where possible take the necessary measures to ensure that new mine infrastructure such as any residue deposit, dam, reservoir, together with any associated structure or any other facility will not be placed within the 1:100 year flood-line or within a horizontal distance of 100 meters from any watercourse or borehole, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked; • Where infrastructure currently exist within the 1:100 year flood-line or within a 100 metres horizontal distance from a water course or borehole or undermined or unstable ground Harmony commits to apply for an authorized exemption from the authorities.	No longer required as per the flood line delineation presented to auditors in the 2021 PAR. Harmony Moab currently has no infrastructure within the flood line areas. This has therefore been removed from the EMPr as per the 2021 PAR audit finding: • ~~Applicant will where possible take the necessary measures to ensure that new mine infrastructure such as any residue deposit, dam, reservoir, together with any associated structure or any other facility will not be placed within the 1:100 year flood-line or within a horizontal distance of 100 meters from any watercourse or borehole, excluding boreholes or wells drilled specifically to monitor the of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked;~~ • ~~Where infrastructure currently exist within the 1:100 year flood-line or within a 100 metres horizontal distance from a water course or borehole or undermined or unstable ground Harmony commits to apply for an authorized exemption from the authorities.~~
Emissions from upcast shafts	Assessment of emissions from upcast shafts.	The assessment was conducted by AngloGold Ashanti and was found unnecessary for Air Emissions reporting. This has therefore been removed from the EMPr as per the 2021 PAR audit finding • ~~Assessment of emissions from upcast shafts.~~ And replaced with: • <u>Ventilation specialist to assess all occupational impacts for vent shaft emissions. Air Pollutants, Noise and Thermal Stress, etc. are done by</u>

Environmental Aspect	Wording in Original 2017 EMPr	Amended/New Wording (underlined text is new, strike-out text has been removed)
		Occupational Environmental Department and reports are submitted Quarterly to Department of Mineral Resource and Energy).
Surface Water	• Hydrocarbons are collected regularly from the separation sumps and disposed of via the Central Salvage Yard	Replaced with: • Hazardous Waste are removed directly from the Business Units by approved Service Providers. Alternatively, it is managed through the Moab Central Salvage Yard, which uses approved service providers.
Biodiversity Management Planning	Additional mitigation measures included based on Biodiversity Management Plans, updated 2013	The following additional mitigations have been included: • Planning of all new developments should be done with increased sensitivity to the environment and comply with the Biodiversity Management Plan (Appendix 2: Biodiversity Management Plan: AngloGold Ashanti – Vaal River Operations (including the Moab Khotsong Operations)). • Implement alien and invasive eradication planning, fire break planning and controls as per the Alien Invasive Plant Assessment and Management Plan (Appendix 3: Moab Khotsong Alien Management Plan).
Process Water Dams	Eye dam and boating club is not applicable to the Moab Khotsong Operations	Removal of the following section: • ~~Flow measurements at the legal boundary discharge points are conducted on a monthly basis (Eye dam and Boat Club);~~
Incident Management	Additional mitigations added to include low risk incidents.	The following additional mitigations have been included: • All low risk incidents (where there are no risk to a water resource to be reported to DWS annual report as required by the approved WUL.
Aquatic Monitoring	Additional measures included based on 2021 Annual Water Monitoring Report.	The following additional mitigations have been included:

Environmental Aspect	Wording in Original 2017 EMPr	Amended/New Wording (underlined text is new, strike-out text has been removed)
	Aquatic information regarding Schoonspruit has been removed because it is not applicable to Moab Khotsong Operations.	• A competent and capable aquatic scientist must be appointed by the Licensee to submit a monitoring programme for aquatic macro-invertebrates and habitat integrity. • Habitat Integrity must be assessed using the Rapid Bio-assessment Analysis (C.J. Kleynhans 1999) method described by the Department (SASS 2002).
Settling dams and Return Water dams	Addition management measures identified with respect to settling dams that were not included in original EMPr.	The following additional mitigations have been included: • Desilting and clean-up of return water dams to be conducted. • Daily foreman dam patrols. • Installation and ensuring security measures at the dams. • Pipelines to be checked regularly to enable effective water pumping to the thickener tanks. • A spillage clean-up Programme will be implemented by Noligwa Gold Plant/Tailings Department.
Waste Rock Dump	Complete reclamation of the Great Noligwa and Moab Khotsong waste rock dumps.	The current waste rocks dumps are either in a stage of being re-mined or have been re-mined (concurrent rehabilitation). Final footprint rehabilitation will be addressed during the mine closure phase. An old dirt road was upgraded to be a temporary gravel road to transport (truck) waste rock from Moab Khotsong Mine Waste Rock Dump to Noligwa Gold Plant (Mispah Mill tip) for processing. This road will be rehabilitated during the mine closure phase. Refer to the annually updated Closure Cost Assessment/ Closure Cost Report. Re-mine the Noligwa and Moan waste rock dumps to continue and footprint rehabilitation will be done during mine closure phase.
Generation of acid rock drainage - Groundwater	Expected 8.9 Mℓ/day will be allowed to decant subsurface into the dolomite aquifer as per groundwater assessment completed by MvB Consulting (MvB013/18/A009).	Update of mitigation measures: After all mining activities and associated pumping from Margaret and Noligwa shafts cease water level and quality monitoring will be done during the approximate 15.5 years it will take for the mine void to fill to the aquifer level. Potential liabilities of mine flooding and decant of deep mine water was assessed.

Environmental Aspect	Wording in Original 2017 EMPr	Amended/New Wording (underlined text is new, strike-out text has been removed)
		The modelling has shown that the decant water quality will be relatively good, especially after mixing with the dolomite water. The decant volume is low enough and mixing occurs rapidly resulting in negligible impacts. Over time the mine water quality is expected to improve due to stratification and the risk to the environment reduces further.
Operation of Mispah 1 & 2 and Kopanang Paydam TSFs	No groundwater in the Moab Operations is used as potable water and pollution plume does not move towards neighbouring farms. Seepage water has been updated to be assessed against DWAF livestock and irrigation guidelines. Moab Khotsong Operations makes no use of trenches. Return water from dams are transported via pipelines (inside secondary earth trenches) to the Metallurgical Plants.	Update of mitigation measures: • Installation of drains along wet and seepage areas at the Mispah TSF (where possible) – the option of interception borehole fields directly below some of the old TSF could help to reduce and to intercept seepages and should be further investigated (implemented and feeds into the Orange Tank and water is used in the metallurgical process); • Assess groundwater liability as part of the annual financial provision review (Refer to annual Closure Cost Assessment/ Closure Cost Report NW30/5/1/2/2/15MR and NW30/5/1/2/2/16MR for Moab Khotsong Operations) • Moab Khotsong Operations are planning to reclaim (re-mine) parts of the Mispah TSF (Mispah 1 specifically). Any additional Authorisations requirements will be assessed and applied for, if required (it is planned that existing infrastructure will mostly be utilized).
Soil Conservation Plan	A Soil Conservation Plan (including borrow pit management plan, stockpile management, firebreak management plan, riparian zone management plan, and road management plan) must be implemented to prevent land and soil degradation	None of the Soil Conservation Plan (including borrow pit management plan, stockpile management, riparian zone management plan and road management plan) will be implemented by Harmony. These were AngloGold initiatives. Only the annual Fire Management planning will be done by Moab Khotsong Operations Soil Conservation Plans are no longer applicable for Harmony and mitigation measure has been removed

Environmental Aspect	Wording in Original 2017 EMPr	Amended/New Wording (underlined text is new, strike-out text has been removed)
		• ~~A Soil Conservation Plan (including borrow pit management plan, stockpile management, firebreak management plan, riparian zone management plan, and road management plan) must be implemented to prevent land and soil degradation~~;
Phytoremediation	• Housekeeping controls need to be continuously reviewed where the interception or phyto-remediation options are not possible; • If interception or phyto-remediation is not possible increased housekeeping measures and storm water control needs to be considered as opposed to no action on groundwater contamination;	Replaced with the following: Moab Khotsong Operations will assess the need to implement phytoremediation strategically to address shallow ground water interception and as part of closure and rehabilitation measures.
Dolomitic Management Plan	Develop and maintain a dolomite management programme, including: • Upgrading 'wet services' infrastructure where necessary; • Regularly maintaining 'wet services'; • Restricting further development on dolomite (approval required from a registered engineering or geotechnical professional); • Obtaining written Authorization from a registered engineering or geotechnical professional before rectifying a sinkhole; and • Liaison with local authorities for disaster management planning	The Dolomite Management Plan done by AngloGold Ashanti covers the Moab Khotsong Operations activities. It is now included as Appendix 4: Dolomitic Risk Management Report of this OEMPr. Seismicity risk are addressed in Moab's Emergency Preparedness arrangements. The following has been removed: ~~Develop and maintain a dolomite management programme, including:~~ • ~~Upgrading 'wet services' infrastructure where necessary;~~ • ~~Regularly maintaining 'wet services';~~ • ~~Restricting further development on dolomite (approval required from a registered engineering or geotechnical professional);~~ • ~~Obtaining written authorisation from a registered engineering or geotechnical professional before rectifying a sinkhole; and~~ • ~~Liaison with local authorities for disaster management planning~~ And replaced with: <u>Refer to Dolomitic management included under Appendix 4</u>: Dolomitic

Environmental Aspect	Wording in Original 2017 EMPr	Amended/New Wording (underlined text is new, strike-out text has been removed)
		Risk Management Report of this OEMPr.
Removal of EIA and PP information included in original EMPr	Harmony Moab Khotsong Operations has not conducted any additional activities in their operational phase since the 2017 EMP update. The EIA impact assessment section and Public Participation information included in 2017 SRK EMPr have been removed. The impact assessment undertaken previously is no longer required to be included in this updated Harmony Moab Khotsong operational OEMPr.	
Updated Monitoring Requirements	Details of the Moab Khotsong Operations network have since been amended and 12 dust monitoring stations are monitored, which only covers Harmony- Moab Khotsong Operations network. An updated approved Water Use Licence was issued to Moab Khotsong Operations. Both surface- and ground-water monitoring and reporting are done in accordance with the approved Water Use Licence (as amended). Air Quality and Dust fall-out monitoring and reporting are done in accordance with the approved Air Emissions Licence. Surface and ground-water monitoring and reporting is done in accordance with the updated Licence requirements. The updated Water Use License provides details of the number of surface and ground water samples to be analysed either Monthly or Quarterly. Moab Khotsong do quarterly noise assessment – done by the Occupational Environmental Department). A once-off noise Monitoring was last undertaken in 2012/2013. Since 2012/13, no additional activities were added to the Moab Khotsong Operations that could have resulted in an increase or additional noise, therefore the additional noise monitoring requirements (besides noise assessments done quarterly by the Occupational Environmental Department) have been excluded from the current EMPr.	

3 OPERATIONAL PHASE IMPACTS AND MANAGEMENT MEASURES

Table 7 below indicates the impacts and associated mitigation measures applicable to the operational phase of the Moab Khotsong operations.

Table 7: Operational phase impacts and management measures (underlined mitigation measures are new mitigation measures or amendments relevant to this 2022 revised / amended OEMPr)

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
Operation of Great Noligwa and Moab Khotsong shafts and underground mining	46 ha 62 ha	Geology	**Potential seismic events resulting in earth tremors due to deep mining** Seismic events have been experienced in the Klerksdorp region due to deep mining activities impacting on geological faults. Although changes in mine production affect frequency of seismic events, an analysis of seismicity in the Klerksdorp region indicated a recurrence time for magnitude 5 events of about 20 years. Whereas dewatering of the rock mass during mining operations will tend to stabilize faults that might have been close to failure, re-watering is likely to trigger seismic events. This is because flooding can increase the pore fluid pressure on a fault's surfaces, thereby diminishing the effective stress clamping the fault. It is considered unlikely that any event triggered by a rising water table will have a greater magnitude than the events that occurred during mining and it is expected that seismicity will decrease once the water table stabilizes.	• A qualified rock engineer will approve mining plans before they are implemented. Strategies employed in mining plans to limit the frequency and/or magnitude of seismic events include: o Reduced extraction ratio by leaving portions of un-mined reserve as regional pillars; o Portions of un-mined ground are left adjacent to large geological structures. These are referred to as clamping/bracket pillars; o Overall mining direction is from the mined out area towards solid, preventing formation of high stress areas; o Favourable approach angles to geological structures (> 35 degrees); o Take special precautions if highly stressed remnants are to be mined, especially if they are intersected by faults and dykes; and o Notify the mining regulator if clamping or bracket pillars are to be removed. • Continue with continuous monitoring of seismic activity on all shafts. • Integrate information obtained from seismic data and research into the short, medium and long-term planning processes. • Comply with appropriate standards for building modifications and new buildings; and • Liaise with local authorities for disaster management planning. • Refer to the Emergency Preparedness and Response COP on how Moab manages potential disasters (Appendix 8: Emergency Preparedness and Response Plan).	Prevent seismic events.	Not available.
Underground mining	46 ha 62 ha	Soils, land use and land capability	**The loss and degradation of soils, land use and land capability due to the formation of sinkholes** Vaal River Operations is largely situated on dolomitic substrata which is subject to the formation of	• Implement dolomitic management measures included Appendix 4: Dolomitic Risk Management Report of this OEMPr.	To prevent contamination and sterilisation of the topsoil;	Manage soils in line with the requirements of the National Norms and Standards for the

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
			sinkholes. This kind of rock is susceptible to dissolution from the percolation of rainwater and the flow of sub-surface water, which results in the formation of underground cavities and caves. The process of weathering also results in the formation of a complex residual soil mantle known as "wad", overlying the dolomite bedrock. Wad is a low density, weak material that is easily eroded and highly compressible, thus unsuitable for foundations. The presence of cavities or very loose material in the dolomites and overlying sediments can lead to the formation of sinkholes. Sinkholes may form gradually or very suddenly and vary in size depending on several factors including groundwater level, surface water infiltration rate, overburden depth and water chemistry (acidity). Such events could results in negative impacts on soils, land use and land capability.		Leak/Spill Procedure; Emergency Preparedness Plan; Waste Management; and GN704 Audit Report.	Remediation of Contaminated Land and Soil Quality (GN 37603 No 331). Hydrocarbon spillages are addressed according to Hazardous Substances Management Procedure and Emergency Preparedness and Response Procedure. (implemented to also ensure ISO 14001:2015 compliance/certification.
Operation Moab Khotsong shaft and underground mining	62 ha	Groundwater	**Generation of a groundwater pollution plume** The groundwater pollution plume indicates a limited pollution plume extent.	• Sources of groundwater pollution must be minimised. This process must be linked to a risk-based-approach and to certain spatial risk points (i.e. Vaal River, Schoonspruit, etc.). The following mitigation actions should be considered for the mitigation of pollution sources: ○ <u>Installation of drains along wet and seepage areas at the Mispah TSF (where possible) – the option of interception borehole fields directly below some of the old TSF could help to reduce and to intercept seepages and should be further investigated (implemented and feeds into the Orange Tank and water is used in the metallurgical process);</u> ○ <u>Moab Khotsong Operations will assess the need to implement phytoremediation strategically to address shallow ground water interception and as part of closure and rehabilitation measures.</u> ○ Sealing/<u>secondary containment/maintenance</u> of earth trenches in areas where perched water table aquifers exist. The Vaal River earth trenches were constructed over large areas from the TSFs to the return water dams. Significant quantities of salt migration occur from these trenches; ○ The seepage from existing waste water dams seems to add to the groundwater pollution problem;	No dirty water spillage to the catchment thereby preventing contamination of waterbodies downstream by: Developing a groundwater monitoring programme and model; Responding to complaints and implementing a grievance mechanism with regards to groundwater; and Prevent decant of AMD water to surface water resources.	Moab – Hazardous Substances and Waste Management Procedures and Environmental Emergency Manual and operational arrangements. Water Quality Objectives as specified in the Water Use License issued by DWS \South African National. Seepage water assessed again DWAF South African Water Quality Guidelines for Agricultural Use: Irrigation and Livestock (1996).
Operation of Mispah 1 & 2 and Kopanang Paydam TSFs	306 ha 46 ha	Groundwater	**Generation of a groundwater pollution plume** Figure 8 shows the 2007 status of mass TDS transport across the Vaal River Southern area for the top weathered aquifer system. The Southern Plumes could be subdivided into four (4) sub-plumes and extend approximately over an area of 6000 m x 10 000 m. From the simulations polluted groundwater sampled at the site is primarily derived from the Mispah and Great Noligwa areas. **Mispah and Kopanang Paydam** The Mispah plume is a result of tailings related seepage and SO_4 dominates. The plume will increase during the life of mine and for a certain period thereafter. From then onwards it will start to reduce due to the reduction in the phreatic surface within the compartments. The driving force towards seepage will thereof be minimized through the application of effective rehabilitation methods.			
Operation of the Great Noligwa shaft complex,	46 ha	Groundwater	**Generation of a groundwater pollution plume** **Great Noligwa**			

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
plant and waste rock dump			The Great Noligwa Area plume has been classified as complex and its origin is divided between a number of historical and existing contamination sources. It is believed that approximately 30 % of the salt contribution to this plume can be eliminated through the application of source control. This includes tailings spillages, contaminated soils below the return water dams area, and clean-ups within the old U plant area (clean-up work did occur within the 2004/2005 period). The following can also be regarded as identified issues: • GN WRD indicates high salt contributions; • Historical spillages around plant areas and dumping of possible hazardous material to the south west of the U plant; and • Seepage below 8 Shaft bridge.	○ Visual tailings material in overflow paths, reclamation sites and old evaporation areas should be 100% reclaimed and free drainage should be achieved. • Assess groundwater liability as part of the annual financial provision review (Refer to annual Closure Cost Assessment/ Closure Cost Report NW30/5/1/2/2/15MR and NW30/5/1/2/2/16MR for Moab Khotsong Operations). • Moab Khotsong Operations are planning to reclaim (re-mine) parts of the Mispah TSF (Mispah 1 specifically). Any additional Authorisations requirements will be assessed and applied for, if required (it is planned that existing infrastructure will mostly be utilized). • The management options that are evaluated in this section should be considered at different time scales and at different spatial locations relative to the sources or risk points. The possible combinations of remediation options that can be considered are: ○ Woodlands on low permeable parts of the aquifer with interception boreholes in certain fractured zones (identified preferred groundwater pathways); ○ The combination of the options should be developed over time – i.e. interception boreholes within the short term and the Woodlands beyond the closure time frame period; ○ Interception directly down-gradient of the sources should also be part of the short term solution; ○ A long-term plan should subsequently be incorporated within the next liability update report. This investigation should be refined to include each of the identified sources and a remediation or management plan should be set up for each source; ○ Thereafter the numerical flow and transport models need to be recalibrated and updated to reflect the new conceptual model; ○ The numerical groundwater models must be used to optimize the remediation options on a six-monthly basis and are in the context of a human health and ecological multi-tiered risk assessment.		
Operation of the TSFs and waste rock dumps	Mispah 1 & 2: 306 ha Kopanang Paydam: 45 ha WRD: 30 ha	Groundwater	**Generation of acid rock drainage resulting in a deterioration of groundwater quality** Sources of sulfide minerals that generate ARD at Vaal River Operations include TSFs, ore stockpiles, low-grade ore in waste rock dumps, spilled mine residue material, stope faces and on-reef pillars left underground (e.g. for regional support or clamping along faults or dykes). Although the location of MRSs on dolomite is sometimes believed to mitigate ARD, increased salinity and lowered pH of ARD increase the water's ability to dissolve dolomite. Two potential major implications of this are: • widening of preferred pathways causing greater overall transmissivity in the dolomites and greater storage volumes; and • possible stability problems, should excessive karstification result.			

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
				The risk assessment will develop site specific clean up targets; ○ Further intrusive studies might be necessary to refine the detail design of feasible remediation options; ○ Carry out a cost benefit analysis to select the most appropriate groundwater remediation system in terms of reaching the overall environmental compliance towards mine closure; ○ Steps must be taken to ensure that the Water Use Authorisation requirements are met. This includes the pro-active management of the Vaal River water balance and water reticulation system. A water balance needs to reflect seasonality to ensure the optimal re-use of water and zero effluent discharges; ○ Bi-annual groundwater monitoring reports need to be compiled to ensure continuous evaluation of groundwater contamination and involvement of Business Units; ○ The impacts that seepage of contaminated groundwater could have on surface soils must be assessed and updated in the liability evaluation; ○ Potential liabilities/risk from radionuclide contamination (uranium mobilisation and transport) needs to be included in the follow-up assessment. This should also include a broader spectrum of indicator elements- i.e. CN, NO_3, Fe, Mn and SO_4. The overall management option considered for the above, might require revisiting of the proposed groundwater management plan as it will determine the ultimate site closure requirements; ○ After all, mining activities and associated pumping from Margaret and Noligwa shafts ceased water level and quality monitoring will be done during the approximate 15.5 years it will take for the mine void to fill to the aquifer level; ○ Potential liabilities of mine flooding and decant of deep mine water was assessed. After all, mining activities and associated pumping from Margaret		

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
				and Noligwa shafts cease water level and quality monitoring will be done during the approximate 15.5 years it will take for the mine void to fill to the aquifer level; ○ The groundwater management plan should be considered in the overall site surface water management plan. It is possible that in most cases an improved surface water management plan will result in lower groundwater risks; and ○ Complete reclamation of the Great Noligwa and Moab Khotsong waste rock dumps and Mispah1 and TSF.		
Operation of all facilities		Soils	**Increase in soil erosion and contamination of soils as a result of operation activities** Soils of the Vaal River Operations area are considered to have a low erosion potential. However, erosion is likely to take place on an infrastructures with low to high gradients such as the TSFs and waste rock dumps and cleared areas. The impact would be a result of movement of the mine vehicles on unpaved roads, exposed/ unvegetated soils within the shaft complex and unrehabilitated soil stockpiles and rock dumps. The contamination of soils as a result of leaching of contaminants from Waste Rock Dumps and spills from workshops and offices during operations.	• Erosion should be addressed as part of regular maintenance to prevent the loss of topsoil. • The roads are to be maintained regularly to ensure proper storm water management systems are in place; • Any new borrow pits that could be developed in future will have to comply with the relevant legislation to minimise the impact on the environment and will have closure and rehabilitation plans to ensure their closure; • Contaminated soils will be removed, from specific areas where high contamination levels have been identified, and either safely disposed or processed; • Proper management and maintenance of pollution sources (e.g. tailings storage facilities) have been implemented to prevent as far a practical further contamination of soil; • Borrow pits will be closed and rehabilitated as per the pre-closure and concurrent remediation programs currently being implemented; • All non-essential roads are to be closed and rehabilitated when mining is terminated in the lease area; • Erosion in the lease area will be addressed as and when it occurs; • A proper growth medium (“top soil”) management plan will be developed and implemented for all new projects (expansions and new projects); and • Implement annual alien and invasive eradication planning and fire breaks management planning in accordance to the Alien Invasive Plant Assessment and Management Plan (Appendix 2: Biodiversity Management Plan: AngloGold Ashanti – Vaal River Operations (including the Moab Khotsong Operations)).	To prevent soil contamination by implementation of: Inspection and maintenance Plan; Leak/Spill Procedure; Emergency Preparedness Plan; Waste Management; and GN704 Audit Report.	Manage soils in line with the requirements of the National Norms and Standards for the Remediation of Contaminated Land and Soil Quality (GN 37603 No 331). Moab’s spill and hazardous substances management arrangements.
Operation of all facilities	550 ha	Aquatics	**Potential impact on aquatic ecosystem due to mining activities**	• Harmony (Group) is currently undertaking a gap assessment on its biodiversity requirements. Any actions applicable to Moab Khotsong Operations will be assessed (feasibility) on implementation e.g. alien and invader assessments and eradication programmes and biodiversity management.	To avoid or where not possible, minimise and remedy pollution of water;	IRWQO for the Vaal Catchment

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
			The application of the SASS5 index indicated that habitat deterioration was responsible for downstream deterioration in biotic integrity of the Vaal River The application of the FAII index indicated that there was no evident deterioration in the Vaal River, based on fish, between sites VR-US and VR-DS; and The biotic integrity of the Schoonspruit, based on fish (FAII) was poor, especially in the upper reaches (site SS-US). Conditions improved somewhat towards the downstream site. The poor conditions are expected to be related to both habitat and water quality degradation and could also be related to predation / competition with the exotic Mosquito fish.	• A competent and capable aquatic scientist is appointed by the Licensee to submit a monitoring programme for aquatic macro-invertebrates and habitat integrity (Done by Harmony – Vaal River Operations) (refer to Biomonitoring Report). • Habitat Integrity must be assessed using the Rapid Bio-assessment Analysis (C.J. Kleynhans 1999) method described by the Department (SASS 2002).	Implementing a Leak/Spill Procedure; Compiling monitoring report; Implementing the Storm water Management Plan; and Responding to complaints and implementing a grievance mechanism. To demonstrate active stewardship of land and biodiversity by: Identifying and removing relevant species if necessary.	Hydrocarbon spillages are addressed according to Hazardous Substances Management Procedure and Emergency Preparedness and Response Procedure. Harmony Biodiversity arrangements. Manage soils in line with the requirements of the National Norms and Standards for the Remediation of Contaminated Land and Soil Quality (GN 37603 No 331). GNR 893 Minimum Emission Standards.
Operations of all facilities	550 ha	Biodiversity	**Loss of native biodiversity at Vaal River Operation** Physical disturbance of soils, vegetation. Contamination of soil and water. Altered veld fire regimes due to anthropogenic impacts on vegetation structure and biomass (increased fuel-loads for hotter fires in secondary wetlands and grasslands); Invasion by terrestrial alien plants such as *Eucalyptus*, Australian *Acacia* species, *Tamarix ramosissima* and *Opuntia* (prickly pear) species, which out-compete indigenous species, and can in some cases negatively impact on soil chemical properties for indigenous ecosystems; Eutrophication of upstream and on-site water bodies, and invasion by aquatic alien invasive plants such as water hyacinth, which alter stream flow regimes, smother aquatic ecosystems and impact negatively on aquatic invertebrates, amphibians and fish; Dust from TSFs, waste rock dumps and dirt roads, which may smother vegetation, reduce the palatability	• Planning of all new developments should be done with increased sensitivity to the environment and comply with the Biodiversity Management Plan (Appendix 3: Moab Khotsong Alien Management Plan). • Implement alien and invasive eradication planning, fire break planning and controls as per the Alien Invasive Plant Assessment and Management Plan (Appendix 3: Moab Khotsong Alien Management Plan). • Planning of all new developments should be done with an increased sensitivity to the environment and must comply with the Land use and Biodiversity Management Standards. Development is prohibited in the riparian zone within a designated distance (as appropriate to the locality) from the river banks; • Development (unless Authorization is obtained) in the Endangered Vaal Vet Sandy Grassland, the Vulnerable Vaal Reef Dolomite Sinkhole Woodland, and the endemic and unique Black Reef Metallophyte Woodland should be prevented or restricted; • Maintain and restore the structure, function and composition of ecological processes. To achieve this the applicant will develop and maintain a Biodiversity Action	To demonstrate active stewardship of land and biodiversity by: Identifying and removing relevant species if necessary; and Compilation and implementation of the Biodiversity Action Plan.	Harmony Biodiversity Management Plan. Manage soils in line with the requirements of the National Norms and Standards for the Remediation of Contaminated Land and Soil Quality (GN 37603 No 331). Harmony Policies and Guidelines to manage and remediate spills. GNR 893 Minimum Emission Standards. Moab AEL conditions. .

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
			of the vegetation, cause soil pollution and alter the distribution of animals. Persecution of animals by hunting with dogs, snares, traps, poisoning and collecting as pets; Collection of protected or vulnerable plant and animal species (all native vertebrates, and some invertebrates, are protected; all monocotyledon plant species are protected, excluding some grasses, reeds and sedges; some dicotyledon plant species are protected); and Unsustainable harvesting of plants and animals.	Plan (BAP) for the Harmony Moab Khotsong that respond to "thresholds of probable concern" (TPCs) where appropriate; and which will be informed by analyses of ecosystem services and key ecological process drivers, with environmental quality, species and populations being used as indicators of change. ○ Harmony (Group) is currently undertaking a gap assessment on its biodiversity requirements. Any actions applicable to Moab will be assessed (feasibility) on implementation e.g. alien and invader assessments and eradication programmes; ○ Compile an inventory of disturbed and contaminated areas, with emphasis on the characterisation of the disturbance or contamination and bioavailability; and ○ The BAP will include components for: sensitive habitat restoration (e.g. wetlands including the riparian zone, rocky ridges); protection of sensitive habitats from further development; limitations on grazing or other agricultural encroachment into habitat; fire controls; eradication of alien invasive species; engagement with natural resource harvesters; restrictions on pesticide and fertilizer use; and control of other forms of environmental pollution. • None of the Soil Conservation Plan (including borrow pit management plan, stockpile management, riparian zone management plan and road management plan) will be implemented by Harmony. These were AngloGold initiatives. Only the annual Fire Management planning will be done by Moab Khotsong Operations. • Construction of effective pollution control structures (berms) along tailings pipelines must be implemented only where ponding will not occur over dolomites, and the remedial standard after tailings spillage must be implemented; • Develop a rehabilitation plan for historic spillages or ensure closure rehabilitation provision; • Ensure compliance with the compulsory firebreak requirements in terms of the National Veld and Forest Fire Act of 1998. Burning of grassland should not be used as a land management tool without the recommendation of a		

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
				professional fire ecologist registered with the SAIE&ES. Awareness campaigns will be implemented regarding veld fires and the effect on the environment and habitat for the African Grass Owl and other species; • Develop and implement a co-ordinated (between the different business units) and systematic invader plant control programme which will address integrated control and comply to the Conservation of Agricultural Resources Act, 1983 and National Environmental Management Biodiversity Act, 2004; • Conduct specialist investigations on all identified areas and implement control measures at sources (tailings dams). Implement tested phytotechnologies to degrade / remove harmful chemicals from impacted soil and groundwater, and restore soil carbon; • Implement effective dust control measures at sources. Limit the use of dirt roads where possible; • Ad hoc awareness campaigns on the mine and local community to inform the people about the impact their actions, and their pets, have on nature and what they can do prevent it; • If/when required, awareness campaigns will be implemented to inform the people about the status and role of animals and plants in the ecosystem; • If/when required, investigation will be done on the harvesting pressures on natural resources, including utilization of endangered or rare plant species, their distribution within Harmony's surface land and the measures to ensure sustainable use of plants by harvesters.		
Operations of all facilities	550 ha	Surface water	**Deterioration of surface water quality** Contamination of surface water as a result of seepage and run-off from waste rock dumps, TSFs, shaft complexes and plants. This contaminated water may run into the Vaal River resulting in deterioration of water quality in the Vaal River.	• The following management measures are in place to monitor and to protect water resources: **Metallurgical Plants:** • Volumes of water entering and exiting metallurgical plant areas are recorded in a site water balance; • Plants boundary sampling points have been identified and sampling of these points are conducted should discharge occurs. The water quality analysis includes i.e., cyanide,	To avoid or where not possible, minimise and remedy pollution of water; Implementing a Leak/Spill Procedure; Compiling monitoring report; Implementing the Storm water Management Plan; and	Drinking water standards (SANS241:2011). IRWQO for the Vaal River catchment. Hydrocarbon spillages are addressed according to Hazardous Substances Management Procedure and Emergency

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
				suspended solids, dissolved solids, pH, conductivity, etc. as prescribed per the site water sampling schedule; • Metallurgical plant solution spillages are directed via lined trenches to collection sumps for re-circulation within the process; • Slurry spillage is hosed into concrete sumps and returned into the process; • Ore spillage is manually collected and returned to the appropriate process; • Final treated residue is disposed of onto tailings storage facilities; and • Polluted water run-off is collected and contained in internal pollution control dams for re-use. **Mines:** • Volumes of water entering and exiting the shafts are recorded in a site water balance; • Boundary sampling points have been identified and sampling of these points are conducted should discharges occurs. The water quality analysis includes i.e., suspended solids, dissolved solids, pH, conductivity, etc. as prescribed per the site water sampling schedule; • Flow measurements at the boundary discharge points are recorded prior to being discharged into the process water reticulation system; and • The Environmental Department to ensure the first flush sample arrangements annually **Hazardous materials and potential pollutants:** • Hazardous materials and potential pollutants are limited to primary and secondary containment in the business units where special precautions are taken in accordance with required legislation, standards and procedures. The handling of hazardous materials is in accordance with storage and handling procedures, standards and codes of practices as prescribed by Harmony; and • Bund walls have been constructed around hazardous material storage areas and potential pollutants. **Wash Bays:**	Responding to complaints and implementing a grievance mechanism.	Preparedness and Response Procedure.

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
				• Bund walls have been constructed around wash bays and separation sumps have been constructed in order to prevent polluted water from leaving the Business Unit; • Hydrocarbons are removed directly from the Business Units by approved Service Providers. Alternatively, it is managed through the Moab Central Salvage Yard, which uses approved service providers; • Sludge and excess water is returned to the process water reticulation system; • Maintenance of the water reticulation system and water meters; and • Regular inspections are carried out on water reticulation infrastructure and associated equipment. **Tailings Storage Facilities:** • The following management system will be implemented for the tailings storage facilities: o A Code of Practice. (Harmony Mandatory Code of Practice for Mine Residue Deposits) (latest approved COP) (refer to Appendix 1: Code of Practice for Mine Residue Deposits); o A Tailings Storage Operating Manual; o Harmony's Guideline for Tailings Management (Appendix 7: Harmony Guidelines for Tailings Management); o Operational Manual for Hydraulic Reclamation. Fraser and Alexander Tailings – AGA; o Reporting. Tailings Management at Vaal River Operation. Annual Tailings Dam/Residue Deposition Report; and o Regular systems and operation audits. **Return Water Dams and Settling Dams:** • The return water dams are operated at levels that will allow adequate capacity for storage of water in the return water dam and supply to the Metallurgical processes. Return water dams are managed according to the Mandatory Code of Practice for Mine Residue Deposits, Wates, Meiring and Barnard, Harmony, which include the following:		

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
				• Maintaining the volume of water on the return water dams as low as possible to allow storms to be absorbed in the system. • Returning the maximum volume of water to the metallurgical plants for re-use. The management of water on the facilities is carried out in the following manner: • Water is delivered with the slurry. The solids are allowed to settle on the beach and the supernatant water flows to the pool in the centre of the TSF. The clean water is decanted the same day; • Rain water arising on the TSF is decanted through the penstock to the return water dams. Storm water is decanted off as soon as possible; • Harmony's Freeboard Standard is in line with the legal minimum standard of 0.8m and daily assessment to be conducted; • Desilting and clean-up of return water dams to be conducted regularly; • Daily foreman dam patrols; • Installation and ensuring security measures at the dams; and • Pipelines to be checked regularly to enable effective water pumping to the thickener tanks. **Process Water Dams** • The following measures are in place to prevent polluted water from entering the environment: • The dams are cleaned out at regular intervals, reducing silt levels and assisting to maintain the required capacity and freeboard; • Water is returned from the dams and used as process water; • Volumes of water are recorded, in the water balance, of water entering and exiting the dams; and • Regular inspections are carried out on the water reticulation infrastructure and associated equipment and maintenance is scheduled accordingly.		

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
				Incident Management • Applicant management will notify the Regulator(s) of any emergency incident or potential emergency incident involving a water resource at or incidental to the operation of a mine or the conducting of any activity according to the requirements set out in Regulation 704 2 (c) and (d). • <u>All low risk incidents to be reported to DWS annual report or when there are 3 or more repeating incidents and the same facility, these will then be reported to DWS.</u> **Capacity requirements of clean and dirty water systems** Applicant commits to: • Confine unpolluted water to a clean water system, away from any dirty area; • Design, construct, maintain and operate clean water systems at the mine or activity so that it is not likely to spill into dirty water systems more than once in 50 years; • Collect the water arising within dirty areas, including water seeping from mining operations, outcrops or any other activity, into a dirty water system; • Design, construct, maintain and operate any dam or tailings facility that forms part of a dirty water system to have a minimum freeboard of 0.8 meters above full supply level; and • Design, construct and maintain all water systems in such a manner as to guarantee the serviceability of such conveyances for flows up to and including those arising as a result of the maximum flood with an average period of recurrence of once in 50 years. **Protection of water resources** Applicant commits to take reasonable measures to, and assign responsibilities to management to: • Prevent water containing waste or any substance which causes or is likely to cause pollution of a water resource from entering any water resource, either by natural flow or by seepage; • Retain or collect such substance or water containing waste for use, re-use, evaporation or for purification and disposal;		

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
				• Design, modify, locate, construct and maintain all water systems, including residue deposits, in any area so as to prevent the pollution of any water resource through the operation or use thereof and to restrict the possibility of damage to the riparian or in-stream habitat through erosion or sedimentation, or the disturbance of vegetation, or the alteration of flow characteristics; • Cause effective measures to be taken to minimise the flow of any surface water or floodwater into mine workings, opencast workings, other workings or subterranean caverns, through cracked or fissured formations, subsided ground, sinkholes, outcrop excavations, adits, entrances or any other openings; • Design, modify, construct, maintain and use any dam or any residue deposit or stockpile used for the disposal or storage of mineral tailings, slimes, ash or other hydraulic transported substances, so that the water or waste therein, or falling therein, will not result in the failure thereof or impair the stability thereof; • Prevent the erosion or leaching of materials from any residue deposit or stockpile from any area and contain material or substances so eroded or leached in such area by providing suitable barrier dams, evaporation dams or any other effective measures to prevent this material or substance from entering and polluting any water resources; • Ensure that water used in process at the mine or an activity is recycled as far as practicable, and any facility, sump, pumping installation, catchment dam or other impoundment used for recycling water, is of adequate design and capacity to prevent the spillage, seepage or release of water containing waste at any time; and • At all times keep any water system free from any matter or obstruction which may affect the efficiency thereof. **Security and additional measures** Applicant commits to take reasonable measures to, and assign responsibilities to management to: • Cause any impoundment or dam containing any poisonous, toxic or injurious substance to be effectively fenced-off or demarcated, where possible, so as to restrict access thereto, and must erect warning notice boards at		

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
				prominent locations so as to warn persons of the hazardous contents thereof; • Ensure access control in any area used for the stockpiling or disposal of any residue or substance which causes, has caused or is likely to cause pollution of a water resource; • Not allow the areas used for containing polluted water, or mine residue deposits or stockpiling, to be used for any other purpose, if such use causes or is likely to cause pollution of a water resource; and • Protect and maintain any existing pollution control measures from being damaged or destroyed by the removing or reclaiming of materials from any residue deposit or stockpile, and establish additional measures for the prevention of pollution of a water resource which might occur, is occurring or has occurred as a result of such operations.		
Operations of all facilities	550 ha	Air Quality	**Generation of dust fallout** The Mispah TSF and waste rock dumps are not located in close proximity of any towns or villages. The predominant wind directions are north, north northeast and north northwest which is away from Orkney and Buffelsfontein which are the closest residential areas. Significant emissions arise due to the mechanical disturbance of granular material from tailings impoundments. Parameters which have the potential to impact on the rate of emission of fugitive dust include the extent of surface compaction, moisture content, ground cover, the shape of the tailings, particle size distribution, wind speed and precipitation. Any factor that binds the erodible material, or that reduces the availability of erodible material on the surface, has the ability to decrease the erosion potential of the fugitive source. High moisture contents, whether due to precipitation or deliberate wetting, promote the aggregation and cementation of fines to the surfaces of larger particles, thus decreasing the potential for dust emissions. Surface compaction and ground cover similarly reduces the potential for dust generation. The shape of a tailings dam also influences the potential for dust emissions by altering the airflow field. The particle size	• Moab Khotsong Operations baseline Air Quality Risk Assessment and Dust Fall-out Assessment. • Assessment of odour emissions from sewage treatment facilities (and other potential odour activities) • <u>Ventilation specialist to assess all occupational impacts for vent shaft emissions.</u> • Participate in forums in order to influence decisions from tiers of government and the public at large. Such forums include: ○ Kenneth Kaunda Air Pollution Forum; ○ KOSH Air Quality Forum.	To minimise the entrapment potential of dust. To keep PM_{10} (and in the future, $PM_{2.5}$) and dust fallout levels at key receptor sites around the project area within Guideline levels. As the Guidelines vary depending on the priority area and year, the South African Air Quality Information System (http://www.saaqis.org.za/) will be consulted for the most recent Guidelines. These aforementioned standards will be achieved by: Dust monitoring programme; and Providing evidence of dust suppression.	GNR 893 Minimum Emission Standards. Moab Khotsong AEL requirements/ compliance conditions. SANS standards for dust deposition: ambient air quality – Limits for common pollutants. SANS 1929: 2005, Section 4.8 - Dust Deposition.

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
			distribution of the material on the disposal site plays an important role since it determines the rate of material entrainment from the surface, as well as the nature of dispersion of the dust plume and the rate of deposition. When the tailings storage facilities and associated waste rock dumps are left uncovered, consistent heavy dust fall problems may be common. These waste rock dumps can also be a cause for concern because they are constantly being reworked thus exposing fresh surface to wind erosion.			
Operations of all facilities	550 ha	Heritage	A heritage and cultural study was undertaken. The following cultural significant structures were identified. • Pretoriuskraal graveyard (PTN 24) • Pretoriuskraal graveyard (PTN 13 Private land) • Chrystalkop graveyard • Zuiping graveyard • Zuiping Restant graveyard • Mispah graveyards • Moab graveyard • Zaaiplaats graveyard • Groot Vaders Bosch graveyard • De Hoek graveyard • Doornkom West structures • Chrystalkop structures • Zuiping structures • Zuiping Restant structures • Mispah structures The above heritage sites are not located within the Harmony Moab Khotsong Operations infrastructure footprint and as part of this EMP no new infrastructure will be developed.	No management measures were included in the 2009 AGA EMP. Annual cleaning and maintenance of grave-sites are done to enable access and control, should it be requested by the public or mine personnel.	To ensure heritage resources are not damaged during the mining process.	Ordinance on Excavations (Ordinance No. 12 of 1980) (replacing the old Transvaal Ordinance No. 7 of 1925).

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
Operations of all facilities	550 ha	Noise	The ambient noise around the Vaal River Operations is typical of rural/urban environment interspersed with mining / industrial activities which are confined to the immediate operational areas. Noise levels are measured on the mine in all underground workings, metallurgical plants and workshops at least once every three (3) months. Areas where the noise level exceeds the maximum allowable noise levels are mainly workshops especially boiler and blacksmith workshops. Hearing protection devices are available to all employees in these areas. Surface noise level surveys are regularly undertaken and reported on and made available in specific instances. The major sources of noise within the Vaal River Operations include: • The following sources of noise are experienced during the operation of the Vaal River Operations mining related activities: • Vehicular traffic from contractors and visitors; • Heavy machinery and equipment transporting goods and materials to and from the mines; • Maintenance around the mines on infrastructure and servitudes; • Winder houses and headgear; • Main fans and air coolers; • Compressors and Ice plant; • Conveyor belt; • Salvage yard; • Ore dropping into silos; and • Processing plant. Blasting and Vibrations – during mining activities, blasting and drilling activities are carried out to release the ore body and allow for extraction to surface. During this process, vibrations are generated which may negatively impact on the surrounding environment.	A noise assessment was done in 2012/3. Additional noise assessment will only be done, if there are an expansion or addition to current Moab Khotsong Operations activities. Quarterly noise, ambient air quality and thermal stress assessments are done by the Occupational Environmental Department and submitted to the DMRE. Measures, which are commonly adopted include: • Selecting low noise plant and equipment incorporating available noise control kits; • Adding attenuators to mine ventilation fans; • Providing acoustical enclosures and acoustical treatment of process buildings; • Optimum placement of waste dumps, location of haul roads, location of fixed plant such as crushers and loading hoppers which can be used to shield fixed items of plant which generate noise; • Provision of sound walls and acoustical screening; • Incorporating optimum buffer zones and setback distances. This is only of use where large distances are involved. In general, doubling the distance between the source and receiver will result in a 6 dBA reduction in noise level; • Implementing a noise monitoring programme if any new noise generating activities are undertaken; and • Community/residence liaison - As part of a Noise Management , Moab Khotsong Operations have a complaints system and noise complaints will be investigated, if required.	To minimise noise impacts on sensitive receptors by: Developing a complaints register to record complaints regarding noise; and To maintain noise levels at the standards for suburban areas (SANS 10103) as far as practicable.	Compliance with SANS 10103 Acceptable Ambient Levels and SANS 10210 of 2004, the national standard for the calculating and predicting of road traffic noise. SANS 10328 of 2008. Noise Control Regulations – General Notice R154 of 10 January 1992.

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
Operations of all facilities	550 ha	Social	Social impacts were not assessed as part of the 2009 AGA EMP.	N/A	To enhance benefits from the development of the Project; To maximize opportunities for local residents; To facilitate employment of local labour on the Mine; To avoid creating unrealistic expectations; and These standards will be achieved by the implementation of the SLP. To ensure that retrenched employees can pursue alternative livelihoods by: Developing a Closure Plan.	Harmony existing Standards and Procedure
Operation of all facilities	550 ha	Waste management	Impact on the receiving environment due to inadequate waste storage and management (excluding TSFs and waste rock dump, general and hazardous waste only)	The integrated waste management programme, which includes the following components: • Segregation, handling and storage o Measures to segregate waste types according to their chemical and physical characteristics or disposal method. o The location and design specifications of waste transfer and disposal facilities suited to the waste type being managed and ensure protection of the environment and the health and safety of people. • Transport and disposal o The regulatory requirements relating to the transportation of hazardous & non-hazardous waste materials specified in the waste management programmes. o Waste disposal on Harmony property, including in landfill sites, pits and via co-disposal in rock dumps, will only take place if approved by relevant Authority. o Proof of safe off-site disposal of hazardous waste materials.	Minimise generation and disposal of general and hazardous waste on site.	Ensure that waste is avoided, reduced, re-used, re-cycled, recovered, treated or disposed. Ensure that SDS sheets are available at storage site.

Activity	Size	Environmental aspect	Potential Impact	Mitigation Measures	Standard to achieve	Compliance with standard
				○ Where off-site disposal is done by contractors, the contractor must provide proof of registration to conduct such business and the proof of safe disposal. • Monitoring ○ Where waste transfer, sorting or disposal activities present a risk of land and water becoming contaminated, suitable monitoring programmes to enable corrective and preventative actions will be developed and implemented. • Emergency Preparedness and Response ○ Sites must include appropriate responses to hazardous waste incidents in emergency preparedness and response planning. Waste to be managed in accordance with the IWWMP and Waste Management Procedure.		

4 DESCRIPTION OF IMPACT MANAGEMENT OBJECTIVES

4.1 CLOSURE OBJECTIVES

The following rehabilitation and closure objectives were included in the 2009 AGA EMP. Harmony will adopt these closure objectives:

Specific closure objectives are to:

- Protect the environment and public health and safety by using safe and responsible closure practices;
- Minimize potential environmental effects, such as surface or ground water impacts;
- Rehabilitate or remove any waste or potentially hazardous substances from site;
- Develop landforms that, within reasonable and practical limitations, are stable and blend with the surrounding terrain;
- Improve water quality consistent with the water quality standards within Harmony's area of responsibility;
- Development of end land use that takes into account the beneficial uses of the site and surrounding areas (where possible);
- Leave a closed mine that does not represent a risk to the health and safety of the community;
- Reduce the requirement for long-term monitoring and maintenance by establishing stable landforms;
- Comply with national regulatory requirements;
- Address relevant stakeholder expectations, concerns and issues;
- To enhance a positive socio-economic impact by achieving a sustainable land use condition or alternatively as agreed upon with the applicable government regulator and affected communities (where possible and practical); and
- Obtain a closure certificate.

In addition to these objectives Harmony has considered relevant pieces of legislation, own environmental policies and commitments on mine rehabilitation and closure. The benefits arising from the rehabilitation are:

- Harmony's legal obligation of mine rehabilitation and closure is met;
- Restoration of the environment;
- The site is made safe;
- Address long-term fauna, flora and aesthetic impacts;
- Address long-term water impacts;
- The visual impact of the mine will be reduced;
- Some areas could be used for future alternate uses; and
- Able to leave a positive legacy for future generations.

4.1.1 POTENTIAL POLLUTION SOURCES

The sources that could have potentially impacts on the water resources within Harmony Moab Khotsong Operations and their potential mechanism of impact are indicated below

Table 8.

Table 8: Potential pollution sources of the Harmony Moab Khotsong Operations

Potential pollution source	Description	Potential mechanism of impact
OPERATIONAL PHASE		
Advancing mine workings	Potential decant points	Seepage to aquifers or decant into surface water
	Dewatering underground workings	
TSF and associated return water dam	Unlined facilities	Seepage to aquifers and watercourse and formation of a groundwater pollution plume
Pollution control dams and associated silt traps	Unlined facilities	Seepage to aquifers if liner integrity is compromised Spillage will be captured in dirty water management system and could result in an impact if not contained
Waste rock dumps	Material containing exposed sulfates and potentially radioactive material	Seepage into aquifers and contaminated run-off entering watercourses
Dirty water management system	Unlined canals	Seepage to aquifers Potential spillage into watercourses
Metallurgical plants	Unlined facility	Seepage into aquifers and contaminated run-off entering watercourses Potential spillage into watercourses
Salvage yards	Various waste streams	Seepage to aquifers or contaminated run-off if adequate protection (e.g. lining/bunding) is not provided

4.1.2 POTENTIAL RISK OF ACID MINE DRAINAGE

ARD occurs when sulfide minerals (e.g. pyrite) are oxidized through exposure to air, water and the action of sulfur-utilising bacteria such as *Thiobacillus ferrooxidans*. Oxidation yields sulfates and metal cations, and secondary minerals formed in this manner include jarosite, copiapite, gypsum and melanterite, among many others (Naicker *et al*., 2003). In shales and mudstones, chlorides may also be abundant.

Sources of sulfide minerals that generate ARD at Moab Khotsong Operations include the TSFs, ore stockpiles, low-grade ore in waste rock dumps, spilled mine residue material, stope faces and on-reef pillars left underground (e.g. for regional support or clamping along faults or dykes).

Although the location of Mine Residue Stockpiles on dolomite is sometimes believed to mitigate ARD, increased salinity and lowered pH of ARD increase the water's ability to dissolve dolomite (Hodgson *et al*., 2001). Two potential major implications of this are:

- Widening of preferred pathways causing greater overall transmissivity in the dolomites and greater storage volumes; and
- Possible stability problems, should excessive karstification result.

The most significant impacts of ARD on soils and water-bodies are considered to be decreases in pH, increases in electrical conductivity, increased availability of some metals, and coating of surfaces with iron oxides (`yellow boy'). Aquatic ecosystems, soil micro-organisms and micro-fauna are generally highly sensitive to variations in salinity and acidity or alkalinity, and coating. Many terrestrial and aquatic plants can tolerate fairly high sulfate concentrations, but (with the exception of halophytes) are more sensitive to sodium and chlorides at the same osmotic potentials.

On the Highveld, evapotranspiration exceeds precipitation by greater that two (2) (>2) times, hence during the dry winter season, mineral salts accumulate in the upper soil profile through capillary rise and evaporation (Naicker *et al*., 2003). On TSFs, soils overlying shallow seepage, and sediments of impacted wetlands and mine evaporation pans this results in mineral efflorescence of gypsum and other sulphates and chlorides that contain a number of metals and naturally-occurring radioactive elements such as uranium (Naicker; Tutu *et al*., 2008; Winde *et al*.; Witkowski and Weiersbye, 1998a; 2007). Depending on the mineral form, these elements may become less or more bio-available. During the rainy season the more soluble salts in this crust dissolve and release sulphates and low pH and metal-rich solutions into the soil profile, whereas the less soluble minerals remain in situ (Naicker *et al*., 2003; Tutu *et al*., 2008). Gypsum and jarosite are the commonest precipitate observed on ARD-impacted soils at Harmony Vaal River Operations forming white crusts on impacted soils. Gypsum has the lowest solubility of any sulphate and is a relatively benign and non-toxic soil-forming mineral. Jarosite is readily soluble.

4.1.3 STEPS TAKEN TO INVESTIGATE, ASSESS AND EVALUATE THE IMPACTS OF ACID MINE DRAINAGE

As part of the 2017 SRK EMP a groundwater specialist study was undertaken by GCS (Pty) Ltd. The groundwater and AMD impacts are described in Table 9. In the 2017 SRK EMP Consolidation additional groundwater studies were undertaken and the sulfate pollution plume further modelled. Refer to Figure 8.

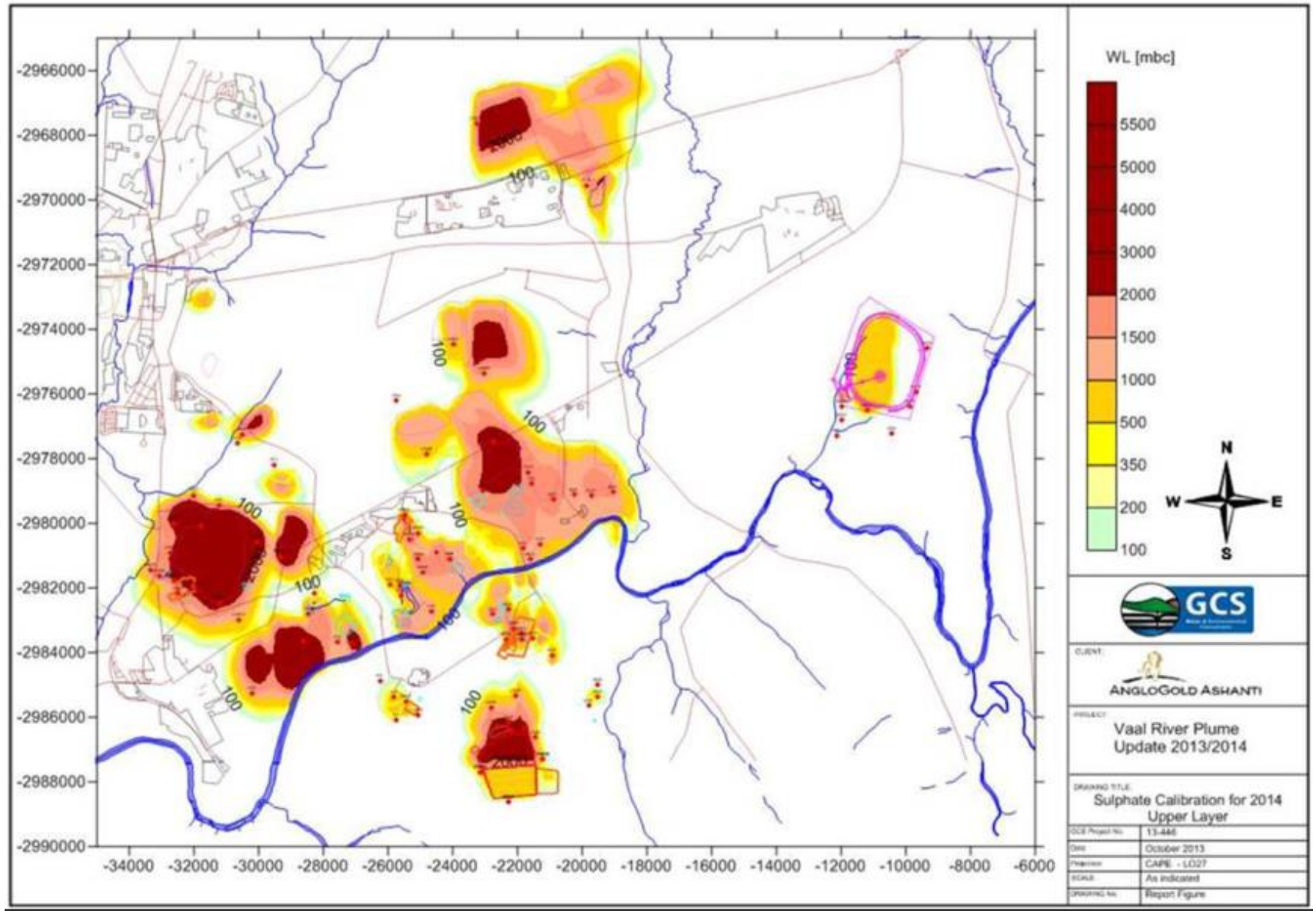

Figure 8: 2023/2014 sulfate plume delineation for the Vaal River Operations

5 MECHANISMS FOR MONITORING COMPLIANCE

5.1 MONITORING OF IMPACT MANAGEMENT ACTIONS

Harmony Moab Khotsong Operations will update and implement the existing Vaal River Operations monitoring programme and its acquired assets. The following impacts and environmental components will be monitored during all phases of the project:

- Surface water;
- Groundwater;
- Biodiversity;
- Air quality; and
- Noise.

5.2 MONITORING AND REPORTING FREQUENCY

The monitoring of impacts and reporting frequency will be different for the various environmental aspects.

Continuous dustfall monitoring has been operating around Moab Khotsong Operations since April 2004. The dust-monitoring network is done according to AEL requirements.

An updated Water Use License was issued to Moab Khotsong Operations. Both surface and ground-water monitoring are done in accordance with the updated License requirements. The updated Water Use Licence provides details of the number of surface and groundwater samples to be analysed either Monthly or Quarterly.

The latest monitoring points for the Harmony Moab Khotsong Operations are shown in the following figures and tables;

- Surface water:
- Groundwater:
- Biomonitoring:
- Noise monitoring:
- Dust fallout:

Table 9: Environmental components to be monitored and frequency

Aspect	Component	Data collection frequency	Phase of project	Reporting frequency
Surface water	Water quality	Quarterly and Monthly	Operational and closure	Quarterly reporting
Groundwater	Groundwater quality	Quarterly	Operational and closure	Quarterly reporting
	Groundwater level	Monthly	Operational and closure	Quarterly reporting
Biomonitoring	Instream water quality, IHAS and SASS5, FAII	Bi-annually	Operational and closure	Bi-annual

Aspect	Component	Data collection frequency	Phase of project	Reporting frequency
Air quality	Dust fallout	Monthly sampling	Operational and closure	Annual reporting
	Scheduled processes	Quarterly	Operational	Annual reporting

5.2.1 SURFACE AND GROUNDWATER

Table 10: Surface water quality monitoring points for Harmony Moab Khotsong Operations

Site ID	Description	Latitude (WGS84)	Longitude (WGS)
VRS20	Mispah return water dam. The dam is unlined (rock lined on side wall)	-26.9911	26.77082
VRS37	Great Noligwa Gold and South Uranium Plants return water dam. The dam is lined	-26.9603	26.77085
VRS55	Kopanang Pay Dam return water dam at overflow point. The dam is unlined (rock lined on side walls).	-26.9903	26.77989
VRS58	Seepage into Vaal River.	-26.9462	26.78092
MS08	Mispah underdrains.	-26.9934	26.77089

Table 11: Groundwater quality monitoring points for Harmony Moab Khotsong Operations

Site	Description	Co-ordinates		Monitoring Frequency
		Latitude	Longitude	
Vaal River Waste Disposal Facility's Monitoring Boreholes				
VR12	North western corner of VR Domestic Waste Site	S 26^0 57' 00.86"	E 26^0 44' 19.39"	Quarterly
VR13	Down gradient-Southern end of Domestic Waste Site	S 26^0 57' 12.02"	E 26^0 4' 31.56"	Quarterly
VR14	East of Domestic Waste Site	S 26^0 57' 01.47"	E26^0 44' 30.02"	Quarterly
Great Noligwa Shaft area Monitoring Results				
GN02	Between No.8 Met plant return water dams & Vaal River	S 26^0 57' 30.94"	E 26^0 46' 14.83"	Quarterly
GN04	Upstream of 8# Waste Rock	S 26^0 58' 11.67"	E 26^0 47'20.79"	Quarterly
GN06	Within 8 Sewage Plant	S 26^0 57' 25.98"	E 26^{0}46' 31.64"	Quarterly
GN08	West of Waste Rock Dump, between dump and South U-Plant	S 26^0 57' 55.02"	E 26^0 46' 59.91"	Quarterly
GN10	Between VRE7 and Vaal river	S 26°56'58.96"	E 26°46'38.92"	Quarterly

Site	Description	Co-ordinates		Monitoring Frequency
		Latitude	Longitude	
GN11	West and Downstream of GN10	S 26°57'4.34"	E 26°46'0.05"	Quarterly
Great Noligwa Gold and South Uranium Plants Monitoring Boreholes				
VRM32	North of Barren Dams South U-Plant	S 26^0 57' 50.37"	E 26^0 46' 46.90"	Quarterly
VRM33	Northwest of Barren Dams South U-Plant	S 26^0 57' 56.44"	E 26^0 46' 46.70"	Quarterly
VRM48	South West of Noligwa Gold Plant	S 26^0 57' 44.88"	E 26^0 46'38.34"	Quarterly
VRM50	North West of South U-Plant	S 260 57' 55.62"	E 260 46'29.12'	Quarterly
Mispah TSF Complex				
VRM06	Directly north of Mispah	S 260 59' 33.90"	E 260 46'20.10"	Quarterly
VRM07	North of Mispah	S 260 59' 20.15"	E 260 46' 31.60"	Quarterly
VRM14	In Mispah Game Reserve, on eastern side of slimes dam.	S 260 59' 34.91"	E 260 47' 02.29"	Quarterly
VRM51D	North of Mispah TSF (Deep)	S 260 59' 26.50"	E 26°46'36.18"	Quarterly
VRM58D	North of old Mispah RWD	S 260 59' 22.74"	E 26°46'19.82"	Quarterly
VRM59D	South Western corner of Mispah TSF	S 270 00' 09.21"	E 260 46' 00.66"	Quarterly
VRM59S	South Western corner of Mispah TSF	S 270 00' 09.38"	E 260 46' 00.67"	Quarterly
VRM61D	East of old Mispah TSF	S 260 59' 56.60"	E 260 47' 10.73"	Quarterly
VRM61S	East of old Mispah TSF	S 260 59' 56.59"	E 260 47' 10.57"	Quarterly
VRM70	North East of Mispah TSF	S 260 58' 52.70"	E 260 46' 40.48"	Quarterly
MP16D	South of Old Mispah	S 270 00' 39.55"	E 260 46' 32.23"	Quarterly
MP16S	South of new Mispah TSF	S 270 00' 39.48"	E 260 46'32.41"	Quarterly
VRM71	North West of Mispah TSF	S 260 59' 04.42"	E 260 46' 12.91"	Quarterly
Moab Khotsong				
MKOI	South of Moab WRD	S 260 59 02.65"	E 260 48' 02.27"	Quarterly
MK04	East of the Moab WRD	S 260 58' 54.00"	E 260 48' 11.94"	Quarterly
MK06	North of Moab Waste Rock Dum	S 260 59’41.99’	E 260 48' 12.01"	Quarterly
MK12	North of Moab Waste Rock Dum	S 26°58'41.91"	E 26°47'47.42	Quarterly
Northern Wellfield				
VRE06	East Wellfield (South of Vaal River)	26°57'12.02" S	26°44'31.56" E	Quarterly

Figure 9: Harmony Moab Khotsong Water Monitoring Map according to latest water monitoring reports

5.2.2 BIOMONITORING

Harmony Moab Khotsong Operations have 3 biomonitoring sites as per the 2009 AGA EMP. Biomonitoring will occur bi-annually (Figure 10) (Done by Harmony's Vaal River Operations and the report will be shared with Moab Khotsong Operations).

Figure 10: Biomonitoring points for Vaal River Operation

5.2.3 DUST MONITORING

Table 12: Dust fallout monitoring points for the Moab Khotsong Operations (according to latest dust monitoring reports) Refer to Figure 9 for the location of the monitoring points.

Site Description	Site Classification	Filter No	Geographical (WGS84)	
			Latitude	Longitude
S.A METALLURGICAL TECH SERVICES	Residential	HMK 21/41	26° 57’ 06.9’’ S	26° 47’ 07.0’’ E
EAST OF KOPANANG PAYDAM (site decommissioned)	Non-residential	HMK 21/42	26° 00’ 31.9’’ S	26° 47’ 28.3’’ E
SOUTH OF MISPAH TSF	Non-residential	HMK 21/43	26° 00’ 41.7’’ S	26° 46’ 31.1’’ E
EAST OF MISPAN MISPAH TSF	Non-residential	HMK 21/44	26° 59’ 41.1’’ S	26° 47’ 08.2’’ E
WEST OF MISPAN MISPAH TSF	Non-residential	HMK 21/45	26° 59’ 51.8’’ S	26° 45’ 38.3’’ E
WEST NOLIGWA SEWAGE PLANT	Residential	HMK 21/46	26° 57’ 28.6’’ S	26° 46’ 36.8’’ E
HG4 MZIMUHLE - NEXT TO MOAB KHOTSONG PARKING AREA	Residential	HMK 21/47	-26.98951833 S	26.80092000 E
11# WASTEWATER TREATMENT PLANT	Non-residential	HMK 21/48	-26.98383988 S	26.80370333 E
HG1 NORTH MOAB KHOTSONG MINE WASTE ROCK DUMP	Non-residential	HMK 21/49	-26.97860500 S	26.80006333 E
HG5 SOUTH BEHIND KOPANANG GOLD PLANT	Non-residential	HMK 21/50	-26.98670333 S	26.74277500 E
HG3 – VILLAGE REEF MINE SCRAPYARD AREA	Non-residential	HMK 21/51	-26.97866167 S	26.74134000 E
SOUTH NOLIGWA – WEATHER STATION SOUTH OF SOUTH URANIUM PLANT	Non-residential	HMK 21/52	-26.97073833 S	26.77660000 E

Figure 11: Dust fallout monitoring sites for Harmony Vaal River Operations (updated)

5.3 RESPONSIBLE PERSONS

An Environmental Manager and Environmental Management Coordinators will be responsible for ensuring that all necessary environmental monitoring required for the Harmony Moab Khotsong Operations is undertaken as per the monitoring and measurement system.

5.4 TIME PERIOD FOR IMPLEMENTATING IMAPCT MANAGEMENT ACTIONS

As the Moab Khotsong Operations is already operating, impact management actions have been implemented. These management actions will continue to be implemented for the life of the mine by Harmony Moab Khotsong Operations. Current Life of Mine is estimated till 2044, with consideration of the Zaaiplaats mining activities.

5.5 MECHANISMS FOR MONITORING COMPLIANCE

The mechanisms for monitoring compliance are described in Table 13.

Table 13: Harmony Moab Khotsong monitoring compliance

SOURCE ACTIVITY	IMPACTS REQUIRING MONITORING PROGRAMMES	FUNCTIONAL REQUIREMENTS FOR MONITORING	ROLES AND RESPONSIBILITIES (FOR THE EXECUTION OF THE MONITORING PROGRAMMES)	MONITORING AND REPORTING FREQUENCY and TIME PERIODS FOR IMPLEMENTING IMPACT MANAGEMENT ACTIONS
Operation of all Harmony Moab Khotsong facilities	Pollution of surface water	A grab surface water sample is undertaken required from watercourses around the project area. A monitoring programme for the water management facilities at the shaft complexes have been developed and should be updated.	The Environmental Co-ordinator at the Mine is responsible for sourcing the necessary specialist to undertake the water monitoring.	• Surface water (quality and quantity) are sampled at various frequencies (monthly or quarterly) and a monitoring report is generated on a quarterly basis. • Impacts are managed immediately should water monitoring detect contamination or a change in water quantity during all phases of the Project.
	Pollution of groundwater	Pump tests from the boreholes are required and undertaken in accordance with the Harmony Moab Khotsong Operations borehole network. Network to be updated by Harmony Moab Khotsong Operations.	The Environmental Co-ordinator at the Mine is responsible for sourcing the necessary specialist (or in house specialist) to undertake the groundwater monitoring.	• Groundwater quality is monitored on a quarterly basis and reports are compiled accordingly. • Borehole depth is monitored on a quarterly basis and reported on annually. • Impacts are managed immediately should groundwater monitoring detect contamination or a change in water quantity or

SOURCE ACTIVITY	IMPACTS REQUIRING MONITORING PROGRAMMES	FUNCTIONAL REQUIREMENTS FOR MONITORING	ROLES AND RESPONSIBILITIES (FOR THE EXECUTION OF THE MONITORING PROGRAMMES)	MONITORING AND REPORTING FREQUENCY and TIME PERIODS FOR IMPLEMENTING IMPACT MANAGEMENT ACTIONS
				depth in monitoring boreholes during all phases of the Project.
	Aquatics	Biomonitoring is undertaken bi-annually. Biomonitoring points to be updated by Harmony Moab Khotsong Operations.	The Environmental Co-ordinator at the Mine is responsible for sourcing the necessary specialist to undertake the biomonitoring.	• Biomonitoring (including IHAS, SASS5 and FAII) is undertaken bi-annually to capture the impacts during the wet and dry seasons. • Reporting is undertaken on a – bi-annual basis.
	Increase in dust fallout affecting adjacent landowners/households.	Gravimetric analysis is undertaken for all dust buckets. The Air Quality monitoring plan should be updated by Harmony Moab Khotsong Operations.	The Environmental Co-ordinator at the Mine is responsible for sourcing the necessary specialist to undertake the dust fallout monitoring.	• Dust fallout is monitored on a monthly basis. • An annual report is generated to illustrate the findings. • Air quality impacts are investigated and monitoring detect an increase in nuisance dust. • Management actions are applicable for all phases of the Project.

SOURCE ACTIVITY	IMPACTS REQUIRING MONITORING PROGRAMMES	FUNCTIONAL REQUIREMENTS FOR MONITORING	ROLES AND RESPONSIBILITIES (FOR THE EXECUTION OF THE MONITORING PROGRAMMES)	MONITORING AND REPORTING FREQUENCY and TIME PERIODS FOR IMPLEMENTING IMPACT MANAGEMENT ACTIONS
	Noise monitoring	• Noise monitoring is conducted according the SANS 10103:2008 standards. • The daytime and night-time industrial guidelines of 70dBA and 60dBA respectively is applicable.	The Environmental Co-ordinator at the Mine is responsible for sourcing the necessary specialist to undertake the noise monitoring. Done by the Occupational Environmental Department.	• Noise monitoring as required. • Monitoring includes daytime and nighttime sampling as the facilities are operating full time (24 hour operation).

5.6 PERFORMANCE ASSESSMENT PLAN

The EMPr performance assessment (audit) must be undertaken every two years by an external auditor, following the approval/submission of this amendment and a report must be compiled and submitted to the competent authority.

An internal peer audit should be undertaken every alternate year by Harmony Environmental Services. This involves environmental personnel from other Harmony mines coming to audit the mine on the Environmental Management Systems (EMS) and other environmental parameters.

Operational internal environmental inspections will need to be done quarterly by the mine's environmental personnel (as per EMS requirements).

5.7 ENVIRONMENTAL AWARENESS PLAN

5.7.1 MANNER IN WHICH THE APPLICANT INTENDS TO INFORM HIS OR HER EMPLOYEES OF ANY ENVIRONMENTAL RISK WHICH MAY RESULT FROM THEIR WORK

Environmental requirements are included in any operational contracts, thereby making contractors aware of the potential environmental risks associated with the project and the necessity to prevent accidental spillages by the implementation of good housekeeping practices.

The following principles will apply to the Environmental Awareness Plan (safety, health and environmental (SHE) training):

- All personnel are as a minimum, undergo general SHE induction and awareness training;
- An EMS Representative and coordinators have been appointed; and
- The EMS coordinator/ Site Environmental Officers will identify the SHE training requirements for all personnel and contractors.

The training requirements are recorded in a training needs matrix indicating particular training that must be undertaken by identified personnel and contractors. The training matrix is administered by the Training Department

- Development of Training Programme; and
- General Awareness Training.

Personnel

All employees, current, new and contractors are to undergo induction, a part of which is environmental awareness training. At the end of this training, personnel are required to complete the awareness test and the level of awareness assessed by the Training Department. Re-testing or induction may be required.

All personnel performing tasks which can cause significant or major environmental impacts shall be competent on the basis of training, education and/or experience. This applies to, but is not limited to, supervisor level and above, i.e. operators and artisans.

Type

Awareness training will include the potential consequences of departure from specified operating procedures as well as significant environmental impacts, actual or potential, of their work activities.

Training is appropriate to the activity of individual employees.

Quarterly environmental topics are generated to raise awareness of employees on environmental issues.

Evaluation

Evaluation of awareness and competency training are carried out through questionnaires or post-training tests conducted during training sessions and are also done through questioning of employees during audits.

5.7.2 MANNER IN WHICH RISKS WILL BE DEALT WITH IN ORDER TO AVOID POLLUTION OR THE DEGRADATION OF THE ENVIRONMENT

Harmony has an existing Emergency Preparedness Procedure (EPP) and Compliant/ Grievances system that will be implemented for the Harmony Moab Khotsong Operations. The operational EPP provides comprehensive and site-specific measures and information for successful response to, and management of, emergencies arising from either internal or external factors. The EPP should apply to emergencies within the Harmony Moab Khotsong Operations, and as such encompasses incidents affecting the facilities, infrastructure and operations.

The EPP is subject to annual review and updating with records being retained of key changes, and those responsible for changes. A protocol for distribution and accessibility of components of the plan will need to be developed should aspects of the plan require confidentiality, such as for security reasons.

Sound environmental management is a priority for Harmony. A key component of implementing strong environmental practice will be the development of an environmental management system specifically for Harmony Moab Khotsong Operations, which includes the EPP and Occupational Health and Safety Plan (OHSP). In the event of an environmental emergency, these plans link to each other with actions commencing in terms of the relevant individual business unit emergency preparedness plans and procedures and escalating upwards to the corporate level.

Environmental Operational Management Procedures (EOMPs) should be developed for various potential risk sources. These EOMp's should be reviewed annually to:

- Determine their effectiveness; and
- Injuries or fatalities during all mining phases.

Training will be an important activity supporting the implementation of a management system in the form of induction training on general environmental management and job specific training such as control and clean-up of hydrocarbon spills. The objective of an environmental training programme should be to develop a culture of environmental awareness, accountability, responsibility and prevention. Personnel at all levels should have sufficient knowledge and authority to proactively identify and prevent a situation that could potentially result in an environmental or safety emergency.

In addition, figures of the site layout with emergency response information for key areas will be made available to all personnel. Furthermore, a generic description of the dangers associated with being exposed to hazardous chemicals or materials will be developed as well as a description on the procedures to be implemented to help control hazardous substance releases.

Environmental and social emergency planning and response requires the involvement of local communities, authorities and other external stakeholders in the EPP.

6 UNDERTAKING

The EAP herewith confirms:

a) The correctness of the information provided in the reports relating to the amendment activities;

b) The inclusion of comments and inputs from stakeholders and I&AP's relating to the amendment activities;

c) The inclusion of inputs and recommendations from the specialist reports where relevant to the amendment activities; and

d) That the information provided by the EAP to interested and affected parties regarding the proposed amendments to the EMP rand any responses by the EAP to comments or inputs made by interested and affected parties regarding this are correctly reflected herein.

Please note that: SRK Consulting complied the previous EMPr in 2017 which the update EMPr is based. EIMS has been appointed by Harmony Moab Khotsong Operations as the independent EAP to assist in preparing the updated 2022 EMPr. This report supersedes the previous 2017 SRK EMPr and relates specifically to the current operations at Harmony Moab Khotsong Operations.

Appendix 1: Code of Practice for Mine Residue Deposits

Appendix 2: Biodiversity Management Plan: AngloGold Ashanti – Vaal River Operations (including the Moab Khotsong Operations)

Appendix 3: Moab Khotsong Alien Management Plan

Appendix 4: Dolomitic Risk Management Report

Appendix 5: Water Use License

Appendix 6: Air Emission License

Appendix 7: Harmony Guidelines for Tailings Management

Appendix 9: Harmony Moab Baseline Air Quality Assessment