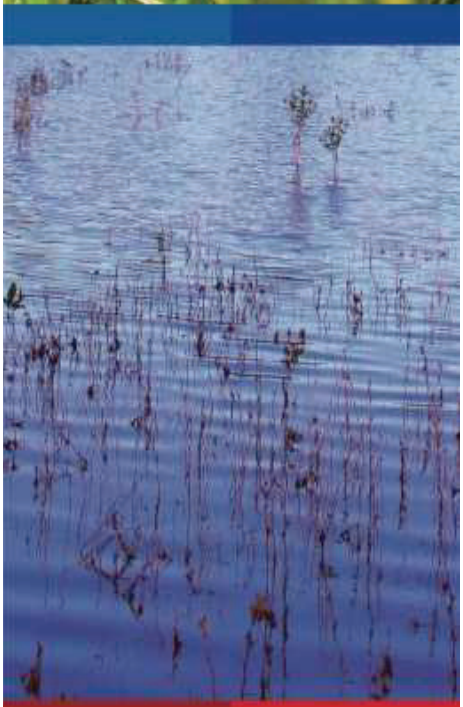

DIGBY WELLS
ENVIRONMENTAL

Environmental Impact Assessment for the Blyvoor Gold Mining Project near Carletonville, Gauteng

Community Health Impact Assessment

Project Number:

BVG4880

Prepared for:

Blyvoor Gold Capital (Pty) Ltd

October 2018

Digby Wells and Associates (South Africa) (Pty) Ltd
Co. Reg. No. 2010/008577/07. Turnberry Office Park, 48 Grosvenor Road, Bryanston, 2191. Private Bag X10046, Randburg, 2125, South Africa
Tel: +27 11 789 9495, Fax: +27 11 069 6801, info@digbywells.com, www.digbywells.com

This document has been prepared by Digby Wells Environmental.

Report Type:	**Community Health Impact Assessment**
Project Name:	**Environmental Impact Assessment for the Blyvoor Gold Mining Project near Carletonville, Gauteng**
Project Code:	**BVG4880**

Name	Responsibility	Signature	Date
Natasha Taylor-Meyer	Report Compiler		September 2018

Digby Wells and Associates (South Africa) (Pty) Ltd

Contact person: Natasha Taylor-Meyer

Digby Wells House
Turnberry Office Park
48 Grosvenor Road
Bryanston
2191

Tel: 011 789 9495
Fax: 011 789 9498
E-mail: tashtaylor@gmail.com

I, **Natasha Taylor-Meyer** as duly authorised representative of Digby Wells and Associates (South Africa) (Pty) Ltd., hereby confirm my independence (as well as that of Digby Wells and Associates (South Africa) (Pty) Ltd.) and declare that neither I nor Digby Wells and Associates (South Africa) (Pty) Ltd. have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of Blyvoor Gold Capital (Pty) Ltd, other than fair remuneration for work performed, specifically in connection with the Environmental Authorisation for the Blyvoor Gold Mine, West Rand.

Full name:	Natasha Taylor-Meyer
Title/ Position:	Environmental Health Consultant
Qualification(s):	MSc Medical Virology
Experience (years):	7 years

EXECUTIVE SUMMARY

Blyvooruitzicht Gold Mine was placed under provisional liquidation in August 2013. The Mining Right relevant to the former Blyvooruitzicht operation was acquired by Blyvoor Gold Capital (Pty) Ltd (hereinafter Blyvoor Gold) through a cession as contemplated in terms of Section 11 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA).

Digby Wells Environmental (hereinafter Digby Wells) was appointed in 2017 by Blyvoor Gold to manage the Environmental Legal application processes pertaining to the Blyvoor Gold Mine (the Project) and the Section 93 Directive issued by the Department of Mineral Resources (DMR) regarding the review of the Environmental Management Plan (EMP) and other documents submitted as part of the request for consent of the Minister of the DMR in terms of Section 11 of the MPRDA.

The purpose of this submission is to approve the existing operations at the Blyvoor Gold Mine and to align the existing documentation pertaining to the operations to the National Environmental Management Act, 1998 (NEMA) and the Environmental Impact Assessment Regulations, dated December 2014, as amended in April 2017 (the Environmental Impact Assessment [EIA] 2014 Regulations). Furthermore, two metallurgical processing plants are required to be authorised as part of this application, as well as the reclamation of eight Tailings Storage Facilities (TSFs).

The scope includes the Environmental Authorisation process as well as to address and incorporate comments raised by Interested and Affected Parties during the 2017 EMP process, which were not previously included. This report addresses potential community health impacts to communities in proximity to the Blyvoor Gold Mine; specifically windblown dust and to a lesser extent groundwater, surface water, and radiology. As requested by Blyvoor Gold, the focus of this Community Health Impact Assessment (cHIA) is Project specific (i.e. local).

Since the liquidation of Blyvoor Gold, the surface of the TSFs has dried out considerably and these have become a major source of air pollution.

The health impacts discussed within this report have been based solely on comments as received by the Federation for a Sustainable Environment (FSE) (September 2016), Dr Phil Tanner (October 2016), the Comment and Response Report (CRR) from Golder Associates (2016, Report Number: 1656096-307577-5) and the recently conducted specialist reports (September 2018), including the Social Impact Assessment, incorporating information from the Lawyers for Human Rights (LHR) report (January 2017). These comments refer specifically to windblown dust, groundwater and surface water pollution and radiology.

Stakeholder engagement with the communities of concern has not been conducted for this report, although a Public Participation Process (PPP) was conducted in 2017 for the EIA/EMP and this Report has been based on that PPP. Key health issues that may have

been identified during a community health focussed stakeholder engagement have not been identified or assessed.

The objectives of the cHIA were:

- To predict the likely impacts the project may have on the health of surrounding communities; and
- To formulate mitigation measures to avoid or ameliorate negative community health impacts and to enhance positive ones.

This was achieved through:

- Evaluating various determinants of health[1], including those identified in the various specialist studies;
- Reviewing and assessing comments as received by the by the FSE, Dr Phil Tanner (consultant appointed by the FSE), and the CRR (Golder Associates); and
- Desktop and literature reviews.

Based on the above, and in accordance with the Environmental Health Areas (EHAs) (Section 6.2, Table 6-2), number 5: *Soil- and water-sanitation related diseases,* number 8: *Exposure to potentially hazardous materials*, and number 9: *Social determinants of health*, have been identified as the potential impacts to the surrounding communities. These have been assessed, from a desktop perspective, and discussed within this report.

The waste disposal from the Project poses health risks to communities located in close proximity to the mine. Windblown dust from the tailings travel extended distances as dust particles or Particulate Matter (PM) or by water and/or soil. Tailings samples were collected from six Tailings Storage Facilities (TSFs) at Blyvoor Gold Mine, by digging to a depth of one metre into the deposited material, and sent for analysis. Laboratory results indicated Blyvoor TSF No. 6 does not pose an environmental risk; there is no evidence of acid generation potential and leachate quality is inert. All other samples were classed as Type 3 waste and would, unless a risk assessment by a competent person concludes otherwise, require a Class C liner. The waste disposal from the Project poses health risks to communities located in close proximity to the mine. Windblown dust from the tailings travel extended distances as dust particles or PM or by water and/or soil. The potential of health pollution is very much dependent on the: size of the particles; the metal/element content; the minerology and physicochemical characteristics of the tailings material.

The major health impacts are presented in the table below.

[1] The determinants of health, include individual, social and environmental, and institutional factors, that are directly or indirectly (representing underlying issues), and cumulatively affected by the proposed project (IFC, 2009).

Health Impacts of Concern

Without Mitigation					With Mitigation				
Duration	**Extent**	**Intensity**	**Probability**	**Overall Significance**	**Duration**	**Extent**	**Intensity**	**Probability**	**Overall Significance**
EHA 5: Soil- and Water- Related Issues									
Exposure to refuse and raw sewage									
Project Life	Local	Very serious	Definite	Major Negative (-) 84	Project Life	Local	Minor	Probable	Minor Negative (-) 36
EHA 8: Exposure to Potentially Hazardous Materials									
Air Pollution: Exposure to Potentially Hazardous PM in the Air									
Project Life	Local	Very Serious	Definite	Major Negative (-) 91	Project Life	Limited	Minor	Unlikely	Minor Negative (-) 40
Groundwater – basic impact assessment conducted, no impacts rated									
-	-	-	-	-	-	-	-	-	-
Surface Water: Water Contamination from runoff from dirty water areas (Operational)									
Beyond Project Life	Municipal	Very Serious	Probable	Minor Negative (-) 60	Medium Term	Limited	Minor	Unlikely	Negligible (-) 14
Surface Water: Water Contamination from Acid Mine Drainage into Surface Water Resources (Decommissioning)									
Beyond Project Life	Municipal	Very Serious	Almost Certain	Major Negative (-) 90	Project Life	Limited	Minor	Unlikely	Minor Negative (-) 36

Without Mitigation					With Mitigation				
Duration	**Extent**	**Intensity**	**Probability**	**Overall Significance**	**Duration**	**Extent**	**Intensity**	**Probability**	**Overall Significance**
EHA 9: Social Determinants of Health									
Employment Opportunities									
Project Life	Municipal	Low-level	Probable	Minor Positive (+) 40	Project Life	Municipal	Average	Probable	Minor Positive (+) 52
Community Development									
Project Life	Municipal	Average	Almost Certain	Minor Positive (+) 72	Beyond Project Life	Region	Great	Almost Certain	Major Positive (+) 102
Quality of Life									
Project Life	Local	Serious	Likely	Minor Negative (-) 60	Project Life	Limited	Minor	Unlikely	Negligible Negative (-) 27

In conclusion, the findings from the specialist studies indicate both positive and negative outcomes. The current ongoing negative socio-economic impacts could be partially reversed through employment opportunities, community development and improving the quality of life within the communities. The tailings material, in particular the windblown dust, is one of the major negative pollutants on communities within 6 km of the Project. The toxicity of the tailings material should be further analysed, including:

- Frequency of dust storms;
- Longitudinal PM monitoring and additional PM monitoring locations to determine trends (seasonal variations and distribution/dispersion of ambient PM);
- Determining the size of the PM, which would determine where in the respiratory system a given particle is deposited, smaller particles lodging deeper within the system; and
- Chemical analysis of the PM.

As noted above, no focussed stakeholder discussion has taken place for this Report. To fill this gap, at the very least health data must be monitored and/or collected from clinics/hospitals detailing the number of respiratory infections in children and in adults.

Such further analysis would assist in identifying the toxicity of the particulate matter on individuals impacted by tailings dust and provide information into existing community health impacts.

Environmental factors are beyond the control of the individual and therefore of great importance. Individual exposure to pollutants depends on the amount of concentration in the exposed environment, duration, and time pattern of exposure. This becomes a cause for concern as respiratory diseases like asthma are becoming more prevalent (Massyn et al., 2016), which indirectly is placing a strain on health services. This strain should be prompting government into legislating dust control measures to include the protection of individuals residing in communities.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

List of Acronyms

AIDS	Acquired Immunodeficiency Syndrome
AMD	Acid Mine Drainage
Bylvoor Gold (Pty) Ltd	Blyvoor Gold
cHIA	community Health Impact Assessment
CRR	Comment and Response Report
DEA	Department of Environmental Affairs
EHA	Environmental Health Area
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
FSE	Federation for a Sustainable Environment
HDPE	High Density Polyethylene
HIV	Human Immunodeficiency Virus
IFC	International Finance Corporation
LED	Local Economic Development
LHR	Lawyers for Human Rights
LoM	Life of Mine
MCLM	Merafong City Local Municipality
MPRDA	Minerals and Petroleum Resources Development Act, 2002
NCD	Non-Communicable Diseases
NEMA	National Environmental Management Act, 1998
NEM: AQA	National Environmental Management: Air Quality Act, 2004
NWA	National Water Act, 1998
PCD	Pollution Control Dam
PM	Particulate Matter
PS	Performance Standard
QoL	Quality of Life
RWD	Raw Water Dam
SIA	Social Impact Assessment
SLP	Social and Labour Plan
TB	Pulmonary Tuberculosis
TSFs	Tailings Storage Facilities

WHO	World Health Organisation

1 Introduction

Digby Wells Environmental (hereinafter Digby Wells) was appointed in 2017 by Blyvoor Gold Capital (Pty) Ltd (hereinafter Blyvoor Gold) to manage the Environmental Legal application processes pertaining to the Blyvoor Gold Mine Project (the Project) and the Section 93 Directive issued by the Department of Mineral Resources (DMR) regarding the review of the Environmental Management Plan (EMP) and other documents submitted as part of the request for consent of the Minister of the DMR in terms of Section 11 of the Mineral Resources and Petroleum Development Act, 2002 (Act No. 28 of 2002) (MPRDA), for cession of the Mining Right to Blyvoor Gold.

Digby Wells initially proposed to undertake an amendment process to update the 2017 EMP submitted with the Section 11 transfer, as well as address comments made by Interested and Affected Parties (I&APs) during that process. To initiate the Project, Blyvoor Gold provided the historical EMPs related to the historic Blyvooruitzicht mining operations which are dated 2000, 2002, 2007, 2012, and 2017. A review of information provided by Blyvoor Gold determined that, *inter alia*, the application would need to follow a Scoping and Environmental Impact Assessment (EIA) process in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) and the EIA Regulations, dated December 2014, as amended in April 2017 (the EIA 2014 Regulations) thereunder, as opposed to a simple amendment process as the metallurgical plants require an Air Emissions Licence. Also noted was the fact that very few Specialist investigations have ever been undertaken for the Blyvooruitzicht operation.

A Scoping Report was duly compiled and submitted to the DMR and in a letter dated 27 March 2018, the DMR noted that:

- The 2017 EMP was not approved as part of the Section 11 transfer, and
- All listed activities not previously authorised must be included in this application process.

Digby Wells met with the DMR on 23 May 2018 to discuss the implications of the dated EMP on the current application process, during which it was confirmed that the current process can continue without having to repeat the Scoping Phase. The validity of the baseline and impact assessment information contained in the 2000 EMP was also discussed and it was determined that Specialist studies will be required to compensate for the lack of Specialist investigations, meet the legal requirements to complete the EIA Process, and facilitate a thorough response to the I&AP comments.

The Project is located directly south of Carletonville and Welverdiend in the Gauteng Province, shown Figure 1-1.

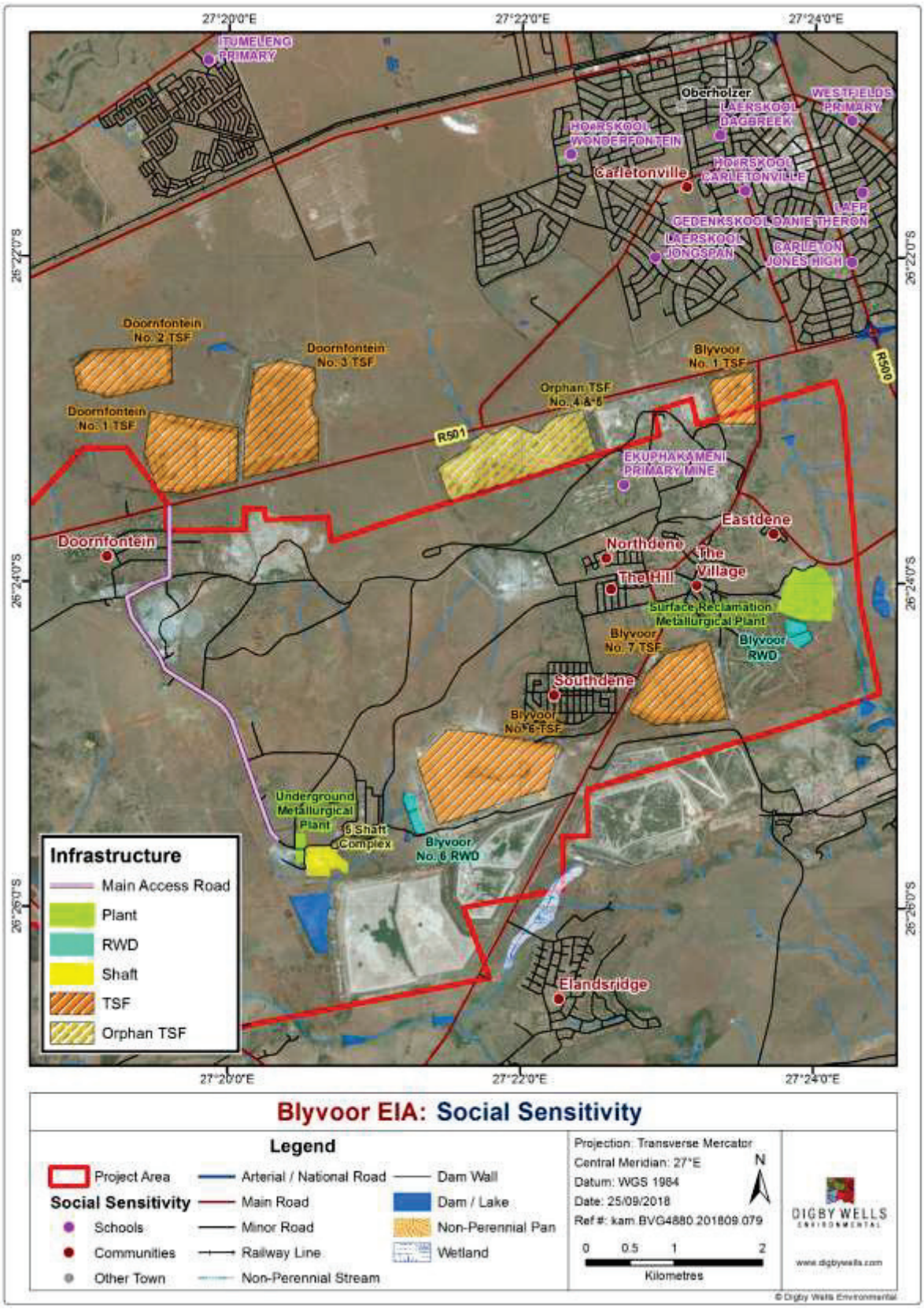

Figure 1-1: Local Setting and Social Sensitivity

1.1 Project Background

In 2016, Blyvoor Gold and Blyvoor Gold Operations (Pty) Ltd acquired eight Tailings Storage Facilities (TSFs) and the Shaft No. 5 complex situated at the former Blyvooruitzicht operation. The mining right relevant to the former Blyvooruitzicht operation (now called the Blyvoor mine) was subsequently acquired by Blyvoor Gold in 2017 through a cession in terms of Section 11 of the MPRDA.

The purpose of this application is to approve the existing operations at the Blyvoor Gold Mine and to align the existing documentation pertaining to the operations to the National Environmental Management Act, 1998 (NEMA) and the EIA 2014 Regulations. Furthermore, two metallurgical processing plants are required to be authorised as part of the environmental authorisation, as well as the reclamation of the eight TSFs.

1.1.1 Description of Activities to be Undertaken

1.1.1.1 Proposed Mining Schedule

The estimated Life of Mine (LoM) for the Blyvoor underground operation exceeds 30 years and Blyvoor Gold has an operational strategic plan for the first fifteen of those years. Tailings reclamation will be staggered within the 30-year LoM. Blyvoor TSF No. 7 will be mined over the first eight years of the LoM, Blyvoor TSF No. 6 will be mined over a period of the next seven years and the Doornfontein TSFs will be mined from year 15 to the end of the LoM.

1.1.1.1.1 Surface Metallurgical Plant

The Surface Reclamation Metallurgical Plant is located to the east of the former Blyvooruitzicht Golf Club. This plant will require major reconstruction to be operational again. The water pipeline servitude which runs from the plant to both Blyvoor TSFS No. 7 and No. 6 will need to be reconstructed due to being vandalised.

The previously existing gold plant will be returned to operation and will be used to process the reclaimed tailings. The reclaimed tailings do not require a milling process. The plant process for the retreatment of tailings consists of thickening and leaching of slurry, gold adsorption by a pump cell, carbon treatment, gold recovery (elution/smelting) and finally, residue disposal. The tailings after retreatment at the plant will be disposed on Blyvoor TSF No. 6 initially and thereafter onto the area vacated by the reclamation of either Blyvoor TSF No. 4& 5 or Blyvoor TSF No. 7.

The water recovered from the tailings deposition will be returned to the treatment plant in a High Density Polyethylene (HDPE) lined open channel for re-use. The return water will pass through a sediment trap with the clear water discharged to Blyvoor TSF No. 7 Return Water Dam (RWD). Water will be fed under gravity from Blyvoor No. 7 RWD to the plant. In total, Blyvoor purchased eight TSFs that can be retreated, which are divided into five TSFs known as the Blyvoor TSFs, and three TSFs known as the Doornfontein TSFs. These TSFs are shown in Table 1-1.

Blyvoor TSFs

Five TSFs are associated with the Blyvoor Operation namely: Blyvoor TSFs No. 1, No. 4 & 5. No. 6, and No. 7 are detailed in Table 1-1. As mentioned, deposition will continue onto Blyvoor No. 6 and potentially Blyvoor TSFs No. 4 & 5. Blyvoor No. 7 will be reclaimed and the remainder of TSFs associated with the Mining Right will be under care and maintenance until these resources are reclaimed.

Table 1-1: Blyvoor TSFs

Description	Foot-print	Height	Volume	Tonnes
Blyvoor No. 1				
TSF No. 1 was operated as an emergency dam and because of its relatively small top surface area, deposition could only take place for a few hours per day. The TSF is a paddock dam and has no under drainage system.	29 ha	20 m	4 633 829	6 797 827
Blyvoor No. 4& 5				
Mostly reclaimed but unlined.	69 ha	N/A	N/A	435 000
Blyvoor No. 6				
Blyvoor TSF No. 6 was used for tailings placement during the reclamation of Blyvoor TSFs No. 4 and 5 and underground operations. This ended in August 2013. Tailings were placed in a cyclone upstream deposition method. Prior to the reclaiming of TSFs No. 4 & 5. TSF No.6 was divided into two daywall operated compartments. The cyclone placed material from TSFs No. 4&5 covered the total surface area of TSF No. 6, combining it into a single storage facility. The RWD associated with TSF 6 is not lined. The total capacity of the existing RWD is 71 500 m^3, this excludes the volume which has been allowed for the regulatory freeboard of 800 mm.	132 ha	26 m	29 019 056	44 697 110
Blyvoor No. 7				
TSF No. 7 dam is a paddock dam with no under drainage system. The dam is the highest TSF and, as indicated in the EMP, dated 2012, the TSF started showing signs of depression on the western flank of the upper compartment.	75 ha	48 m	26 741 680	40 460 161

Doornfontein TSFs

Three Doornfontein TSFs formed part of the sale to Blyvoor Gold and all three of these TSFs will remain in Care and Maintenance for the current 15-year LOM. Details of these TSFs are provided in Table 1-2 below. Due to the historic nature of the TSFs and WRD, these dumps are not lined nor to the WRDs have underdrainage systems.

Table 1-2: Doornfontein TSFs

Description	Foot-print	Height	Volume	Tonnes
Doornfontein No. 1				
This TSF was mothballed when it attained its maximum designed height. The dam is characterised by steep side slopes with no step-ins. The dam was rehabilitated by the construction of cross walls and perimeter walls on the top surface. Catchment paddocks have been constructed around the toe of the dam to prevent the migration of eroded material. The dam is situated on gently sloping ground and is not near to any watercourses. The area is fenced. The dam is situated on dolomite; as indicated in the EMP, dated 2012, no sign of instability had been noted.	54 ha	36 m	15,546,000	22,479,516
Doornfontein No. 2				
The TSF is characterised by fairly steep side slopes (1:2) with no step-ins. The dam is situated on gently sloping ground. Catchment paddocks have been constructed around the toe of the dam to contain eroded material. Rehabilitation of the dam was implemented by the construction of cross walls and perimeter walls on the top surface. The area is fenced. The dam is situated on dolomite; as indicated in the EMP, dated 2012, no sign of instability had been noted.	37 ha	12 m	6,641,000	9,496,630

Description	Foot-print	Height	Volume	Tonnes
Doornfontein No. 3				
This TSF is situated on gently sloping ground and consists of a tow paddock construction. Tailings were delivered *via* an in-wall piping system into a day wall operation. Surface water was decanted off the top surfaces of the paddocks *via* a penstock decant system. The penstock decant pipes conveyed the water by gravity to two return water dams approximately 500 m from the tailings dam. Catchment paddocks have been constructed around the toe of the tailings dam to contain eroded material. The area is fenced and there are no structures or services nearby.	73 ha	32 m	11,487,000	17,127,117

Support Infrastructure

All support infrastructure was approved in the EMP dated 200. These included power supply, roads, water resources and management, as well as waste management on site.

Employment

The Social and Labour Plan (SLP) dated 31 July 2017, proposes targets of employment from surrounding areas and further afield. The SLP proposed a target of 70% of the workforce on the mine be from Merafong Local Municipality, and the remaining 30% be employed from within the Gauteng Province. The projected employment requirements for the first five years of operation are estimated between 729 and 732 employees as defined in the SLP for this period. After the first five years, the 2017 EMP projects employment of approximately 842 workers.

2 Details of the Specialist

Natasha Taylor-Meyer holds a Master's degree in Medicine (Virology). Natasha has one and half years of experience working in the sustainability field of Social Return on Investments, where responsibilities included compilation of detailed reports based on analysis of raw data and stakeholder engagement. Natasha has over seven years of experience in the environmental field, conducting and managing Community Health Impact Assessments (Reports) and Environmental Impact Assessments (EIAs) (Reports); including the compilation of Health and Environmental Management Plans (Reports), in accordance with both local South African standards and International standards. Natasha has worked in the Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) research environment for over eight years, where responsibilities included managing vaccine trials, data analysis, conducting laboratory audits, Report writing and presentations (Appendix A).

3 Terms of Reference

Health is gaining prominence in public policies in accordance with its importance as a core value for population wellbeing and thus, as a driving force for sustainable human and social development. The assessment and management of community health is part of risk management and social responsibility of an operator.

Mining of gold, coal and other natural resources has played a significant role in South Africa's economy, with both positive and negative consequences. However, the majority of mining companies often come under scrutiny, from the public, for dumping waste without taking the necessary precautions or considering the health of the communities who reside in close proximity. The result has been a significant amount of air, soil, water and health pollution.

Gold mine dumps contain a complex mixture of metals such as cadmium, manganese, gold, arsenic, selenium, lead (Jasso-Pineda et al, 2012). One area of particular concern is the disposal facility known as tailings, a by-product of the mining process. In addition to the metals composition, tailing dumps consist of large quantities of dust particles including Particulate Matter (PM). Particles with the size of 500 - 1000µm get dislodged from the rock surface, but only those with an aerodynamic diameter of less than 7.5µm will get suspended in the atmosphere, resulting in the exposure of communities living in close proximity to air, soil and water pollutants, which can be predominantly high during windy conditions and when it is dry and vegetation cover is low.

Epidemiological studies have shown that living near mine dumps is a major risk for exposure to PM and metals such as cadmium, manganese, lead, and arsenic (Moreno et al. 2010). Children are particularly vulnerable because their respiratory system is still developing.

A recent study has shown there is a strong association between higher levels of asthma (wheeze), rhinoconjunctivitis, pneumonia, emphysema, chronic bronchitis and coughs among communities residing in close proximity to mine dumps (within 1 – 2 kms) (Nkosi V et al (2015). Environmental factors are beyond the control of the individual and therefore of great importance. Individual exposure to pollutants depends on the amount of concentration in the exposed environment, duration, and time pattern of exposure. This becomes a cause for concern as respiratory diseases such as asthma are becoming more prevalent (Massyn et al., 2016), which indirectly is placing a strain on health services. This strain should be prompting government into legislating dust control measures to include the protection of individuals residing in communities.

In the light of the locality of the TSFs to communities of concern; comments as received by the Federation for a Sustainable Environment (FSE) and the Comment and Response Report (CRR) from Golder Associates (2016, Report Number: 1656096-307577-5); and the location of the TSFs to communities of concern (less than 6 km from the centre of Carltonville), a community Health Impact Assessment (cHIA) was included as part of the EIA process (Figure 1-1). Recently conducted specialist studies were used to determine which environmental impacts were affecting the health of the nearby communities, specifically

windblown dust and to a lesser extent groundwater, surface water, and radiology. As requested by Blyvoor Gold, the focus of this cHIA is Project specific (local) and is not regionally focused.

4 Aims and Objectives

The over-riding objective of a cHIA is to maximise health gain and reduce health inequalities. The International Council of Mining and Metals (ICMM) indicate that health assessments 'help mining and metals managers and health and safety advisors address the public health impacts of their activities on the communities near their operations to better manage their responsibilities' (ICMM, 2010).

The overarching aim of the cHIA was to provide decision-makers with a set of recommendations on health issues associated with the Project, so that health objectives may be considered at the same level as socio-economic and environmental objectives.

The objectives were:

- To predict the likely impacts the project may have on the health of surrounding communities; and
- To formulate mitigation measures to avoid or ameliorate negative community health impacts and to enhance positive ones.

This was achieved through:

- Evaluating various determinants of health[2], including those identified in the various specialist studies;
- Reviewing and assessing comments as received by the by the FSE, Dr Phil Tanner (consultant appointed by the FSE), and the CRR (Golder Associates); and
- Desktop and literature reviews.

5 Assumptions and Limitations

The health impacts discussed within this report are based solely on comments as received by the FSE (September 2016), Dr Phil Tanner (October 2016), the CRR from Golder Associates (2016, Report Number: 1656096-307577-5) and the recently conducted specialist reports (September 2018), including the Social Impact Assessment, incorporating information from the Lawyers for Human Rights (LHR) report (January 2017), as requested from Blyvoor Gold.

Based on this, and in accordance with the Environmental Health Areas (Section 6.2, Table 6-2), number 5: *Soil- and water-sanitation related diseases,* number 8: *Exposure to*

[2] The determinants of health, include individual, social and environmental, and institutional factors, that are directly or indirectly (representing underlying issues), and cumulatively affected by the proposed project (IFC, 2009).

potentially hazardous materials, and number 9: *Social determinants of health*, have been assessed and discussed within this report.

5.1 Stakeholder engagement

Not all the data that is crucial in obtaining a robust baseline of the area was collected, as stakeholder engagement with the communities of concern (including clinical health data, etc.) was not conducted for this report, therefore key health issues which ordinarily would have been identified through the engagement process have not been identified nor assessed.

5.2 Air Quality

A fine particulate matter (PM) sampler was set up near the existing plant in August 2018 to monitor PM_{10} and $PM_{2.5}$ records (Figure 13-1). PM monitoring was conducted for a period of three weeks only. It would be beneficial to have PM monitoring conducted for a period of one year, for a holistic overview and to monitor the PM dispersion and trends.

5.3 Groundwater

The limitation of the groundwater study is that neither groundwater samples nor water levels were acquired from the project area, as identified boreholes were either found to be dry or destroyed. Therefore, the groundwater levels are defined according to the outcomes of a drilling programme conducted in 2003; however, no groundwater quality data is available to define the groundwater status from that study. Groundwater levels will be updated, and the groundwater quality will be obtained from the monitoring boreholes as recommended in the groundwater report. The current groundwater quality conditions will serve to define the presence or absence of contamination and provide a basis on which to define future impacts.

A basic impact assessment was conducted, as there was insufficient information available to undertake a detailed impact assessment that included ratings i.e. water levels, water quality, groundwater flow direction and predictive modelling, to indicate the extent and intensity of the potential contamination. The basic impact assessment has taken into consideration all significant potential impacts and provides mitigation measures to reduce all expected impacts.

A numerical groundwater model should be conducted once updated data is available to complete a full risk and impact assessment. On completion of this model, this cHIA report needs to be updated accordingly.

6 cHIA Framework

All proposals and resultant projects have the ability to result in unintended positive and negative impacts. These impacts affect the environment, society and human health.

The 1948 Constitution of the World Health Organisation (WHO) defined human health as “not merely the absence of disease and infirmity, but a state of complete physical, mental, social, and spiritual well-being” (www.who.int). Health is a positive concept emphasising social and personal resources, as well as physical capacities (www.who.int).

Community health (health of a community) comprises those aspects of human health, including quality of life, that are determined by physical, biological, social and psychosocial factors in the environment. It is also related to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that can potentially affect the health of present and future generations.

HIA is an instrument for preparing justified recommendations for the management of future/identified health impacts of projects on a surrounding community (Birley, 2011). The undertaking of a cHIA thus ensures that human health issues are addressed prior to the commissioning of a mining activity/project or with this particular project where concerns have been received by the FSE (discussed within this report) relating to the effects of pollutants.

As part of the EIA process for the proposed Project, findings and recommendations from this cHIA report will be integrated into the EMP.

6.1 Legislative and Policy Framework

Currently, in South Africa, there are no specific laws and regulations legally required for the assessment of community health. However, there are a number of underpinning policies, including the following:

6.1.1 The Constitution

The over-arching legislation is the Constitution of South Africa, 1997, in particular Section 24, which places people and their needs at the forefront of environmental management. The Constitution brought about a change in South African environmental policy by providing a right to “an environment that is not harmful to [human] health or well-being” and to have the environment protected, for the benefit of present and future generations, through reasonable legislative measures. These measures include the prevention of pollution and ecological degradation, the promotion of conservation, the securing of ecologically sustainable development and the utilisation of natural resources while promoting justifiable economic and social development.

6.1.2 The National Health Act

The National Health Act, 2003 (Act No. 61 of 2003) provides a framework for a structured uniform health system in South Africa, taking into account the obligations with regard to health services imposed on the national, provincial and local governments by the Constitution and other laws. The Director General (DG) should issue and promote adherence to, norms and standards on health matters, including conditions that constitute a health hazard and facilitate the provision of indoor and outdoor environmental pollution control services. The Act also provides for environmental health investigations in Section 88.

6.1.3 National Environmental Management Act (NEMA)

The Act states that sustainable development requires the consideration of all relevant factors including:

- Negative impacts on the environment and on people's environmental rights be anticipated and prevented or (minimised and remedied);
- Environmental justice must be pursued so that adverse environmental impacts are not distributed unfairly discriminate against any person, particularly vulnerable and disadvantaged persons; and
- The social, economic and environmental impacts of activities are considered, assessed and evaluated, and decisions made based on these consideration and assessment.

6.1.4 National Environmental Management: Air Quality Act (NEM: AQA)

Guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to minimum ambient levels of pollutants that are known or likely to be hazardous to human health and wellbeing (WHO, 2000). Once the guidelines are adopted as standards, they become legally enforceable. These standards prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified time period in a defined area. If the air quality guidelines/standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest. The prevailing legislation in the Republic of South Africa with regards to the Air Quality field is the National Environment Management: Air Quality Act (Act No. 39 of 2004) (NEM: AQA). The NEM: AQA repealed the Atmospheric Pollution Prevention Act (45 of 1965) (APPA) and various other laws dealing with air pollution. According to NEM: AQA, the Department of Environmental Affairs (DEA), the provincial environmental departments and local authorities (district and local municipalities) are separately and jointly responsible for the implementation and enforcement of various aspects of the Act. Each of these spheres of government is obliged to appoint an air quality officer and to co-operate with each other and co-ordinate their activities through mechanisms provided for in the NEMA. The purpose of NEM: AQA is to set norms and standards that relate to:

- Institutional frameworks, roles and responsibilities;
- Air quality management planning;
- Air quality monitoring and information management;
- Air quality management measures; and
- General compliance and enforcement.

Amongst other things, it is intended that the setting of norms and standards will achieve the following:

- The protection, restoration and enhancement of air quality in South Africa;

- Increased public participation in the protection of air quality and improved public access to relevant and meaningful information about air quality; and
- The reduction of risks to human health and the prevention of the degradation of air quality.

DEA has established National Ambient Air Quality Standards for PM_{10} and particulate matter of aerodynamic diameter less than 2.5 µm since June 2012 (GN 486: 2012).

6.1.5 National Environmental Management: Waste Act (NEM: WA)

To ensure that people are aware of the impact of waste on their health, well-being and the environment.

6.1.6 International Management Standards

There are a number of international guidelines or best practice guidelines that refer to community health in developing projects.

The International Finance Corporation (IFC), a subsidiary of the World Bank, has published a set of Performance Standards describing its commitments, roles, and responsibilities relating to environmental and social sustainability, in line with its strategic commitment to sustainable development, and as an integral part of its approach to risk management. These Standards were revised with effect from January 2012. In addition, the IFC has produced a set of Environmental, Health, and Safety Guidelines, which are technical reference documents with general and industry specific examples of Good International Industry Practice ("GIIP"). The Environmental Health and Safety (EHS) Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs.

Of particular relevance is Performance Standard 4 (PS4): Community Health, Safety and Security, recognises that project activities result in both positive and negative impacts to communities (IFC, 2012). The objectives of PS4 are:

- To avoid or minimise risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances; and
- To ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimises risks to the community's safety and security.

The general PS4 community health and safety requirement states that the client will evaluate risks and impacts to the health and safety of the affected community during all stages of a project, and will establish preventative measures to mitigate and manage the identified health impacts. An Action Plan is to be disclosed and on-going engagement with affected communities is to be established (see box).

IFC Performance Standard 4 "Community Health, Safety and Security"

"The client will evaluate the risks and impacts to the health and safety of the Affected Communities during project life-cycle and will establish preventive and control measures consistent with good international industry practice (GIIP), such as in the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) or other internationally recognised sources. The client will identify risks and impacts and propose mitigation measures that are commensurate with their nature and magnitude. These measures will favour the prevention or avoidance of risks and impacts over minimization."

In addition to being considered the benchmark standards for major projects, the IFC's Performance Standards are applicable to projects seeking financing from either the IFC or other Equator Principles banks.

South Africa is a signatory to certain international conventions that may be applicable to the project and these may be seen to provide additional direction in the absence or limitation of local legislation or policy. Those relevant to health include the following:

- The United Nations Declaration on Rights of the Indigenous Peoples;
- Stockholm Convention on Persistent Organic Pollutants;
- Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal; and
- United Nations Agencies including:
  - United Nations Environmental Program;
  - International Health Regulations as promulgated by the World Health Organisation; and
  - United Nations Development Program. Global and Inclusive Agreement 2002.

6.2 Determinants of Health

Community health comprises aspects relating to human health, including quality of life, that are determined by physical, biological, social and psychosocial factors in the environment. It is also associated with the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that can potentially affect the health of present and future generations. Health can be influenced by a broad range of determinants, as shown in Table 6-1. The Project activities may impact on these determinants, which as a result will lead to changes in health outcomes or the health status of individuals and communities.

For the purpose of this assessment, the determinants of health are largely social and environmental (air quality, water quality and radiology).

Table 6-1: Key Factors that determine Community Human Health (Determinants)

Fixed	Social and economic	Lifestyle and behaviours
■ Genes ■ Gender ■ Ageing ■ Race	■ Poverty ■ Employment ■ Social ills ■ Communal life ■ Crime	■ Diet ■ Physical activity ■ Smoking ■ Alcohol ■ Sexual conduct ■ Drugs ■ Coping skills ■ Culture

Access to services	Environmental
■ Education ■ Health services ■ Social services ■ Transport ■ Leisure ■ Basic services	■ Air quality ■ Noise ■ Housing ■ Water quality ■ Water quantity ■ Waste management ■ Social environment ■ Risk of injury ■ Sun exposure ■ Disease vectors & pests ■ Communicable diseases ■ Climate change ■ Food safety ■ Environmental pollution ■ Occupational hazards ■ Radiation ■ Hazardous substances

To ensure health determinants are evaluated in a systematic manner, the use of standard Environmental Health Areas (EHAs) have been considered. The EHA framework defines the type of health impacts and provides a structure for organising and analysing potential project impacts on the community. The table below defines the various EHAs (Table 6-2).

Taking into consideration the nature of this cHIA, EHA 5, 8 and 9, formed the basis of this report.

Table 6-2: Environmental Health Areas

	Environmental Health Areas (EHAs)
1.	**Vector-Related Diseases -** Malaria, schistosomiasis, dengue, onchocerciasis, lymphatic filariasis, yellow fever, etc.
2.	**Respiratory and Housing Issues -** Acute respiratory infections (bacterial and viral), pneumonias, tuberculosis; respiratory effects from housing, overcrowding, housing inflation, etc.
3.	**Veterinary Medicine and Zoonotic Issues** - Diseases affecting animals (e.g. bovine tuberculosis, swinepox, avian influenza) or that can be transmitted from animal to human (e.g. rabies, brucellosis, Rift Valley fever, Lassa fever, leptospirosis, etc.).
4.	**Sexually Transmitted Infections -** HIV/AIDS, syphilis, gonorrhea, chlamydia, hepatitis B; etc.
5.	**Soil- and Water-Sanitation Related Diseases -** Giardiasis, worms, water access and quality, excrement management
6.	**Food- and Nutrition- Related Issues** - Stunting, wasting, anemia, micronutrient diseases (including deficiencies of folate, Vitamin A, iron, iodine); changes in agricultural and subsistence hunting, fishing, and gathering practices; gastroenteritis (bacterial and viral); food inflation
7.	**Accidents and Injuries** - Road-traffic related, spills and releases, construction (home- and project-related) and drowning
8.	**Exposure to Potentially Hazardous Materials** - Pesticides, fertilizers, road dust, air pollution (indoor and outdoor, related to vehicles, cooking, heating, or other forms of combustion or incineration), landfill refuse or incineration ash, and any other project-related solvents, paints, oils or cleaning agents, by-products, or release events
9.	**Social Determinants of Health (SDH)** - Including psychosocial, social production of disease, political economy of health, and ecosocial issues such as resettlement or relocation, violence, gender issues, education, income, occupation, social class, race or ethnicity, security concerns, substance misuse (drug, alcohol, smoking), depression and changes to social cohesion, etc.
10.	**Cultural Health Practices** - Role of traditional medical providers, indigenous medicines, and unique cultural health practices
11.	**Health Services Infrastructure and Capacity** - Physical infrastructure, staffing levels and competencies, technical capabilities of health care facilities at district levels; program management delivery systems; coordination and alignment of the project to existing national- and provincial-level health programs (for example, TB, HIV/AIDS), and future development plans
12.	**Noncommunicable Diseases (NCDs) -** Hypertension, diabetes, stroke, cardiovascular disorders, cancer, and mental health

6.3 Methodology

The methodology for conducting the cHIA has been designed so as to comply with the relevant South African legislation as well as with international best-practice standards – most notably, those set out in the IFC Performance Standards (PS) and the Equator Principles (EP).

Published literature reviews were conducted on the internet and health-related information pertaining to South Africa and mining was extracted and has been integrated into this report. Stakeholder engagement did not form part of the Impact Assessment phase of the project.

cHIA is by nature a multi- and inter-disciplinary endeavour. This is because community health is influenced by a multitude of social, environmental and structural factors, and also because project-related impacts may impact on community health by various indirect means (e.g. by effecting social or environmental changes in the area surrounding the project).

For this reason, when a cHIA is undertaken in the context of an EIA, it is standard practice for the cHIA specialist to work in close collaboration with the other specialists involved in the EIA. For this assessment air quality, water (ground and surface), social and radiological studies were reviewed and where impacts relating to health were identified, these impacts were further assessed and integrated accordingly.

Consequently, a large part of the baseline profile presented in Section 7 is concerned with socio-economic conditions that are relevant to community health or could mediate project-derived community health impacts. This inter-disciplinary approach will be continued into subsequent phases of the assignment, when health-related impacts are assessed and mitigation measures defined.

7 Baseline Community Health Profile

Blyvoor falls within the West Rand District Municipality. The content within this section refers specifically to the local municipality, Merafong, where possible and as requested.

Section 7.1 refers to socio-economic attributes (demographics, level of education, access to service delivery, etc.) that play a vital role in shaping the health and well-being of communities. Information for this section has been obtained from Community Survey 2016, IDP for Merafong Local Municipality (2017 – 2018), www.wazimap.co.za, www.merafong.gov.za and www.gauteng.gov.za.

Section 7.2 focuses more specifically on health-related attributes including the prevalence of disease and utilisation of health facilities. Information pertaining to this section has been obtained from www.wrdm.gov.za, www.hst.org.za, UNAIDS and Massyn N et al (2016).

7.1 Socio-economic attributes

Merafong City Local Municipality (MCLM) (GT 484) is a category B municipality as defined in the Municipal Structures Act. It comprises twenty eight (28) wards. MCLM is situated in the South Western part of Gauteng Province and forms a part of West Rand District Municipality.

7.1.1 Demographics

Merafong City has a population of 188 843 people in 1 633.5 km^2, equating to 115.6 people per square kilometre. The male population exceeds the females by 14.2%, which could be due to the mining activities that the residents and in-migrants rely on. The median age is 30 years old, relative to the working environment. Setswana is the language mostly spoken.

7.1.2 Households

Merafong consists of 79 833 households, where 65% of people reside in houses, and 17.2% of people reside in informal dwellings (shacks). Of the households, 29.2% are headed by women with approximately 478 households have heads under the age of 18 years old. The average household size is estimated to be 2.8 persons per household. The annual household income is R29 400.

7.1.3 Service Delivery

The following figure indicates the access to basic services for households within Merafong (Figure 7-1).

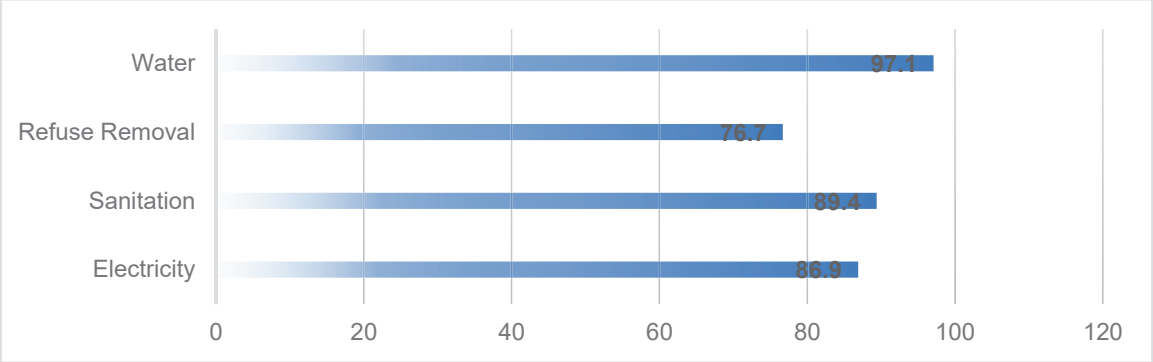

Figure 7-1: Service Access

7.1.4 Economics

Of the population, 46.5% are employed. People are largely employed in the mining (25.4%) and trade sector (20.6%). The main economic sectors include: mining (50.7%), trade (9.7%), finance and business services (9.9%), community services (9.2%) and general government (9.1%).

7.1.5 Education

Approximately 70.7% of children have completed grade 9 or higher, whilst 37.5% have completed matric or higher (under- and post-graduates). There is a very high school attendance record of children aged between five and 17 years of age (96.3%). Approximately 15.6% of the children (15 – 17 years of age) who are not attending school, are in the labour force and have an average annual income of R2 400.

7.1.6 Children

There are 54 661 children living in the local municipality, 84% of these children reside with both of their parents, whilst 0.9% of children 14 years old and under have no living biological parents. It is estimated that there are 478 households where children, less than 18 years of age, are heads of the house.

7.2 Health-related attributes

According to the Merafong Annual Report (2016/7/8) (www.merafong.gov.za), health is a District function; based on this health related attributes have been discussed from a District perspective.

7.2.1 Health Centres

The West Rand District Municipality is made up of 43 clinics, three Community Health Centres (CHC), two district hospitals, one regional hospital and nine other health facilities (District Health Barometer 2015/16). The majority of the clinics are government/public organisations. The clinics are primary health care facilities, offering HIV, AIDS and Tuberculosis (TB)-related treatment, care and support services. The medical facilities offer community orientated primary health care programmes that monitor and proactively work towards the improved health and wellbeing of families in the surrounding areas. The clinics are accredited antiretroviral (ARV) treatment initiation and on-going treatment site. The majority of the clinics provide porridge to malnourished patients as well as to underweight TB, HIV and AIDS patients. Support groups for HIV-positive people are available. A few of the clinics have social workers who assist those who are applying for social grants. Maternity services for pregnant women are also available. Patients, at the clinics, who require further medical treatment are referred to Carletonville Hospital or Bheki Mlangeni District Hospital.

7.2.2 Death Percentage and Reason

For the period of 2009 – 2014, the percentage of broad-based deaths was classified into four groups:

- Injuries;
- Non-communicable disease (NCD);
- HIV and TB; and
- Communicable diseases, together with maternal, perinatal and nutritional conditions.

This has been differentiated into males and females and age group (Figure 7-2).

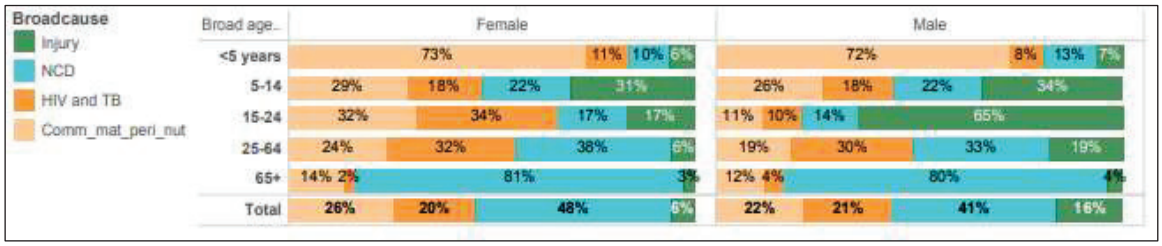

Figure 7-2: Broad based deaths (2009 – 2014) (Massyn et al, 2016)

The 10 leading single causes of death within each age group (both genders) for 2009–2014 combined, is shown in Figure 7-3.

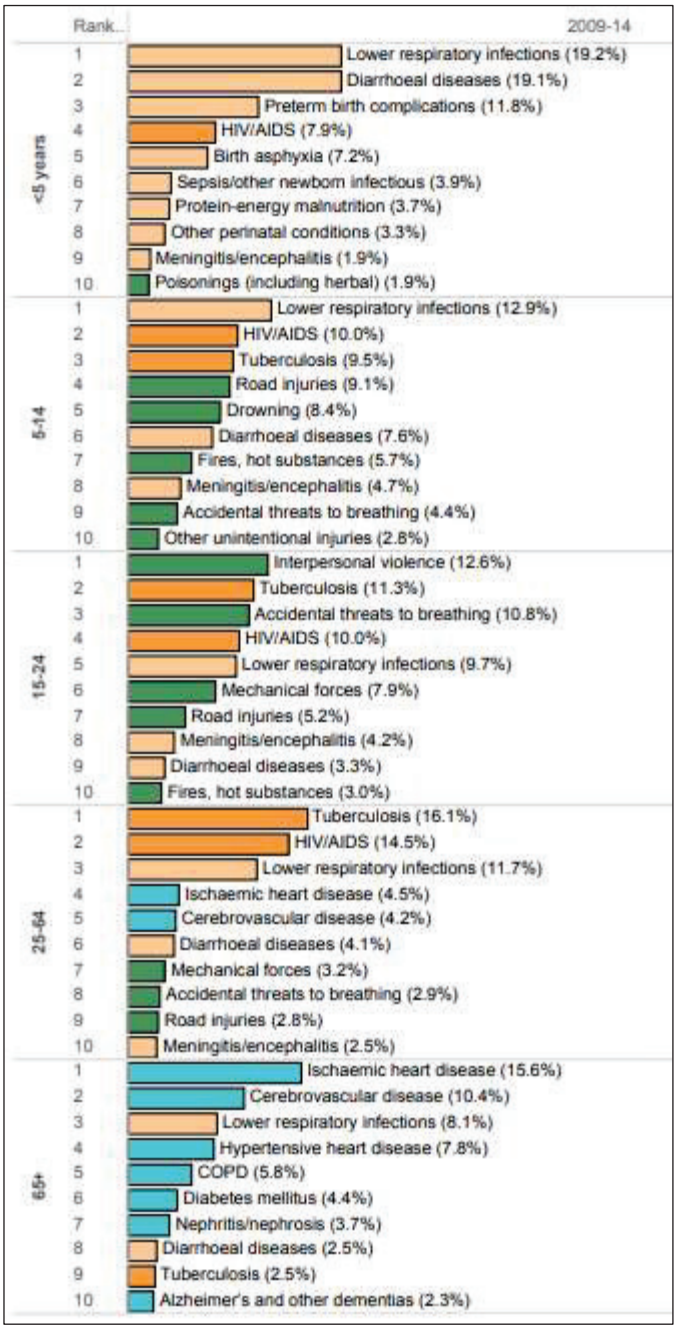

Figure 7-3: Causes of death per age group (Massyn et al, 2016)

7.2.3 Communicable Diseases

The incidence (diagnosed cases) of TB has reduced from 462.3 (2013/14) to 396.9 (2015) (Cases per 100 000 population). TB death rate appears to be decreasing from 8.7% (2013/14) to 6.3 (2015). The percentage of TB cases with known HIV status has increased from 93.8% (2013/14) to 96% (2015).

HIV testing coverage has increased from 22.9% (2013/14) to 43.1% (2015). In 2015, a total of 25 869 people tested HIV positive, of those, 4 347 were pregnant women. There are

approximately 774 944 HIV positive people on anti-retroviral therapy. The HIV status for an infant under the age of two months shows that there has been a decline from 7.1% (2008/9) to 2.9% (2011/12). Male condom distribution coverage has increased from 18.5% (2013/14) to 51.9%.

7.2.4 Non-communicable Diseases

Undoubtedly, NCDs (and communicable diseases) are playing an increasingly important role in defining South Africa's health profile, as they are attributable to environmental risk factors and they are an essential element to be taken into account in policy development and planning purposes at both national and local level.

Conditions in this broad class include cardiovascular and kidney disease, diabetes, chronic respiratory conditions, cancer, mental disorders, oral and eye pathologies, and musculoskeletal conditions. Today these conditions are among the top causes of death in South Africa. A common cause of death, across all age groups, is lower respiratory infections (Figure 7-3).

NCDs include chronic medical conditions (asthmas and diabetes) and non-infectious diseases (stroke, heart attacks, cancer and depression). Unhealthy behaviours/circumstances/living conditions can lead to risk factors for NCDs and subsequent disease.

The West Rand District Municipality has a somewhat high hypertension prevalence in people 15 years and older (42.2%) (range: 19.5% and 56%, across all provincial districts). The diabetes incidence per 1000 population was 1.70% (range: 0.59 – 4.02). When comparing percentages obtained in 2015 to those of 2008, there has been a decrease in prevalence, this is probably due to an increase in access to medication and a positive change to a healthier lifestyle.

Cervical cancer screening coverage (annual) has dropped from 44.8% (2013/14) to 39.0% (2015), indicating improved strategies are urgently required.

7.3 Baseline Health Status

The communities of concern include those who still reside in the Blyvooruitzicht mine's residential village areas (Northdene, Southdene, Eastdene, The Village, The Hill and Doornfontein), and other communities within a six kilometre radius from Project site; are those who are likely to experience health impacts as a result of the Project.

The social history of the mine village is detailed hereunder.

7.3.1 History of the Mine Village

The Blyvooruitzicht Gold Mining Company Ltd (BGMC) owned and operated the mine between 1937 and 1997, after which DRD Gold Limited (DRD) acquired the share capital of BGMC and took over the management of the mine.

BGMC housed most of their employees in a racially divided housing system consisting of company-owned houses and hostels within the mine village. The system gave way in the 1990s, allowing black employees and their families to move into the mine village, which was traditionally reserved for white employees. Within the mine village, BGMC built and maintained recreational facilities, including community halls, sports fields, and a golf course. BGMC also provided all basic services including running water, sanitation, electricity, and refuse removal – i.e. all the services usually provided by local government. These were all taken over by DRD when they took over the operation of the mine in 1997.

At the start of 2009, DRD began to experience financial difficulty due to a declining gold price and initiated business rescue proceedings for BGMC which was terminated when the gold price recovered. However, in early 2012, DRD sold its entire shareholding in BGMC (then 74%) to Village Main Reef Ltd (VMR), who took over the operation of the mine in June 2012. By July 2013, neither DRD nor VMR acknowledged any responsibility for the mine – during this time both entities publicly announced that they will not provide any further funding to the mine. The mine was placed under provisional liquidation in August 2013 which resulted in widespread socio-economic impacts on the surrounding village. The majority of the mine's employees were retrenched with immediate effect.

The MCLM refused to declare the village a township and formally incorporate it into the MCLM. Access to basic services is repeatedly threatened and in some areas of the village, refuse is piling up in open fields and sewerage systems are breaking down. Environmental mitigation measures, including dust suppression at the TSFs, are not being conducted, reportedly leading to health impacts on the surrounding residents. Illegal miners moved into the area to access the remaining gold in the mine's unsecured premises, which reportedly led to an increase in crime and conflict with local residents.

Within the mine village are two functional schools: Laerskool Blyvooruitsig in The Village and Rockland Primary in The Hill. These schools are located approximately 500m apart. The Gauteng Department of Health runs a primary health care clinic (the Blyvoor Clinic) in Northdene. The mine village hospital that was run by the mine was closed in 2013.

Additional information can be obtained from the Social Impact Assessment report prepared by Golder and Associates (2016) for the proposed Blyvoor Gold Operations (report number 1656096-307576-4), updated by Digby Wells, September 2018.

7.3.2 Environmental Health Areas

The EHAs framework defines the types of health impacts and provides a structure for organising and analysing potential proposed Blyvoor Gold Project impacts on the community.

As mentioned previously, health impacts discussed within this report have been based solely on comments as received by the FSE, Dr Phil Tanner, the CRR and the recently conducted specialist reports (September 2018), including an update by Digby Wells to the Social Impact Assessment (SIA) report prepared by Golder and Associates (2016), wherein information

from the LHR report (January 2017) was incorporated, for the proposed Blyvoor Gold Operations (report number 1656096-307576-4).

Stakeholder engagement with the communities of concern was not conducted for this health report, therefore the possibility exists that key health issues associated with the Project, have not been identified or assessed. Based on the above, and in accordance with the Environmental Health Areas (Section 6.2, Table 6-2), number 5: *Soil- and water-sanitation related diseases,* number 8: *Exposure to potentially hazardous materials*, and number 9: *Social determinants of health*, have been further assessed and discussed within this report.

7.3.2.1 EHA 5: Soil-, and Water-Sanitation-Related Diseases

Prior to liquidation, the majority of houses (around 94%) had access to piped water. Likewise, most houses were connected to electricity. Most (ranging between 85% and 90%) had their refuse removed by a service provider. Almost all the households (between 84% and 92%) had access to a flush toilet connected to a waterborne sewerage system. All of these services were provided by the mine, at a nominal fee, that was deducted from employees' monthly wages. When the mine went into liquidation, these services were threatened. The municipality could not take over the services due to lack of funding and capacity and furthermore stated that the mine village was on "private property" and therefore not within the municipality's jurisdiction. According to the LHR report (January 2017), the community secured a court order requiring the municipality to provide access to water and sanitation, however sewage is still of concern.

According to the updated SIA, uncollected refuse and raw sewage was seen in the streets, which can have negative health impacts on the communities of concern, including but not limited to diarrhoea, eye and skin infections.

7.3.2.1.1 Water and Sanitation Related Diseases

The most common types of poor sanitation related diseases include:

Diarrhoea is caused by a variety of micro-organisms including viruses, bacteria and protozoans. Diarrhoea causes a person to lose both water and electrolytes, which leads to dehydration and, in some cases, to death. Repeated episodes of diarrhoeal disease make children more vulnerable to other diseases and malnutrition. Diarrhoea is the most important public health problem directly related to water and sanitation. The simple act of washing hands with soap and water can cut diarrhoeal disease by one-third. Next to providing adequate sanitation facilities, it is the key to preventing waterborne diseases.

Dysentery and diarrhoea are often used as similar terms. However, these two conditions are clinically different from each other. The most important difference between dysentery and diarrhoea relates to the affected area. While watery diarrhoea is a disease that affects the small bowel, dysentery affects the colon. The second difference between the two relates to the typical symptoms that are observed. Diarrhoea is presented as watery stool that may or may not be accompanied by cramps or a pain. However, in case of dysentery, the person suffers from a mucoid (resembling/ similar to mucin) stool that may be accompanied by

blood. Dysentery is also accompanied by fever at times. Persons suffering from dysentery usually complain of cramps and pain in the lower abdominal area. It is interesting to note that four respondents listed abdominal pains/"stomach pain" as one of the most common illnesses affecting their villages, which could be a possible link to dysentery.

Cholera is an acute bacterial infection of the intestinal tract. It causes severe attacks of diarrhoea that, without treatment, can quickly lead to acute dehydration and death. Cholera is a world-wide problem, especially in emergency situations. It can be prevented by access to safe drinking water, sanitation and good hygiene behaviour (including food hygiene).

Trachoma is an eye infection spread mainly through poor hygiene caused by lack of adequate water supplies and unsafe environmental sanitation conditions.

Intestinal worms, also known as Helminths, in an intestinal parasitic worms, which people come into contract with through contact with soil that has been contaminated with human faeces from an infected person, or by eating contaminated food. Depending upon the severity of the infection, it can lead to malnutrition, anaemia or retarded growth. Children are particularly susceptible and typically have the largest number of worms.

A hygienic environment, clean water and adequate sanitation are key factors in preventing opportunistic infections associated with **HIV/AIDS**, and in the quality of life of people living with the disease. AIDS-affected people are more susceptible to water-related diseases than healthy individuals, and they become sicker from these infections than people with healthy immune systems. Maintaining a healthy environment is essential to safeguarding the health, quality of life and productivity of people living with HIV/AIDS.

7.3.2.2 EHA 8: Exposure to Potentially Hazardous Materials

Health considerations include air, groundwater and surface water pollution.

Wind erosion is a major cause of both loss and dispersion of tailings material from a tailings dam facility to its surrounding environment. Such dust dispersion is not only a nuisance but also a potential health hazard to inhabitants in close proximity and can also cause soil and water pollution. The main pollutant of concern during the Project will be PM including PM_{10} and $PM_{2.5.}$ A detailed Air Quality Impact Assessment Report is appended to the EIA Report.

7.3.2.2.1 Health Implications as a result of Pollutants

The WHO confirms that particulate air pollution is associated with complaints of the respiratory system (WHO, 2000). PM size is relevant in terms of health because it controls where in the respiratory system a given particle is deposited. Fine particles are thought to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not penetrate deep into the lungs compared to smaller particles (Manahan, 1991). Larger particles are deposited into the extra-thoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2000). The range of adverse health effects of PM is broad, involving respiratory and cardiovascular systems in children and adults. Both short- and long-term exposures lead to

adverse health effects (Table 7-1). Very young children are particularly sensitive to the adverse effects of PM, due to their stage pf physical growth, immature immune system and developing respiratory organs with a more susceptible and reactive respiratory epithelium (Yohannessen, K et al. (2015). Adverse effects of PM on lung development include reversible deficits of lung function as well as chronically reduced lung growth rate and long-term lung function deficit. The available evidence is also sufficient to assume a causal relationship between exposure to PM and aggravation of asthma, as well as cough and bronchitis symptoms. Daily mortality and hospital admissions have been linked with short term variation of PM levels. Increased mortality from cardiovascular and respiratory diseases and from lung cancer has been observed in residents of more polluted areas (WHO, 2011).

WHO revised the Air Quality Guidelines (AQG) for PM based on existing evidence of adverse health effects at lower concentrations (WHO, 2005). For $PM_{2.5}$, the AQG are 10 µg/m^3 (annual average) and 25 µg/m^3 (24-hour mean) [not to be exceeded for more than 3 days/year]. The corresponding annual and daily guidelines for PM_{10} were set as 20 µg/m^3 and 50 µg/m^3.

Ambient PM_{10} concentrations are a good approximation of population exposure to PM from outdoor sources. Numerous epidemiological studies conducted in Europe and in other parts of the world have shown adverse health effects of exposure to PM_{10} and $PM_{2.5}$ at concentrations that are currently observed in Europe and the rest of the world. WHO estimated that approximately 700 annual deaths from acute respiratory infections in children aged 0–4 years could be attributed to PM_{10} exposure in the WHO European Region in the late 1990s alone. Population health effects of exposure to PM in adults are dominated by mortality associated with long-time exposure to fine PM ($PM_{2.5}$).

Table 7-1: Short-term and long-term health effects associated with exposure to PM (WHO, 2004)

Pollutant	Short-term exposure	Long-term exposure
Particulate Matter	Lung inflammatory reactions	Increase in lower respiratory symptoms
	Respiratory symptoms	Reduction in lung function in children
	Adverse effects on the cardiovascular system	Increase in chronic obstructive pulmonary disease
	Increase in medication usage	Reduction in lung function in adults
	Increase in hospital admissions	Reduction in life expectancy
	Increase in mortality	Reduction in lung function development

7.3.2.3 EHA 9: Social Determinants of Health

Social determinants of health are the economic, physical and social conditions that influence the health of individuals, communities and jurisdictions as a whole. Social determinants of

health include housing, education, social networks and connections, racism, employment, and law enforcement and the legal and custodial system. The absence or presence of these determinants, and the interaction between them, influence both health outcomes and risk behaviours (www.aph.gov.au).

7.3.2.3.1 Population Influx

According to the updated SIA (appended to the EIA), the study found no evidence of large-scale in-migration to the area; on the contrary, the population has decreased, more than likely due to the liquidation of the mine. Based on the limited number of job opportunities created by the recommissioning of parts of the mine, it is unlikely that the operation would draw large numbers of job seekers to the area. However, through news coverage it is possible that people who worked at the mine previously might assume that the entire mine has become operational again and decide to return the area in the hope of being reappointed at the new operations. Again, it is expected to be a few individuals rather than large groups. Correct communication, including employment opportunities, type of skills required and availability of positions will help with regard to employment expectations.

The actual presence of newcomers (or returnees) is not an impact in itself, but rather a process that could lead to conflict over limited resources both in terms of the number of job opportunities, and the availability and reliability of infrastructure and services. The effect of newcomers has already partially materialised with the arrival of the suspected zama-zamas who lead to conflict and violent clashes with the local community and SAPS.

7.3.2.3.2 Employment Opportunities

According to the LHR Report, the mine village consists of approximately 6,000 people. Of these, 72.2% are in the economically active age range, amounting to roughly 4,332 people. Most (though likely not all) were retrenched by the mine in 2013, meaning they have mining-related experience. Of the 4,332 people, roughly 75% (or 3,249) are still unemployed. Blyvoor Gold committed in its SLP that 70% of its labour force will be recruited from the local area, which means that roughly 590 employment opportunities will be created for the local area at the mine itself.

Several media reports, including the LHR report (2017) mention that retrenched workers remained in the area for hope of the mine restarting, and being re-employed. It is now a reality, but job opportunities are limited, approximately 18% of the local workforce would be able to secure employment at the recommissioned mine, assuming they have the right skills and experience. The impact is regarded as positive, but the limited number of opportunities does mean that Blyvoor Gold will not be able to rely on job creation alone but would have to consider additional measures that could benefit the wider community as well in an attempt to reduce the risk for social disintegration and conflict.

Blyvoor Gold also intends to hire local labour for use in their Local Economic Development (LED) projects as part of its SLP commitments. This will create a further 60 temporary positions and 16 longer term positions. Although temporary work creates immediate

economic benefits to the worker and his/her family, the impact is not sustainable due to the transiency of employment. The 16 more permanent positions are grouped with the operational staff, bringing the total number of positions created at the mine to 606.

7.3.2.3.3 Economic benefits

Based on the MPRDA guideline for mining royalties, it was estimated that the Project would generate approximately R 31m over the next 10 years in royalties payable to the local and district municipalities as well as the provincial government. Blyvoor Gold would also be paying taxes as applicable to the various levels of government. In addition, it will also be contributing approximately R 1.7m over 10 years to the National Skills Fund. Part of the mine's SLP is to participate in LED projects, with spend in the order of R 56m over a 10-year period.

7.3.2.3.4 Community Development

The mine could aid with the upliftment of the mine village by contributing to the repair of services, particularly refuse removal and the sewerage network. The preliminary SLP (2017) has already identified and described a number of LED projects, including:

- The refurbishment of the Ekuphakameni waste water treatment works;
- Cleaning storm water channels to support the drainage network and prevent the formation of sinkholes;
- Removing dumped waste from the mine village; and
- Rendering financial support to the Harmony orphanage with identified projects such as building upgrades, etc.

Blyvoor Gold is entering an area with a negative legacy left by its predecessors, and although the company's willingness to support noteworthy causes is encouraging, it is also important that the company considers investing in sustainable longer-term community development projects in an effort to build and sustain a so-called Social Licence to Operate (SLTO), especially in view of the fact that Blyvoor Gold would not be able to re-employ workers from the previous operation. Community development projects also aid in curbing the 'honey-pot' effect by investing wider than just the immediate area, preventing people from focusing all their attention solely on the mining operation itself, which in turn curbs project-induced in-migration. However, it is important that the local community is fully engaged to advise on the urgent needs. It is hoped that with the interventions to promote community development, that crime, will gradually reduce. It will be counterproductive to a Social Licence to Operate (SLTO) process to approach community development from a top-down approach. Although this SIA would therefore recommend that the mine develop and implement a voluntary Social Investment Strategy, the actual content of such a strategy cannot be determined within the current scope of work.

7.3.2.3.5 Quality of Life

Quality of Life (QoL) is defined as the general wellbeing of an individual/society. The Public Participation Process, followed by Golder, identified project related areas of concern:

- Uncertainty of future mining plans and further non-adherence to environmental regulatory requirements (e.g. dust suppression at TSFs), leading to negative environmental and health impacts;
- Fear of property damage from blasting and vibration and related noise levels;
- Traffic impacts to the existing road network, on-site vehicular traffic and hazards from hazardous materials;
- Informal shacks constructed on the mine site and tailings dumps that will need to be removed. People have expressed their concern for the health of these shack dwellers who might have been exposed to high levels of toxic substances; and
- Concerns related to the security of the operations and human rights violations, including the use of security personnel to control illegal miners.

Two common themes emerged through the consultation process that influence stakeholders' impact experiences:

- Communication: on-going and regular communication processes must be put in place between Blyvoor Gold and affected communities aimed at building a relationship between the two parties. Meaningful communication will assist in addressing negative perceptions; and
- Governance, monitoring and accountability: The current situation at the mine points to lapses in governance, monitoring and accountability. These have become legacy issues as there is a healthy dose of cynicism amongst residents on how the new owners will deal with historic issues.

8 Impact Assessment

8.1 Key Issues and Related Health Impacts

This section provides an analysis of the potential impacts associated with the Project and has included the analysis of potential negative impacts and their mitigation measures, but also includes potential positive impacts and measures to enhance these. This is based on the evidence presented in the baseline health description, the planned Project activities and information obtained from the other available specialist studies.

The key health impacts and needs have been described in the EHA framework to ensure consistency. Project specific determinants and comments will be described so as to inform the impact assessment. While it is recognised that some of these existing health needs will be inherited by the Project, and are maybe the responsibility of the government, they may influence the impacts and need to be considered for mitigation/management. It is also true

that some of these management measures could overlap into social investment, especially for enhancement of certain impacts.

8.2 Impact Rating Methodology

The impacts are assessed based on the impact's magnitude as well as the receiver's sensitivity, culminating in an impact significance which identifies the most important impacts that require management.

Based on international guidelines and South African legislation, the following criteria are taken into account when examining potentially significant impacts:

- Nature of impacts (direct/indirect, positive/ negative);
- Duration (short/medium/long-term, permanent(irreversible) / temporary (reversible), frequent/seldom);
- Extent (geographical area, size of affected population/habitat/species);
- Intensity (minimal, severe, replaceable/irreplaceable);
- Probability (high/medium/low probability); and
- Possibility to mitigate, avoid or offset significant adverse impacts.

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 8-3. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this EIA/EMP Report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in

Table 8-2, which is extracted from Table 8-1. The description of the significance ratings is discussed in Table 8-3.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 8-1: Impact Assessment Parameter Ratings

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
7	Irreplaceable damage to highly valued items of great natural or social significance or complete breakdown of natural and / or social order.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable damage to highly valued items of natural or social significance or breakdown of natural and / or social order.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.
5	Very serious widespread natural and / or social baseline changes. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
4	On-going serious natural and / or social issues. Significant changes to structures / items of natural or social significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.
3	On-going natural and / or social issues. Discernible changes to natural or social baseline.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	Minor natural and / or social impacts which are mostly replaceable. Very little change to the baseline.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
1	Minimal natural and / or social impacts, low-level replaceable damage with no change to the baseline.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 8-2: Probability/Consequence Matrix

Significance																																						
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Probability

Consequence

Table 8-3: Significance Rating Description[3]

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Substantial (positive)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Major (positive)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Major (negative)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Substantial (negative)

[3] It is generally sufficient to only monitor impacts that are rated as negligible or minor

8.3 Impact Analysis, Mitigation and Enhancement

Construction activities will be limited to the refurbishment of the existing No 5 Shaft and the upgrade of the existing infrastructure at the Processing Plant (within the existing footprints). The construction phase will be short-term and associated impacts will be negligible, hence have not been considered.

For the operational phase and decommissioning phase, only those impacts resulting in an overall rating of Minor (negative and positive) are discussed below.

8.3.1 EHA 5: Soil- and Water-Sanitation Related Diseases

According to the updated SIA, uncollected refuse and raw sewage was seen in the streets, this will have a negative health impact on the communities of concern, including but not limited to diarrhoea, eye and skin infections.

Although indicated as negligible, the influx of people may also play a role on water and waste related diseases.

Water contamination may occur as a result of runoff from contaminated surfaces and from any dirty water discharges including treated sewage effluent within the Project area, into the water course in proximity to the site, thereby potentially impacting on the communities within the Project area. The impact of water contamination as a result of Blyvoor Gold Mine, is discussed further in EHA 8.

Table 8-4: Summary of Impact Assessment for Soil- and Water Sanitation-related diseases

Dimension	Rating	Motivation	Significance
Soil- and Water-Sanitation Related Diseases			
Impact Description: Exposure to refuse and raw sewage			
Prior to Mitigation/Management			
Duration	Project Life (5)	Impact will occur for the life of the Project	Major (negative) – 84
Extent	Local (2)	Exposure extent will extend within Project area	
Intensity x type of impact	Very Serious (5)	Serious impacts on exposed receptors and environment	
Probability	Definite (7)	The impact is already happening	
Nature	Negative		

Dimension	Rating	Motivation	Significance
Mitigation/Management Actions			
▪ Manage the influx of people; ▪ The quality of groundwater and surface water must be monitored to ensure that the Project does not have any detrimental effects on community water sources; ▪ Conduct baseline water and sanitation studies on communities based on accepted health indicators; ▪ Monitor for groundwater organics, bi-annually, including: Total Coliform, E. Coli and Heterotrophic plate count; ▪ Ensure proper disposal of human waste that is generated from the Project; ▪ Ensure proper waste management from Project generated waste according to waste management principles; ▪ Support the local authority in supporting and improving water and sanitation services, including the collection and disposal of waste in the communities; ▪ Establish water and sanitation committees in the communities to manage their own water and sanitation services. This will improve sustainability of any outreach support; ▪ Support information campaigns in the community on water use, hygiene and general sanitation; and ▪ Depending on the results of the baseline data gathering, support the government's school deworming programme in partnership with local authorities.			
Post-Mitigation			
Duration	Project Life (5)	Impact will occur for duration of Project	Minor (negative) – 36
Extent	Local (2)	Exposure extent will extend within Project area	
Intensity x type of impact	Minor (2)	Minor impact anticipated after mitigation measures have been applied	
Probability	Probable (4)	It is still probable that the impact may still occur, after mitigation measures are applied	
Nature	Negative		

8.3.2 EHA 8: Exposure to Potentially Hazardous Materials

8.3.2.1 Operational Phase

8.3.2.1.1 Air Pollution

A detailed air quality impact assessment (AQIA) has been conducted (attached as an appendix to the EIA). The model predictions showed that emissions associated with wind

erosion of the TSFs will lead to increased levels of PM, including Total Suspended Particulates (TSP), PM_{10} and $PM_{2.5}$ in the surrounding atmosphere. Dust will be airborne, leading to nuisance effect, reduction in the quality of air, with potential health and environmental implications from exposure. Exposure to the pollutants will be worse for receptors within a six kilometre radius from the centre of origin. Findings from the AQIA are summarised as follows:

The problem with wind erosion is it can affect tailings dams in all types of climate, but becomes worse as climatic aridity increases. Because clouds of dust are often observed billowing across the top surfaces of tailings dams in dry windy weather, there is a common misconception that the dust arises from wind erosion of the top surface. As a result, much effort and money is vainly spent on treating the tops of tailings dams (planting grasses/spraying water) to prevent dust generation, whereas the slopes of the dams are the true major dust source. The upper windward slopes, and particularly the area just below windward crests, are the most susceptible to wind erosion. The top surfaces are less susceptible to significant wind erosion.

With correct mitigation and management measures, the emissions can be reduced to be within the South African standards

Table 8-5: Summary of Impact Assessment for Potentially hazardous PM

Dimension	Rating	Motivation	Significance
Stockpiling on Blyvoor TSF No. 6 and reclamation of Blyoor TSF No. 7			
Impact Description: Exposure to Potentially Hazardous PM in the air			
Prior to Mitigation/Management			
Duration	Project Life (5)	Impact will occur for the life of the Project	Major (negative) – 91
Extent	Local (3)	Exposure extent will extend outside the mine footprint	
Intensity x type of impact	Very Serious (5)	Serious impacts on exposed receptors and environment	
Probability	Definite (7)	It is almost certain that the impact will occur	
Nature	Negative		

Dimension	Rating	Motivation	Significance
Mitigation/Management Actions			
▪ Develop a dust management plan; ▪ Apply wetting agents, dust suppressant or binders on the exposed area; ▪ Vegetate, with grass or a gravel monolayer, the exposed areas; ▪ Reduce erosion loss by roughening slope surface - this dissipates energy of water or wind moving over the slope; ▪ Assess the angle of the slope, as maximum erosion occurs on slopes with angles between 30° and 35°; ▪ Improve upon the surface strength of a slope, which will lower the rate of erosion; ▪ Implement PM monitoring and continue with ongoing dust fallout monitoring; ▪ Collect data on a longitudinal basis from the local health centres on incidence of increased respiratory disease - especially respiratory tract infections that could be ascribed to dust. While these may not be specifically ascribed to the Project, the prevailing trends are useful to monitor so that any concerns could be addressed. This may require health systems strengthening to support recording; and ▪ Establish a monthly and annual reporting structure to appraise performance, compliance and complaints.			
Post-Mitigation			
Duration	Project Life (5)	Impact will occur for duration of Project	Minor (negative) – 40
Extent	Local (3)	Exposure extent will extend within Project area	
Intensity x type of impact	Minor (2)	Minor impact anticipated after mitigation measures have been applied	
Probability	Probable (4)	It is still probable that the impact may still occur, after mitigation measures are applied	
Nature	Negative		

8.3.2.1.2 Groundwater

A basic impact assessment was conducted, resulting in the identification of impacts and resultant management/mitigation measures, but there is insufficient data to rate the impacts. The groundwater report is appended to the EIA (Section 5.3). The mineralogy results show no or very low carbonate mineral content (only found in trace minerals). Carbonates are beneficial as they have the potential to buffer acid. However no sulphide bearing minerals (such as pyrite or arsenopyrite) have been detected, therefore reducing the risk of acid generation. Acid-Base Accounting indicated representative samples, from the Project area to have acid generating potential, however TSF 6 showed to have a low acid generating

potential. Therefore the reactions would be of short duration due to the low sulphide content. According to the NEM:WA waste classification and management regulations, Total Concentration Results classed all samples as Type 3 waste, requiring a Class C liner, whereas Leachable Concentration Results again classed all samples as Class C, but Blyvoor TSF No. 6 as Type 4 waste requiring a Class D liner.

Results indicate TSF 6 does not pose an environmental risk based on the laboratory results yielding the following outcomes:

- Acid-base-accounting results consistently show that the material at TSF 6 does not show evidence of acid generation; and
- The leachate quality is found to be inert.

Surrounding communities including Carletonville, Welverdiend, Wedela and Khutsong may be impacted negatively if the groundwater quality deteriorates as a result of the TSFs. Dams and non-perennial streams (draining towards the Mooiriverloop), within the project area may be affected should the groundwater be contaminated, and they receive baseflow. Although, due to limited groundwater occurrence, impacts to the groundwater by the TSFs may be less.

Impact

The TSFs may generate contaminating leachate. As rainwater infiltrates through any of the facilities, metals could be dissolved, and leachate is formed. The leachate then seeps to the groundwater and migrates by advection through the groundwater environment.

Management/Mitigation Measures

- Deposition of tailings, for Blyvoor TSF No. 4 and 5, should be on a Class C liner and therefore this footprint should be completely cleared of existing materials and a liner installed prior to deposition; alternatively, a comprehensive risk assessment should be carried out for a new TSF in accordance with the amended Regulations for managing TSFs;
- It is proposed, that the maintenance of the inactive TSFs be conducted by developing an effective return water system to manage excess water that may accumulate at the tailings facilities;
- Groundwater monitoring must be implemented to assess the time series water level and water quality trends;
- A numerical groundwater model needs to be conducted, once updated data is available, to complete a full risk and impact assessment;
- Affected receptors (if proven through monitoring) should be compensated; and
- Ensure that the hazardous materials response plan includes response to offsite proposed Project related spills and effluent discharge into the nearby communities.

8.3.2.1.3 Surface Water

Although water is an essential requirement in the mine for various purposes, the use of it has the potential to affect the quality of surrounding resources. All mines are, therefore, required to contain, recycle and re-use dirty water within their operational systems, to avoid discharging contaminated water into the natural environment.

Water contamination may occur as a result of runoff from contaminated surfaces and from any dirty water discharges including treated sewage effluent within the mine into the water course in proximity to the site. The dirty water areas at the Blyvoor Gold Mine site include TSFs, Mine Plant area and Pollution Control Dams (PCDs). Contamination of surface water resources will lead to the deterioration of water quality affecting aquatic ecosystems and downstream water users.

On-site and surrounding Project area, surface water was tested for and results indicated:

- pH – showed alkaline water quality, within acceptable levels with respect to DWS irrigation target values. A considerable drop in pH was noted for one monitoring on the eastern side of the Project area, showing acid contamination, which is not suitable for irrigation;
- Electrical Conductivity – showed acceptable levels, except for one monitoring point on the eastern side of the Project area, possibly due to a spill of pollutants from upslope waste water dams;
- Nitrates – acceptable levels were noted, indicating faecal pollution in the water is absent or minimal, thereby providing a suitable environment for aquatic ecosystems;
- Metal Toxins (Lead [Pb], Cadmium [Cd], Uranium [U], Selenium [Se] and Aluminium [Al]) – Pb was slight above acceptable level for all monitoring points, Cd, U and Se indicated higher concentrations at the one monitoring point on the eastern side of the Project area, which could be attributed to spillage from waste water dams upslope or from the Savuka Mine. Al levels fluctuated but declined to an acceptable limit; and
- Cyanide Dissolved – indicated the legovels were lower (<0.02 mg/L) than the DWS target water quality range of 0.1 mg/L.

Table 8-6: Summary of Impact Assessment for water contamination from runoff

Dimension	Rating	Motivation	Significance
Surface Water Contamination			
Impact Description: Water Contamination from runoff from dirty water areas			
Prior to Mitigation/Management			
Duration	Beyond Project Life (6)	Impact will remain for some time after the life of the Project	Minor (negative) – 60

Dimension	Rating	Motivation	Significance
Extent	Municipal (4)	Impacts will be localized to the nearby watercourses and to the immediate downstream water users	
Intensity x type of impact	Very Serious (5)	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate	
Probability	Probable (4)	Without appropriate mitigation, it is probable that this impact will occur	
Nature	Negative		
Mitigation/Management Actions			
▪ Runoff from dirty areas should be directed to the existing storm water management infrastructure (PCDs) and should not be allowed to flow into the stream, unless DWS discharge authorisation has been granted upon compliance with relevant effluent discharge standards as stipulated in the National Water Act (NWA). The PCDs and dirty water channels should be lined either by concrete or HDPE to prevent contamination of groundwater through seepage; and ▪ Water quality monitoring should continue downstream and upstream of the mine site, and within all surface water circuits at the mine to detect any contamination arising from operational activities.			
Post-Mitigation			
Duration	Medium Term (3)	The impact will only likely persist in the absence of proper monitoring and maintenance of storm water management plan infrastructure on site	Negligible (negative) – 14
Extent	Limited (2)	The impact footprint will be limited to the nearby watercourses and to the immediate downstream water users	
Intensity x type of impact	Minor (2)	Minor impact anticipated after mitigation measures have been applied	
Probability	Unlikely (2)	Impact is unlikely to occur, after mitigation measures are applied	
Nature	Negative		

8.3.2.2 Decommissioning Phase

8.3.2.2.1 Surface Water

Acid Mine Drainage (AMD) causes acidification and metal contamination of surface and ground water bodies when mine materials containing metal sulphides are exposed to

oxidizing conditions. Heavy-metal contaminated and acidified groundwater discharges into streams at points where the water table is close to the surface. The oxidation of iron sulphide precipitates sulphuric acid which lowers in-stream water pH. Acidic water environments are detrimental to most aquatic life species; in addition they affect irrigation and livestock watering functions for downstream water users.

Many of the components and pollutants in AMD are dangerous to humans. It is also known that the heavy metals, found in AMD, accumulate in plant and animal tissue. Continued exposure leads to high levels of the pollutant in an organism's tissues, potentially causing damage.

Table 8-7: Summary of Impact Assessment for water contamination from AMD

Dimension	Rating	Motivation	Significance
Acid Mine Drainage			
Impact Description: Water Contamination from Acid Mine Drainage into Surface Water Resources			
Prior to Mitigation/Management			
Duration	Beyond Project Life (6)	Impact will remain for some time after the life of the Project	Major (negative) – 90
Extent	Municipal (4)	Impacts will be localised to the immediate surroundings of the mine site	
Intensity x type of impact	Very Serious (5)	Highly significant impact on health and the environment. Irreparable damage to highly valued species, habitat or ecosystem	
Probability	Almost Certain (6)	Without appropriate mitigation, it is almost certain that this impact will occur	
Nature	Negative		
Mitigation/Management Actions			
The best option to limit AMD is early avoidance of sulphide oxidation through use of a combination of several techniques which include the following (Sahoo et al., 2013): ▪ Electrochemical treatment of the acidified effluent producing re-usable water; ▪ Physical barriers using wet or dry covers that retard sulphide oxidation; ▪ Chemical passivation, which involves encapsulation of sulphide surfaces using organic and/or inorganic coatings such as silica, phosphate, lipids and humic acid; ▪ Desulphurization which separates sulphide minerals into a low-volume stream, that mainly results in non-acid-generating waste with low sulphur content; ▪ Use of accredited contractors for removal or demolition of infrastructure is recommended; this will reduce the risk of waste generation and accidental spillages; and ▪ Should decant occur at a later stage, decant water should be treated to acceptable water quality levels prior to discharge into the natural stream.			

Dimension	Rating	Motivation	Significance
Post-Mitigation			
Duration	Project Life (5)	The impact will remain for the duration of the life of the Project	Minor (negative) – 36
Extent	Limited (2)	Limited to site and its immediate surroundings	
Intensity x type of impact	Minor (2)	With effective prevention of the oxidation of iron sulphides, the AMD impact will have minor intensity	
Probability	Unlikely (4)	It is probable the impact will occur	
Nature	Negative		

8.3.3 EHA 9: Social Determinants of Health

It is not the intention of the cHIA to address social issues in detail as they are covered in more detail in the Social Impact Assessment (SIA). However, it is important to recognise the wellbeing and perceptions on quality of life have both a social and health basis. The SIA is appended to the EIA.

8.3.3.1 Population Influx

Based on the limited number of job opportunities created by the recommissioning of parts of the mine, it is unlikely that the operation would draw large numbers of job seekers to the area.

Conflict could arise over limited resources both in terms of the number of job opportunities, and the availability and reliability of infrastructure and services. The effect of newcomers has already partially materialised with the arrival of the suspected zama-zamas that lead to conflict and violent clashes with the local community and SAPS.

This impact is negligible and has not been discussed further.

8.3.3.2 Employment Opportunities

The job opportunities which will be created through the recommissioning of the mine should be as enhanced as possible, so as to benefit the mine village. A large number of community members in the mine village were previously employed by the mine and thus have mining related skills. There is a total number of 606 positions to be created at the mine. Expectations will need to be managed, through extensive stakeholder engagement with the mine village residents and could include a high-level skills survey to determine the available skills in the village. Establish A local labour desk, run by an independent party, needs to be established so as to reduce the risk of nepotistic or otherwise fraudulent local recruitment.

Table 8-8: Summary of Impact Assessment for Employment Opportunities

Dimension	Rating	Motivation	Significance
Employment Opportunities			
Impact Description: Employment and income generation that could assist in uplifting an estimated 606 households in the local village			
Prior to Mitigation/Management			
Duration	Project Life (5)	It is expected that jobs will be sustained for the operational lifespan of the mine	Minor (positive) + 40
Extent	Municipal (4)	The SLP states that 70% of job opportunities will be offered to the local municipal area	
Intensity x type of impact	Low-level impact (1)	Jobs offered to people who are not from the area detracts opportunities from the local community	
Probability	Probable (4)	Blyvoor Gold has committed in their SLP to the DMR to source 70% local labour but in the absence of a skills database, it is not known if required skills are available	
Nature	Positive		
Mitigation/Management Actions			
▪ Develop and implement a Stakeholder Engagement Plan (SEP), inclusive of a communications plan for the mine village; ▪ Undertake a skills survey in the local community, allowing local residents to register their interest and particular skills for upcoming job opportunities; ▪ Reduce the 30% employment target for Gauteng (as per the SLP) based on the outcome of the skills survey, i.e. if required skills are found in the mine village, rather increase the 70% local employment target to ensure maximum uptake of local residents; ▪ Establish a local labour desk where interested work seekers can register and provide proof of qualifications and experience. The desk should be operated by an independent party to prevent nepotistic requirement and increase local confidence that the mine is following a fair and transparent process; ▪ Explore the possibility of expanding job opportunities beyond mining-related work to also include hiring contract workers to assist with LED projects; and ▪ Comply with minimum wage requirements for unskilled labour and all other requirements of the Employment Equity Act to ensure maximum benefits accrue to workers.			
Post-Mitigation			
Duration	Project Life (5)	It is expected that jobs will be sustained for the operational lifespan of the mine	Minor (positive) +52

Dimension	Rating	Motivation	Significance
Extent	Municipal (4)	The SLP states that 70% of job opportunities will be offered to the local municipal area	
Intensity x type of impact	Average (4)	Average social benefits to some elements of the baseline	
Probability	Probable (4)	Minimum of 70% local labour committed to in SLP, assuming required skills are available	
Nature	Positive		

8.3.3.3 Community Development

The mine could aid with the upliftment of the mine village by contributing to the repair of services, particularly refuse removal and the sewerage network. The preliminary SLP (2017) has already identified and described a number of LED projects. It is important that the positive benefits that will arise from the mining operation be dispersed to as many affected people as possible.

Table 8-9: Summary of Impact Assessment for formalised Community Development Initiatives

Dimension	Rating	Motivation	Significance
Formalise community development initiatives			
Impact Description: The mine can extend their LED commitments to the wider community by voluntary investing in philanthropy and more sustainable community and regional development projects			
Prior to Mitigation/Management			
Duration	Project Life (5)	Pure LED investment will cease after LoM	Minor (positive) +72
Extent	Municipal (4)	LED investment limited to local municipal area	
Intensity x type of impact	Average (3)	Although positive benefits, it is only felt by some of the baseline	
Probability	Almost certain (6)	The mine is required by commitments in the SLP to invest in LED projects	
Nature	Positive		

Dimension	Rating	Motivation	Significance
Mitigation/Management Actions			
▪ Develop a Social Investment Strategy. This is additional voluntary investment that the mine makes in the sustainable development of the local communities and can include supporting development projects on a regional (district or province) level (often this can be done by financing a certain project through a local NGO); ▪ Avoid investing in philanthropy projects only (i.e. building or repairing infrastructure, providing food parcels, etc.) – although these projects are 'quick wins' necessary for the mine to win the trust of the local community, it creates the expectation that the mine will continue to, for example, maintain the infrastructure they built, which ceases when the mine suspends operations (as is currently experienced in the mine village); ▪ Local developmental NGOs who have the experience to implement sustainable development projects are key stakeholders in determining community development projects that are not mine dependent and can continue past the LoM; and ▪ Be slow in making promises to the community to first ensure that commitments are well researched and feasible.			
Post-Mitigation			
Duration	Beyond Project Life (6)	Sustainable community development projects eventually create their own sources of funding and can therefore continue past LoM	Major (positive) +102
Extent	Region (5)	Certain projects can benefit the wider region (district and province)	
Intensity x type of impact	Great (6)	Great improvements to the overall condition of a large percentage of the baseline	
Probability	Almost Certain (6)	LED projects have to be implemented. These can be augmented with wider SI projects	
Nature	Positive		

8.3.3.4 Quality of Life (QoL) Impacts

Communication needs to be on-going and regular. Issues and concerns as raised by the communities need to be addressed. A Stakeholder Engagement Process (SEP) for the Project, inclusive of a communications plan for the mine village, must be developed. Endeavour to meet with the community at least once a quarter to address their issues and concerns. Establish a formal grievance mechanism as part of the SEP and undertake to resolve grievances within 14-21 days.

Table 8-10: Summary of Impact Assessment for Quality of Life

Dimension	Rating	Motivation	Significance
Quality of Life Impacts			
Impact Description: Mining activities impacts on people's sense of wellbeing, some of which is a direct cause of how their complaints are being managed			
Prior to Mitigation/Management			
Duration	Project Life (5)	Based on Golder's assessment that the duration of the impact will last 8-15 years	Minor (negative) - 60
Extent	Local (3)	Based on Golder's assessment that the impact will be local	
Intensity x type of impact	On-going serious social issue (4)	Based on Golder's assessment that the magnitude of the impact will be high	
Probability	Likely (5)	Based on Golder's assessment that it is highly probable that the impact will occur	
Nature	Negative		
Mitigation/Management Actions			
▪ Establish a sound communication strategy that includes newspaper articles and radio broadcasts, regular community meetings, a 24-hour hotline service that residents can call, and individual communication with residents, service providers and business owners via letter, phone or face-to-face as and when required. Of particular importance will be the need to put an effective complaints management process in place (termed a grievance mechanism in the updated SIA by Digby Wells); ▪ Public health concerns need to be addressed at a design level, taking into consideration the specific recommendations emanating from specialist studies. The includes the need to identify institutions that may be drawn in to assist with testing, monitoring and arranging appropriate health interventions for shack dwellers once moved from the mine site; ▪ Measures identified in the Environmental Management Plan Report (EMPR) be followed accordingly to reduce the occurrence of any health and safety impacts flowing from blasting activities, vibration and mining-related noise (these issues will typically be addressed through the grievance mechanism, which again highlights the importance of developing and implementing such a system as part of the mine's SE activities); ▪ Measures identified in the EMPR related to the control of traffic and vehicular movement be implemented to reduce hazards and impacts from on and off-site traffic and road networks. Traffic rules are currently not followed because of the absence of road markings and the expectation of no to little traffic. The mine should reinstate road markings when mining related traffic increases, especially around sensitive receptors such as the two primary schools in close proximity to the TSFs (and therefore likely to experience an increase in traffic volumes). (Taken from the Golder SIA):			

Dimension	Rating	Motivation	Significance
Post-Mitigation			
Duration	Project Life (5)	Impact will have to be managed through mitigation for the LoM	Negligible (negative) -27
Extent	Limited (2)	Grievances that are addressed timeously can limit its influence on the site or immediate surroundings	
Intensity x type of impact	Minor (2)	Minor impacts will continue but can be addressed effectively	
Probability	Unlikely (3)	Widespread QoL impacts are unlikely if they are addressed within a realistic timeframe as they appear. Proactive management will prevent QoL impacts occurring regularly	
Nature	Negative		

9 Cumulative Impacts

The cumulative impacts were assessed taking into consideration the project area and its surroundings (within a 10 km radius). Mining related activities are observed to be prevalent within the immediate surroundings, mostly saturated in the east and south in relation to the project area, however, mining activities are observed to be limited north-east of the project area. All of these mining related activities will contribute towards air quality, surface water and groundwater impacts. The TSFs at the project area are an expected source of contamination, in particular for air pollution, surface water and groundwater. It is expected that Blyvoor Gold Mine will contribute towards an improvement in air and water quality, specific to Project area and a 6 km radius from Project site, as stringent environmental management practices would be implemented as required by the mine's updated EMPR in compliance with the MPRDA. The intensity of the potential impact to the groundwater is reduced by an observed limited occurrence of groundwater at the project area. This is likely assumed to be an impact of dewatering activities originating from the project area and surrounding mines.

The MRPDA aims to achieve socio-economic upliftment of mining impacted communities by requiring that mining right applicants submit and adhere to a SLP, which is approved and then monitored by the DMR. The SLP will describe how the mine will ensure that affected communities benefit from their operations, including post-closure. An SLP must therefore detail "specific programmes to save jobs and manage downscaling and/or closure" (aimed at mine employees) and "ameliorate the social and economic impact" of the operation in general (aimed at impacted communities). All the mining rights holders in the area are therefore required to aid the diversification of skills unrelated to mining activities to avoid

creating dependency on the mining sector. In addition, mining operators must identify and support certain LED projects that further aid the general socio-economic upliftment of the local area.

10 Community Health Management Plan

The surveillance of health impacts is a crucial element for the Project, in particular PM emanating from the TSFs and social impacts affecting the communities within the Project area. The Community Health Management Plan (CHMP) provides mitigation and management measures to avoid/ameliorate negative impacts and enhance positive impacts.

The EHAs relating to the Project activities are summarised in Table 10-1. Inclusive within this summary are the impacts which have been rated both without and with mitigation measures. The EHAs are further consolidated with regard to impact, mitigation measures, legislation and frequency of monitoring in Table 10-2.

Table 10-1: Summary of Impacts Rated

Without Mitigation					With Mitigation				
Duration	**Extent**	**Intensity**	**Probability**	**Overall Significance**	**Duration**	**Extent**	**Intensity**	**Probability**	**Overall Significance**
EHA 5: Soil- and Water-Sanitation Related Diseases									
Exposure to refuse and raw sewage									
Project Life	Local	Very serious	Definite	Major Negative (-) 84	Project Life	Local	Minor	Probable	Minor Negative (-) 36
EHA 8: Exposure to Potentially Hazardous Materials									
Air Pollution: Exposure to Potentially Hazardous PM in the Air									
Project Life	Local	Very Serious	Definite	Major Negative (-) 91	Project Life	Limited	Minor	Unlikely	Minor Negative (-) 40
Groundwater – basic impact assessment conducted, no impacts rated									
-	-	-	-	-	-	-	-	-	-
Surface Water: Water Contamination from runoff from dirty water areas (Operational)									
Beyond Project Life	Municipal	Very Serious	Probable	Minor Negative (-) 60	Medium Term	Limited	Minor	Unlikely	Negligible (-) 14
Surface Water: Water Contamination from Acid Mine Drainage into Surface Water Resources (Decommissioning)									
Beyond Project Life	Municipal	Very Serious	Almost Certain	Major Negative (-) 90	Project Life	Limited	Minor	Unlikely	Minor Negative (-) 36

Without Mitigation					With Mitigation				
Duration	**Extent**	**Intensity**	**Probability**	**Overall Significance**	**Duration**	**Extent**	**Intensity**	**Probability**	**Overall Significance**
EHA 9: Social Determinants of Health									
Employment Opportunities									
Project Life	Municipal	Low-level	Probable	Minor Positive (+) 40	Project Life	Municipal	Average	Probable	Minor Positive (+) 52
Community Development									
Project Life	Municipal	Average	Almost Certain	Minor Positive (+) 72	Beyond Project Life	Region	Great	Almost Certain	Major Positive (+) 102
Quality of Life									
Project Life	Local	Serious	Likely	Minor Negative (-) 60	Project Life	Limited	Minor	Unlikely	Negligible Negative (-) 27

Table 10-2: Identified Impacts, Mitigation and Implementation Period

Impacted Environment	Impact	Phase	Size and Scale of Disturbance	Mitigation Measures	Compliance with Standards	Time Period for Implementation
EHA 5: Soil- and Water-Sanitation Related Diseases						
Communities	Exposure to refuse and raw sewage	Operational	Impact will be localised, extending across the site, to nearby communities, within a 6 km radius	■ Manage influx of people; ■ Quality of groundwater and surface water must be monitored to ensure that the Project does not have any detrimental effects on community water sources; ■ Conduct baseline water and sanitation studies on communities based on accepted health indicators; ■ Monitor for groundwater organics, bi-annually, including: Total Coliform, E. Coli and Heterotrophic plate count; ■ Ensure proper disposal of human waste that is generated from the Project; and ■ Ensure proper waste management from Project generated waste according to waste management principles	■ There is no legislation governing cHIA, refer to Section 6.1	■ Mitigation measures to be established and implemented prior to the commencement of the operational phase and for the duration of the project.
EHA 8: Exposure to Potentially Hazardous Materials						
Air Quality	Reduction in quality of air due to dust generation and wind erosion	Operational	Impact will be localised, extending across the site, to nearby communities, within a 6 km radius	■ Apply wetting agents; ■ Vegetate; ■ Cognisant of slope angle; ■ PM monitoring; and ■ Collect health data	■ National Environmental Management: Air Quality Act, Act.39 of 2004 - National Ambient Air Quality Standard for Particulate Matter PM_{10} and $PM_{2.5}$; and ■ National Dust Control Regulations (2013)	■ Mitigation measures to be established and implemented prior to the commencement of the operational phase and for the duration of the project.
Groundwater	Groundwater contamination from TSFs		Radius of 10 km	■ Deposition of tailings should be on a Class C liner for TSF 4 and 5; ■ Maintenance of the inactive TSFs is proposed to be conducted by developing an effective return water system to manage excess water at that may accumulate at the tailings facilities; ■ Groundwater monitoring to be implemented; ■ A numerical groundwater model should be done once updated data is available to complete a full risk and impact assessment; ■ Affected receptors (if proven through monitoring) should be compensated; and ■ Ensure that the hazardous materials response plan includes response to offsite proposed Project related spills and effluent discharge in the community	■ National Water Act, 1998 (Act No. 36 of 1998); ■ National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEMWA) (as amended by the National Environmental Management: Waste Amendment Act 26 of 2014) and List of Waste Management Activities requiring a Waste Management Licence (WML) GN 718 of 2008; ■ DWS Best Practice Guideline G4: Impact prediction; and ■ Department of Water and Sanitation (DWS). 2006. Best Practice Guideline G3: Water Monitoring Systems.	■ Tailings material should be deposited on recommended liner upon operation; ■ Quarterly groundwater monitoring should be conducted during project initiation, monitoring programme should commence as soon as boreholes are drilled; and ■ Affected receptors should be compensated as soon as impact is proven through monitoring data.

Impacted Environment	Impact	Phase	Size and Scale of Disturbance	Mitigation Measures	Compliance with Standards	Time Period for Implementation
Surface Water	Water contamination from runoff from dirty water areas (including TSFs)		Localised to nearby watercourses and to immediate downstream water users	■ Runoff from dirty areas should be directed to the existing storm water management infrastructure PCDs and should not be allowed to flow into the stream, unless DWS discharge authorisation has been granted upon compliance with relevant effluent discharge standards as stipulated in the NWA. The PCDs and dirty water channels should be lined either by concrete or HDPE to prevent contamination of groundwater through seepage; and ■ Water quality monitoring should continue downstream and upstream of the mine site, and within all surface water circuits at the mine to detect any contamination arising from operational activities	■ National Water Act, 1998 (Act No. 36 of 1998)	■ Monitoring should be conducted upstream and downstream of operation; ■ Sampling should be undertaken monthly; and ■ Monitoring should continue for three after the cessation of the Project, as is standard practice to detect residual impacts.
Surface Water	Water contamination from acid mine drainage into surface water resources	De-commissioning	Radius of 10 km	The best option to limit AMD is early avoidance of sulphide oxidation through use of a combination of several techniques which include the following (Sahoo et al., 2013): ■ Electrochemical treatment of the acidified effluent producing re-usable water; ■ Physical barriers using wet or dry covers that retard sulphide oxidation; ■ Chemical passivation, which involves encapsulation of sulphide surfaces using organic and/or inorganic coatings such as silica, phosphate, lipids and humic acid; ■ Desulphurization which separates sulphide minerals into a low-volume stream, that mainly results in non-acid-generating waste with low sulphur content; ■ Use of accredited contractors for removal or demolition of infrastructure is recommended; this will reduce the risk of waste generation and accidental spillages; and ■ Should decant occur at a later stage, decant water should be treated to acceptable water quality levels prior to discharge into the natural stream	■ National Water Act, 1998 (Act No. 36 of 1998)	■ Monitoring should be conducted upstream and downstream of operation; ■ Sampling should be undertaken monthly; and ■ Monitoring should continue for three after the cessation of the Project, as is standard practice to detect residual impacts.
EHA 9: Social Determinants of Health						
Communities	Employment and income opportunities - Employment and income generation that could assist in uplifting an estimated 606 households in the local village	Operational	Extending to local municipal area	■ Develop and implement a Stakeholder Engagement Plan (SEP), inclusive of a communications plan for the mine village; ■ Undertake extensive stakeholder engagement with the mine village community members, including high level skills survey, so as to understand the available skills in the community; ■ Award as much of the 70% local employment as possible to residents within the mine village; and ■ Establish a local labour recruitment desk;	■ There is no legislation governing cHIA, refer to Section 6.1	■ Mitigation measures to be established and implemented prior to the commencement of the operational phase and for the duration of the project.

Impacted Environment	Impact	Phase	Size and Scale of Disturbance	Mitigation Measures	Compliance with Standards	Time Period for Implementation
Communities	Formalise community development initiative - The mine can extend their LED commitments to the wider community by voluntary investing in philanthropy and more sustainable community and regional development projects	Operational	Extending to local municipal area	■ Develop a Social Investment Strategy. This is additional voluntary investment that the mine makes in the sustainable development of the local communities and can include supporting development projects on a regional (district or province) level (often this can be done by financing a certain project through a local NGO); ■ Avoid investing in philanthropy projects only (i.e. building or repairing infrastructure, providing food parcels, etc.) – although these projects are 'quick wins' necessary for the mine to win the trust of the local community, it creates the expectation that the mine will continue to, for example, maintain the infrastructure they built, which ceases when the mine suspends operations (as is currently experienced in the mine village); ■ Local developmental NGOs who have the experience to implement sustainable development projects are key stakeholders in determining community development projects that are not mine dependent and can continue past the LoM; and ■ Be slow in making promises to the community to first ensure that commitments are well researched and feasible	■ There is no legislation governing cHIA, refer to Section 6.1	■ Mitigation measures to be established and implemented prior to the commencement of the operational phase and for the duration of the project.

Impacted Environment	Impact	Phase	Size and Scale of Disturbance	Mitigation Measures	Compliance with Standards	Time Period for Implementation
Communities	Quality of Life - Mining activities impacts on people's sense of wellbeing, some of which is a direct cause of how their complaints are being managed	Operational	Extending to local municipal area	■ Establish a sound communication strategy that includes newspaper articles and radio broadcasts, regular community meetings, a 24-hour hotline service that residents can call, and individual communication with residents, service providers and business owners via letter, phone or face-to-face as and when required. Of particular importance will be the need to put an effective complaints management process in place (termed a grievance mechanism in the updated SIA by Digby Wells); ■ Public health concerns need to be addressed at a design level, taking into consideration the specific recommendations emanating from specialist studies. The includes the need to identify institutions that may be drawn in to assist with testing, monitoring and arranging appropriate health interventions for shack dwellers once moved from the mine site; ■ Measures identified in the Environmental Management Plan Report (EMPR) be followed accordingly to reduce the occurrence of any health and safety impacts flowing from blasting activities, vibration and mining-related noise (these issues will typically be addressed through the grievance mechanism, which again highlights the importance of developing and implementing such a system as part of the mine's SE activities); and ■ Measures identified in the EMPR related to the control of traffic and vehicular movement be implemented to reduce hazards and impacts from on and off-site traffic and road networks. Traffic rules are currently not followed because of the absence of road markings and the expectation of no to little traffic. The mine should reinstate road markings when mining related traffic increases, especially around sensitive receptors such as the two primary schools in close proximity to the TSFs (and therefore likely to experience an increase in traffic volumes)	■ There is no legislation governing cHIA, refer to Section 6.1	■ Mitigation measures to be established and implemented prior to the commencement of the operational phase and for the duration of the project.

11 Comments and Responses

The EIA will be placed for public review. During this time, comments will be captured and addressed. Health related comments received thus far relate to:

- Air pollution/Dust emanating from the TSFs and management measures thereof; and
- Radiology – this health report will be updated accordingly once the Radiology report is available.

12 Conclusion

The TSFs are the main contamination sources to human health in the surrounding environment. TSP, PM_{10} and $PM_{2.5}$ levels all exceeded the South African Standards and extended to a 6 km radius of influence. Currently, due to liquidation, the Blyvoor Gold mine is inactive and as a result, the TSFs are dry and thus exposed and susceptible to wind erosion with resultant dispersal of dust, impacting surrounding communities. Once the mine is re-instated, the TSFs will be operational through reclamation and disposal of wet tailings, and provided the documented management measures are implemented, there will be a reduced impact of dispersed air pollutants from the TSFs.

Studies have shown there is a strong association between respiratory tract infections among communities residing in close proximity to mine dumps (Nkosi V et al, 2015). Environmental factors are beyond the control of the individual and therefore of great importance. Individual exposure to pollutants depends on the amount of concentration in the exposed environment, the constituents of the pollutants, duration, and time pattern of exposure. This should become a cause for concern, as respiratory diseases, including asthma etc., are becoming more prevalent, which indirectly is placing a strain on health services. This strain should be prompting government into legislating dust control measures to include the protection of human health of individuals residing in communities, negatively affected by air pollutants. It is strongly recommended that on-going PM, in particular PM_{10} and $PM_{2.5,}$ be monitored.

Despite the identified health impacts, and provided the suggested mitigation and management measures and recommendations are implemented and adhered to, there is no reason why the Project should not proceed.

13 Recommendations

cHIA is an instrument that is used for preparing reasonable recommendations for the management of probable health impacts as a result of a project. The intention of a cHIA is to make recommendations supported by evidence that modifies a project, to safeguard and enhance population health of communities.

This cHIA report has been compiled solely on a desktop review and environmental specialist studies, with no engagement with the communities who will be impacted upon (Figure 1-1). Findings, from all specialist studies, indicate air quality to be a major source of contamination, within a six km radius from the Project site.

- It is recommended the communities, who will be impacted upon, be engaged with, to understand the current health baseline, the current health impacts and to minimise, if possible, the impacts when the Project commences; and
- It is recommended that health data, relating to respiratory infections, be collected from the clinics/hospitals, most frequented by community members.

13.1 Air Quality

With the dust deposition measurement already in place, it is strongly recommended that a real-time PM monitor (PM_{10} and $PM_{2.5}$) be set up to measure fine particulate matter in the project area to fulfil regulatory requirements on monitoring and reporting. A year is recommended, to determine trends and analysis of findings. These results need to be included into an updated cHIA report.

The toxicity of the tailings material could be further analysed. This could include:

- Monitoring the frequency of dust storms;
- Longitudinal PM monitoring and additional PM monitoring locations to determine community impacts and trends;
- Determining the size of the PM, which would determine where in the respiratory system a given particle is deposited, smaller particles lodging deeper within the system; and
- Chemical analysis of the PM.

13.2 Water Supply and Sanitation

Although the overall *in situ* water quality is in an acceptable state, no biological sampling has been conducted on the water to determine whether there are any health contaminants. Access to safe and clean water and good sanitation are a vital determinant of health, and can be positively or negatively affected by the proposed Project. Mines can be heavy users of local water and can also release materials into existing water sources.

13.2.1 Groundwater

Considering the limitations to the groundwater study, it is recommended that monitoring boreholes are drilled during Project re-initiation (Figure 13-1). The groundwater report needs to be updated in terms of; groundwater levels and groundwater quality. Once updated data is available, a numerical groundwater flow and contaminant transport model will be completed, which will serve as a predictive tool in identifying the future impacts of the potential contamination plume associated with the TSFs, i.e. flow direction, extent and to identify receptors that are at the highest risk as a result of the existence of the TSFs (if any).

Groundwater monitoring will establish both groundwater level and quality trends, allowing for early detection and mitigation measures. Monitoring of inorganic constituents should be

conducted quarterly to reflect influences of wet and dry seasons and monitoring of organic constituent should be conducted biannually. Parameters to be monitored include:

- Inorganics:
  - TDS, EC, pH, Alkalinity;
  - Major ions (Ca, Mg, Na, K, SO4, NO3, F, Cl; and
  - Minor and trace metals (As, Al, Co, Cr, ZN, Cd, Cu, Fe, Ni, Pb, V, Mn, U.
- Organics:
  - Total Coliform, E. Coli and Heterotrophic plate count.

Results from the updated groundwater report need to be incorporated into this cHIA report.

13.2.2 Surface Water

The storm water management plan for the mine should be optimised to ensure that the clean and dirty water separation systems are updated for the refurbished mine plant. This will include the following:

- Placement of a perimeter berm and channel around TSFs No. 7 and 6;
- Confirmation of the RWD capacity and sizing of the perimeter berm; and
- Channelling of polluted runoff from the RWD and associated dirty catchment to a PCD.

13.3 Mental Health and Wellbeing

Open, transparent and continuous two-way communication channels need to be established with the impacted communities, where voices can be heard and solutions shared. Blyvoor Gold Mine needs to be honest with regard to the details of employment opportunities, including employment needs, skills level required and number of positions.

The current environment within the mine village is very much negative; raw sewage, discarded waste and crime due to illegal miners. This needs to be reversed, which Blyvoor Gold can invest in and assist the communities.

13.4 Radiology

On submission of this cHIA report, the radiology report was not available; based on findings within that report, the cHIA report may need to be updated accordingly.

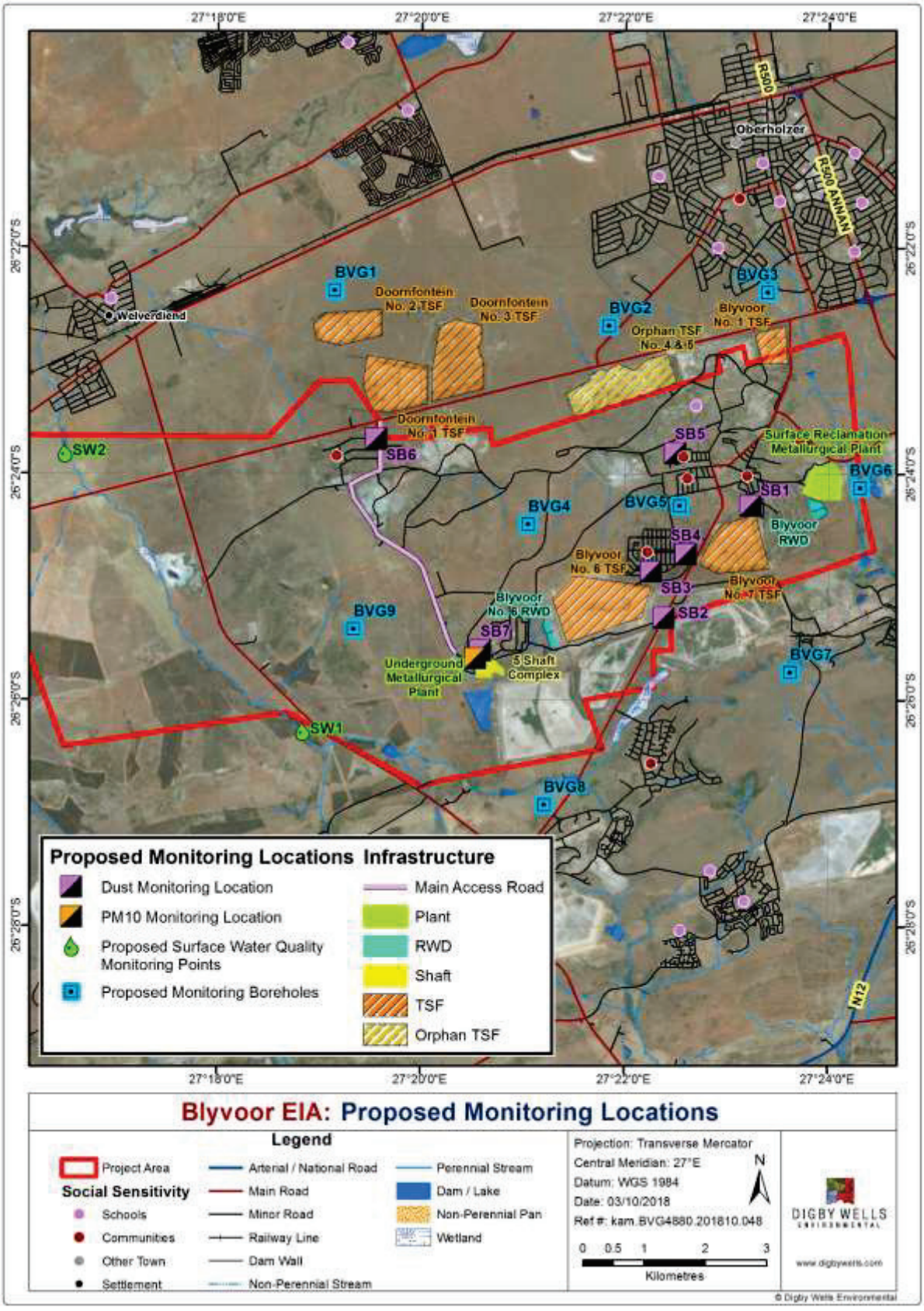

Figure 13-1: Proposed Monitoring Locations

14 References

https://wazimap.co.za/profiles/municipality-GT484-merafong-city/#educationIt is situated about 65km from Johannesburg – accessed 11/09/2011

www.aph.gov.au

www.merafong.gov.za

www.samrc.ac.za

www.statssa.gov.za

www.who.int/about/mission/en/, accessed August 2018

Annual Health Statistics (2012)

Birley, M. H. (2011). Health Impact Assessment: Principles and Practice. Earthscan UK

Blight, G. E. (2007). Wind erosion of tailings dams and mitigation of the dust nuisance. The Journal of The Southern African Institute of Mining and Metallurgy. Vol 107:99-106

Department of Health (2010). Environmental Health Impact Assessment (EHIA) in South Africa, Guidelines compiled in May 2010

ICMM (2010). Good Practice Guidance on Health Impact Assessment.

IFC. Introduction to health impact assessment. Washington, D.C., USA: International Finance Corporation; 2009b [http://www.ifc.org/ifcext/sustainability.nsf/Content/Publications_Handbook_HealthImpactAssessment; accessed: 11 September 2018]

Jasso-Pineda Y, Díaz-Barriga F, Calderón J, Yáñez L, Carrizales L, Pérez-Maldonado IN. 2012. DNA damage and decreased DNA repair in peripheral blood mononuclear cells in individuals exposed to arsenic and lead in a mining site. Biol Trace Elem Res. 146:141–149

Massyn N, Peer N, English R, Padarath A, Barron P, Day C, editors. District Health Barometer 2015/16. Durban: Health Systems Trust; 2016.

Moreno ME, Acosta-Saavedra LC, Meza-Figueroa D, Vera E, Cebrian ME, Ostrosky-Wegman P, Calderon-Aranda ES. Biomonitoring of metal in children living in a mine tailings zone in Southern Mexico: a pilot study. Int J Hyg Environ Health. 2010;213:252–258.

Nkosi V, Wichmann J, Voyi K. Mine dumps, wheeze, asthma, and rhinoconjunctivitis among adolescents in South Africa: any association International Journal of Environmental Health Research. 2015;25(6):583-600. doi:10.1080/09603123.2014.989493.

Sahoo et al. (2013). Current approaches for mitigating acid mine drainage. In S. e. al., Reviews of Environmental Contamination and Toxicology Volume 226 (pp. https://doi.org/10.1007/978-1-4614-6898-1_1). New York: Springer.

WHO. (2000). Air quality guidelines for Europe. Copenhagen: World Health Organisation Regional Office for Europe (WHO Regional Publication, Europe Series, No.91).

WHO, (2005). Air Quality Guidelines Global Update, World Health Organisation, October 2005, Germany.

World Health Organisation (WHO) - Air Quality and Health - Fact sheet N°313 - Updated September 2011. http://www.who.int/mediacentre/factsheets/fs313/en/index.html, accessed September 2018.

World Health Organisation (WHO) – Exposure to Air Pollution (Particulate Matter) in Outdoor Air – Fact Sheet 3.3 – July 2011. http://www.who.int/ipcs/assessment/public_health/ENHIS_Factsheet_3.3_July_2011.pdf, accessed October 2018.

Yohannessen, K., Alvarado, S., Mesías, S., Klarián, J., Silva, C., Vidal, D. and Cáceres, D.D. (2015) Exposure to Fine Particles by Mine Tailing and Lung Function Effects in a Panel of Schoolchildren, Chañaral, Chile. Journal of Environmental Protection, 6, 118-128. http://dx.doi.org/10.4236/jep.2015.62014