February 2017

SAMANCOR CHROME

EIA/EMPr Report: Application for Mining Right, Environmental Authorisation, Waste Management Licence and Water Use Licence on Varkensvlei 403 KQ

Due date for public comment: 6 March 2017

Submitted to:
Department of Mineral Resources
Reference numbers: LP30/5/1/2/2/ 10130MR and LP 30/5/1/2/3/2/1(10130) EM

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REPORT

Golder Associates

Purpose of this Document

Samancor Chrome applied for mining right on the farm Varkensvlei 403 KQ on 22 September 2015. This farm lies on the border between the North West and Limpopo Provinces and the mining operations will stretch across the provincial border.

The application for a mining right and environmental authorisation on Varkensvlei was submitted to the Polokwane Regional Office of the Department of Mineral Resources (DMR). In terms of the EIA Regulations GN R.982, GN R.983, GN R.984 and GN R.985, which commenced on 8 December 2014, Samancor Chrome is required to submit a Scoping Report, followed by an Environmental Impact Assessment Report and an Environmental Management Programme (EMPr), which describe the environmental impacts of the proposed development and how they will be managed and mitigated. The EMPr must be based on an Environmental Impact Assessment (EIA).

The mine will require a water use licence (WUL) and an integrated water and waste management plan (IWWMP). A waste management licence will be required for the waste rock and tailings storage facilities.

The chrome ore on Varkensvlei will be mined by opencast and underground methods and processed through an ore beneficiation plant.

Golder Associates Africa (Pty) Ltd, an independent environmental and engineering company, is conducting the EIA and licensing process for Samancor Chrome.

The first phase of an EIA is the Scoping Phase, during which interested and affected parties are given the opportunity to comment on the proposed activities and the proposed scope of the EIA specialist studies. The Scoping Report was submitted to the DMR on 23 September 2016.

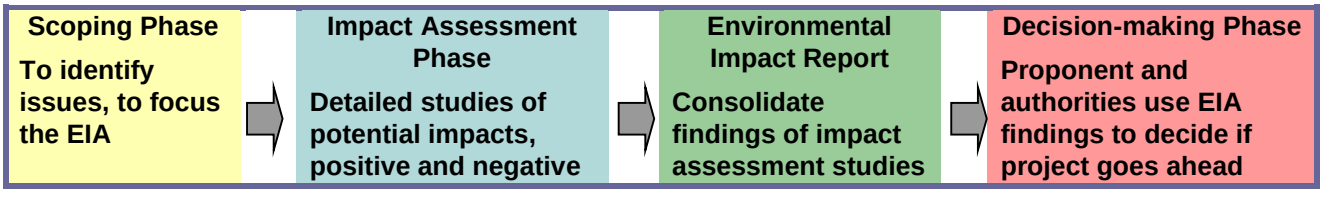
This EIA|/EMPr Report was presented to stakeholders so that they may confirm that the comments they made during the scoping phase have been recorded, to share the findings of the impact assessment studies and to provide them with an additional opportunity to provide comment and/or raise issues of concern.

The due date for comment on the EIA/EMPr Report is ***6 March 2017.***

Summary of what the EIA/EMPr Report contains

This report contains:

- A description of the proposed mining activities;
- An overview of the EIA process, including public participation;
- A description of the existing environment in the proposed project area;
- The identified environmental issues and impacts;
- The findings of the specialist studies undertaken during the Impact Assessment phase;
- A list of interested and affected parties and their comments; and
- A draft Environmental Management Programme (EMPr), based on the findings of the specialist studies



The figure above shows the various phases of an Environmental Impact Assessment. The Impact Assessment Phase, during which interested and affected parties comment on the findings of the impact assessment studies, has been completed.

PUBLIC REVIEW OF THE EIA/EMPR REPORT

This EIA/EMPr Report was available for comment for a period of 30 days from **Friday 3 February 2017** until **Monday 6 March 2017** at the public places in the project area listed in the table, and upon request from the Public Participation Office of Golder Associates.

Mantserre Tribal Offices	Ms Mogale	082 541 1894
Public Library at Thabazimbi Local Municipality	Letta Mokwena	(014) 777 1525/073 278 0461
Golder Associates Africa, Midrand	Ms Antoinette Pietersen	(011) 254 4994
The Golder Associates Africa website	www.golder.com/public	

OPPORTUNITIES FOR PUBLIC REVIEW

Stakeholders who wished to comment on the EIA/EMPr Report could do so in any of the following ways:

- Completing the comment sheet enclosed with the report or on-line via the Golder website (www.golder.com/public);
- Additional written submissions; and
- Comment by e-mail or telephone.

DUE DATE FOR COMMENT ON THE EIA/EMPR REPORT IS MONDAY 6 MARCH 2017

Comments could be submitted to the Public Participation Office:

Antoinette Pietersen / Sinazo Moyakhe

Golder Associates

P O Box 6001

HALFWAY HOUSE, 1685

Tel: (011) 254 4800

Fax: 086 582 1561

Email: samancorv@golder.co.za

EXECUTIVE SUMMARY

Background

Samancor Chrome operates two chrome ore mining complexes and three ferrochrome plants in South Africa and is one of the world's largest integrated producers of ferrochrome. The Company holds prospecting rights on the farm Varkensvlei 403 KQ, and has applied for a mining right with the intention of mining the LG6 and LG6A chromitite seams by opencast and underground methods over an area of 822 ha. Surface infrastructure, roads and servitudes will involve an additional area of about 26 ha.

The life of the mine will be approximately 30 years.

The chrome ore will be processed through a beneficiation plant, located on the farm Varkensvlei 403 KQ, to produce various size fractions of chromite ore as products. Other surface infrastructure on Varkensvlei will include a power supply, a workshop, administrative offices, bulk services and a weighbridge. Waste product will be deposited on waste rock dumps and later backfilled into the opencast void where available.

This EIA is being undertaken in support of the application for a mining right, environmental authorisation for several listed activities, and licences for waste management and water use.

This EIA is being undertaken in support of the application for a mining right, environmental authorisation for several listed activities, and a water use licence.

After the scoping phase, specialist studies applicable to the project will be undertaken to investigate the potential impacts that may result from the proposed project and to formulate appropriate mitigation measures.

Baseline Environmental Conditions

The current, pre-project environmental characteristics of the area on Varkensvlei where Samancor proposes to mine chromite ore can be summarised as follows:

Geology

The proposed mining area is located in a triangular segment of lithologies of Lower, Critical and Main Zones of the Bushveld Complex. The Lower Critical Zone consists mainly of Ruighoek Pyroxenite that hosts the Lower Group of chromitite layers, from the LG1 to the LG6A.

The LG6A layer is developed within pyroxenite, overlain by a coarse-grained pyroxenite. The ore is fine grained, solid and well packed. Pyroxenite bands or lenses may occur in the bottom contact of this layer. Immediate hanging wall and footwall pyroxenite is solid, and unaltered. The LG6A layer is separated from the LG6 layer by fine- to medium-grained pyroxenite with an average thickness of 12.00 m. The LG6A seam averages 0.30 m in thickness.

The LG6 layer is a fine-grained, well packed-chromitite, with sharp top and basal contact. It usually includes a disseminated band up to 15 cm thick in the top contact of the layer. The immediate footwall consists of alternating pyroxenite layers. The LG6 seam averages 1.01 m in thickness.

Climate

The climate is subtropical, with warm to hot summers and mild, generally dry and frost-free winters. About 89% of the rain falls during the summer months (October to March) and averages 516 mm/annum. The evaporation rate averages 2 363 mm/annum.

The winds originate mainly from the east-south-east (12.5% of the time) and east (9.5% of the time), wind speeds being low (1 – 4 m/s) to moderate (4 – 6 m/s), with a low percentage (19.24%) of calm conditions (<1 m/s). Significant seasonal variations, but only slight diurnal variations are experienced.

Topography

The topography is flat, with a slight slope (about 1 in 100) to the north-west and various artificial landforms such as the tailings dams and rock dumps at the adjacent Anglo American Union mine. There are several isolated ridges and outcrops about 7 km to the north-east and 10 km to the west-north-west.

Soil, Land Use and Land Capability

The soil types occurring on the proposed mining areas and their agricultural potentials are Arcadia (low), Bainsvlei (medium – high) and Mispah (low).

The soils are characterised by neutral pH values (5.3 and 7.2) and low electrical conductivity levels (<250 mS/m). Under these conditions plant-available nitrogen (15-20 mg/kg), phosphorus (10 - 15 mg/kg) and potassium (>50 mg/kg) are readily available for plant uptake and sustainable plant growth.

Current land use is largely natural veld, which has the capability to support grazing.

Terrestrial Ecology

Most of the proposed mining area has been disturbed by past agriculture and is characterised by low floral and faunal species diversity and a lack of large mammals. On abandoned agricultural fields, vegetation has recovered well in terms of cover, but there are about a dozen exotic species and severe encroachment by *Acacia mellifera* is prevalent in some areas.

All the surface water resources were dry at the time of the survey and no amphibians were observed.

No Red Data or Protected species were observed, but the Yellow throated Sandgrouse (*Pterocles gutturalis*) the Giant Bullfrog (*Pyxicephalus adspersus*) the Rusty pipistrelle (*Pipistrellus rusticus*) could potentially occur.

The ecological integrity of the proposed mining area was conservatively assessed as moderate to low and the conservation importance as low.

Surface hydrology

The area falls within the quaternary catchments A24D, A24E and A24F. Several drainage lines and minor watercourses combine to form the Bierspruit and the Bierspruit dam just north of the proposed mining area. All the watercourses were dry at the time of the survey, but a report by SRK dated August 2011 recorded a mean electrical conductivity (EC) value of 31 mS/m over the period 2007-2011 for the water in the Bierspruit Dam, which is well within the guideline of 70 mS/m for domestic use and is indicative of negligible impacts due to anthropogenic activities.

Groundwater

On a regional scale the geohydrology comprises a shallow weathered, unconfined, phreatic bedrock aquifer system which might be laterally connected to alluvial aquifers associated with river systems and a deeper fractured bedrock system.

The Frank fault, some 17 km to the west of the proposed mining lease area, constitutes a major aquifer in the area, with boreholes yielding 10 ℓ/s and higher, but this aquifer is not believed be connected to the proposed mining area.

Recharge to the groundwater regime in the Bushveld Complex (BIC) is estimated to be approximately 3% of the mean annual precipitation (MAP).

Locally, the groundwater levels broadly follow the topography, but where they are affected by anthropogenic activities they vary from about 2.4 mbgl near the return water dam on the Union mine property, 7.5 mbgl near the Bierspruit dam on the farm Nooitgedacht to 23.6 mbgl near Bierspruit village, and 24.25 mbgl at Mantserre on the farm Varkensvlei.

The pH of groundwater samples taken in the vicinity of the proposed mining area ranged from about 7.4 to 7.7 and the TDS concentration ranged from about 600 to 1 300 mg/ℓ.

Noise

Prevailing noise levels at potentially noise sensitive receptor points are typical of residential areas in the vicinity of roads and distant mining activities. Higher noise levels recorded during night time periods were due to insects.

Visual

The regional visual character is largely rural, consisting of wilderness/conservation and agricultural uses, contrasted in various locations by extensive mining, human settlements and linear infrastructure. Watercourses in the landscape are identified by taller and denser vegetation growing along them, rather than by visible water.

The flat topography is punctuated by several isolated ridges and outcrops to the northwest and southeast of the project area and artificial landforms (tailings dams and slag dumps) at Union mine.

Most of the study area retains a rural sense of place, due to the relatively low levels of transformation and limited degree of land use, but the Union mine infrastructure and operations southeast of the site are visually prominent and intrusive, as are the power lines and roads in the region.

Cultural and heritage

With the exception of a large formal graveyard with hundreds of graves near the southern perimeter of the village of Mantserre, no cultural or heritage resources have been identified on or close to the proposed mining areas.

Socio-economics

Varkensvlei falls within the Bojanala District Municipality (DM) and the Moses Kotane Local Municipality (LM) in the Northwest Province.

The Moses Kotane LM has a total population of 242,554, with an average household size of 3.2.

Mantserre is host to an estimated 1,081 households. Kraalhoek (approximately 1 km from the farm boundary) and Mopyane (approximately 500 m - 1 km from the farm boundary) are located adjacent to the proposed mining area.

The mining sector contributes about 47% of the Waterberg District Municipality's GGP. Cultivation of cash crops and horticulture is declining, but hunting and eco-tourism are showing growth.

Moses Kotane LM has a 30% employment rate, which is lower than the overall employment rate for North West Province.

Table of Contents

TABLES

FIGURES

APPENDICES

PART A
SCOPE OF ASSESSMENT AND ENVIRONMENTAL IMPACT ASSESSMENT REPORT

1.0 INTRODUCTION

1.1 Background

Samancor Chrome was established in 1975 as a result of a merger between SA Manganese Ltd (formed in 1926 to mine manganese ore in the Northern Cape) and Amcor Ltd. (established in 1937 to exploit mineral deposits for the steel industry and to process those minerals into ferroalloys). The Kermas Group acquired Samancor Chrome from BHP Billiton and Anglo American in June 2005. International Mineral Resources (IMR) became the majority shareholder in Samancor Chrome Limited in November 2009 through the acquisition of a 70% direct shareholding in the holding company, Samancor Chrome Holdings (Pty) Limited.

Samancor Chrome's corporate office is based in Sandton, Johannesburg. The Company's core business is the mining and smelting of chrome ore. The Company's total chromite resources exceed 650 million tons and are expected to support current mining activity for well over 200 years at the current rate of extraction. More than 80% of Samancor Chrome's chrome ore output is consumed in the production of ferrochrome in South Africa. The remainder of the ore is exported.

Samancor Chrome is one of the world's largest integrated producers of ferrochrome, producing more than a million tons of charge chrome, about 70 thousand tons of intermediate carbon ferrochrome, and some 40 thousand tons of low carbon ferrochrome per annum. In addition, Samancor Chrome sells more than 700 thousand tons of chrome ore per annum on the export market. Ferrochrome is used in the production of stainless steel. The chrome content in stainless steel gives it its lustre and resistance to corrosion. Some 85% of South Africa's chrome alloy production is exported to stainless steel producers across the globe and South Africa currently supplies more than 50% of worldwide charge chrome demand.

Samancor Chrome operates the following two chrome ore mining complexes and three ferrochrome plants as separate business units:

- Western Chrome Mines in the Rustenburg area in the North West Province.
- Eastern Chrome Mines near the Lydenburg /Steelpoort area of the Limpopo Province.
- Ferrometals plant near eMalahleni, Mpumalanga Province.
- Middelburg Ferrochrome and Technochrome plants near Middelburg, Mpumalanga Province.
- Tubatse Ferrochrome plant in the Lydenburg / Steelpoort area of the Limpopo Province.

An application for environmental authorisation for listed activities associated with opencast mining on Varkensvlei 403 KQ and the adjacent farm Nooitgedacht 406 KQ was submitted to the Department of Environmental Affairs (DEA) on 27 February 2013 and an EIA process was undertaken. The DEA granted the environmental authorisation, with Reference Number 14/12/16/3/3/2/524, on 27 March 2015. An application for a water use licence was also submitted. This application is still pending.

Samancor submitted an application for a mining right on Nooitgedacht 406 KQ early in February 2014. The supporting scoping report was submitted on 6 March 2014 and the final EMPr was submitted towards the end of June 2014.

On 22 September 2015 Samancor Chrome submitted an application to the Department of Mineral Resources (DMR) for a mining right on portions 0, 1 and 2 of the farm Varkensvlei 403 KQ. In terms of the new EIA Regulations GN R.982/983/984/985 that commenced on 8 December 2014, an application for a mining right triggers an application for environmental authorisation, which must be supported by a scoping and impact assessment process and which must also be submitted to the DMR. In terms of changes in the legislation on waste management (GN R.632/633) that commenced on 24 July 2015, Samancor Chrome must also apply for a waste management licence.

The application submitted on 22 September 2015 was an integrated application that constituted an application for environmental authorisation and a waste management licence.

Samancor has decided to change the originally envisaged mining methodology on Varkensvlei from opencast mining only to include both opencast and underground mining of chrome ore and to change the originally envisaged ore processing methodology from dry to wet processing. Waste products will be deposited on waste rock dumps and a tailings storage facility and later backfilled into the opencast void. The life of the mine will be approximately 30 years.

The change in ore processing methodology requires the submission of an amended water use licence and an application for a waste management license.

Contents of this Report

This document has been structured as follows to meet the requirements of the South African environmental legislation:

1) **Introduction and overview** – Introduces the Project and the Project proponent, gives an overview of the Project, provides the details of the environmental practitioner, and explains the ESHIA/EIA process.

2) **Project Motivation** – Provides an indication of the need for and desirability of the Project.

3) **EIA Process –** Summarises the process being undertaken with respect to Environmental, Social and Health Impact Assessment for the Project, inclusive of the methodology utilised for Scoping**.**

4) **Description of the Proposed Project** - Provides a summary of the key Project components, the Project location, scale, nature and design, production process, main inputs and outputs, schedule and activities during different phases of the Project, inclusive of a description of the Project location and the properties on which the Project will take place.

5) **Project Alternatives –** Summarises alternatives considered by the Project proponent.

6) **Policy, Legal and Administrative Framework** – Discusses the environmental policy, legal, and administrative framework applicable to the Project. This includes a summary of relevant South African regulations, the applicable administrative framework, and the environmental permitting process.

7) **Description of the Environment that may be Affected** – Describes the current pre-project biophysical, socio-economic, and cultural status of the area, key characteristics (sensitive or vulnerable areas), important heritage resources, current land use and livelihoods.

8) **Environmental Issues and Potential Impacts of the Project -** Summarises the identified impacts and issues and potential mitigation measures that were assessed in the EIA.

9) Public Consultation – This section provides a summary of the public consultation activities proposed and carried out as part of the EIA process.

10) Next Steps in the Process – Indicates what the next steps in the process are.

11) **References –** References to literature consulted.

Appendices – Material supporting the EIA/EMPr Report, including the database of interested and affected parties, project announcement documents comments and response report and specialist reports.

2.0 PROPONENT AND PRACTITIONER DETAILS

2.1 Details of the proponent

For purposes of this EIA, the following person may be contacted at Samancor Chrome:

Table 2-1: Proponent's contact details

Contact Person	Heather Booysen
Address	1st Floor, Block B, Cullinan Place, Cullinan Close (off Rivonia Road), Morningside
Telephone	013 249 4407
Fax	013 249 4894
E-mail	Heather.Booysen@SamancorCr.com

2.2 Details of Environmental Assessment Practitioner

Samancor Chrome has appointed Golder Associates Africa (Pty) Ltd (GAA) as an independent Environmental Assessment Practitioner (EAP) to undertake Environmental Impact Assessment (EIA) that is required to support the application for a mining right.

Golder Associates Africa is a member of the world-wide Golder Associates group of companies, offering a variety of specialised engineering and environmental services. Employee owned since its formation in 1960, the Golder Associates group employs more than 9 000 people who operate from more than 180 offices located throughout Africa, Asia, Australasia, Europe, North America and South America. GAA has offices in Midrand, Pretoria, Florida, Durban, Rustenburg, Cape Town, Maputo and Accra. GAA has more than 300 skilled employees and is able to source additional professional skills and inputs from other Golder offices around the world.

GAA has no vested interest in the proposed project and hereby declares its independence as required by the EIA Regulations.

For purposes of this EIA, the following persons may be contacted at Golder:

Contact Persons	Etienne Roux	Antoinette Pietersen
Purpose	Technical	Public Participation
Address	P O Box 6002 Halfway House 1685	P O Box 6002 Halfway House 1685
Telephone	011 254 4970	011 254 4805
Fax	011 315 0317	011 315 0317
Cell phone	082 774 2045	083 280 5024
E-mail	Eroux@golder.co.za	Apietersen@golder.co.za

2.2.1 Expertise of environmental assessment practitioner

2.2.1.1 Qualifications

The EAP holds an MSc degree in physical chemistry from the University of Pretoria (1966) and an MBL degree from the University of South Africa (1974). He also completed a Development Programme in Labour Relations at the University of South Africa (1984).

2.2.1.2 Summary of past experience

1962-1966: African Explosives and Chemical Industries Ltd, Modderfontein – research and development work on industrial electrochemical processes;

1967-1993: Foskor Ltd, Phalaborwa – analytical chemistry, systems analysis, research and development, geological exploration, mining, production, tailings storage, environmental management, strategic corporate planning;

1993-2005: Industrial Development Corporation: Responsible for developing corporate environmental, health and safety policy and capability, managing environmental aspects of IDC's larger industrial, mining and agricultural projects, managing remediation programs on polluted sites, designing and implementing an EHS risk assessment methodology specifically for a financial institution and overseeing its application. Participated in more than 50 EIAs within South Africa and seven other African countries, several with involvement from World Bank, IFC, European Investment Bank, African Development Bank, Kreditanstalt für Wiederaufbau, provided environmental guidance on IDC's investment decisions and served as director on boards of two IDC subsidiaries.

2006 – Present: Golder Associates Africa (Pty) Ltd – Undertook more than 20 complete EIAs, 5 environmental audits and several environmental due diligence investigations.

2.3 Description of the property

Table 2-2: Details of area applied for

Aspect	Description
Farm Name	Varkensvlei 403 KQ
Application area	822.2238 hectares
Magisterial District	Waterberg
Distance and direction from nearest town	About 13 km to the west of Northam
SG Codes	TOKQ00000000040300000 TOKQ00000000040300001 TOKQ00000000040300002

2.4 Locality map

The farm Varkensvlei 403 KQ is located in the Magisterial District of Waterberg in the Limpopo Province, about 13 km west of the town of Northam and 80 km north of Rustenburg. See Figure 2-1. The farm lies on the border between the North West and Limpopo Provinces and the proposed mining operation will stretch across the border. An application for environmental authorisation for listed activities associated with opencast mining on Varkensvlei and the adjacent Nooitgedacht was submitted to the Department of Environmental Affairs (DEA) on 27 February 2013. This process is still under review by the Department of Environmental Affairs.

Samancor Chrome has applied for a mining right on portion 1, portion 2 and the Remaining Extent of the farm Varkensvlei 403 KQ and this includes the mining methodology for underground mining. In terms of the new EIA Regulations GN R.982/983/984/985 that commenced on 8 December 2014, an application for a mining right triggers an application for environmental authorisation, which must be supported by a scoping and impact assessment process and which must also be submitted to the DMR.

2.4.1 Magisterial District and relevant Local Authority

Varkensvlei 403 KQ falls within the jurisdiction of the Waterberg Magisterial District. Varkensvlei 403 KQ is located in the Moses Kotane Local Municipality, which falls within the boundaries of the Bojanala Platinum District Municipality, in the North West Province.

2.4.2 Landowners and use of immediately adjacent land

The proposed mining area is surrounded by mainly agricultural activities, with some undeveloped land to the east. Anglo Platinum's Swartklip mining complex and staff village are located about 900 metres south-east, the village of Mmopyane about 1 100 metres north- west and the village of Mantserre about 600 metres to the north of the proposed mining area on Varkensvlei. The surface right owners of the various farm portions are indicated in Table 2-3.

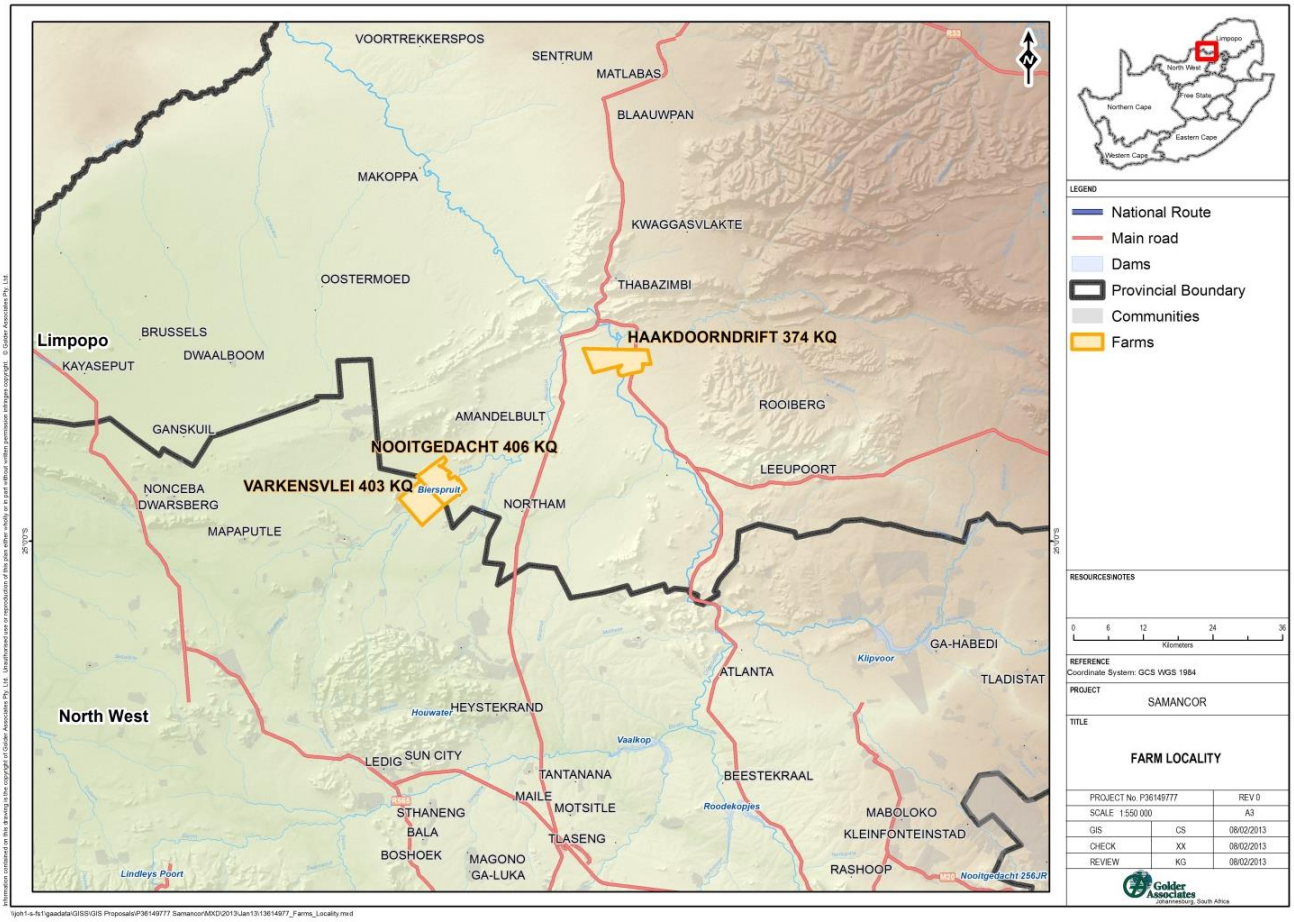


Figure 2-1: Locations of Samancor Chrome mining right applications

Table 2-3: List of landowners

Portion Number	Mineral Right	Surface Right Owner
1	Chromite & Associated minerals	Minister of Rural Development and Land Reform in trust for the Baphalane Community
2	Chromite & Associated minerals	Jabasigo Family Trust
Remaining extent	Chromite & Associated minerals	Minister of Rural Development and Land Reform in trust for the Baphalane Community

According to the Office of the Regional Land Claims Commissioner in Polokwane, there is no record of any land claim on the above farm portions (Maunye, K M;, 2015).

2.5 Description and Scope of the Proposed Overall Activity

2.5.1 Mining operations

Samancor Chrome holds prospecting rights on the farm Varkensvlei 403 KQ (portion 1, portion 2 and Remaining Extent of the farm).

Sufficient chrome ore reserves have been proven to support opencast and underground mining of the LG6 and LG6A chromitite seams. An area of about 26 ha will be required for surface infrastructure, roads and servitudes.

The chrome ore reserves on Varkensvlei occur in seams. The LG6 forms the principal seam of economic interest based on its high chrome content and thickness, the LG6 consists of 4.8 million tons in-situ to a mineable depth of 50m below surface, with an average thickness of 1.08m and a chrome grade of 45.52% Cr_2O_3.

The LG6A layer is located 12m above the LG6 in the stratigraphy and is only about 0.3 metres thick, too thin to be mined by underground methods. The LG6A consists of 0.57 million tons in-situ ore to a mineable depth of 50m below surface, with an average grade of 42.32% Cr_2O_3. The economic viability of mining the LG6A chromitite seam by opencast methods is largely dependent of the global chrome market price and the mining costs. This is due to the high strip ratio and the additional cost of mining the thinner seam. However, the overlying LG6A has to be extracted in order to mine the LG6 seam. This is only the case in the opencast mining environment due to the nature of the seams' dip and orientation where the seams sub-outcrop on surface. In the underground mining environment the LG6A would not be feasible.

The chromitite seams occur over a strike length of nearly 6.9 km across Varkensvlei and Nooitgedacht with an average dip of 25^0, reaching a depth of 300 metres. With an average thickness of about 1 metre, there is a good potential for underground mining of the LG6 seam.

An application for environmental authorisation for activities listed in the 2010 EIA Regulations GN R.544, R.545 and R.546 was submitted to the Department of Environmental Affairs (DEA) on 15 February 2013. A full EIA, with extensive public participation, was undertaken (Roux, E; Perry, E;, May 2014) and the DEA granted an environmental authorisation on 27 March 2015.

Samancor Chrome applied for a mining right, which application was accepted by the DMR on 17 February 2014, on the farm Nooitgedacht 406 KQ in the Magisterial District of Waterberg. Samancor Chrome also applied for mining right on Varkensvlei 403 KQ on 22 September 2015. These two farms lie on either side of the border between the North West and Limpopo Provinces and the mining operations will stretch across the provincial border, as shown on Figure 2-2. Figure 2-3 shows an existing opencast operation on a chromitite seam at Bushveld Chrome Resources (McQuade, 2013) in the same area.

The application for a mining right and environmental authorisation on Varkensvlei was submitted to the Polokwane Regional Office of the Department of Mineral Resources (DMR). Under the EIA Regulations GN R.982, GN R.983, GN R.984 and GN R.985, which commenced on 8 December 2014, Samancor Chrome is required to submit a Scoping Report, followed by an Environmental Impact Assessment Report and an Environmental Management Programme (EMPr), which describe the environmental impacts of the proposed development and how they will be managed and mitigated. The EMPr must be based on an Environmental Impact Assessment (EIA).

The mine will also require a water use licence (WUL), an integrated water and waste management plan (IWWMP), and a waste management licence for the waste rock and tailings storage facilities.

Opencast mining will be done by means of drilling and blasting, using the single benching method as defined in the blast design. The mining bench will be planned at 3- 5 m intervals with a catchment berm at 6m intervals, making the effective bench stack height 4m. The first 18 m bench will be mined or excavated in four half benches or interim benches of 4m each. Thereafter the second bench of 12m will be mined or excavated in three 4 m benches. The final bench will be 10 m and will be mined or excavated in three benches of 3 m each. Ore recovery from the opencast mining operation is expected to be between 85% and 95% with minimal dilution.

The blast design will involve the blasting of three benches. Typically, the first bench will be drilled to a depth of 18 m and blasted. Once this bench has been mined out to the 18 m depth after several cuts, the second

bench will be drilled and blasted to a further depth of 12 m, and this bench will be mined out to the final bench after several cuts. The final bench will be drilled and blasted to a depth of 10 m to reach the final depth of the opencast pit. This bench will be mined out, after which the opencast will be rehabilitated.

Topsoil and overburden removal and mining of the chrome ore will be done by means of the truck and shovel method. Topsoil and overburden will be stockpiled separately.

The rollover mining method will be practised, whereby the topsoil and overburden from the first cut of the opencast mine are stockpiled at the position of the last cut. As the opencast mine progresses, the overburden and topsoil from each successive cut are backfilled into the void from the previous cut, the surface is shaped to be free draining, the topsoil is analysed and treated appropriately and the surface is re-vegetated. At the end of the life of the opencast mine the final void is backfilled with the overburden from the final cut of the last remaining pit.

To gain access to the underground mineral resource an area will be left open during opencast operations and made safe to be used as a portal. Twin declines will be developed from the portal in the highwall on the LG6 chromitite seam at a 10 degree dip in the south-easterly and south-westerly directions (Figure 2-5). It will be a semi-mechanised mine with twin strike production drives (SPD) developed from the declines with an average back length of 150m. Conveyor belts will be installed on the downdip strike drive and linked with the decline belts through normal chutes. The two main belts will feed the crusher on surface.

Other surface infrastructure will include a waste rock storage site for material removed during underground mining, a tailings dam, water management infrastructure, power supply, a workshop, office space and a security kiosk.

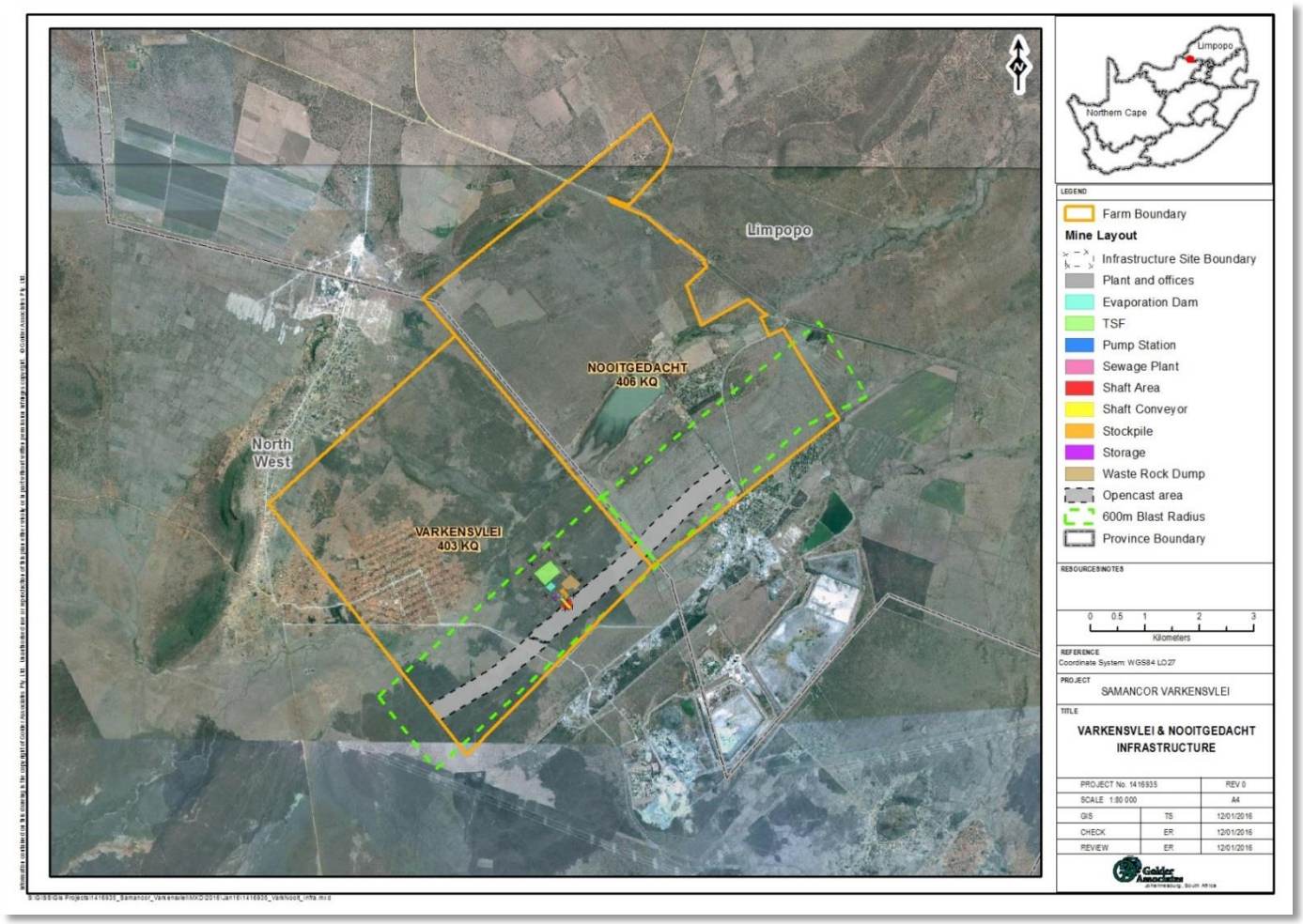


Figure 2-2: Proposed opencast mining area

Figure 2-3: A view of the opencast pit and chromitite seams at nearby BCR mine

The proposed opencast and underground mining layouts are shown on Figure 2-4 and Figure 2-5 respectively.

The initial engineering work and construction of the surface infrastructure for the site would take about 12 to 18 months. Based on an average production rate of 13 000 tons of run of mine (RoM) ore per month, the life of mine for the opencast will be approximately 7 years. During this time Samancor Chrome will complete the planning and implementation of the activities for the underground mine, which could increase the life of mine (LoM) to about 30 years.

Underground mining of the deeper chrome ore seams will commence about 4 years after the commencement of opencast mining.

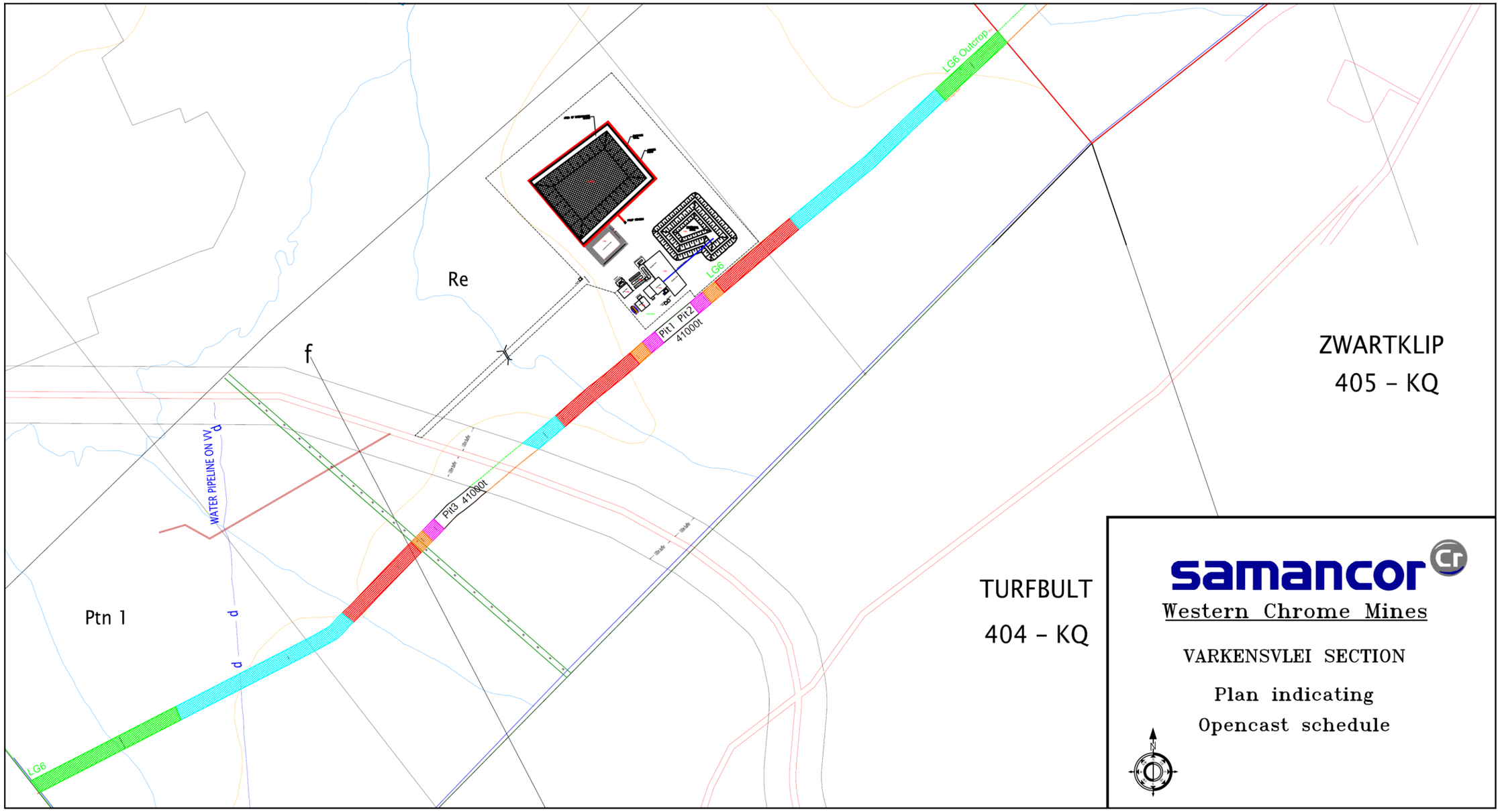


Figure 2-4: Schematic layout for opencast mine

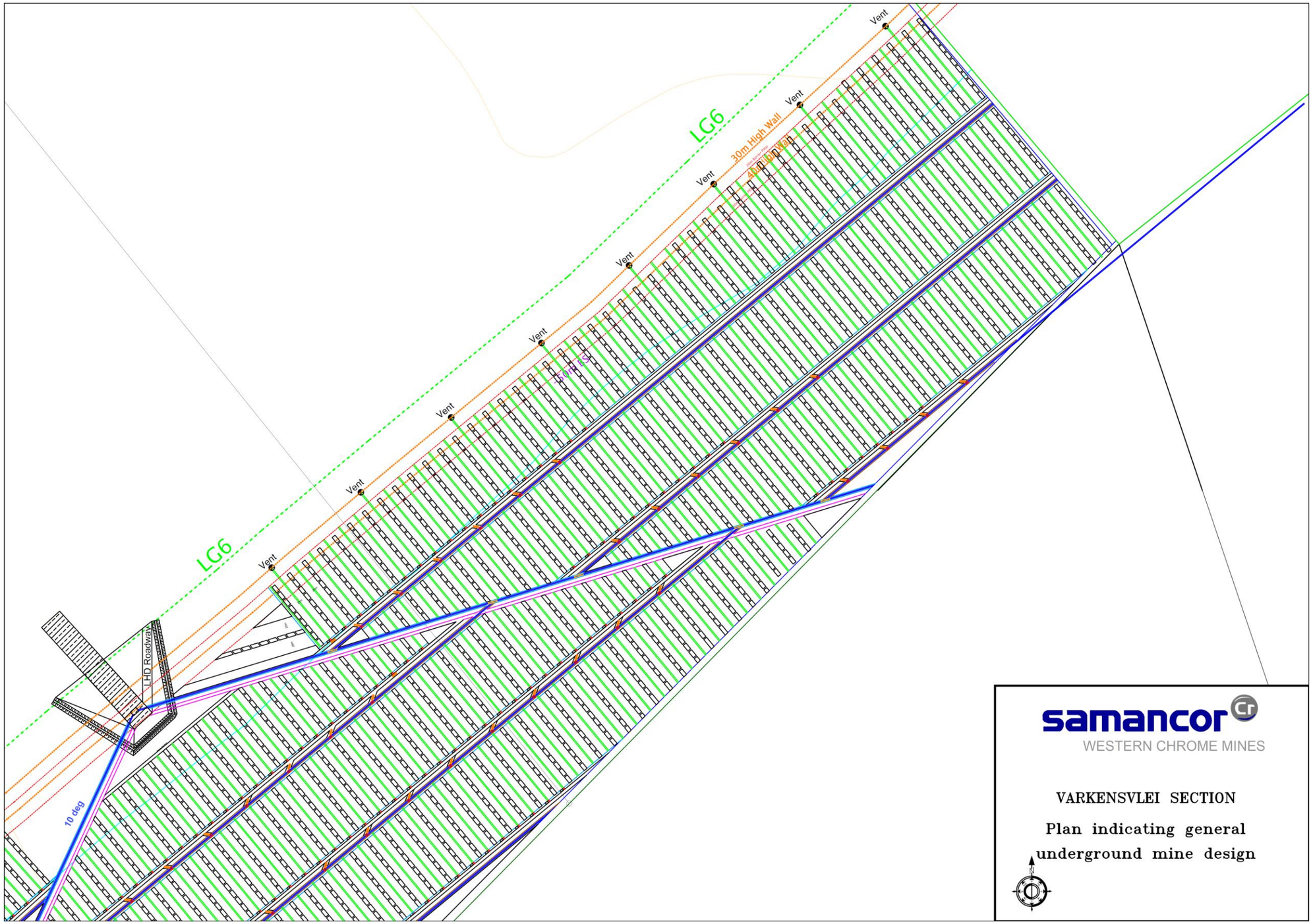


Figure 2-5: Schematic layout for underground mine

2.5.2 Other operations

The proposed infrastructure to be established at surface includes an ore beneficiation plant, offices, a lamp room, change houses, workshops, stores, waste storage areas, storm water management infrastructure, a sewage treatment plant, a sub-station and parking bays, as illustrated in Figure 2-6.

The plant components and process flowsheet, which are depicted schematically in Figure 2-7, will be as described below.

Scalper and primary crusher: Ore will be delivered to the run-of-mine ore stockpile from the opencast mine by means of dump trucks and from the underground mine by means of a conveyor belt. The ore will be reclaimed from the stockpile and passed over a magnetic scalper to remove pieces of steel that could damage the crushers and other plant components. Thereafter, the ore will pass through the primary crusher.

Sizing screen and conveyor: The primary crushed ore will pass over a sizing screen with an opening of 1.5 mm. The screen oversize (>1.5mm) will be conveyed to the secondary crusher. The screen undersize (<1.5mm) will go to a washing and dewatering screen.

Secondary crusher and conveyor: The oversize material from the sizing screen will be crushed and conveyed to the dense media separation (DMS) plant *via* two surge bins.

Washing and dewatering screen: The undersize from the sizing screen will be conveyed to the washing and dewatering screen with an opening of 0.850 mm. The screen oversize (<1.5 mm >0.850 mm) will be conveyed to a jigging plant. The undersize from the screen will be pumped to the spiral concentration plant.

Jigging plant: The oversize from the screen will be conveyed to the jigging plant. The larger particles with higher specific gravity (SG) and higher chrome content (concentrate) will be separated from the smaller particles and those of lower SG (tailings). The concentrate will be bagged and sold as product. The tailings will be sent to the DMS plant.

Dense media separation plant (DMS): The tailings from the jigging plant and the secondary crusher material from the surge bins will be subjected to dense media separation by mixing the material with a dense medium, consisting of very finely ground magnetite or ferrosilicon suspended in water, and passing the resulting slurry through flat-bottomed cyclones. This process will separate the larger and denser (higher SG) particles containing higher chrome values in the <1.5 mm >0.850 mm size fraction (concentrate) from the smaller, lower SG particles containing less chrome (tailings). The magnetite (or ferrosilicon) will be recovered from the concentrate and tailings by means of a drum magnetic separator and recycled. The concentrate and tailings will both be dewatered by means of cyclones. The water will be recirculated back into the process. The tailings will be deposited on the final tailings storage facility (TSF). The concentrate will be filtered, dried, bagged and sold as product.

Spiral concentration plant: This plant will consist of twelve rougher spirals, twelve cleaner spirals, six re-cleaner and six scavenger spirals and will separate the larger and denser (higher SG) particles containing higher chrome values in the <0.850 mm size fraction (concentrate) from the smaller, lower SG particles containing less chrome (tailings). The concentrate will be dewatered and sent to the concentrate stockpile, from which it will be reclaimed and sold. The tailings will be pumped to a settling cone where it will be partially dewatered. Water recovered as cone overflow will be recycled back into the process. The thickened cone underflow will be further dewatered with cyclones and deposited on the final tailings storage facility (TSF). Water recovered by the cyclones and from the TSF will be recirculated back into the process.

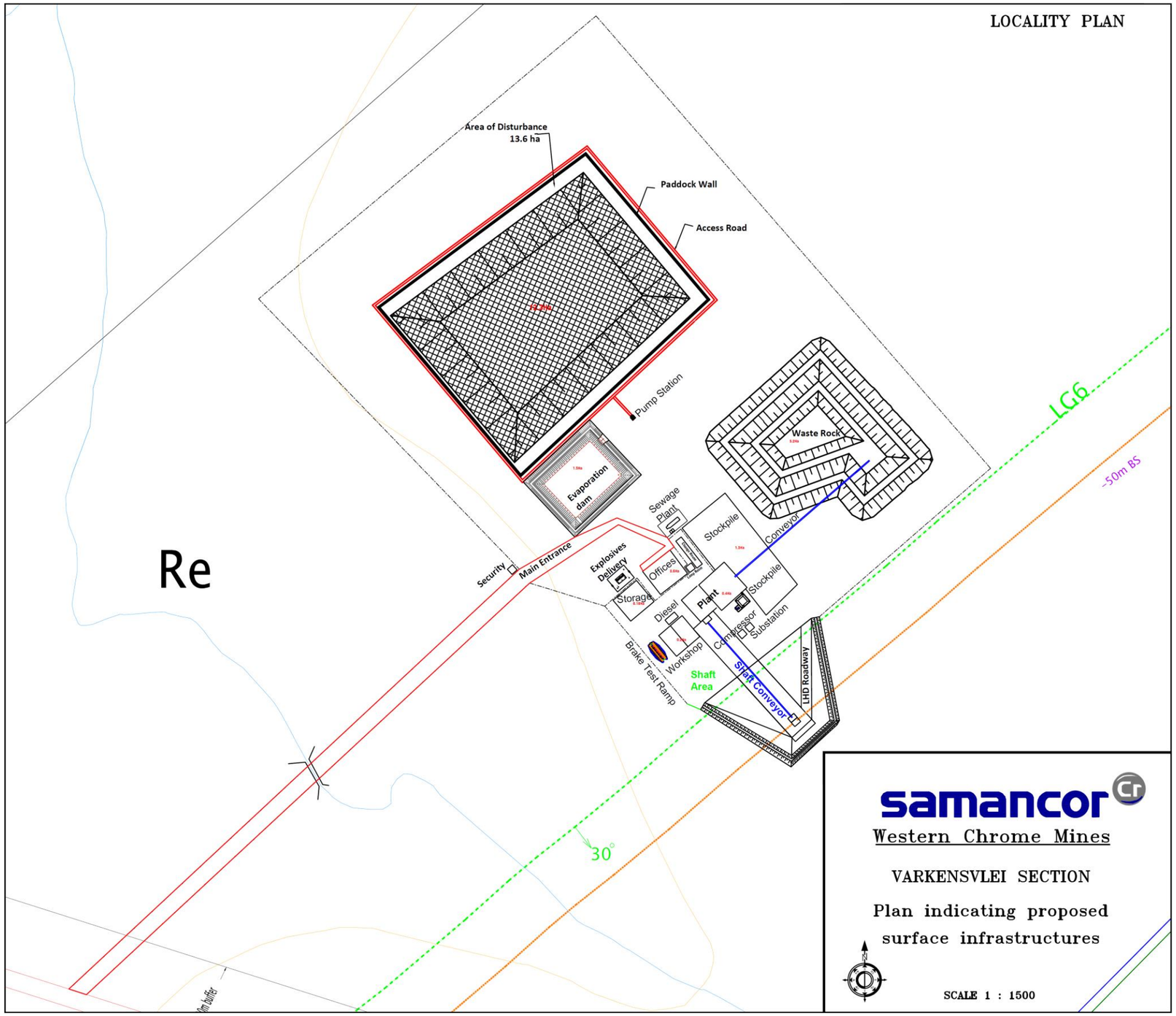


Figure 2-6: Proposed surface infrastructure

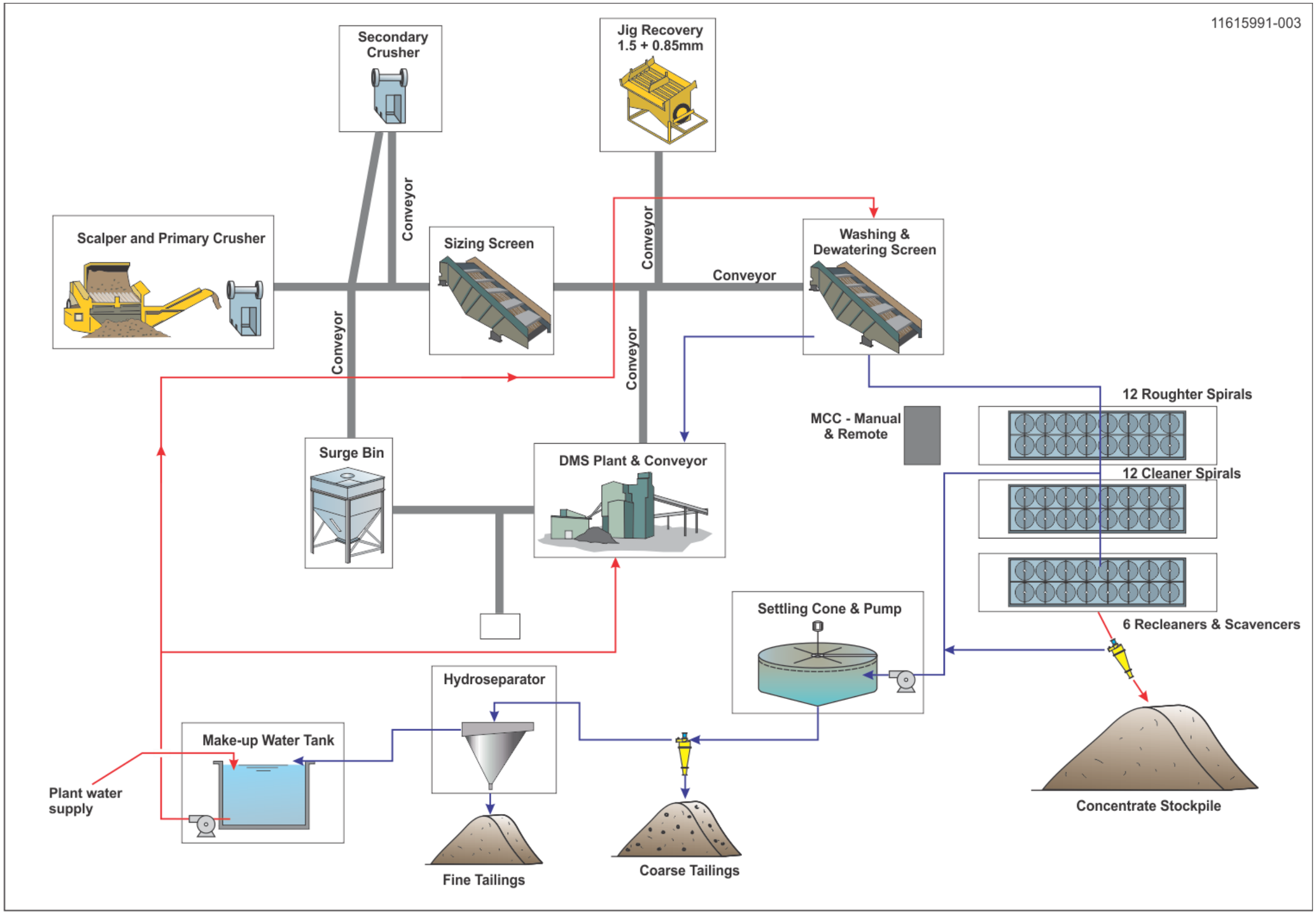


Figure 2-7: Schematic illustration of beneficiation plant

2.5.3 Listed and Specific Activities

Samancor Chrome has applied for a mining right on Varkensvlei 403 KQ and environmental authorisation for the development of supporting infrastructure. The listed activities that require environmental authorisation in terms of the EIA Regulations GN R.982/983/984/985 that commenced on 8 December 2014 are indicated in Table 2-4.

Table 2-4: Listed activities requiring environmental authorisation or licensing

Regulation	Activity Number	Description
GN R.983, 8 December 2014	12	Infrastructure for stormwater management will include a small pollution control dam for impoundment of runoff from the mining, plant and workshop areas. The water will be used for dust suppression in the mine and on haul roads.
	14	Two above ground diesel tanks with a combined capacity of more than 80 m^3 but less than 500 m^3 will be erected in the vicinity of the plant and workshop shown in Figure 2-6 to provide fuel for mining and hauling vehicles and other machinery.
	24	Haulage and access roads will be constructed. Some of the haul roads will be up to 10 m wide, but all the access roads will be less than 8 m wide.
GN R.984, 8 December 2014	6	The mining operation will require a water use licence as per the NWA section 21 (a), (g) and (j) for the construction and use of a pollution control dam that will be designed in accordance with Regulation 704 under the National Water Act.
	15	Establishment of the opencast mining operations and associated infrastructure will disturb an area of about 460 hectares.
	17	Samancor Chrome has applied for a mining right.
	21	There will be a chrome ore beneficiation plant to produce chromite concentrates by crushing, screening and gravity separation
GN R.632 and R.633, 24 July 2015, GN 921, 29 November 2013	Category B 4 (1)	The mine will require a waste management licence for the storage/disposal of mine residues (waste rock and tailings)

2.5.4 Specific activities to be undertaken

The specific activities will be:

- Drilling of infill boreholes for detailed mine planning;
- Stripping and stockpiling of topsoil in front of the advancing opencast mining front, with bulldozers and front end loaders;
- Drilling and charging of blast holes, followed by blasting, where necessary. Vibration levels and fly rock occurrence will be recorded during each blast and used to plan subsequent blasts.
- Excavation, loading, hauling and transport of overburden and ore. Bench heights will vary between 10 and 18 metres. The ore will be transported to the beneficiation plant and the overburden and waste rock to temporary stockpiles alongside the opencast by haul trucks;
- Stockpiling of overburden, waste rock and chrome ore concentrate. The overburden will be stockpiled separately from the topsoil and the waste rock;

- Continuously backfilling the void with waste rock, overburden and topsoil, in that order, followed by fertilisation and re-vegetation with locally indigenous species of grass, shrubs and trees. See section 2.5.1 for a description and illustration of the rollover mining method that will be applied;
- When underground mining of the deeper chrome ore seams commences after about 4 years:
  - Construction of decline shafts from the high wall of the open pit;
  - Equipping the shaft(s) with a conveyor system for the removal of mined material from the underground mining areas;
  - Mining the underground seams by the bord and pillar method; and
  - Construction of waste rock and tailings storage facilities.
- Constructing and operating a storm water control system comprising diversion berms, collection channels, and a pollution control dam;
- Constructing and operating a water supply dam and boreholes for monitoring, mine dewatering and water supply purposes;
- Constructing and operating a chrome ore beneficiation plant, conveyors, weighbridges, workshops, ablution facilities, offices, stores, roads, pipelines and fencing. See Figure 2-6 for a layout plan for the supporting infrastructure on Varkensvlei 403 KQ; and
- Transporting chrome ore from the mine for use at Samancor Chrome smelters and for export to customers.

3.0 POLICY AND LEGISLATIVE CONTEXT

This section provides a brief overview of the legal requirements that must be met by this project.

3.1 Mineral and Petroleum Resources Development Act

In terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) and the MPRDA Regulations R. 527, an application for a mining right must be supported by an EIA process. In terms of Regulation 3 of R. 527, consultation must take place with interested and affected parties (I&APs). In terms of the latest EIA Regulations (see section 3.2) a scoping report conforming to Appendix 2 of GN R.982 must be submitted to the DMR, followed by an environmental impact assessment report conforming to Appendix 3 of GN R.982 and an environmental management programme conforming to Appendix 4 of GN R.982. These documents must also be aligned with the templates prescribed by the DMR.

3.2 National Environmental Management Act

In terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), as amended and the EIA Regulations, an application for environmental authorisation for certain listed activities must be submitted to the provincial environmental authority, the national authority (Department of Environmental Affairs, DEA), depending on the types of activities being applied for or, when mining and mineral processing activities are involved, the Department of Mineral Resources (DMR) - see section 3.1 above.

The current EIA regulations, GN R.982, GN R.983, GN R.984 and GN R.985, promulgated in terms of Sections 24(5), 24M and 44 of the NEMA and subsequent amendments, commenced on 8 December 2014. GN R.983 lists those activities for which a Basic Assessment is required, GN R.984 lists the activities requiring a full EIA (Scoping and Impact Assessment phases) and GN R.985 lists certain activities and competent authorities in specific identified geographical areas. GN R.982 defines the EIA processes that must be undertaken to apply for Environmental Authorisation.

The activities requiring environmental authorisation and/or licensing in terms of the NEMA and NEMWA are included in Table 2-4.

Copies of this EIA/EMPr Report have been sent to the Limpopo Department of Economic Development, Environment, and Tourism (LEDET) and the North West Department of Rural, Environmental and Agricultural Development (DREAD) for comment. The two provincial departments are key I&APs and have been kept informed throughout the EIA process. The EIA process has been undertaken in accordance with the requirements stipulated in GN R.982 and the DEA's guidelines on public participation, published as GN 657 in May 2006.

3.3 National Water Act

The National Water Act, 1998 (Act No. 36 of 1998) (NWA) is the primary legislation regulating both the use of water and the pollution of water resources. It is applied and enforced by the Department of Water and Sanitation (DWS).

Section 19 of the National Water Act regulates pollution, which is defined as "the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it:

- less fit for any beneficial purpose for which it may reasonably be expected to be used; or
- harmful or potentially harmful to -
  - the welfare, health or safety of human beings;
  - any aquatic or non-aquatic organisms;
  - the resource quality; or
  - property."

The persons held responsible for taking measures to prevent pollution from occurring, recurring or continuing include persons who own, control, occupy or use the land. This obligation or duty of care is initiated where there is any activity or process performed on the land (either presently or in the past) or any other situation which could lead or has led to the pollution of water.

The following measures are prescribed in the section 19(2) of the NWA to prevent pollution:

- cease, modify or control any act or process causing the pollution;
- comply with any prescribed standard or management practice;
- contain or prevent the movement of pollutants;
- eliminate any source of the pollution;
- remedy the effects of pollution; and
- remedy the effects of any disturbance to the bed or banks of a watercourse.

The NWA states in Section 22 (1) that a person may only use water:

- without a licence –
  - (i) if that water use is permissible under Schedule 1;
  - (ii) if that water use is permissible as a continuation of an existing lawful use; or
  - (iii) if that water use is permissible in terms of a general authorisation issued under section 39;
- if the water use is authorised by a licence under this Act; or
- if the responsible authority has dispensed with a licence requirement under subsection (3).

Water use is defined in Section 21 of the NWA. Samancor Chrome's proposed mining operations on Varkensvlei may involve the following water uses:

a) taking water from a water resource;

b) storing water;

c) impeding or diverting the flow of water in a watercourse;

g) disposing of waste in a manner which may detrimentally impact on a water resource;

h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

i) altering the bed, banks, course or characteristics of a watercourse; and

j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

Regulation 704 of 4 June 1999 defines the manner in which rainwater falling or flowing onto a mining area or an industrial site must be managed and requires *inter alia* the following:

a) Separation of clean (unpolluted) water from dirty water;

b) Collection and confinement of the water arising within any dirty area into a dirty water system;

c) Design, construction, maintenance and operation of the clean water and dirty water management systems so that it is not likely for either system to spill into the other more than once in 50 years;

d) Design, construction, maintenance and operation of any dam that forms part of a dirty water system to have a minimum freeboard of 0.8 metres above full supply level, unless otherwise specified in terms of Chapter 12 of the Act; and

e) Design, construction, and maintenance of all water systems in such a manner as to guarantee the serviceability of such conveyances for flows up to and including those arising as a result of the maximum flood with an average period of recurrence of once in 50 years.

3.4 National Environmental Management: Waste Act

The National Environmental Management: Waste Act, 2008 (Act 59 of 2008)(NEMWA) commenced on 1 July 2009. In terms of this Act, all listed waste management activities must be licensed and in terms of Section 44 of the Act, the licensing procedure must be integrated with the environmental impact assessment process.

Government Notice 921, which commenced on 29 November 2013, lists the waste management activities that require licensing in terms of the NEMWA. Licence applications for activities involving hazardous waste must be submitted to the national authority, the Department of Environmental Affairs (DEA) and those for general waste to the provincial authority, in this case the LDEDET.

One of the major amendments effected by the National Environmental Management Amendment Act 2014 is the insertion of section 24S, as a result of which the NEMWA is now also applicable to mining residue deposits and residue stockpiles, as follows:

‘‘Management of residue stockpiles and residue deposits

24S. *Residue stockpiles and residue deposits must be deposited and managed in accordance with the provisions of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), on any site demarcated for that purpose in the environmental management plan or environmental management programme in question.’’*

Mining residues were classified as hazardous wastes by default In terms section 18, Schedule 3 of the National Environmental Management: Waste Amendment Act, 2014 (Act No. 26 of 2014) (NEMWAA), which commenced on 2 June 2014. In terms of Regulations GN R.632 and R.633, which commenced on 24 July 2015, mining residues must be characterised and classified, and the design and management of residue stockpiles and deposits must be based on an assessment of the potential impacts and risks.

3.5 National Environmental Management: Air Quality Act

The main objectives of the National Environmental Management: Air Quality Act 2004 (Act no. 39 of 2004) (NEM: AQA) are to protect the environment by providing reasonable legislative and other measures to:

- Prevent air pollution and ecological degradation;
- Promote conservation; and
- Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development in alignment with Sections 24a and 24b of the Constitution of the Republic of South Africa.

The Act has devolved the responsibility for air quality management from the national sphere of government to local spheres of government (district and local municipal authorities), who are tasked with baseline characterisation, management and operation of ambient monitoring networks, licensing of listed activities, and development of emissions reduction strategies.

National Ambient Air Quality Standards (NAAQS) for common pollutants, as set in terms of the NEM:AQA, are reproduced in Table 3-1.

Table 3-1: South African Ambient Air Quality Standards for Criteria Pollutants

Pollutant	Averaging Period	Limit Value ($\mu g/m^3$)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
Sulphur dioxide (SO_2)[a]	10 minute	500	191	526	Immediate
	1 hour	350	134	88	Immediate
	24 hours	125	48	4	Immediate
	1 year	50	19	0	Immediate
Nitrogen dioxide (NO_2)[b]	1 hour	200	106	88	Immediate
	1 year	40	21	0	Immediate
Particulate matter <10 micrometres in diameter (PM_{10})[c]	24 hour	75	-	4	Immediate
	1 year	40	-	0	Immediate
Particulate matter <2.5 micrometres in diameter ($PM_{2.5}$)[d]	24 hours	65	-	4	Immediate
	24 hours	40	-	4	01/01/2016 – 31/12/2029
	24 hours	25	-	4	01/01/2030
	1 year	25	-	0	Immediate
	1 year	20	-	0	01/01/2016 – 31/12/2029
	1 year	15	-	0	01/01/2030
Ozone (O_3)[e]	8 hours	120	61	11	Immediate
Lead (Pb) [f]	1 year	0.5	-	0	Immediate
Carbon monoxide (CO)[g]	1 hour	30,000	26,000	88	Immediate
	8 hour (1 hour averages)	10,000	8,700	11	Immediate
Benzene (C_6H_6) [h]	1 year	5	1.6	0	01/01/2015

a. The reference method for the analysis of SO_2 shall be ISO 6767
b. The reference method for the analysis of NO_2 shall be ISO 7996
c. The reference method for the determination of the particulate matter fraction of suspended particulate matter shall be EN 12341
d. The reference method for the analysis of $PM_{2.5}$ shall be EN14907
e. The reference method for the analysis of ozone shall be the UV photometric method as described in ISO 13964
f. The reference method for the analysis of lead shall be ISO 9855
g. The reference method for analysis of CO shall be ISO 4224
h. The reference methods for benzene sampling and analysis shall be either EPA compendium method TO-14 A or method TO-17

The National Dust Control Regulations (GN R.827), which were promulgated on 1 November 2013, define acceptable dust fall rates for residential and non-residential areas as listed in Table 3-2.

Table 3-2: Acceptable dust fall rates

Defined areas	Dust fall rate (mg/m^2/day over a 30 day average)	Permitted frequency of exceedance
Residential areas	Dust fall < 600	Two per annum (not in sequential months)
Non-residential areas	600 < Dust fall < 1200	Two per annum (not in sequential months)

Although Samancor Chrome will not require an atmospheric emission licence for its proposed operations on Varkensvlei, it will have to operate within the NAAQS and the National Dust Control Regulations.

3.6 Need and Desirability of Proposed Activities

A large percentage of the world's economically mineable chromite ore reserves are located in the Bushveld Complex, a saucer-shaped deposit in the northern part of South Africa. The complex is the largest known layered intrusion in the world. It stretches some 480 km east-west and 240 km north-south over the North West and Limpopo Provinces. Chromite ore is mined along the eastern and western rims of the complex, which has a surface area of about 66,000 km^2. The proposed mining project is located on the western rim of the Bushveld Complex.

Chromite ore and concentrates are used primarily in metallurgical applications such as the production of ferrochrome, which is a major input in the production of stainless steel. Other applications include refractories, foundry sands and chromium chemicals. Samancor Chrome utilises its chromite concentrates primarily for the production of ferrochrome in its own smelters, but also exports chromite.

The chrome content in stainless steel gives it its lustre and resistance to corrosion. Some 85% of South Africa's chrome alloy production is exported to stainless steel producers across the globe and South Africa currently supplies more than 50% of worldwide charge chrome demand.

Despite the economic crisis in the Eurozone and the slowdown in the growth rate of the Chinese economy, the long term outlook for chrome remains good as stainless steel is expected to experience renewed growth in demand in the medium to long term. The proposed mining project will have a life of about 7 years as an opencast mine and a further 23 years as an underground mine.

The positive aspects of the proposed mining operations on Varkensvlei include the benefits of employment and income generation in the area as well as the development of BEE opportunities during construction, operation and eventual closure and rehabilitation.

3.7 Process followed to reach preferred site

Mining can take place only within the area for which a mining right is obtained and no alternative site for mining is possible. Several alternative sites and layouts for the supporting infrastructure are possible and were explored, taking into consideration economic viability, practicality and environmental characteristics – see section 6.7 of this report.

3.7.1 Project Alternatives

In terms of Regulation 50 (d) of the MPRDA Regulations R. 527 under the Mineral and Petroleum Resources Development Act, Act 28 of 2002, an environmental impact assessment report must include *inter alia* the following:

> *"(d) A comparative assessment of the identified land use and development alternatives and their potential environmental, social and cultural impacts."*

Alternatives considered for the proposed project are as follows:

3.7.1.1 Opencast mining

There are a number of alternative methods of opencast mining, e.g.:

- Removal of topsoil, overburden and even ore can sometimes be done by means of draglines, bucket wheel excavators or bowl scrapers.
- In some opencast operations, the ore is crushed in the pit and transported to a processing plant by means of conveyor belts or trains.
- Blast designs can vary widely, but are always tailored to the particular pit design and materials handling system.
- Sometimes opencast mines are not backfilled. Instead, the void is allowed to fill with water, while the overburden and waste rock dumps and the tailings dams are re-vegetated.

The description provided in section 2.5.1 reflects the most suitable opencast mining approach for this particular orebody.

3.7.1.2 Underground mining

As discussed in section 2.5.1, the LG6 and LG6A chromite ore seams dip quite steeply at 24° to 36° and reach depths of up to 300 metres below ground level. For this orebody, opencast mining will be the most economically viable method for the shallower ore, thereafter underground mining will be the more viable method of mining the LG6 seam. The LG6A seam is too thin (average of 0.3 metres) for viable extraction by means of underground mining.

There are several alternative methods of underground mining that could be considered, e.g.:

- Sinking one or more vertical shafts into or adjacent to the ore seam and driving horizontal drifts into the ore seam at various levels;
- Constructing one or more incline shafts or decline shafts from the surface, through the host rock and into the ore seam;
- Applying the bord and pillar method of ore extraction, leaving behind adequate pillars of ore to support the roof of the mine and prevent surface subsidence;
- Practising high extraction by removing the pillars of ore and accepting the risk of various degrees of surface subsidence;
- Transporting the ore to surface by means of cocopans or trains running on rails from the underground workings to the surface, by trackless load-haul-dump (LHD) electric or diesel vehicles, or by means of conveyor belts.

3.7.1.3 Location of infrastructure

The preferred location and layout of the supporting infrastructure on Varkensvlei 403 kQ, as shown in Figure 2-4, was chosen with practical, economic, environmental and logistics considerations in mind, as set out in section 6.7 of this report.

3.7.1.4 Postponement of mining project

The chrome reserves on Varkensvlei 403 KQ could be left in the ground to be mined at a much later date, but if Samancor Chrome, who has applied for a mining right, does not pursue this project, Samancor Chrome's rights will lapse and other parties would be free to pursue the right to mine these chrome reserves. Such postponement would result in Samancor Chrome losing a business opportunity and allow other parties to apply for a mining right on Varkensvlei.

3.7.1.5 No-Project Option

If the chromite ore reserves on Varkensvlei are not mined, Samancor Chrome, South Africa and the local communities will forego the benefits of the associated additional employment opportunities and revenue streams and the limited agricultural activities currently being undertaken will continue.

3.7.2 Public Participation Process

This section provides an overview of the public participation process undertaken during the EIA.

3.7.2.1 Objectives of Public Participation

The principles that determine communication with society at large are included in the principles of the National Environmental Management Act (NEMA) (Act 107of 1998, as amended) and are elaborated upon in General Notice 657, titled *"Guideline 4: Public Participation"* (Department of Environmental Affairs and Tourism, 19 May, 2006), which states that: *"Public participation process means a process in which potential interested and affected parties (I&APs) are given an opportunity to comment on, or raise issues relevant to, specific matters."*

Opportunities for Comment

Documents are made available at various stages during the EIA process to provide stakeholders with information, further opportunities to identify issues of concern and suggestions for enhanced benefits and to verify that the issues raised have been considered.

Public participation is an essential and regulatory requirement for an environmental authorisation process, and must be undertaken in terms of Regulations 39 to 44 of the Environmental Impact Assessment (EIA) Regulations GN R.982 (December 2014). Public participation is a process that is intended to lead to a joint effort by stakeholders, technical specialists, the authorities and the proponent/developer who work together to produce better decisions than if they had acted independently.

The public participation process is designed to provide sufficient and accessible information to Interested and Affected Parties (I&APs) in an objective manner and:

During the Scoping Phase to enable them to:

- raise issues of concern and suggestions for enhanced benefits;
- verify that their issues have been recorded;
- assist in identifying reasonable alternatives;
- comment on the plan of study of specialist studies to be undertaken during the impact assessment phase; and
- contribute relevant local information and traditional knowledge to the environmental assessment.

During the impact assessment phase to assist them to:

- contribute relevant information and local and traditional knowledge to the environmental assessment;
- verify that their issues have been considered in the environmental investigations; and
- comment on the findings of the environmental assessments.

During the decision-making phase:

To advise I&APs of the outcome, i.e. the authority decision, and how the decision can be appealed.

3.7.2.2 Identification of I&APs

I&APs were initially identified through a process of networking and referral, obtaining information from Golder's existing stakeholder database, liaison with potentially affected parties in the study area, newspaper advertisements and a registration process involving completion of a registration and comment sheet. The registration sheet encouraged I&APs to indicate the names of their colleagues and friends who may also be interested in participating in the public participation process.

The initial stakeholder database used to announce Samancor Chrome's proposed project for the mining of chrome ore on the farm Varkensvlei 403 KQ near Northam comprised a total of approximately 80 I&APs (See APPENDIX A) representing the various sectors of society listed below.

- Government (national, provincial and local);
- Environmental NGOs;
- Conservation Agencies;
- Agricultural Bodies;
- Community Representatives and CBOs;
- Business and Commerce; and
- Other.

3.7.2.3 Register of I&APs

The NEMA Regulations (GN R.982) distinguish between I&APs and registered I&APs.

I&APs, as contemplated in Section 24(4)(d) of the NEMA include: "*(a) any person, group of persons or organisation interested in or affected by an activity; and (b) any organ of state that may have jurisdiction over any aspect of the activity".*

In terms of the Regulations:

"An EAP managing an application must open and maintain a register which contains the names, contact details and addresses of:

(a) All persons who; have submitted written comments or attended meetings with the applicant or EAP;
(b) All persons who; have requested the applicant or EAP managing the application, in writing, for their names to be placed on the register; and
(c) All organs of state which have jurisdiction in respect of the activity to which the application relates.

Please register as an I&AP!

Stakeholders are encouraged to register as I&APs and participate in the consultation processes by completing the Registration and Comment sheet and returning it to the Public Participation Office. The Registration and Comment Sheet can also be completed on-line via Golder's website: www.golder.com/public. Contact details are provided on page iii of this report.

A Register for I&APs has been opened and currently comprises approximately 50 registered I&APs (See APPENDIX D).

As per the EIA Regulations, **registered I&APs** will be kept informed of developments during the Impact Assessment and Decision-making phases. Stakeholders who were involved in the initial consultation and who attended the public open house during the Scoping Phase have been added to the register. The I&AP register will be updated throughout the EIA process.

3.7.2.4 Public participation during Scoping

This section provides a summary of the public participation process followed during the Scoping Phase of the EIA, after restarting the application process on 12 August 2016 – see section 3.7.2.6 below.

3.7.2.4.1 Announcement of the proposed project

Draft Scoping Report

The Draft Scoping Report was available for public review for 30 days from ***26 August until 26 September 2016*****.** The availability of the report was announced on 26 August 2016 and stakeholders were invited to participate in the EIA and public participation process and to pass on the information to friends/colleagues/neighbours who may be interested and to register as I&APs.

The proposed project was announced as follows:

- Distribution of the Draft Scoping Report (DSR) and a letter of invitation to participate to all I&APs on the database, accompanied by a registration, comment and reply sheet that was mailed/emailed to the entire stakeholder database. Copies of the announcement documents are attached as APPENDIX B.
- The abovementioned documents were made available at the public places listed on page ii of this report and posted to the Golder website www.golder.com/public;
- An advertisement was published in four newspapers, the Sowetan and The Citizen on 26 August 2016, the Rustenburg Herald and the Kwêvoël in the week following (APPENDIX C**);** and
- Site notices were placed at the entrance to the proposed project site and at visible places at the boundary of the property – see APPENDIX E.

Final Scoping Report

The DSR was updated after the expiry of the public review period and submitted to the Department of Mineral Resources (DMR). It was accepted by the DMR on 12 January 2017.

3.7.2.5 Summary of issues raised by I&APs

The issues raised during the scoping phase include the following:

- Ownership of surface rights on the area affected by the application for a mining right and the establishment of supporting infrastructure;
- Relationships with neighbouring mines (Anglo Union and Bushveld Chrome Resources)
- Community development projects;
- The cumulative impacts on air quality, dust fall, noise, lighting, traffic and adjacent land use (crops and grazing);
- Waste disposal, including sewage treatment;
- Effects on surface water and groundwater (quantity and quality);
- Blasting effects on nearby mines, residents and buildings:
- Sourcing of water and power;
- Socio-economics – employment, skills training, population influx, crime;
- Any rare plants and/or animals identified on site;
- Water pollution;
- Management of any finds of cultural and heritage significance; and
- Rehabilitation and closure of the mine.

All issues and comments received during the scoping phase were recorded in a Comment and Response Report, which was attached to the Scoping Report that was submitted to the DMR on 6 November 2015.

3.7.2.6 Public participation during the Impact Assessment Phase

Public participation during the impact assessment phase of the EIA entails a review of the findings of the EIA, presented in the Draft EIA/EMpr Report and the volume of specialist studies.

The report was available for public comment from from Friday 26 February to Tuesday 29 March 2016. No comments on the report were received by Samancor Chrome or Golder, but certain members of the Baphalane ba Mantserre community approached the DMR with objections and demands for a shareholding in the project instead of the royalties on offer. A Regional Mining Development and Environmental Committee (RMDEC) meeting was held at the Polokwane offices of the DMR on 23 June 2016. In a letter dated 1 July 2016, the DMR instructed Samancor Chrome to hold a public participation meeting with the

community. See APPENDIX H. A meeting was convened at the Community Hall in Mantserre on 20 July 2016, but it was disrupted by objectors and adjourned.

Pursuant to the disrupted meeting, Samancor Chrome submitted the EIA/EMPr report to the DMR a few days later than the timeframe stipulated in the EIA Regulations GN R.982 and was required to re-start the authorisation process. Samancor Chrome re-submitted the applications for a mining right and environmental authorisation on 12 August 2016 and proceeded with the scoping process as described in section 3.7.2.4 above.

The EIA/EMPr report has been made available for public comment from 3 February to 6 March 2017. I&APs are encouraged to comment either in writing (mail or email), or by telephone. Focus group meetings will be held at the Union Mine Club on 13 February 2017.

The office of the Land Claims Commissioner confirmed that there were no land claims on the farm Varkensvlei 403 KQ – see APPENDIX H.

3.8 Announcement of Lead Authority's Decision

Once the DMR has taken a decision about the granting of a mining right, the Public Participation Office will immediately notify I&APs of this decision and of the opportunity to appeal. This notification will be provided as follows:

- A letter will be sent, personally addressed to all registered I&APs, summarising the DMR's decision and explaining how to lodge an appeal should they wish to; and
- An advertisement to announce the Lead Authority's decision will be published in the Rustenburg Herald and the Kwêvoël newspapers, if so required by the authorities.

4.0 ENVIRONMENTAL ATTRIBUTES AND DESCRIPTION OF THE BASELINE RECEIVING ENVIRONMENT

This section of the report provides a description of the receiving environment and existing conditions on and in the vicinity of the proposed project components.

4.1 Geology

South Africa's resources of chrome ore and platinum group metals (PGM) are situated within the Bushveld Complex, an enormous ultramafic/mafic intrusion extending for about 480 km from east to west and 240 km north-south over the North West and Limpopo Provinces and covering a surface area of about 66,000 km^2. See Figure 4-1. The proposed mining project is located in the Bushveld Complex.

The ultramafic/mafic rocks of the Bushveld Complex are collectively referred to as the Rustenburg Layered Suite and they are divided, from the lower to the upper layers, into the Marginal, Lower, Critical, Main and Upper Zones. The Critical Zone is the host to all chromium and PGM mineralisation within the Bushveld Complex.

The igneous layering within the Critical Zone is remarkably uniform over much of the Bushveld Complex, with individual layers traceable for tens to hundreds of kilometres. The Critical Zone is subdivided into lower and upper sections and is made up of cyclic units consisting of chromitite, pyroxenite, norite and anorthosite. Cycles in the Lower Critical Zone are entirely ultramafic in character. Cycles in the Upper Critical Zone comprise ultramafic lithologies as well as norite-anorthosite.

The chromitite seams have been classified into lower, middle and upper groups, with the Lower Group occurring in the Lower Critical Zone and the Upper Group in the Upper Critical Zone. The Middle Group chromitite seams straddle the boundary between lower and upper divisions of the Critical Zone.

The chromitite seams are named according to their location within the layered succession, with numbers commencing from the bottom up. The Lower Group consists of 7 layers, the lowermost group being named

LG1, followed by LG2, LG3, up to LG7. The Middle Group comprises 4 layers (MG0, MG1, MG2, and MG3) the Upper Group consists of two layers, UG1 and UG2. The thickness of these chromitite layers ranges from several millimetres to several metres and named chromitite layers may comprise multiple, composite layers of chromitite separated by interlaminated silicate rocks. The thickest chromitite layers, specifically the LG6 and MG1, are mined for their chromite content.

The target area of the application for a mining right on Varkensvlei is underlain by rocks of the Lower Critical Zone and Upper Critical Zone of the Bushveld Complex, consisting of chromitite interlayered with pyroxenite, norite, anorthositic norite, and mottled anorthosite.

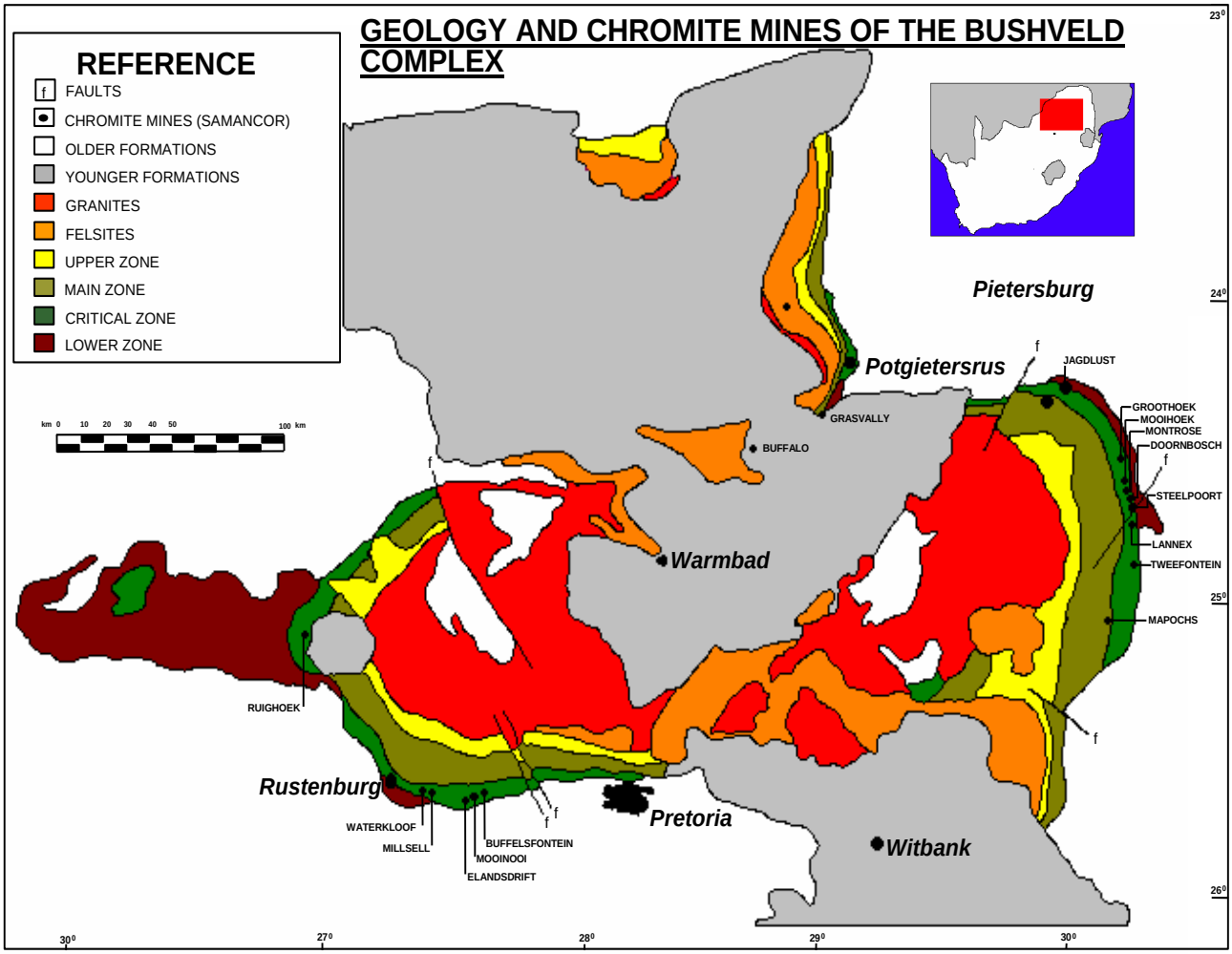


Figure 4-1: Geological features of the Bushveld Complex

Exploration of the intersection of the Middle Group Chromitite (MG2, MG3 and MG4) layers and the Lower Group Chromitite Layers (LG1, LG2, LG3, LG4, LG5, LG6 and LG6A) was done under a new order prospecting right and included 108 diamond drill holes.

The initial drilling programme was based on historical drilling results. The drilling programme was designed to intersect the LG1, LG2, LG3, LG4, LG5, LG6 and LG6A seams at 25m – 50m below surface. The drilling lines were spaced 150m apart, and then filled in at 75m. Trenching was also conducted along the strike to fix the sub-outcrop positions of the LG6 and LG6A chrome seams.

The LG6 became the main focus for exploration drilling due to the high chrome content and consistency in thickness which make the seam economically viable.

The other Lower and Middle Group seams require further investigation and are sensitive to mining costs and global chrome market conditions.

Drilling and trenching also proved that the orebody is steep dipping, ranging from dips of 24° to 36° over the opencastable area for the LG6A and the LG6.

Varkensvlei hosts the Lower Group seams from the LG1 to the LG6A. Currently only the LG6 is of interest, but further investigation into the other Lower Group seams and Middle Group seams is being undertaken. Figure 4-2, which shows the nature of the layering at Samancor's Western Chrome mines near Mooinooi, is illustrative of the generalised stratigraphy of the Lower and Upper Critical, Lower and Middle Group chromitite seams as they occur in the Bushveld Complex.

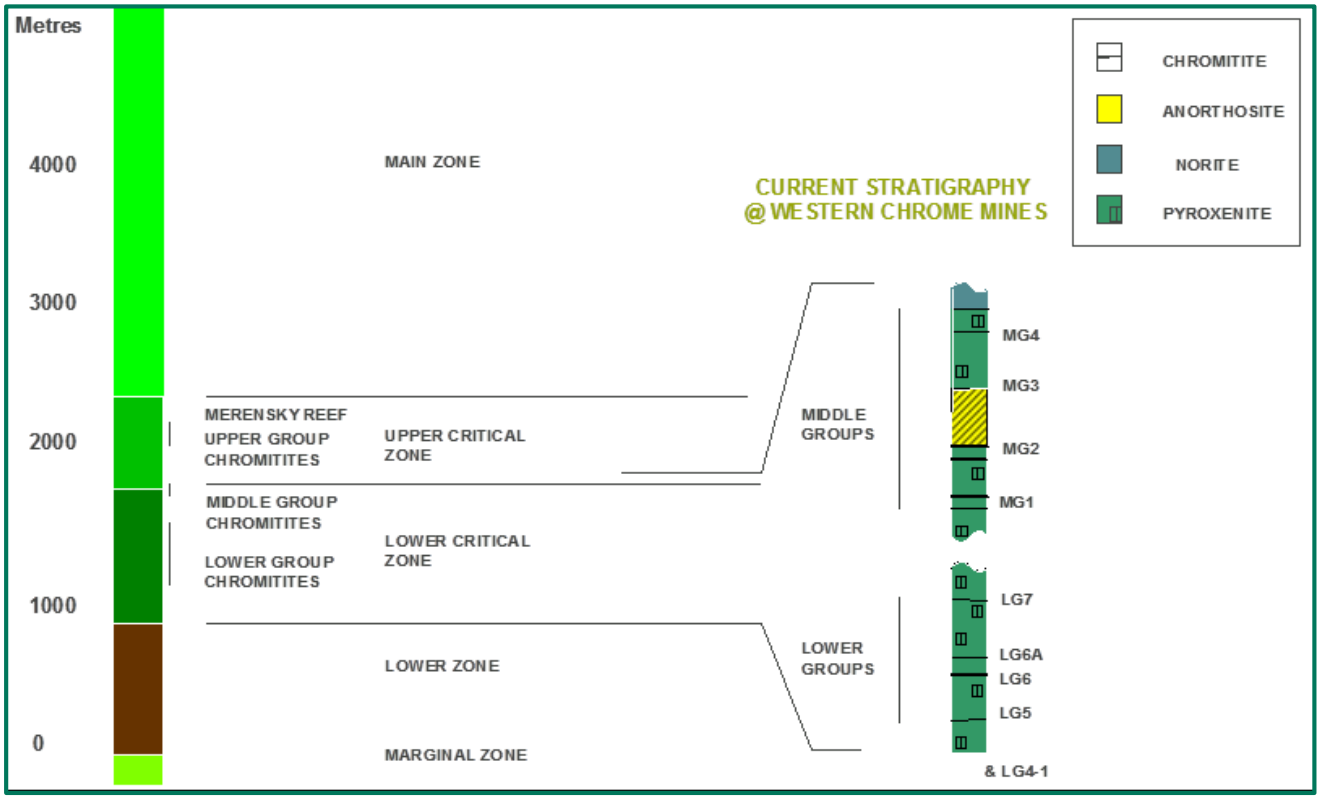
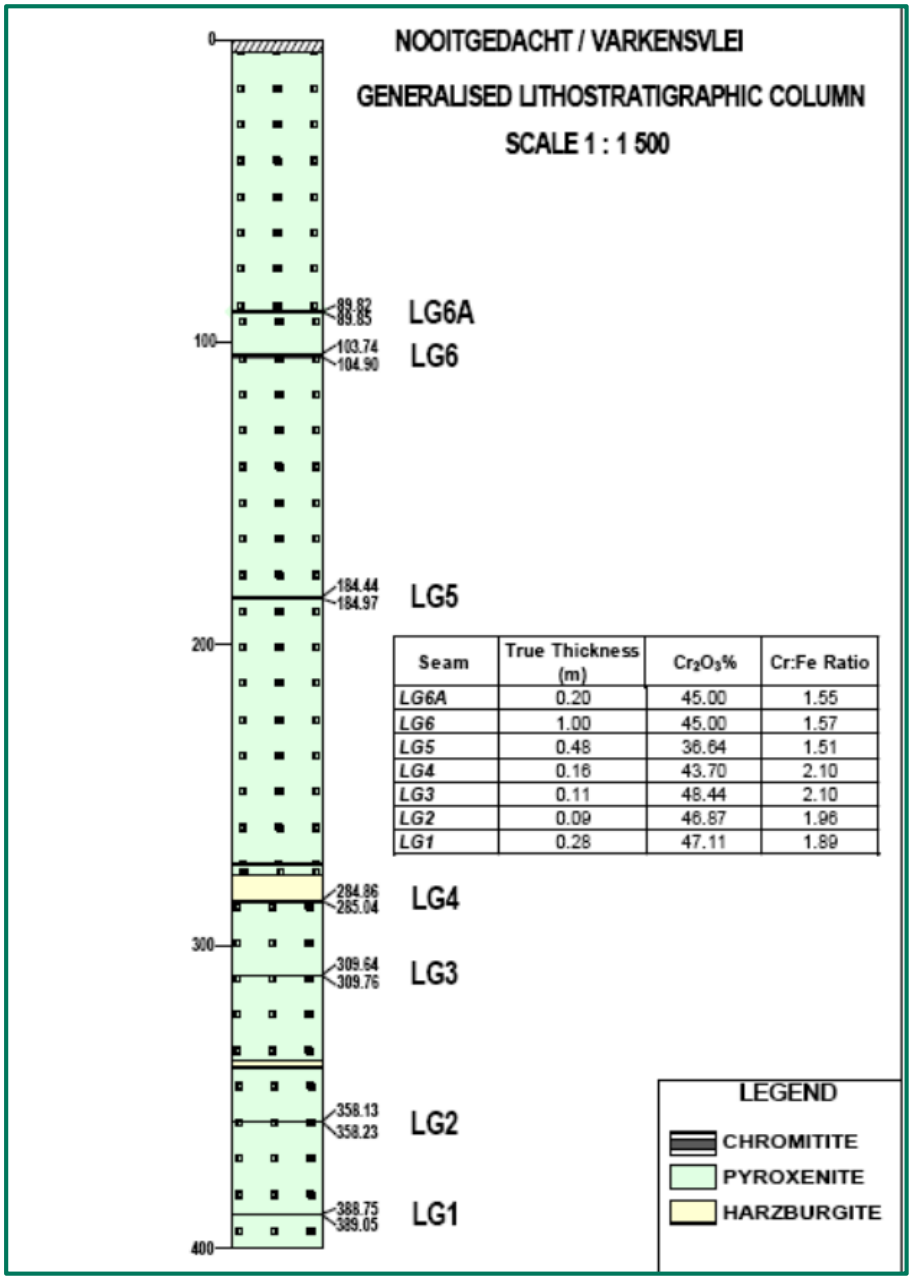


Figure 4-2: Stratigraphy at Western Chrome Mines near Mooinooi

The stratigraphy of the Lower Critical Zone on Varkensvlei is shown in Figure 4-3 (McQuade, 2013).

The LG6A layer is developed within pyroxenite, overlain by a coarse-grained pyroxenite. Both top and basal contacts are gradational to sharp. The ore is fine grained, solid and well packed. Pyroxenite bands or lenses may occur in the bottom contact of this layer. Immediate hanging wall and footwall pyroxenite is solid, and unaltered. The LG6A layer is separated from the LG6 layer by fine- to medium-grained pyroxenite with an average thickness of 12.00m. The LG6A seam averages 0.30m in thickness.

The LG6 layer is a fine-grained, well packed-chromitite, with sharp top and basal contact. It usually includes a disseminated band up to 15cm thick in the top contact of the layer. The immediate footwall consists of alternating pyroxenite layers. The LG6 seam averages 1.01 m in thickness.



Seam	True Thickness (m)	Cr_2O_3%	Cr:Fe Ratio
LG6A	0.20	45.00	1.55
LG6	1.00	45.00	1.57
LG5	0.48	36.64	1.51
LG4	0.16	43.70	2.10
LG3	0.11	48.44	2.10
LG2	0.09	46.87	1.96
LG1	0.28	47.11	1.89

Figure 4-3: Stratigraphy of the Lower Critical Zone on Varkensvlei

4.2 Climate

The baseline characteristics of the climate, wind field and air quality in the project area were determined from literature sources (Bennet, A;, March 2013).

The proposed mining operation is located in the subtropical high-pressure belt. The mean circulation of the atmosphere over the subcontinent is anticyclonic throughout the year, excepting near the surface. The synoptic patterns affecting the typical weather experienced in the region owe their origins to the subtropical, tropical and temperate features of the general atmospheric circulation over Southern Africa.

The subtropical features are controlled by the semi-permanent presence of the South Indian Anticyclone (high pressure cell), Continental High (high pressure cell) and the South Atlantic Anticyclone (low pressure cell) in the high pressure belt located approximately 30° south of the equator. The tropical controls are brought about via tropical easterly flows (low pressure cells) from the equator to the southern mid-latitudes

and the occurrence of the easterly wave and lows. The temperature control is ascribed to perturbations in the westerly wave, leading to the development of low pressure cells or cold fronts from the polar region moving into the mid-latitudes.

Seasonal variations in the positioning and intensity of the high pressure cells determine the extent to which the westerly waves and lows impact the atmosphere over the region. In winter, the high pressure belt intensifies and moves northwards while the westerly waves in the form of a succession of cyclones or ridging anticyclones move eastwards around the South African coast or across the country. The positioning and intensity of these systems have significant impacts on the region. In summer, the anticyclonic high pressure belt weakens and shifts southwards and the influence of the westerly wave and lows weakens.

Anticyclones (high pressure cells) are associated with convergence in the upper levels of the troposphere, strong subsidence throughout the troposphere, and divergence near the surface of the earth. Air parcel subsidence, inversions, fine conditions and little to no rainfall occur as a result of such airflow circulation patterns (i.e. relatively stable atmospheric conditions). These conditions are not favourable for air pollutant dispersion, especially with regard to contaminants emitted close to the ground.

Westerly waves and lows (low pressure cells) are characterised by surface convergence and upper-level divergence that produce sustained uplift, cloud formation and the potential for precipitation. Cold fronts, which are associated with the westerly waves, occur predominantly during winter. The passage of a cold front is characterised by pronounced variations in wind direction and speed, temperature, humidity, pressure and distinctive cloud bands (i.e. unstable atmospheric conditions). These unstable atmospheric conditions bring about atmospheric turbulence which creates favourable conditions for air pollutant dispersion.

The tropical easterlies and the occurrence of easterly waves and lows affect Southern Africa mainly during the summer months. These systems are largely responsible for the summer rainfall pattern and the north easterly wind component that occurs over the region.

In summary, the convective activity associated with the easterly and westerly waves disturbs the persistent inversion which sits over Southern Africa. This allows for the upward movement of air pollutants through the atmosphere, leading to improved dispersion and dilution of accumulated atmospheric pollution. Average temperature and rainfall data for the region are summarised in Table 4-1.

Table 4-1: Climatic data for Thabazimbi region 1935 - 2010

Month	Mean Max temp. (°C)	Mean Min temp. (°C)	Averaged rainfall (mm)
January	33.4	20.7	125.32
February	32.3	21.1	102.64
March	31.9	19.0	81.88
April	29.3	16.6	41.03
May	27.3	12.8	14.41
June	25.1	10.1	8.12
July	25.1	11.1	2.60
August	27.9	14.4	3.75
September	29.8	17.6	12.32
October	31.9	19.9	48.15
November	32.0	20.4	86.15
December	31.6	20.7	121.72
Annual Average	29.8	17.0	648.09

Monthly A-pan evaporation data was available for the DWA station A2E012 at the Bierspruit dam. The mean annual evaporation from this station for the period December 1960 to October 1970 was 2363 mm and evaporation rates varied from 1903 mm/a to 2616 mm/a. Monthly mean, minimum and maximum evaporation is shown in Figure 4-4. For comparison, the WR90 data for S-pan evaporation is given together with the measured A-pan values provided in Table 4-2.

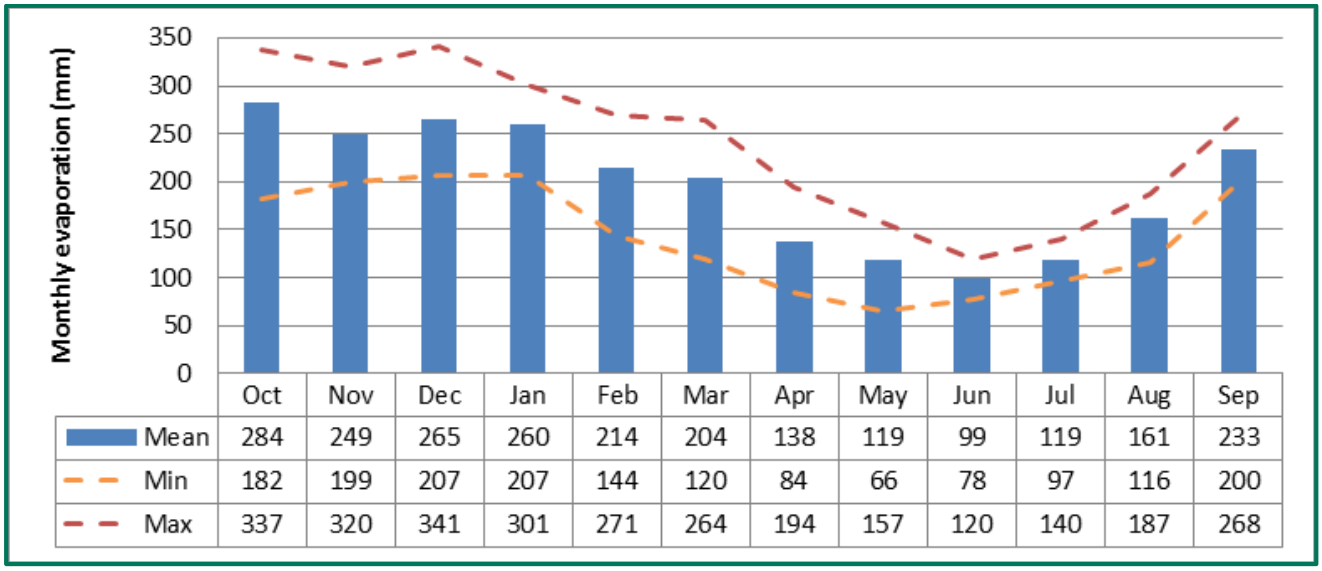


Figure 4-4: Monthly mean, minimum, maximum A-Pan evaporation for station A2E012

Table 4-2: Monthly evaporation for station A2e012 using daily evaporation and WR90

Month	A2E012 (A- pan)	WR90 (S-pan)	WR90 (S-pan) converted to (A-Pan)
Oct	283.60	182.08	268.81
Nov	249.42	182.01	265.77
Dec	265.03	189.92	273.16
Jan	259.62	187.97	267.73
Feb	213.92	160.20	222.72
Mar	204.05	152.75	213.58
Apr	137.67	116.56	169.22
May	119.13	95.41	144.65
Jun	99.26	78.14	125.52
Jul	119.24	84.50	136.17
Aug	161.32	113.16	177.05
Sep	233.05	150.23	226.41

4.3 Wind Field

As Samancor does not undertake any meteorological monitoring at the proposed mining site, the wind field characteristics provided here are based on available literature from the region (Pilanesberg and Thabazimbi regions) and MM5 modelled meteorological data for 2009-2011. The MM5 data modelling process achieved 100% data recovery, i.e. the minimum data quality assurance for data manipulation and summary (SANAS R07-01) was met. The site specific meteorological overview is based on the analysis of the MM5 modelled meteorological data, which is expected to be representative of the actual meteorological conditions on site.

The winds in the Varkensvlei area are expected to originate mainly from the east-south-east (12.5% of the time) and east (9.5 % of the time), wind speeds being low to moderate, with a low percentage (19.24%) of calm conditions (<1 m/s). See Figure 4-5 for the wind rose depicting average annual wind characteristics.

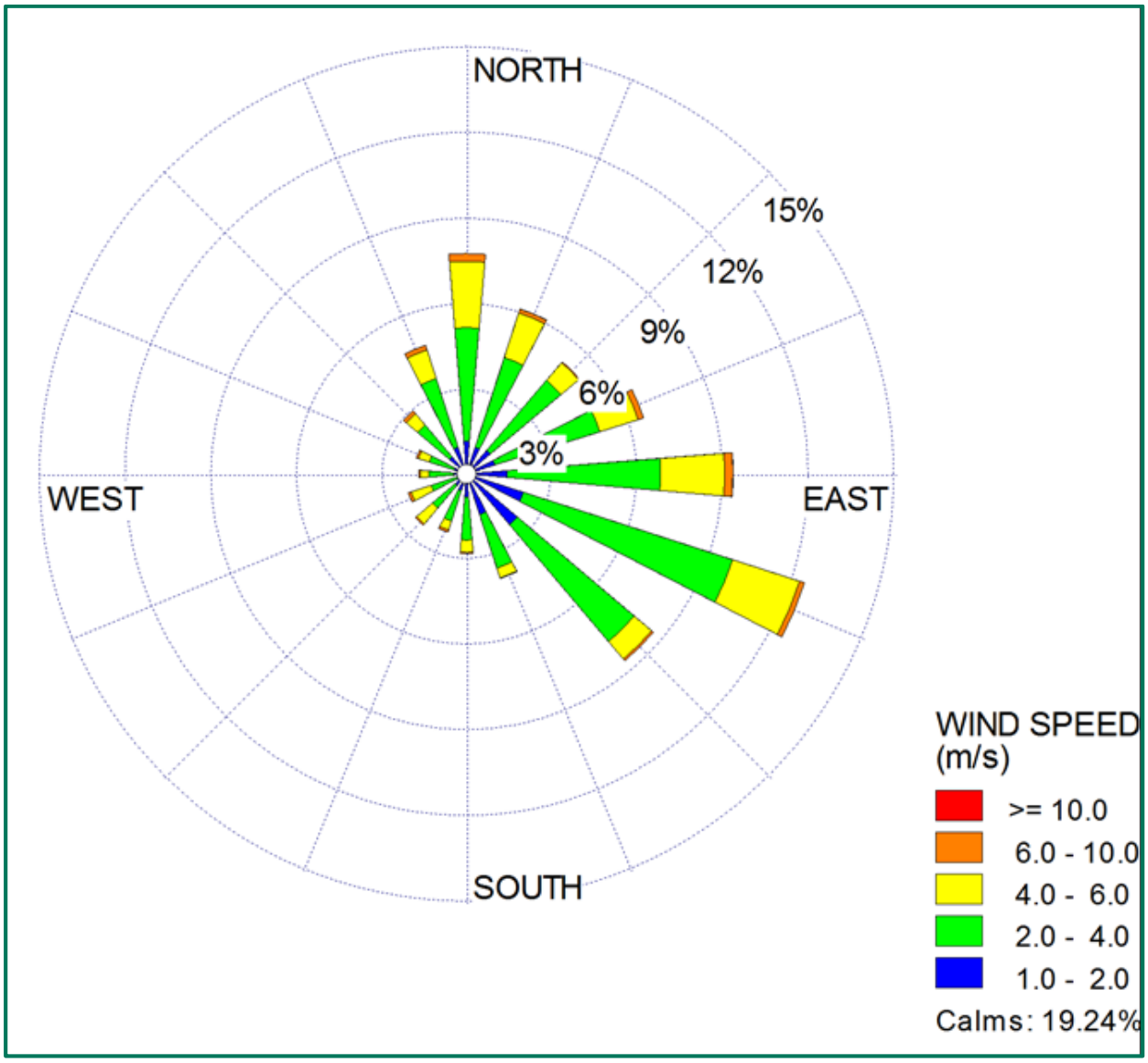
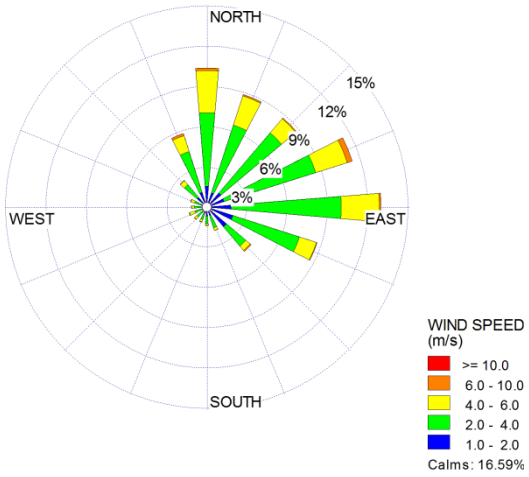


Figure 4-5: Modelled annual wind rose at project area for 2009-2011

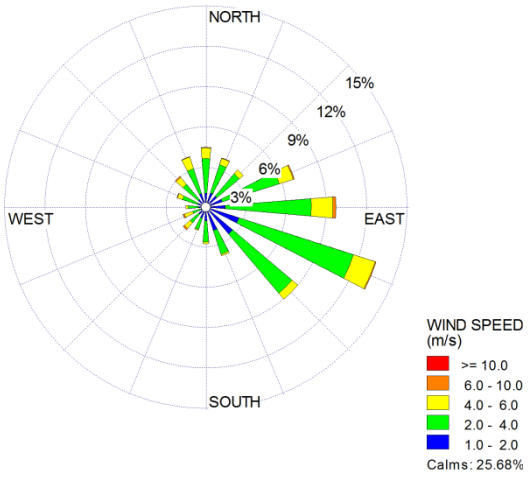
From Figure 4-6 and Figure 4-7 respectively it is seen that significant seasonal variations, but only slight diurnal variations are to be expected.



Summer (DJF)

E 13% of the time

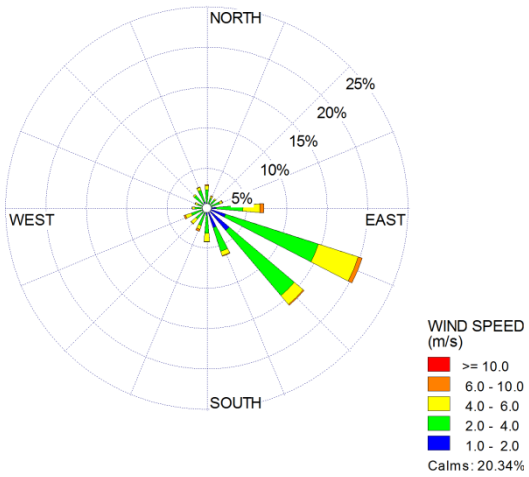
ENE 11.75% of the time



Autumn (MAM)

ENE 13.25 % of the time

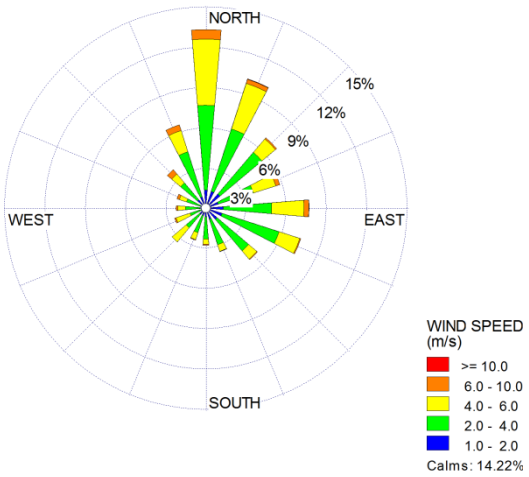
E 9.5% of the time



Winter (JJA)

ESE 20.0 % of the time

EN 16.5% of the time

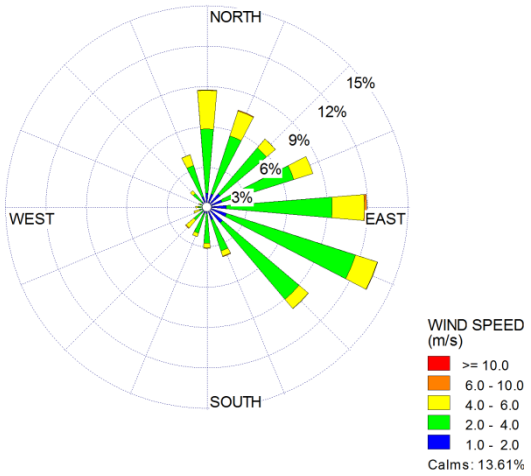


Spring (SON)

N 13 % of the time

NNE 11% of the time

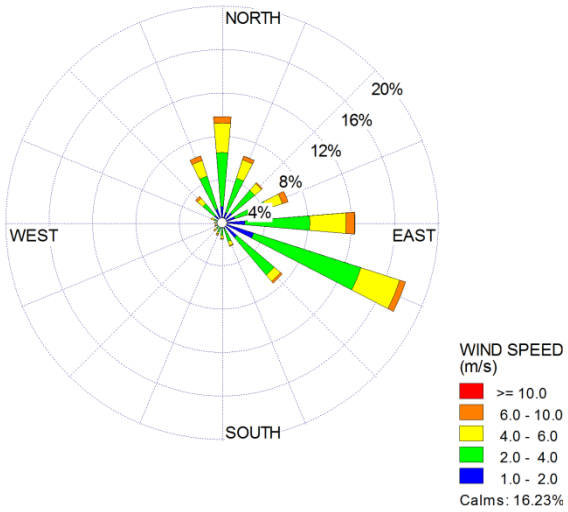
Figure 4-6: Modelled seasonal wind roses for the project area for 2009-2011



00:00 to 05:59

ESE 13.5 % of the time

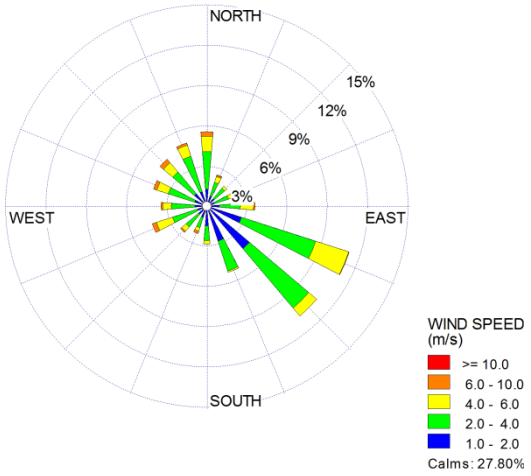
E 12 % of the time



06:00 to 11:59

ESE 18 % of the time

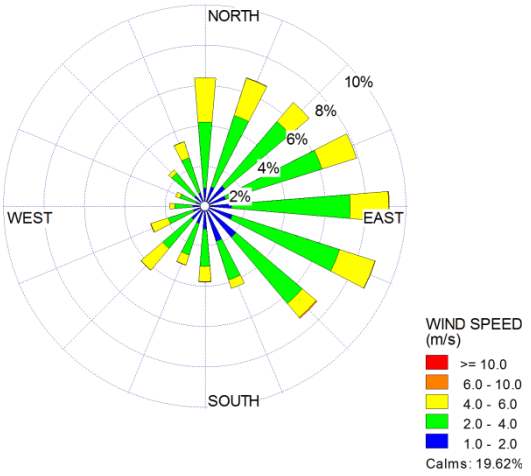
E 12.5 % of the time



12:00 to 17:59

ESE 11.5 % of the time

SE 11 % of the time



18:00 to 23:59

E 9.25 % of the time

ESE 8.75 % of the time

Figure 4-7: Modelled diurnal wind roses for the project area for 2009-2011

4.4 Air Quality

Samancor does not undertake any ambient air quality monitoring at or in the vicinity of the proposed mining area on Varkensvlei. This assessment of the ambient air quality is based on information obtained from the literature review. As may be seen from Figure 4-8, most of the monitoring networks are located near Rustenburg and at the larger mines such as Impala Platinum, Lonmin Platinum and Anglo Platinum (located approximately 60 km to 90 km south-south-east of the proposed NV mine) or at the power generation facilities such as the Matimba Power Station (located approximately 150km north-north-east of the proposed NV mine). Data recorded at these stations, although a long distance from the proposed mine on Varkensvlei, may be used to infer a high level regional air quality overview for the region.

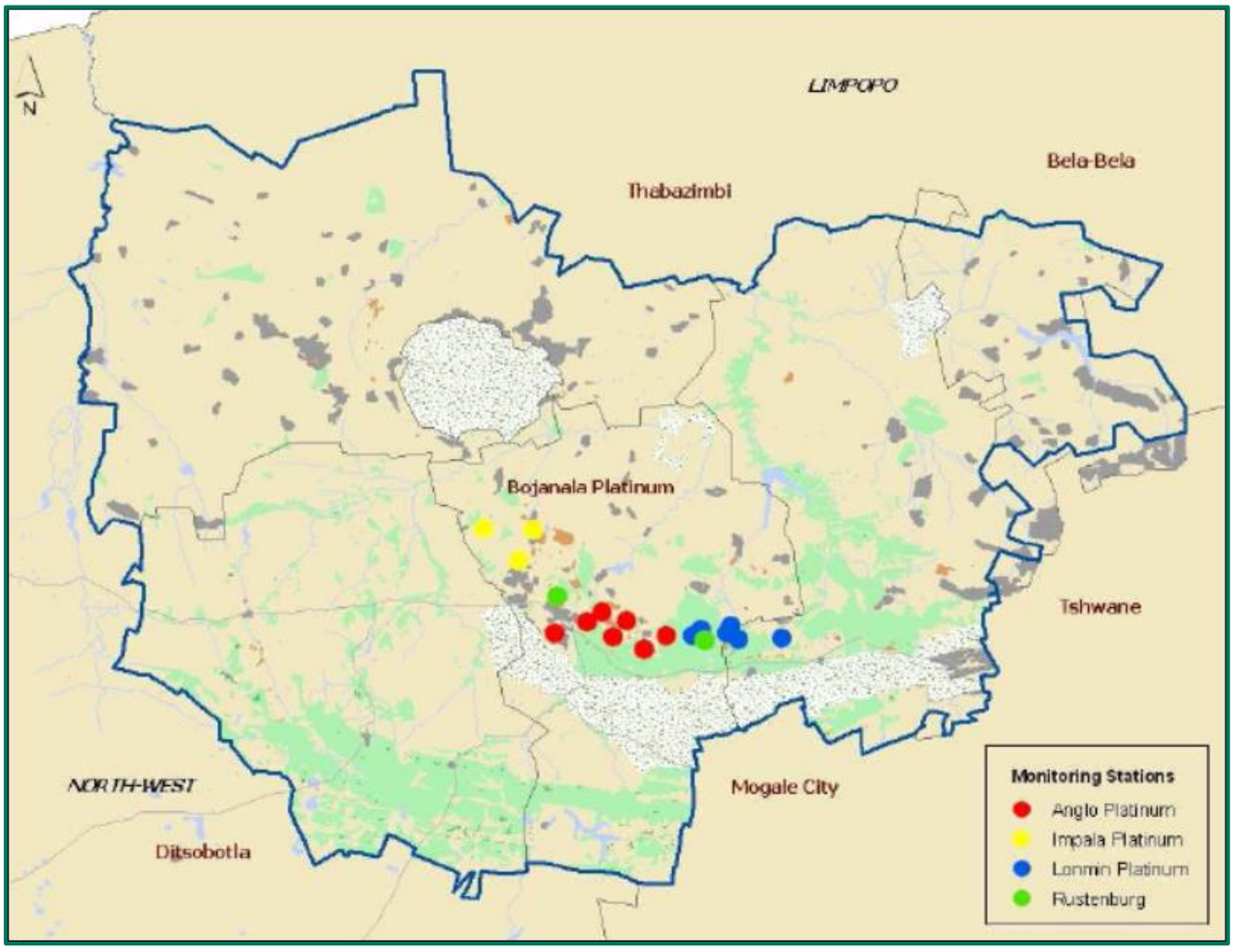
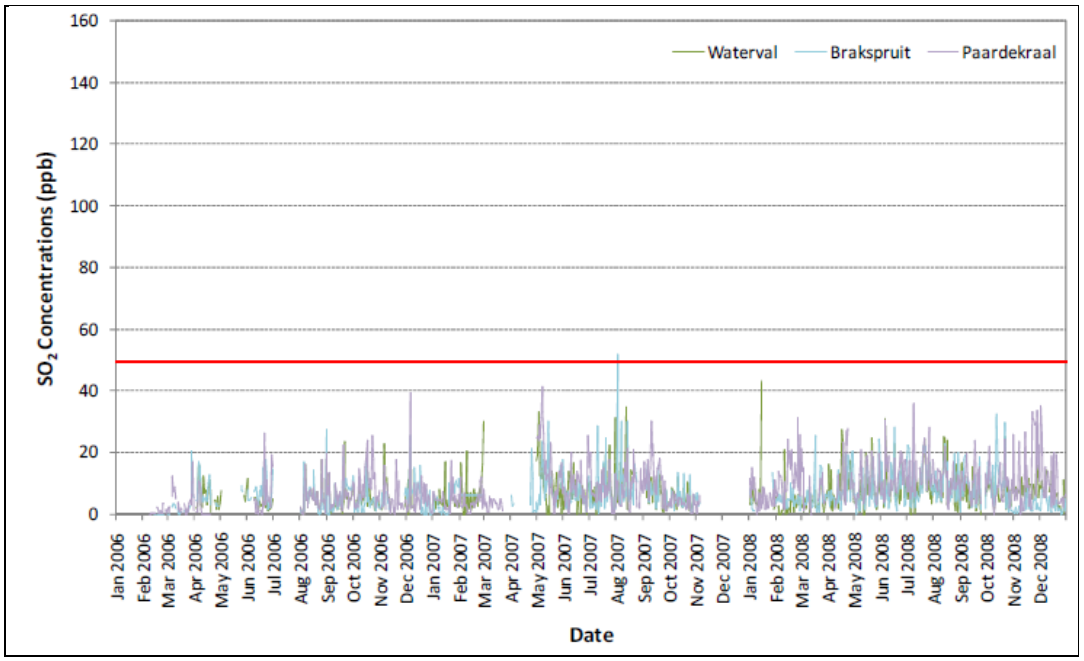


Figure 4-8: Locations of ambient air quality monitoring stations in Bojanala Platinum District Municipality in relation to the farm Varkensvlei

4.4.1 Regional ambient SO_2 concentrations

The ambient SO_2 concentrations for the period January 2006 to September 2009 presented in Figure 4-9 and Figure 4-10 below are based on available information from the Bojanala Platinum District Municipality Air Quality Management Plan Baseline Assessment.



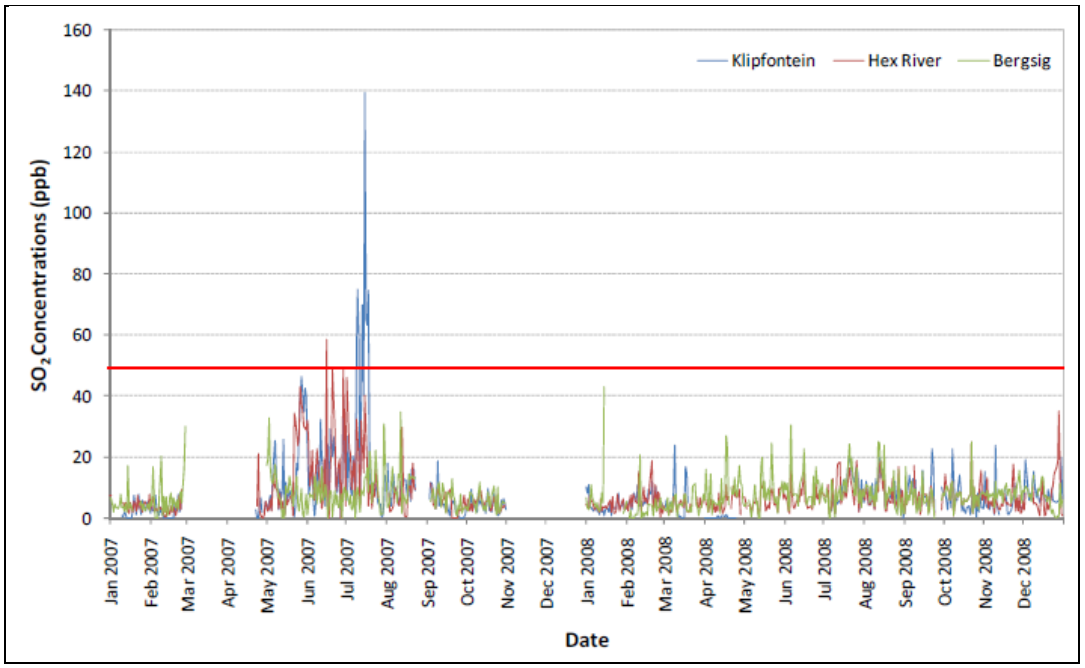


Figure 4-9: Daily SO_2 concentrations (ppb) recorded at the Anglo Platinum Monitoring stations for the period January 2006 – December 2008 (Red line - National daily standard of 48 ppb

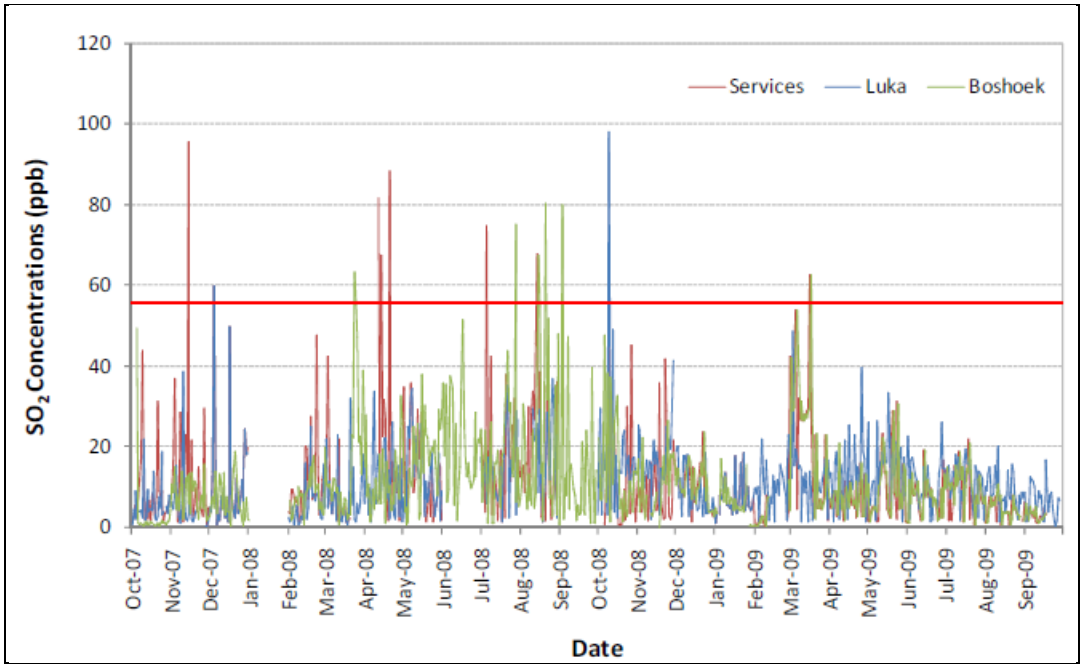


Figure 4-10: Daily SO_2 concentrations (ppb) recorded at Impala Platinum Monitoring stations for the period October 2007 – September 2009 (Red line - National daily standard of 48 ppb

4.4.2 Regional ambient PM_{10} concentrations

The ambient PM_{10} concentrations for the period January 2006 to September 2009 presented in Figure 4-11 and Figure 4-12 below are based on the available information from the Bojanala Platinum District Municipality Air Quality Management Plan Baseline Assessment (2010).

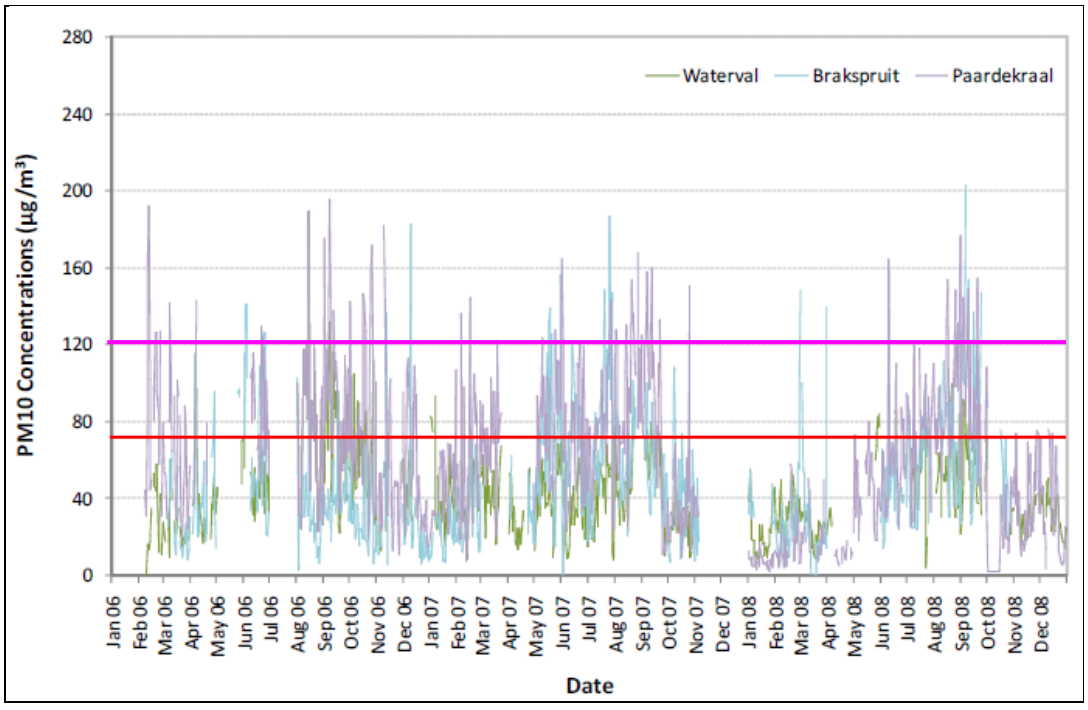


Figure 4-11: Daily PM_{10} concentrations recorded at the Anglo Platinum Monitoring stations for the period January 2006 – December 2008 (Red line – 2015 national daily standard of 75 µg/m³, pink line – current national daily standard of 120 µg/m³)

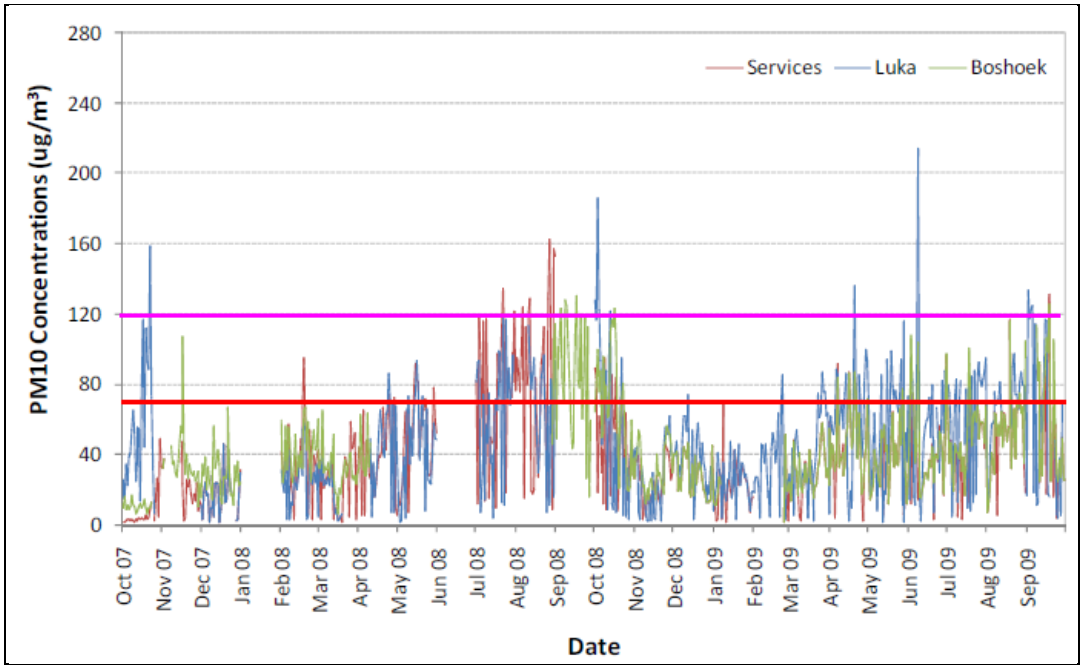


Figure 4-12: Daily PM_{10} concentrations (µg/m3) recorded at Impala Platinum Monitoring stations for the period October 2007 – September 2009 (Red line – 2015 national daily standard of 75 µg/m³, pink line – current national daily standard of 120 µg/m³

4.4.3 Regional ambient dust fall levels

A dust fall monitoring network was in operation between November 2005 to October 2006 at the Thabazimbi iron ore mine (located approximately 47 km north-east of the proposed mine site on Varkensvlei) but has subsequently been decommissioned. No exceedances of the SANS industrial limit (1200 mg/m²/day averaged over 30 days) were recorded during that time.

Dust fall data was recorded at Amandelbult Mine (located approximately 25 km to the north-east of the proposed mining area) for the period May 2006 to December 2007. Dust fall levels were generally in the moderate to heavy classifications over that period, with all sites showing peaks in March, August and September 2007.

Dust levels well below the draft residential guideline of 600mg/m²/day were recorded between 11 October 2012 and 9 January 2013 at Bushveld Chrome Resources (BCR), located approximately 4 km east of the proposed mine on Varkensvlei .

Anglo American's Union mine undertook dust fall monitoring from January 2011 to June 2012 approximately 5.5 km south-east of the proposed Samancor Chrome mine. The dust fall levels were typically well below the respective residential and industrial guidelines. The calculated regional average was 183 mg/m²/day.

4.5 Topography

The topography of the proposed mining area and the immediate vicinity is flat, with a slight slope (about 1 in 100) to the north-west. See Figure 4-13. There are various artificial landforms such as the tailings dams and rock dumps at the adjacent Anglo American Union mine. There are several isolated ridges and outcrops about 7 km to the north-east and 10 km to the west-north-west.

The Northam region is generally a mountainous area, particularly towards the north and west of the project area. To the south the area is dominated by the Pilanesberg volcanic crater. These much larger landforms and mountain ranges are located well outside of the study area.

Figure 4-13: View to the north over Varkensvlei from road bridge over rail line

4.6 Soil, Land Use and Land Capability

A study was undertaken during March 2013 to characterise the soils on the proposed mining area on the farm Varkensvlei 403 KQ, assess the land capability and determine the current land use (Viljoen, June 2015).

4.6.1 Classification of soils

Pursuant to a survey of the available literature, the relevant area was sampled to a depth of 600 mm by means of a 75 mm hand auger on a 200 m x 200 m grid, taking samples at 150 mm intervals. The analyses shown in Table 4-3 were performed on the soil samples.

Table 4-3: Soil characterisation parameters

Parameter	Method
CHEMICAL	
Sample Preparation	Standard
pH (H_2O)	Standard
CEC+K+Na	NH_4Ac-extraction
EC+NO_3	Saturated distilled water extract
P	Bray 1-extract
Lime Requirement	Double Buffer Titration
MINERALOGY	
Clay fraction (<0.002mm) identification	XRD-scan (6 treatments)
PHYSICAL	
Particle size distribution (3 fractions-sand+silt+clay)	Hydrometer

The soils were classified in terms of the soil types listed in and illustrated in Figure 4-14, in accordance with the latest version of the *South African Taxonomical Soil Classification System.*

Figure 4-14: Soil types: Bainsvlei, Arcadia, Avalon, Mispah and Rensburg soils (left to right).

Table 4-4: Soil types

Soil Type	Diagnostic Horizons	Effective Depth (mm)
Avalon	Orthic A – Horizon/Yellow Brown Apedalic B – Horizon/Soft Plinthic B – Horizon	>300
Arcadia	Vertic A – Horizon/G - Horizon	<300
Bainsvlei	Orthic A- Horizon/Red Apedalic B – Horizon/Soft Plinthic B –Horizon	>300
Rensburg	Vertic A – Horizon/G – Horizon	<300
Mispah	Orthic A – Horizon/Hard Rock	<300

The Mispah, Clovelly, Bainsvlei and Rensburg soil types occur on Varkensvlei. The soil types were mapped as shown in Figure 4-15.

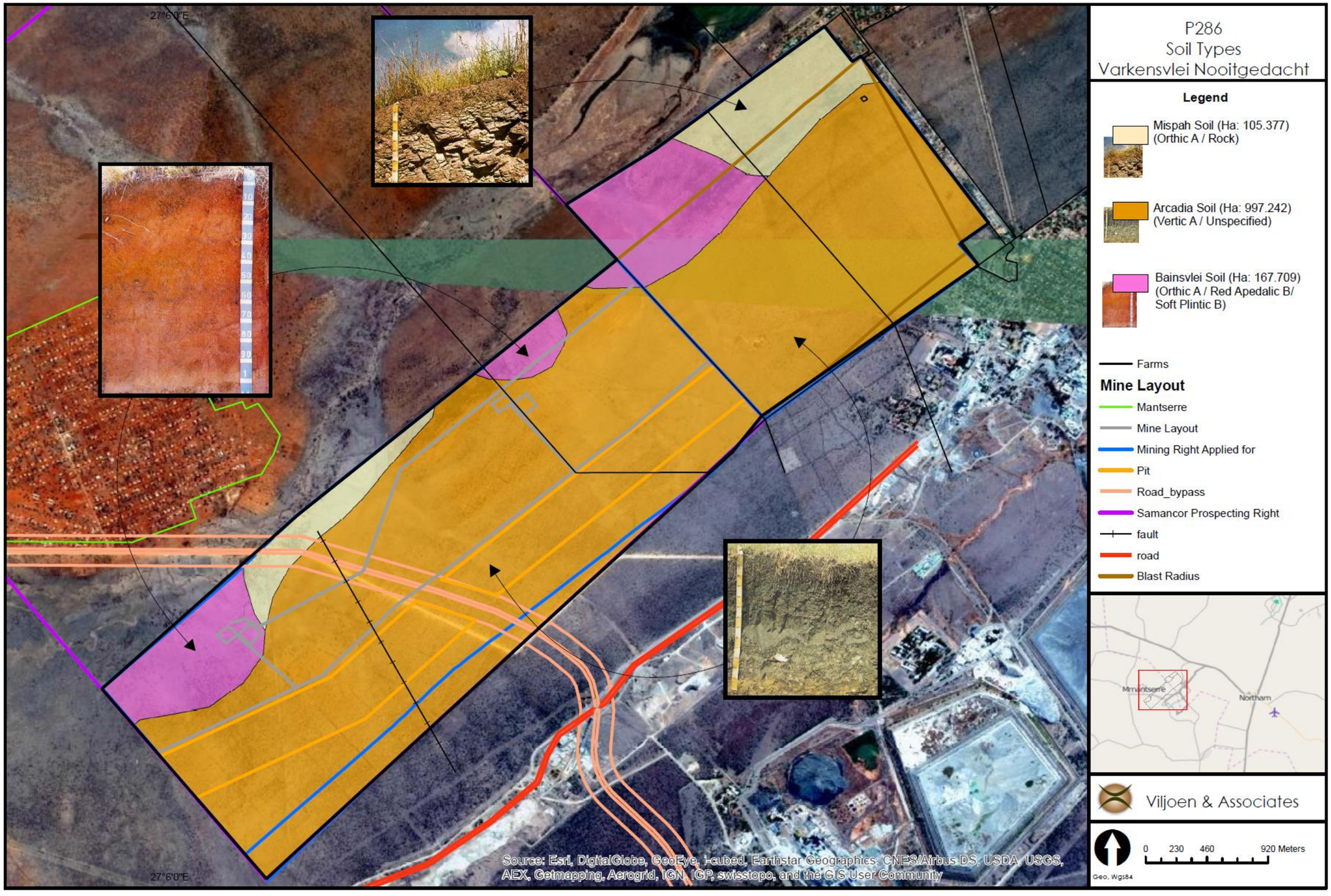


Figure 4-15: Soil map for Varkensvlei 403 KQ and Nooitgedacht 406 KQ

4.6.2 Agricultural Potential

The agricultural potential of the study area as listed in Table 4-5 was assessed on the basis of mean annual precipitation (516 mm), effective soil depth (> 300 mm), aeration and water retention properties of the soil (15% clay content) and growth characteristics of plant species.

Table 4-5: Agricultural potential of soils in study area

Soil type	Agricultural potential	
	Dry land	Irrigation
Avalon	Medium	High
Arcadia	Low	Low
Bainsvlei	Medium	High
Rensburg	Low	Low
Mispah	Low	Low

The exchangeable sodium percentage of the soils is anticipated to be below 15% of the cation exchange capacity, rendering the soils free of dispersion anomalies caused by the hydration of sodium and consequently the soil has a relatively low potential for erosion.

4.6.3 Land Capability and Land Use

As shown in Figure 4-15, the predominant soil type within the study area is Arcadia, which has low agricultural potential and the land capability is classified as grazing – see Figure 4-16. Although there is evidence of past agricultural use, the current land use is largely natural veld interspersed with some exotic plant species.

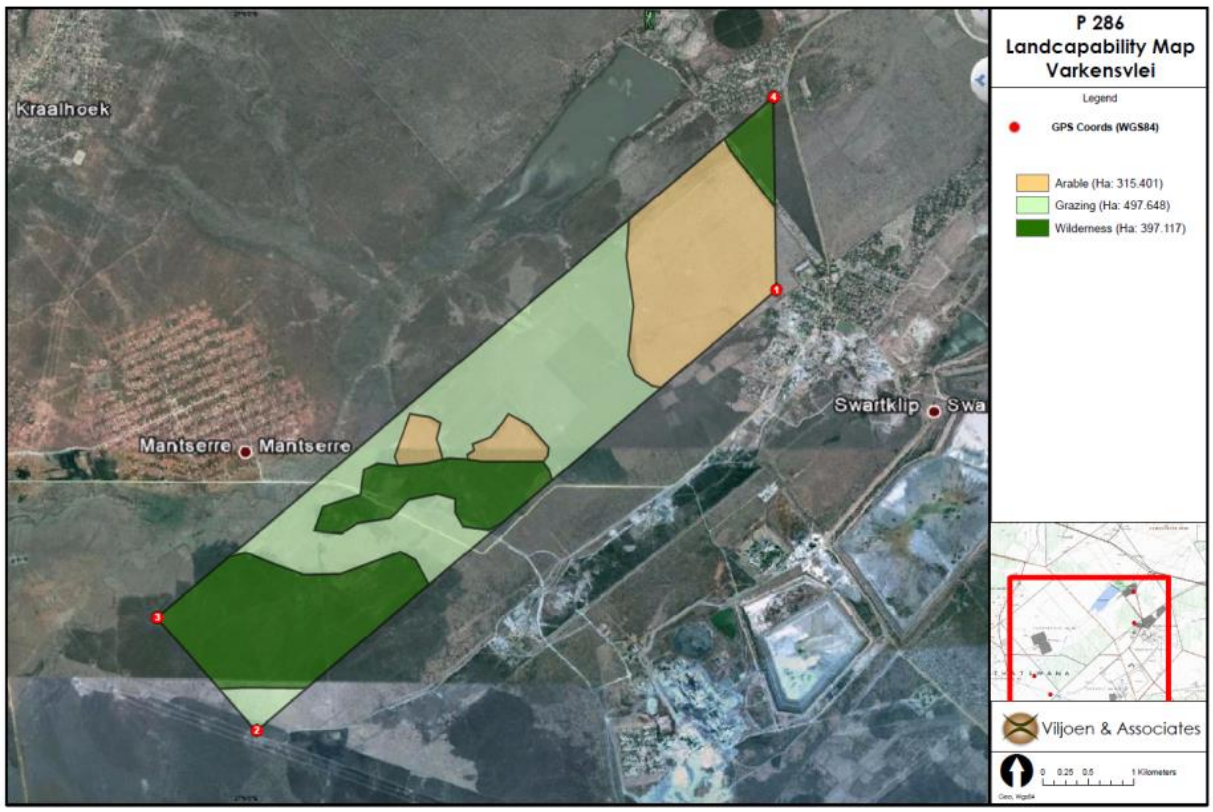


Figure 4-16: Land capability map for Varkensvlei

4.6.4 Chemical, Physical and Mineralogical Properties of Soils

The soils are characterised by neutral pH values (5,3 and 7,2) and low electrical conductivity levels (<250mS/m). Under these conditions plant-available nitrogen (15-20 mg/kg), phosphorus (10-15 mg/kg) and potassium (>50 mg/kg) are readily available for plant uptake and sustainable plant growth.

The Orthic A-Horizon is typically characterised by a low, dense structure and texture distribution of approximately 65% sand, 20% silt and 15% clay with drainage properties in the region of 10 mm/h.

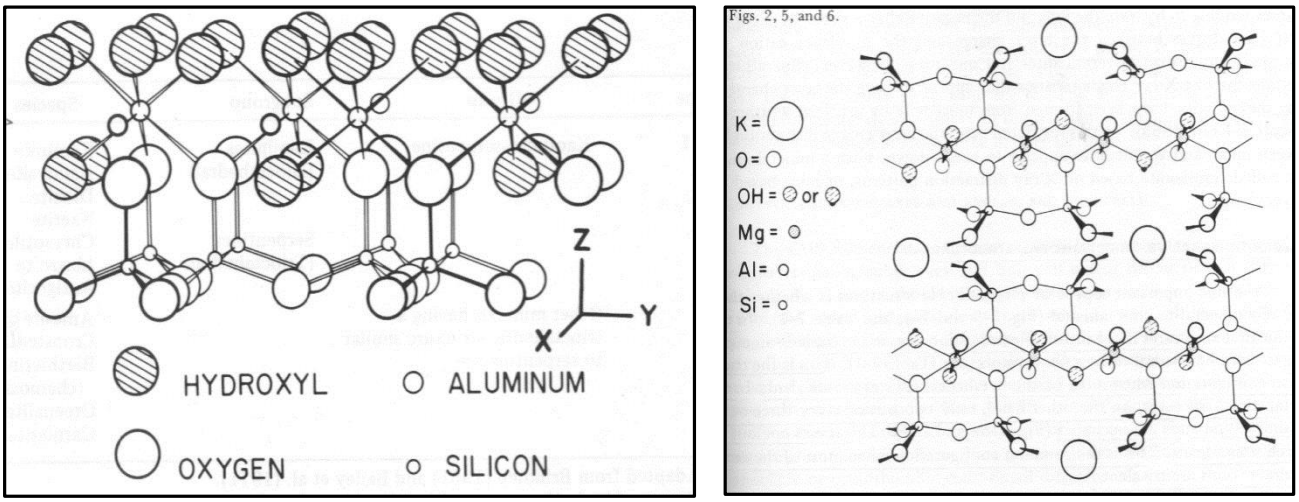


Figure 4-17: 1:1 Clay mineral (left) and 2:1 Clay mineral (right)

The dominant clay mineral (Figure 4-17) in the Orthic A – Horizon, Red and Yellow Brown Apedalic B – Horizon is kaolinite (1:1 layer silicate), with a low buffer capacity due to the low cation exchange capacity (<10 cmol+/kg). The Vertic A-Horizon contains 2:1 clay minerals with high buffer capacity and a cation exchange capacity in excess of 30 cmol+/kg.

4.7 Ecology

An evaluation of the existing terrestrial ecological conditions on the proposed mining areas was undertaken in February 2013 by means of a literature study and satellite imagery, followed by a field survey (Hudson, A; Kimberg, P;, February 2013). Species that were not identified in the field were sampled or photographed for later identification.

In order to assess the Red Data status of species in the study area, the following sources were consulted:

- National Environmental Management: Biodiversity Act (No. 10 of 2004) – Lists of critically endangered, endangered, vulnerable and protected species (NEMBA, 2007);
- National Forests Act (No. 84 of 1998) – List of Protected Tree Species;
- Rare, endangered and endemic flora of the Bojanala Platinum District, North West Province (Hahn, 2011);
- North West Biodiversity Inventory and Database (2003);
- Limpopo Environmental Management Act (No. 7 of 2003);
- International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (2011); and
- International Union for the Conservation of Nature (IUCN) Red List Categories and Criteria (2008).

4.7.1 Flora

The study area falls within Mucina & Rutherford's Dwaalboom Thornveld vegetation type of the savannah biome, which is well represented in the North West Province and this part of the Limpopo Province. Flora species lists for the relevant grid squares (2427CB and 2427CC) were obtained from the PRECIS (National Herbarium Pretoria Computer Information System) database (SIBIS:SABIF, 2009, internet) and the Plants of South Africa database (Plants of Southern Africa, 2009, internet). Information about specific species of concern was obtained from the North West Province Biodiversity Inventory and Database (2003) and other literature sources. Floristic sensitivity analysis was determined by subjectively assessing the ecological integrity and conservation importance of the observed vegetation.

A map of the regional vegetation types is shown in Figure 4-19. The main vegetation and landscape features include plains with a layer of scattered, low to medium high, deciduous microphyllous trees and shrubs with a few broad-leaved tree species. There is almost a continuous herbaceous layer dominated by grass species. *Acacia tortilis* and *Acacia nilotica* dominate on the medium clays (at least 21% clay in the upper soil horizon but high in the lower horizons). On particularly heavy clays (>55% clay in all horizons) most other woody plants are excluded and the diminutive *Acacia tenuispina* dominates at a height of less than 1 m above ground. On the sandy clay loam soils (with not more than 35% clay in the upper horizon but high in the lower horizons) *Acacia erubescens* is the most prominent tree. The alternation of these substrate types creates a mosaic of patches typically 1 – 5 km across (Mucina & Rutherford, 2006).

Dwaalboom Thornveld is classified as Least Threatened. Although the target for conservation is 19%, only 6% of this vegetation type is currently under statutory conservation in areas such as the Madikwe Game Reserve. Cultivation, and to a lesser extent urbanisation, have resulted in the transformation of approximately 14% of Dwaalboom Thornveld, and exotic invasive plants are present. The area is also utilised for the collection of traditional edible and medicinal plants.

The entire extent of the proposed mining area on Varkensvlei was subjected to agriculture about 20 to 35 years ago, judging by the age of the trees. Although the area is recuperating from a structural point of view, it is much degraded from a species composition point of view. The herbaceous layer is dominated by pioneer grass species and exotic herbaceous species. Parts of the study area are also severely encroached by *Acacia mellifera.* Field observations indicate that fire has been used unsuccessfully to try and control bush encroachment by *Acacia mellifera*. Previous and current mining activities have impacted slightly upon the south eastern part of the site.

Only 44 of the 116 plant species listed in the PRECIS dataset by SANBI for the relevant quarter degree squares were recorded during the floristic survey. Twelve exotic species were also recorded. The vegetation community is dominated by pioneer graminoid species such as *Aristida* spp, *Eragrostis* spp, *Sporobolus* spp and *Digitaria* spp . Woody species have begun to recolonise the area and the woody layer is dominated by species such as *Acacia erubescens, A. karroo* and *A. mellifera*. Species such *Grewia subspathulata, Acacia gerrardii and Ozoroa paniculosa* are also found in this vegetation community, but to a much lower extent. Graminoid species are dominant in areas where rehabilitation was successful. In areas where bush encroachment control has not been successful, woody species such as *Acacia mellifera* have encroached and hampered colonisation by graminoid species.

No Red Data plant species were recorded in this vegetation community, and due to the transformed nature it is highly unlikely that any Red Data or protected species will occur in this vegetation community.

Figure 4-18: View of Varkensvlei study area from south to north (Note encroachment by Acacia mellifera in the foreground)

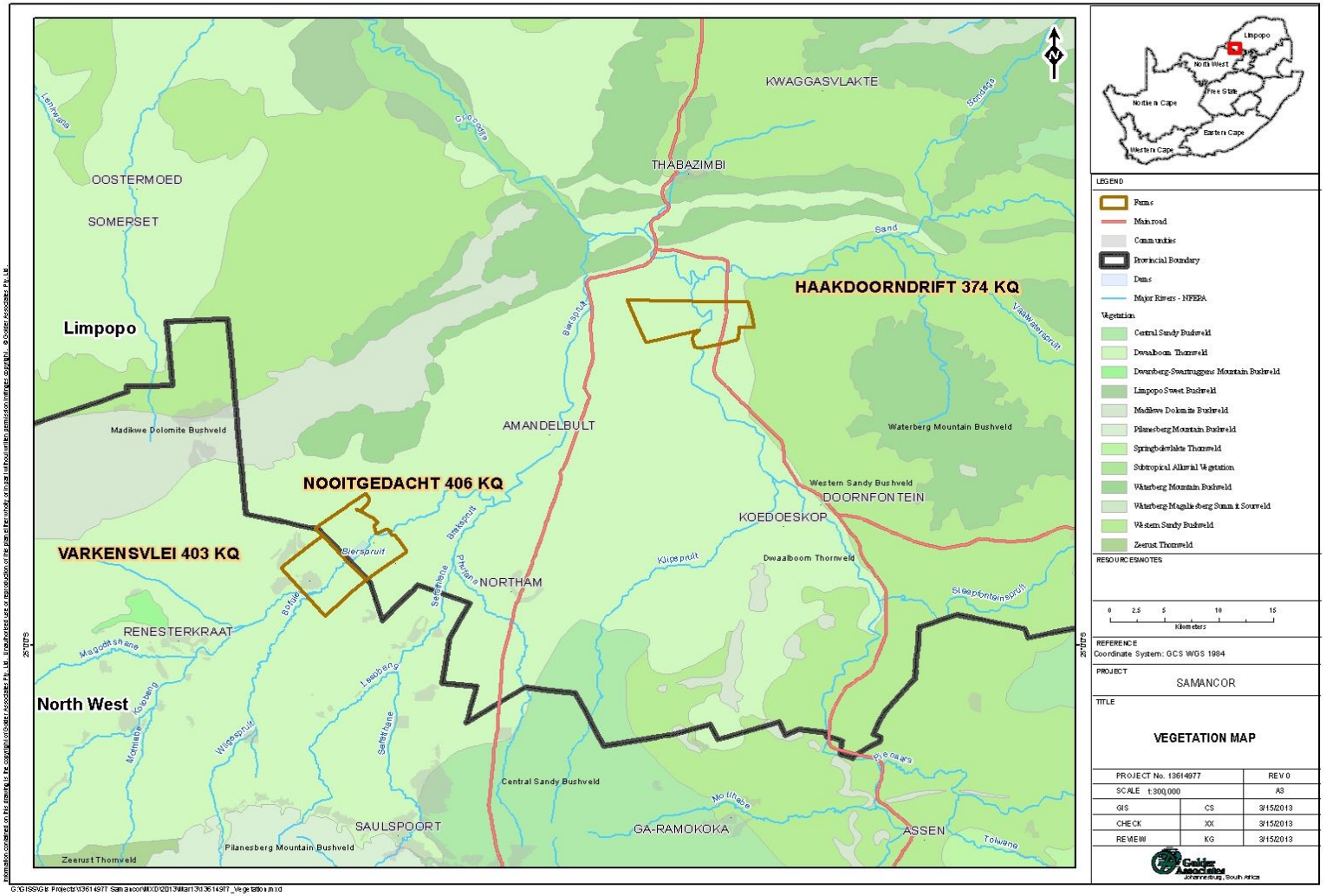


Figure 4-19: Vegetation types of the study area and surrounding regions according to Mucina & Rutherford (2006)

4.7.2 Fauna

4.7.2.1 Mammals

The suitability of available habitat for species of particular conservation concern such as Red Data and protected species was assessed. Small mammals were trapped by means of seven Sherman traps placed in a single grid at each of twelve selected areas.

A bat survey was undertaken from 12 to 14 April 2016 (Dower, A;, April 2016). The bat detection instrument was set to record from 15 minutes before sunset (17h45) for two hours. Active monitoring transects were conducted on two consecutive nights and followed the route shown on Figure 4-20.

Overall, 89 sequences of bat calls were detected during the two nights of monitoring, which represents a relatively low level of bat activity. All bat echolocation calls recorded via the active monitoring survey were calls of the Molossidae and Vespertilionidae families. Both groups were recorded more frequently in the northern parts of the study area (Figure 4-20), where mature *Acacia* woodland offers suitable foraging habitat for bats. Peaks in activity were also recorded in areas that held water, including the impounded area by the road to Mantserre, and in the moist grassland nearest to Bierspruit Dam.

Habitats within the study area were examined for the presence of features with bat roosting potential, such as rocky outcrops, cave systems, and mature and decaying trees. Areas with good foraging potential for bats, including natural habitats with diverse structure/topography and water sources were identified – see Figure 4-21.

Based on species distribution maps documented in Stuart & Stuart (1997), and considering the existing land uses in the general region, 83 species of mammal could potentially occur in the study area, which has a mammal diversity ranking of medium-high (NW Biodiversity Inventory and Database 2003). However, only the six mammal species listed in Table 4-6 were recorded during the survey. This low species diversity can be attributed to direct and indirect disturbances resulting from anthropogenic activities.

Table 4-6: Mammal species recorded during the 2013 and 2016 surveys

Scientific Name	Common Name	NEM:BA Threatened and Protected Species List (2007)	IUCN Red List of Threatened Species (2012.2)
Lemniscomys rosalia	Striped Mouse	Not listed	Least concern
Mastomys coucha	Multimammate Mouse	Not listed	Least concern
Saccostomus campestris	Pouched Mouse	Not listed	Least concern
Lepus saxatili	Scrub Hare	Not listed	Not listed
Neoromicia capensis	Cape serotine	Not listed	Least concern
Tadarida aegyptiaca	Egyptian free-tailed bat	Not listed	Least concern

The above species are common, with generally widespread distributions, and have accordingly been categorised as Least Concern on the IUCN Red Data List (2012).

Some unidentified bat species were also detected. Based on the list of Molossid and Vesper species that might be present according to literature sources, these species might include Rusty pipistrelle (*Pipistrellus rusticus*) – Near Threatened, Dusky pipistrelle (*Pipistrellus hesperidus*), and Rufous myotis *(Myotis bocagi)* both of Least Concern.

The Rusty pipistrelle's preferred foraging habitat is associated with open water bodies. Its roosting habits are not well known, but it has been collected from tree crevices and cavities and it could potentially roost in the woodland in the northern part of the project area.

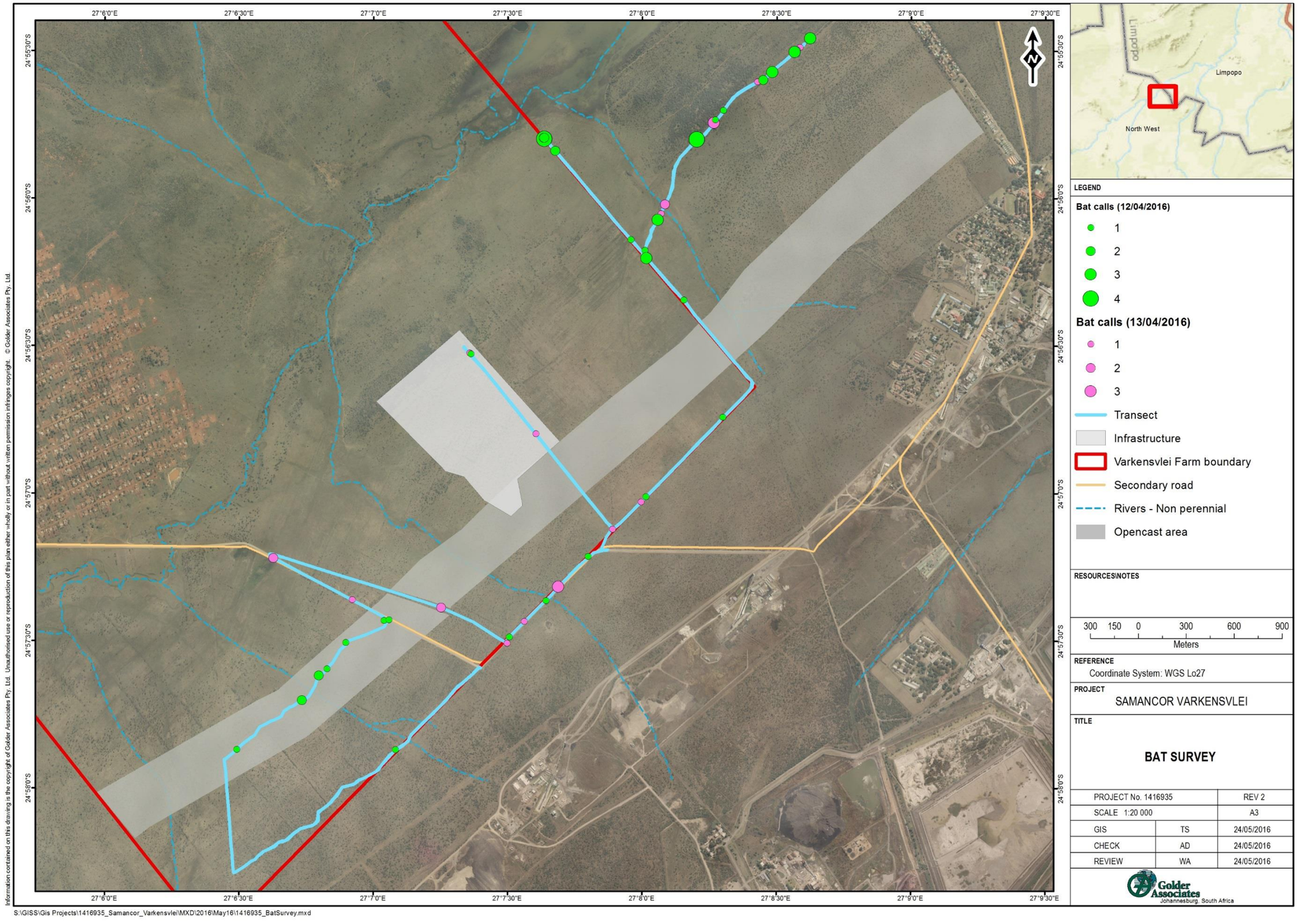


Figure 4-20: Bat activity patterns recorded in April 2016

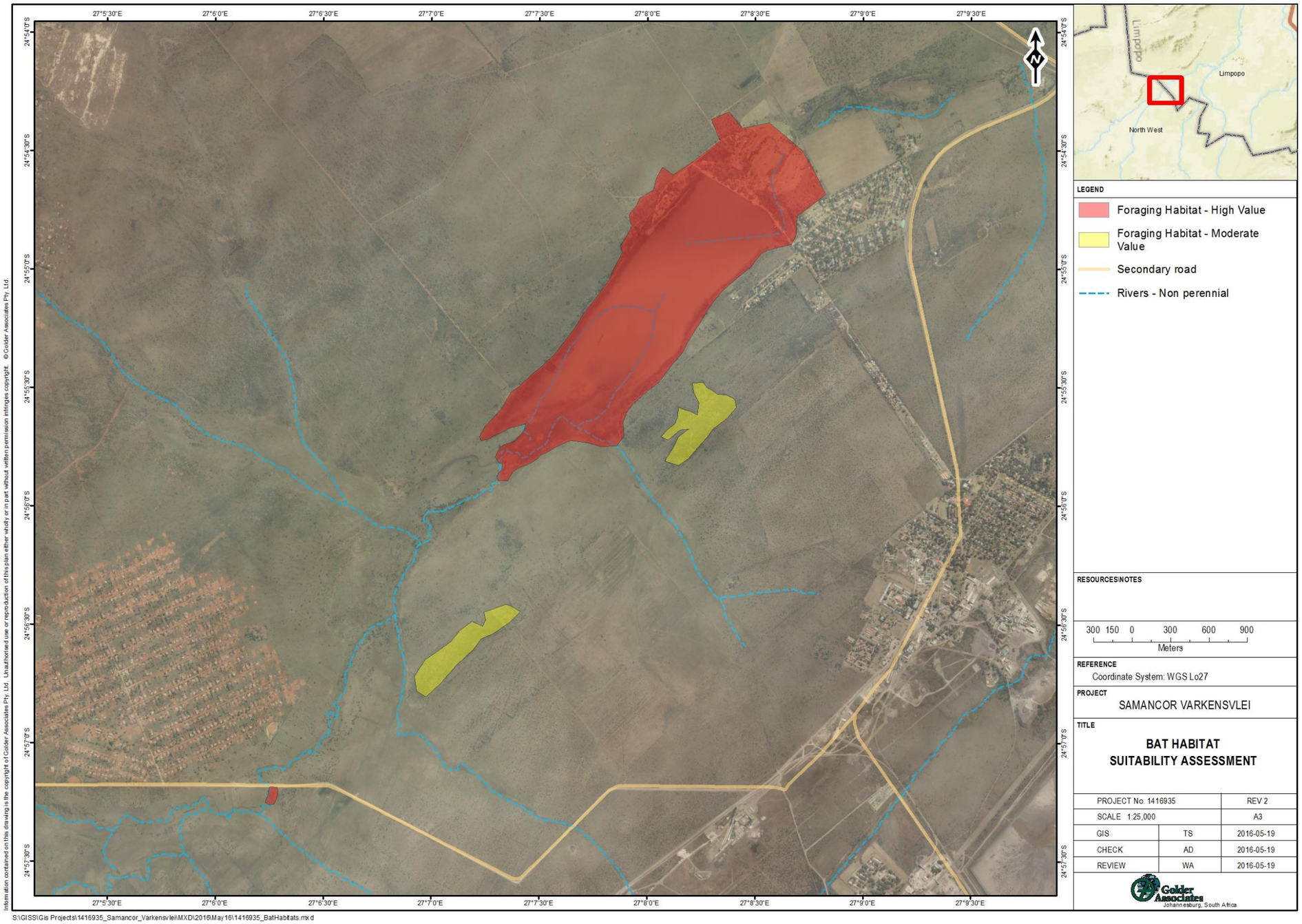


Figure 4-21: Bat Habitat Suitability Assessment

Other species not observed during the field survey, but which have a regional distribution that includes the study area are listed in Table 4-7.

Table 4-7: List of threatened or protected mammal species that may occur in the study area

Scientific Name	Common Name	NEM:BA Threatened and Protected Species List (2007)	IUCN Red Data List (2012a)	Probability of occurrence
Neamblysomus julianae	Juliana's Golden Mole	Vulnerable	Vulnerable	Low
Amblysomus septentionalis	Highveld Golden Mole	Not listed	Near Threatened	Low
Parahyaena brunnea	Brown Hyaena	Protected	Near Threatened	Low
Mellivora capensis	Honey Badger	Protected	Near Threatened	Moderate

4.7.2.2 Avifauna

A list of expected bird species was compiled by consulting a number of literature sources relevant to the study area, including the SANBI's SIBIS database (SIBIS: SABIF, 2009, internet), Harrison *et al.* (1997, a and b), and field guides such as Sinclair et al. (2002). Information relating to species of concern for the grid square was also obtained from the ornithologist based at the North West Department of Economic Development, Environment, Conservation and Tourism.

The bird survey in the field was conducted by means of 15 minute point counts (Bibby, Burgess, & Hill, 1993) at each of the fauna survey sites. Particular attention was paid to suitable roosting, foraging and nesting habitats for Red Data species.

The NW Biodiversity Inventory and Database (2003) categorises the region in which the study area is located as having low-medium bird diversity. Data presented on SANBI's SIBIS database (SIBIS:SABIF, 2009, internet) indicates that a total of 140 bird species have been recorded in the relevant quarter degree grid square. However, only 23 the species listed in Table 4-8 were recorded during the survey.

Table 4-8: Bird species recorded during the 2013 survey

Scientific Name	Common Name
Mirafra sabota	Sabota Lark
Bostrychia hagedash	Hadeda Ibis
Vanellus coronatus	Crowned Lapwing
Vanellus armatus	Blacksmith Lapwing
Streptopelia senegalensis	Laughing Dove
Streptopelia capicola	Ring-necked Dove
Corthaixoides concolor	Grey Go-away-bird
Urocolinus indicus	Redfaced Mousebird
Coracias caudata	Lilacbreasted Roller
Upupa africana	African Hoopoe
Corvus albus	Pied Crow
Pyconotus nigricans	Black-fronted Bulbul
Pyconotus barbatus	Common Bulbul
Cossypha humeralis	Whitethroated Robin-Chat
Zosterops pallidus	Cape White-eye

Scientific Name	Common Name
Tchagra senegala	Blackcrowned Tchagra
Nectarinia mariquensis	Marico Sunbird
Passer domesticus	House Sparrow
Ploceus velatus	Southern Masked Weaver
Pytilia melba	Melba Finch
Estrilda erythronotos	Blackcheeked Waxbill
Uraeginthus angolensis	Blue Waxbill
Bubuculus ibis	Cattle Egret

The low diversity recorded can be attributed to:

- The lack of structural diversity of vegetation on the study areas;
- Mining activities, of which blasting would disturb many bird species in the immediate area, and
- Egg collecting by adjacent land users and bird hunting may reduce the abundance and diversity of resident bird species.

No Red Data or Protected bird species were recorded during the 2013 survey, although six bird species are listed on SANBI's SIBIS database for the relevant quarter degree grid squares (Table 4-9). It is unlikely that any of these species, with the exception of the Yellow throated Sandgrouse (*Pterocles gutturalis*), which favours short, open grassland with clay-like soils, similar to that occurring in the study area, would nest in the area. No signs of Yellow throated Sandgrouse (nests, tracks or droppings) were found during the ecological survey.

Table 4-9: Red Data avifauna species listed for 2427CB & 2427CC quarter degree grid square

Scientific Name	Common name	IUCN Red Data List (2012)	NEM:BA Threatened and Protected Species List (2007)	Probability of occurrence
Buphagus erythrorhynchus	Red billed Oxpecker	Near threatened	-	Low
Gyps africanus	African White-backed Vulture	Vulnerable	Endangered	Low
Gyps coprotheres	Cape Griffon Vulture	Vulnerable	Endangered	Low
Polemaetus bellicosus	Martial Eagle	Vulnerable	Vulnerable	Low
Pterocles gutturalis	Yellow throated Sandgrouse	Near threatened	-	Probable
Torgos tracheliotus	Lappet-faced Vulture	Vulnerable	Endangered	Low

4.7.2.3 Herpetofauna

Expected reptile and amphibian species lists were compiled by consultation of field guides. Branch (1994) was used for reptiles, while Carruthers (2001) and Du Preez & Carruthers (2009) were used for amphibian species.

Active searching was conducted on foot and included searching all suitable habitats (rocks, logs, artificial cover, leaf litter, artificial litter, bark, pools and streams), and scanning basking sites and places where specimens were likely to be found.

According to the NW Biodiversity Inventory and Database (2003) the Dwaalboom thornveld vegetation type has a reptile and amphibian biodiversity ranking of medium and a total of 65 species could potentially occur in the study area. Of these, only the African Rock Python (*Python sebae natalensis*), which favours open savannas and rocky areas (Branch, 1994), is categorised as a Protected species, according to the NEM:BA TOPS List (2007). Open savanna occurs in the study area, but the area is severely impacted and the probability of this species being present is considered to be no more than moderate.

Only five species, namely the Spotted Bush Snake (*Philothamnus semivariegatus*), Puff Adder (Bitis arietans), Mozambique Spitting cobra (*Naja mossambica*) and the Variable Skink (*Mabuya varia*) were recorded during the 2013 field survey. All these species have wide distributions and are common. What was noticeable during the surveys was the large number of reptiles recorded (22 in total). This may be attributed to the very hot weather experienced during the time of the survey. No signs of the presence of the African Rock Python were found.

Of the amphibians potentially occurring in the study area only the Giant Bullfrog (*Pyxicephalus adspersus*) is listed as Near Threatened by the IUCN (2012) and categorised as Protected on the NEM:BA TOPS List (2007). This species breeds in the shallows of temporary rain-filled depressions in grasslands and dry savanna, and spends much of the year buried (Carruthers, 2001). Although no evidence of their presence was observed during the field survey, there is potential for this species to occur in the dry riverbed areas of the Varkensvlei study area. These areas are characterised by poorly drained soils which allow for the formation of temporary pools during the wet season. The probability of this species being present is rated as low to moderate due to the disturbed nature of this area.

No amphibians were recorded during the field survey, which was attributed to the absence of open water.

4.7.2.4 Arthropoda

A list of expected arthropod species list was compiled based on the field guides Picker *et al* (2004) and Migdoll (1994).

Active searching was conducted at each of the fauna survey sites. Active searching was conducted on foot and included searching in suitable habitats (rocks, logs, artificial cover, leaf litter, bark, leaf axils, etc.), and scanning sites where specimens were likely to be found. Burrows, mounds and nests were also noted.

A total of 21 arthropoda taxa were recorded, all of them common to savanna areas and with widespread distributions (see Table 4-10. These species are generally subtropical and reflect the southern extension of the Afrotropical range (Picker et al 2004).

Table 4-10: Arthropoda species recorded during the 2013 survey

Order	Family	Species Name
Lepidoptera	Nymphalidae	*Vanessa cardui*
		Acraea eponina eponina
		Junonia hierta
	Pieridae	*Mylothris rueppellii*
Coleoptera	Coccinellidae	*Henosepilachna bifasciata*
Thysanura	Lepismatidae	
Odonata	Protoneuridae	
	Libellulidae	
Blattodea	Blattidae	*Periplaneta americana*
Isoptera	Hodotermitidae	*Hodotermes mossambicus*
Orthoptera	Gryllidae	
	Acrididae	

Order	Family	Species Name
Phasmatodea	Bacillidae	
Diptera	Muscidae	*Musca domestica*
Hymenoptera	Vespidae	*Belonogaster dubia*
	Apidae	*Apis mellifera*
	Anthophoridae	*Amegilla caelestina*
	Formicidae	*Pachycondyla tarsata*
		Dorylus helvolus

Four species of Red Data and Protected arthropods may occur within the study area (Table 4-11). Both species of flat rock scorpion from the genus *Hadogenes* occur in rocky habitats, which were not found in the study area and the probability of them being present is considered to be low.

The Marsh Slyph (*Metisella meninx*) is a wetland specialist favouring marshy grassland (Henning & Roos, 2001) and the probability of its presence in the study areas is low. *Spialia paula* is a savanna species, occurring on the slopes of hills (Henning & Henning, 1989). According to the NW Biodiversity Inventory and Database (2003) this species has been found in Lekubu Mixed Thornveld habitat type, which does not occur in close proximity to the study area.

Table 4-11: List of Red Data and protected Arthropods that may occur in study area

Scientific Name	Common name	NEM:BA Threatened and Protected Species List (2007)	Probability of occurrence
Hadogenes gracilis	Rock Scorpion	Protected	Low
Hadogenes troglodytes	Rock Scorpion	Protected	Low
Metisella meninx	Marsh Sylph	Vulnerable	Low
Spialia paula	Mite Sandman	Vulnerable	Low

4.7.3 Ecological Integrity

The precautionary principle was applied to the determination of the ecological function of the study area. If ecological function was found to be borderline between two categories, the site was classified in the higher category.

The Varkensvlei study area has been impacted by historic agricultural activities and residential developments. In addition, previous and current mining activities have impacted slightly upon the south-eastern part of the study area, although this impact is mainly due to edge effects, rather than physical transformation of the site. The vegetation has been previously transformed, is now in the early stages of succession with a number of exotic plant species present, and is accordingly regarded as secondary vegetation.

Considering these factors and the recorded species diversity, the ecological integrity of the Varkensvlei study area is regarded as being moderate to low.

4.7.4 Conservation Importance

The precautionary principle was also applied to the determination of the conservation importance of the various vegetation communities. In instances where conservation importance was found to be borderline between two categories, the community was classified in the higher category.

Due to their disturbed nature and the lack of presence or, for that matter, the lack of the likelihood of presence of protected or Red Data species at the study area, the conservation importance is regarded as low.

4.8 Surface Water

A baseline surface water study was undertaken to characterise the hydrology of the proposed mining area and its surroundings and to provide input for the water use licence application (WULA) (Cassa, A; Coleman, T;, March 2013).

The area is located in the Crocodile (West) and Marico Water Management Area and falls within the quaternary catchments A24D, A24E and A24F. The study area included the Varkensvlei farm, which drains into the Bierspruit River (See Figure 4-23).

4.8.1 Precipitation

Rainfall data was extracted using the Daily Rainfall Extraction Utility (Kunz, 2004) and was found for 5 rainfall stations located at distances of up to 39 km from the site. The Swartklip-Nooitgedacht station (0587263 W) was chosen as the most representative one, as it is located within 1 km of the site and its records go back for 21 years.

Table 4-12: Summary of rainfall station data used for Varkensvlei site

Location	**Water Management Area**	**Crocodile (West) and Marico**
	Study area	**Varkensvlei**
	Quaternary Catchments	**A24D, A24D, A24F**
Rainfall	Rainfall gauge	0587263_W Swartklip-Nooitgedacht
	Data period	1979 – 2000
	Mean Annual Precipitation (MAP)	516 mm
	Wet Season Rainfall (October - March) *	458 mm
	Wet Season Rainfall % of MAP	88.7 %
	Dry Season Rainfall (April - September) *	58 mm
	Dry Season Rainfall % of MAP	11.2 %
Evaporation	Mean Annual Evaporation (MAE) A-Pan	2363 mm
	Evaporation Zone (WR90 study) ≠	2B

Note: *******The sum of the average monthly rainfall does not necessarily correspond to the MAP*
≠ *Midgley et al, 1994*

The area is situated on the Escarpment where most of the rainfall falls in the summer months. The monthly rainfall distribution is shown in Figure 4-22.

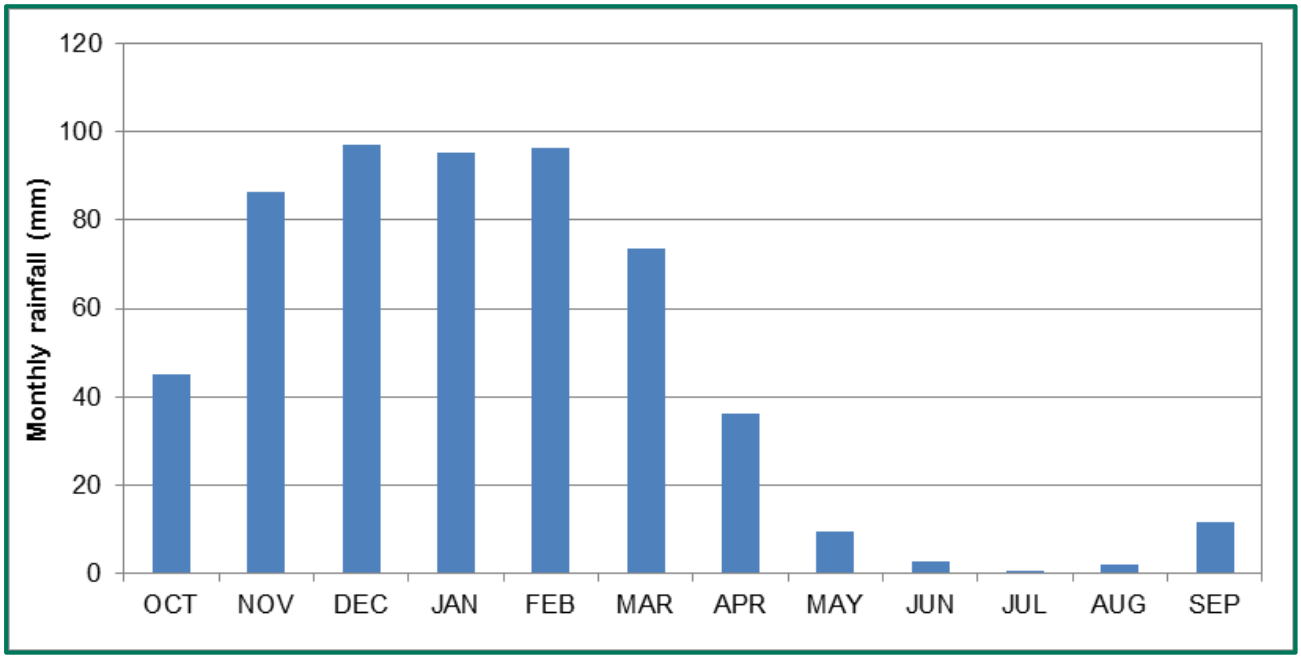


Figure 4-22: Monthly rainfall distribution for 0587263_W Swartklip_Nooitgedacht

The mean annual rainfall for Swartklip is 556 mm. The lowest rainfall year was 1985 with 307 mm and the highest rainfall year was 1997 with 776 mm. The 5, 50 and 95 percentiles of the annual rainfall totals for the rainfall station are shown in Table 4-13.

Table 4-13: 5, 50 and 95 percentiles of the annual rainfall totals

Station number	Station name	5%	50%	95%
0587263_W	Swartklip_Nooitgedacht	391.2	516.3	742.2

The Swartklip_Nooitgedacht station recorded 23 rainfall events exceeding 50 mm/day and 4 exceeding 100 mm/day during the data period.

The 24-hour rainfall depths for the 1 in 2, 1 in 5, 1 in 10, 1 in 20, 1 in 50, 1 in 100 and 1 in 200 recurrence intervals at the station were calculated from the available data. The likely magnitude of storm events was estimated by means of the Reg Flood program (Alexander W.R.J, 2001). The results are summarised in Table 4-14.

Table 4-14: 24 hour storm rainfall depths for Swartklip-Nooitgedacht

Recurrence Interval (years)	1 in 2	1 in 10	1 in 20	1 in 50	1 in 100	1 in 200
Rainfall depth (mm)	58	106	129	164	193	227

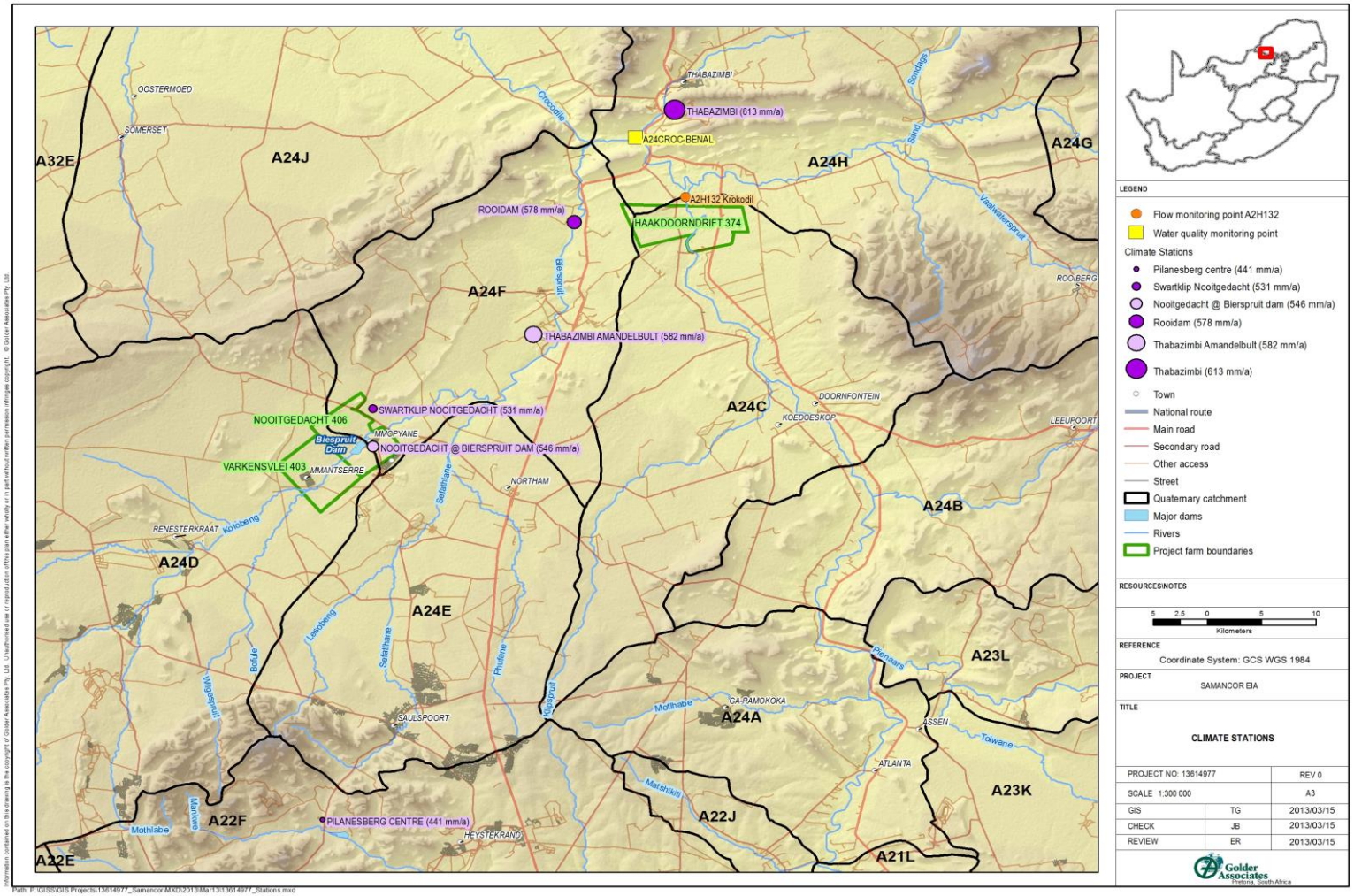


Figure 4-23: Location, quaternary catchments, rainfall stations, water quality and flow monitoring points for the Samancor Chrome site

4.8.2 Water flow and quality

The area falls within the quaternary catchments A24D, A24E and A24F. Several drainage lines and minor watercourses combine to form the Bierspruit and the Bierspruit dam just north of the proposed mining area.

Neither Samancor Chrome nor the Department of Water Affairs (DWA) website could provide any data on surface water flow in the local watercourses. Despite a heavy downpour early in February, these water courses were completely dry, except for one or two spots of ponding, during the site visit undertaken on 20 February 2013. Accordingly, no flow measurements or water sampling could be done, but in 2011 SRK recorded a mean electrical conductivity (EC) value of 31 mS/m over the period 2007-2011 for the water in the Bierspruit Dam, which is well within the guideline of 70 mS/m for domestic use and is indicative of negligible impacts due to anthropogenic activities. (Chimhanda, W; Skinner, S;, August 2011)

As is to be expected, poorer water quality prevails at the Union mine impoundments about 2 km to the south of the proposed mining area.

4.9 Groundwater

A high level investigation of the groundwater regime at and in the broader vicinity of the proposed mining area was undertaken to characterise baseline conditions (Demmer, T; van der Linde, G;, March 2013). This was followed by a drilling and borehole testing programme during 2015 (Demmer, T; van der Linde, G;, December 2015).

4.9.1 Regional Geohydrology

Crystalline rock, such as the norites and pyroxenites of the Bushveld Complex, consist of an unweathered and intact rock matrix with negligible matrix porosity and permeability, with planes of discontinuity, including both faults and joint planes (collectively referred to as fractures).

The infiltration and flow of groundwater in such systems is controlled by the prevailing complex fracture network and can vary in space and time. Such conditions relate to structurally controlled flow systems. The fractures are often in-filled by precipitates from late phase fluids (i.e. vein infill). The geohydrological characteristics of the crystalline rock derive from long-term, tectonically controlled geomorphic processes.

On a regional scale the geohydrology can be described in terms of the following two-layer aquifer model:

- **A shallow weathered, unconfined, phreatic bedrock aquifer system (i.e. intergranular aquifer) which might be laterally connected to alluvial aquifers associated with river systems:**

  This aquifer consists of saprolite, that formed as a result of intensive and in-situ weathering processes and saprock (differentially weathered and fractured upper bedrock underlying the saprolite) (Figure 4-24). The soil and saprolite are collectively termed the regolith. The saprolite and saprock are generally viewed as a single weathered aquifer unit, referred to as the weathered overburden, which varies in thickness from 12 to 50m and is highly weathered, containing yellowish white to yellowish brown sandy, silty soil derived from the in-situ decomposition of the underlying noritic rocks.

  Alluvial material overlies or replaces the weathered overburden in the vicinity of water courses. The weathered and alluvial aquifers support most of the irrigation and domestic water demands in the Bushveld Complex, even in areas which are undermined, which is indicative of limited hydraulic interaction with the underlying fractured bedrock aquifer.

  Numerous pumping tests have yielded reasonable and comparable transmissivities of 3 to 8 m^2/day for the weathered bedrock aquifer in the BIC, but storativities can vary by several orders of magnitude due to semi-confined conditions in areas overlain by confining layers (e.g. black turf) or semi to unconfined conditions in localities where these are absent. Typical storativity (S) values range from E-04 to E-03.

- **Deeper fractured bedrock system:**

  The unweathered and fractured semi-confined bedrock aquifer consists of fractured norites, anorthosites and pyroxenites underlying the upper weathered aquifer. The intact bedrock matrix has a very low hydraulic conductivity which is effectively determined by fractures and mine voids. Groundwater flows through interconnected fracture systems with the potential of rapid vertical groundwater flow from the weathered overburden (and surface water bodies) to greater depths along interconnected conductive zones.

  Water is generally stored and transmitted in fractures and fissures within the relatively impermeable matrix. Fractured crystalline rocks show extreme heterogeneity in their hydraulic properties and the hydraulic conductivity can vary, within the same rock mass, by orders of magnitude and over short distances. These properties account for the observed variable chemical and isotopic signatures obtained for mine fissure inflows in the Bushveld Complex.

  The structurally controlled heterogeneity and the typical scarcity of sufficient deep boreholes renders regional estimates of aquifer properties difficult. However, regional hydraulic conductivity values in the range of E-03 to E-01 m/day, with higher conductivities assigned to fault zones, have yielded satisfactory calibrations of regional numerical models.

Recharge to the groundwater regime in the BIC is estimated to be approximately 3% of the mean annual precipitation (MAP).

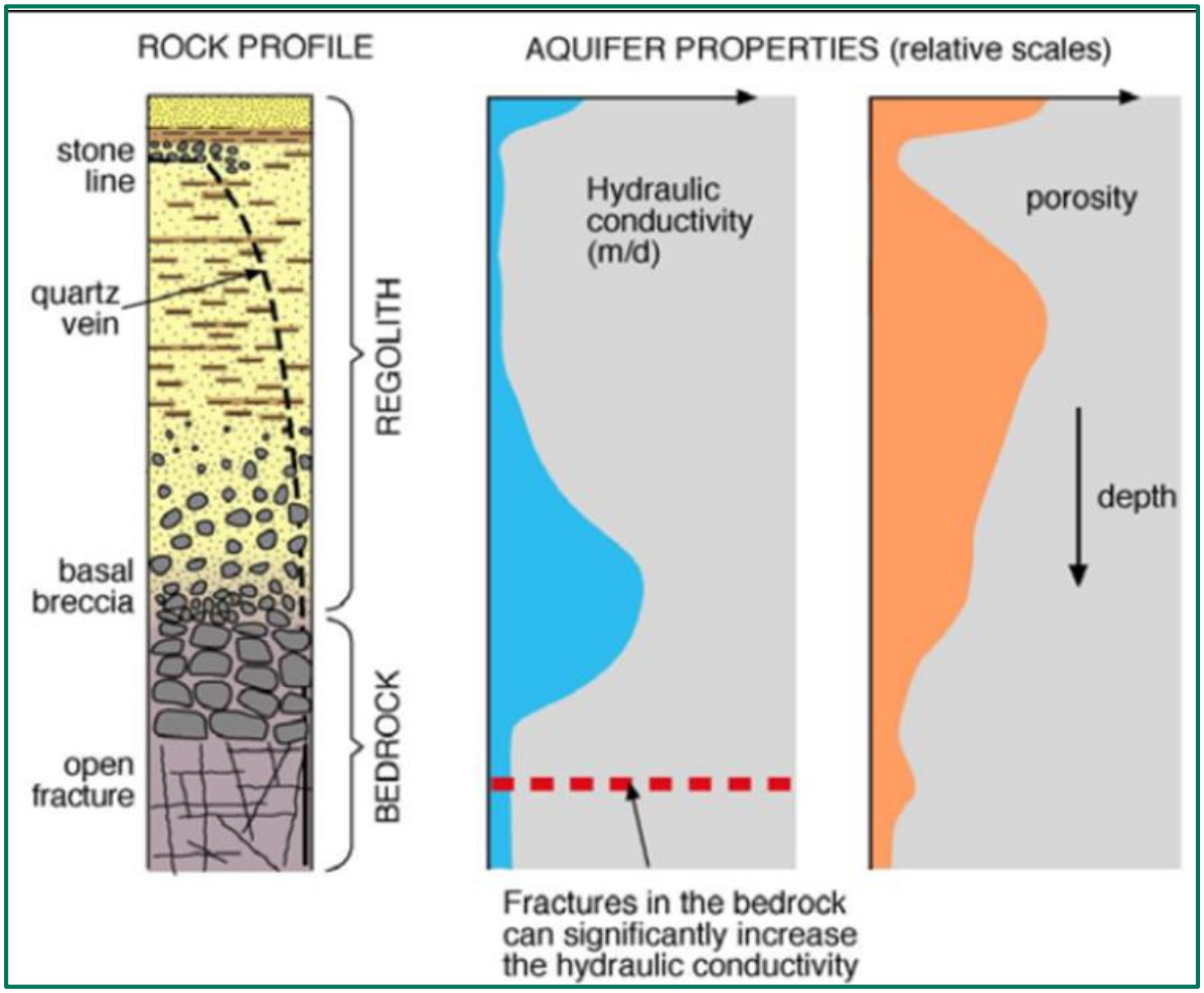


Figure 4-24: Typical weathered profile for basement rocks

4.9.2 Local groundwater levels and flow directions

4.9.2.1 Union Mine groundwater study by SRK Consulting (2011)

SRK Consulting undertook a hydrocensus for the neighbouring Amplats Union mine in 2011, which included sampling of selected boreholes within the Union mine lease area, immediately to the south-east of and surrounding Samancor's proposed mining lease area on Varkensvlei. (Chimhanda, W; Skinner, S;, August 2011). Borehole yields and groundwater uses are shown in Figure 4-25.

The groundwater levels broadly follow the topography with exceptions of where the water levels are affected by anthropogenic activities and were found to vary from about 2.4 mbgl near the return water dam on the mine property to 23.6 mbgl near Bierspruit village, with an average depth of approximately 18 mgbl.

Figure 4-26 shows groundwater contours and flow directions, highlighting higher groundwater elevations in the vicinity of surface mine waste infrastructure and lowered groundwater elevations near shafts, corresponding to anthropogenic recharge and dewatering respectively.

The proposed Samancor Chrome mining area on the farm Varkensvlei falls within the two quaternary catchments A24D and A24F and groundwater flows from these areas towards the north and north-east.

A hydrocensus of eight boreholes closest to the proposed Samancor Chrome mining areas on Varkensvlei was undertaken by Golder late in February 2013 (Demmer, T; van der Linde, G;, March 2013). Four were sampled and analysed. The results are shown in Table 4-15.

The groundwater levels recorded are shown in Table 4-15. These results concur roughly with those measured by SRK in 2011 (Chimhanda, W; Skinner, S;, August 2011), although the average water table is approximately 17 mbgl, slightly less than the average water table depth reported by SRK in 2011.

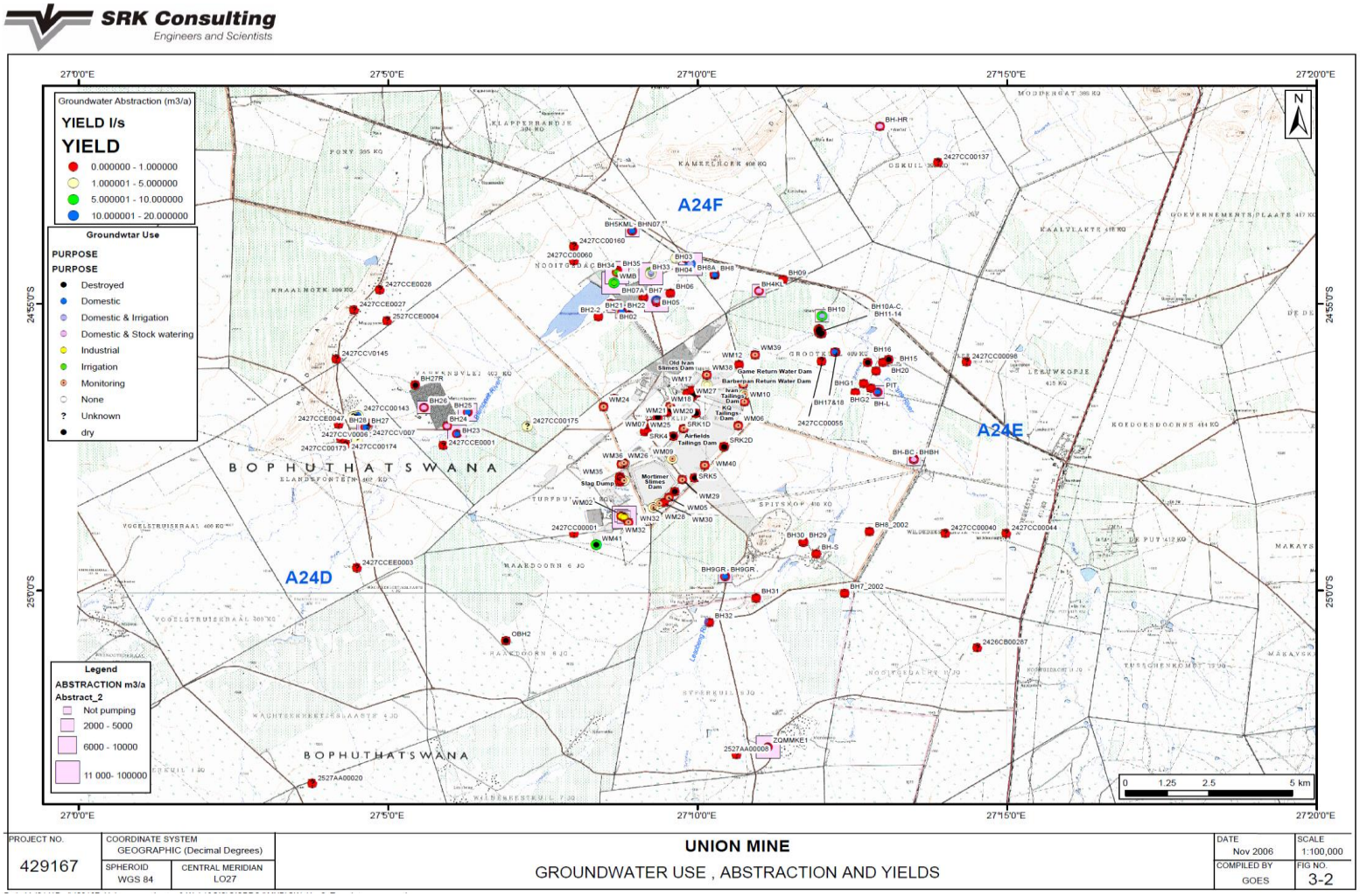


Figure 4-25: Summary of hydrocensus information for Union Mine - SRK 2011

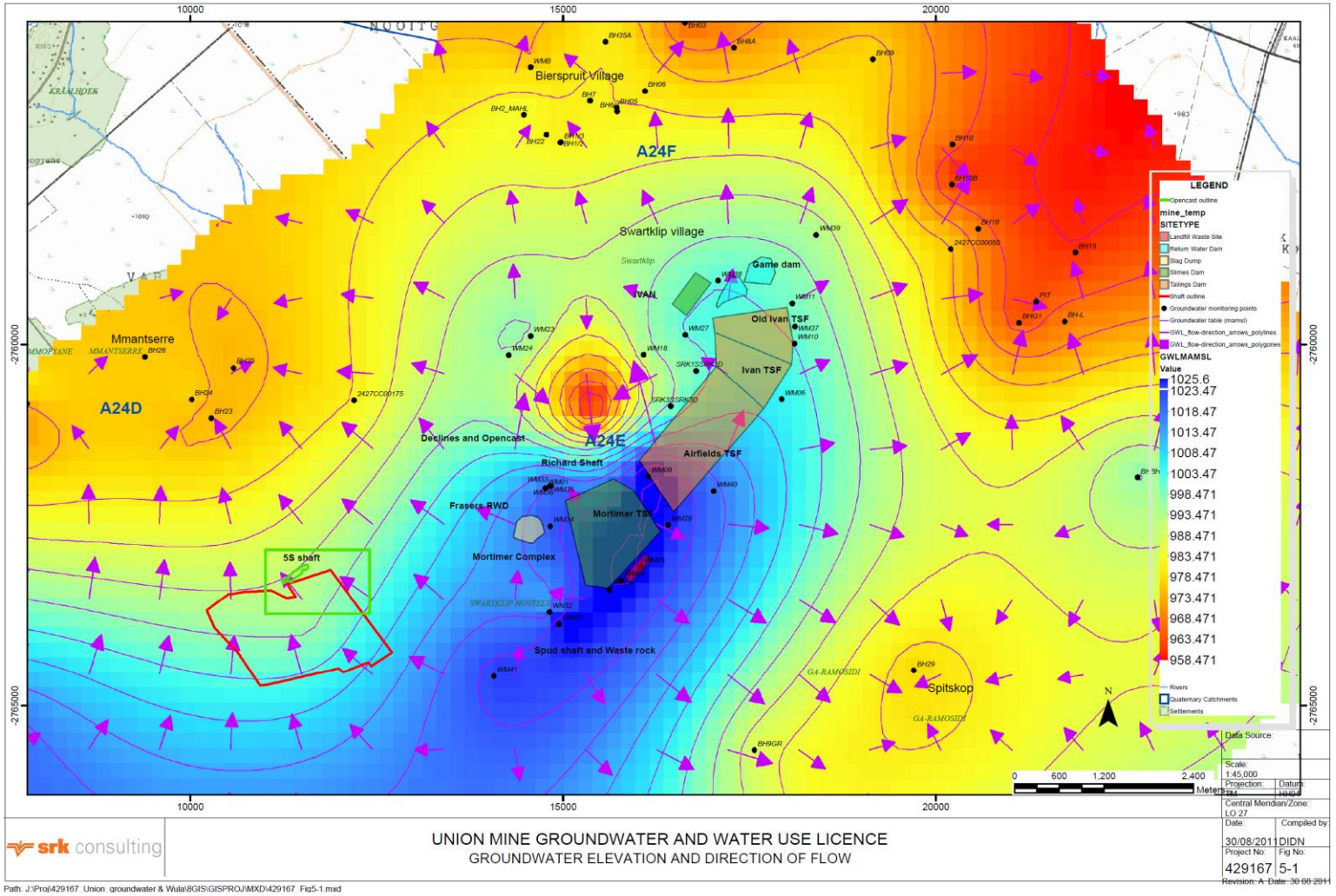


Figure 4-26: Groundwater elevations and flow directions around Union Mine

Table 4-15: Hydrocensus Information

Borehole No/Name	Coordinates (WGS84)		Collar Height (m)	SWL (mbgl)	Owner	Farm	Use	Field Measurements			Sampled	Pumping Equipment installed
	Latitude	Longitude						pH	EC mS/m	TDS (mg/L)		
BH3	24.95187	27.08701	0.2	23.37	Funeral home	Mantserre	Domestic	7.45	142	630	Yes	Submersible
BH4	24.95136	27.08967	0.5	24.26		Mantserre	Domestic	7.54	159	720	Yes	Submersible
BH5	24.90687	27.16882	0	12.84	Gerhard Young	Kameelhoek	Domestic	7.73	132	570	Yes	Submersible
BH6	24.90704	27.17156	0.1	18.09	Gerhard Young	Kameelhoek	Domestic	7.36	293	1320	Yes	Submersible
BH7	24.919058	27.146294	0.4	23.49		Bierspruit dam	Domestic				No	Submersible
BH8	24.90755	27.14484	0.2	7.48		Bierspruit dam					No	none
BH9	24.92033	27.13992	0.3	9.26	Mine	Bierspruit dam					No	none
BH10	24.95451	27.10183	0.3	16.9		Mantserre	Domestic				No	Submersible

4.9.2.2 Groundwater investigation by Golder Associates (2015)

Two geophysical traverses using magnetic and electromagnetic methods were undertaken as indicated on Figure 4-27.

Eleven monitoring boreholes were drilled at the positions shown on Figure 4-28. Slug tests and constant discharge tests (CDT) were performed on selected boreholes.

A slug test involves rapidly lowering a closed cylinder into the borehole and observing the time taken for the water level to recover as the displaced water dissipates into the surrounding aquifer. The aquifer's hydraulic conductivity (K) is calculated from the recovery time.

Short duration Step Discharge Tests (SDT) and longer duration Constant Discharge Tests (up to eight hours long) were conducted on boreholes DS2, DS3, DS6, DS11.

The SDT establishes the maximum pumping rate that can be maintained throughout the CDT. Following the recovery of the water level subsequent to the SDT, the CDT is conducted for long enough to produce significant drawdown of the water level in the test borehole and in nearby monitoring boreholes. The transmissivity (T) of the aquifer in the vicinity of the tested boreholes is calculated from the drawdown curves.

The results of the above tests are listed in Table 4-16. Boreholes DS2, DS3 and DS6 were found to exhibit reasonable conductivity (K), transmissivity (T) and yield. The K and T values are essential for numerical modelling to determine the impact of the proposed mining operations on the local groundwater regime.

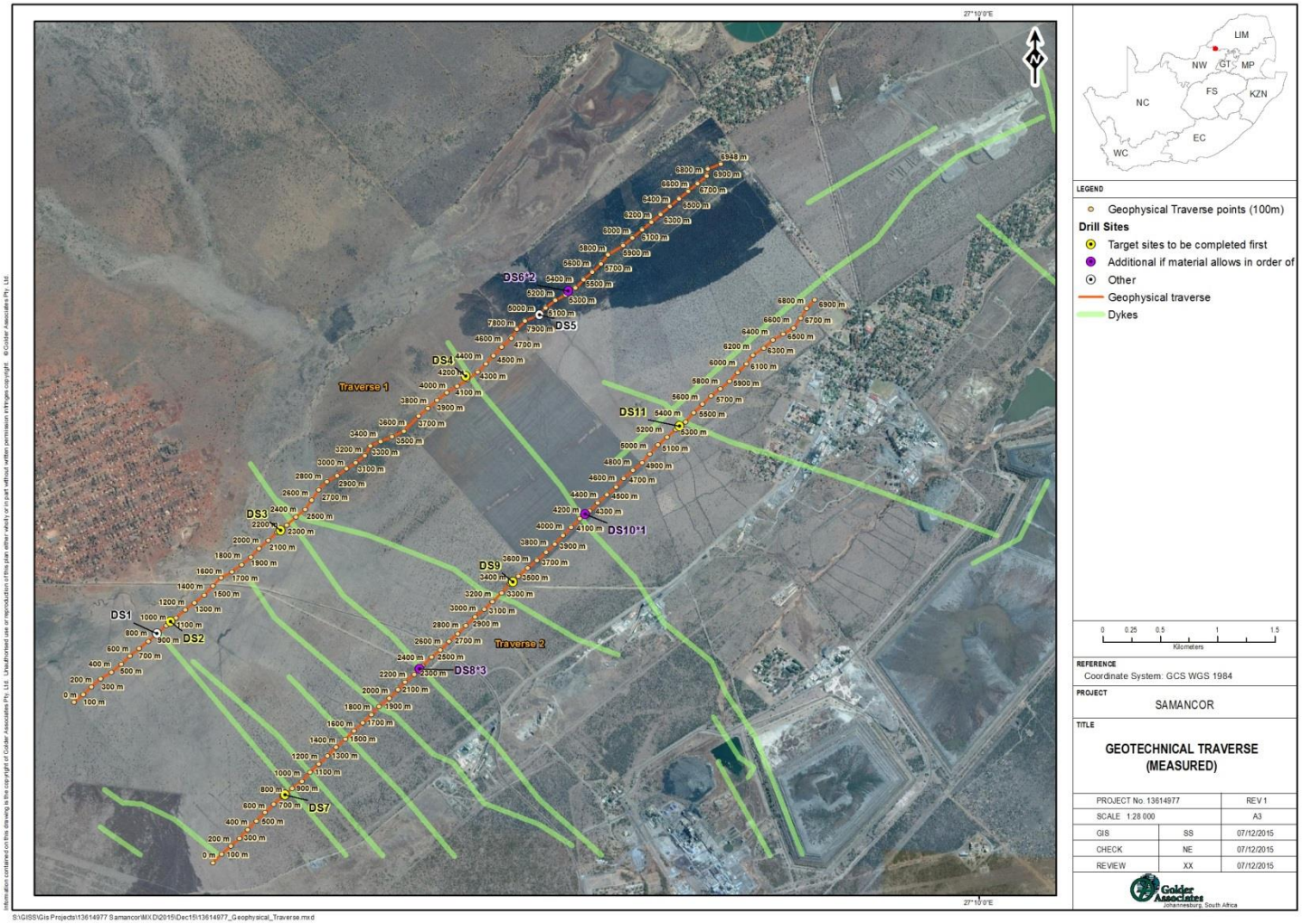


Figure 4-27: Geophyisical traverses

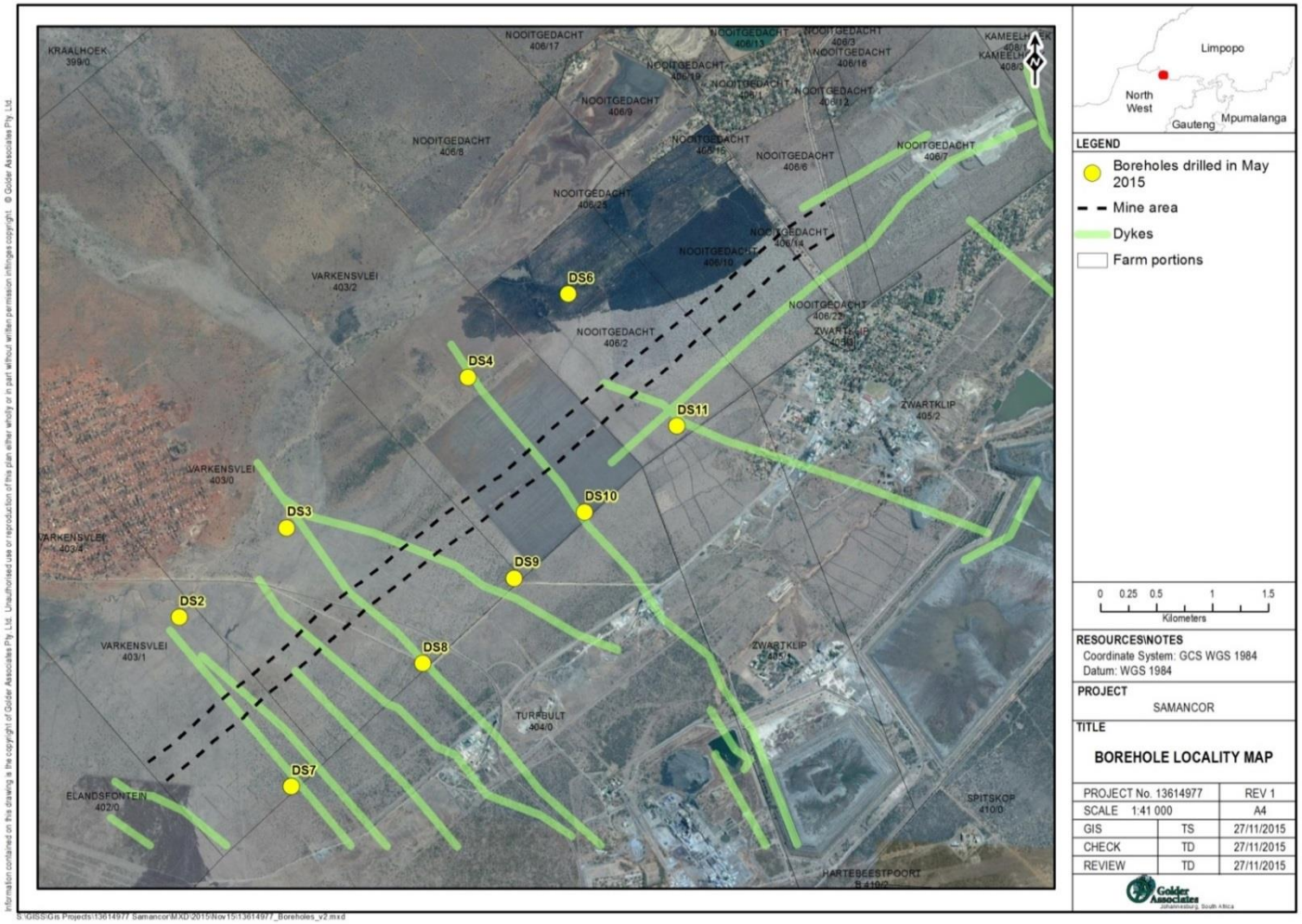


Figure 4-28: Locations of newly drilled boreholes on Varkensvlei/Nooitgedacht

Table 4-16: Borehole testing results

Borehole No.	Static water level (mbgl)	Conductivity K (m/d) Slug test	Airlift yield (L/s)	CDT discharge rate (L/s)	Drawdown (m)	Recovery time (minutes)	Extent of recovery (%)	Transmissivity T (m^2/day)
DS2	16.31	0.68	0.9	0.6	9.58	480	99	0.6-0.7
DS3	14.34	0.87	1.6	0.6	2.19	210	85	16
DS4	19.79	0.0489						
DS6	12.03	0.586	2.0	2.8	4.54	480	89	53
DS7	*							
DS8	28.92	0.0156						
DS9	*							
DS10	25.79	0.00102						
DS11	17.58	0.0102	0.8	Borehole effectively dry				

Table 4-17: Groundwater quality in monitoring boreholes

	pH	EC [mS/m]	TDS [mg/l]	M Alk. [mg/l CaCO3]	Al [mg/l]	Ca [mg/l]	Fe [mg/l]	K [mg/l]	Mg [mg/l]	Mn [mg/l]	Na [mg/l]	V [mg/l]	Zn [mg/l]	F [mg/l]	Cl [mg/l]	NO3 N [mg/l]	SO4 [mg/l]
DS2	8.54	64.5	430	262	0.014	20.7	0.05	2.34	53.7	0.01	68.1	0.047	0.007	0.662	19	0.56	60.6
DS3	8.15	94.5	582	540	0.001	19.3	0.034	1.22	91	<0.001	64.3	0.022	0.018	0.705	12.7	1.3	13.5
DS4	8.32	98.3	608	529	0.086	11.3	0.077	4.64	101	0.053	42.3	0.003	0.012	0.215	27.4	0.48	26.6
DS6	8.15	86	522	463	0.136	5.62	0.046	1.3	102	0.035	36.6	0.021	0.032	0.217	17.3	<0.3	31.7
DS8	7.65	165	1100	670	0.086	29.7	0.033	3.8	148	0.275	41.1	0.036	0.049	0.184	145	9.7	56
DS10	7.93	168	1100	852	0.081	29.5	0.023	4.84	182	0.2	32.6	0.086	0.056	0.153	102	4.41	22.1
DS11	7.85	160	1080	404	0.078	51.1	0.013	5.54	123	0.111	132	0.026	0.04	0.137	278	5.48	90.1
Min	7.65	64.5	430	262	0.001	11.3	0.013	1.22	53.7	<0.001	32.6	0.003	0.07	0.137	12.7	<0.3	13.5
Max	8.54	168	1100	852	0.136	51.1	0.077	5.54	182	0.275	132	0.086	0.056	0.705	278	9.7	90.1
Standard Limit #	**<5, >9.7**	**170**	**1200**		**0.3**	**300**	**2**	**100**	**100**	**0.5**	**200**			**1.5**	**300**	**11**	**500**

- SANS 241:2011 Class II drinking water standards

4.9.3 Groundwater Quality

4.9.3.1 Groundwater investigation by Golder Associates (2013)

The groundwater study undertaken in 2013 came to the following conclusions:

Based on the prevailing aquifer types, three dominant water facies are typically encountered in the Bushveld Complex:

- A Mg-Ca-HCO3 water type for the shallow weathered aquifer, which changes towards a very similar Mg-Ca-HCO3-Cl water type in the alluvial aquifers along major river systems (e.g. Crocodile River). Impacts of irrigation return flows (i.e. elevated Cl concentrations) are therefore difficult to assess based on the major ion chemistry, and the use of isotopes is usually indicated.
- Water in the deeper fractured bedrock aquifer, as encountered in deeper mine fissure inflows, shows a typical, highly evolved Na-Cl water type.)

The relative mineralisation (%-meq/ℓ) plotted on a Piper diagram shows a graphical grouping of groundwater samples. See Figure 4-29. The recently recharged and shallow groundwater is typically dominated by Mg-Ca-HCO_3, attributable to silicate weathering processes associated with the Bushveld Complex.

Deep mine fissure inflows are typically classified as Na-Ca-Cl or Ca-Na-Cl water facies. The total dissolved solids (TDS) concentrations for the mine inflows present a range of values from 350mg/l to more than 1000 mg/l. The total dissolved solid (TDS) concentrations increase with increasing residence times in the subsurface, i.e. time to equilibrate with the aquifer material. The final mineralisation is then determined by the solubility of the minerals.

The following observations are based on the major ion ratios (Figure 4-30):

- Deeper mine fissure inflows are chemically and isotopically different to shallow groundwater and shallow mine inflows associated with the weathered Bushveld Complex aquifer and the alluvial aquifer systems.
- Deep mine fissure inflows are fairly uniform in chemical character (i.e. with a dominant Na-Cl water type) compared to the variable chemical character of the shallow groundwater samples and the Crocodile River water.
- The stable isotope ratios and tritium concentrations point to an indirect link between irrigation return flows from alluvial aquifer systems and a considerable number of deep mine fissure inflows.
- Overall groundwater quality within the Crocodile River drainage direction appears to be unaffected by the current platinum mining activities; and
- Elevated nitrate concentrations are more often than not associated with the use of nitrate based explosives, and are therefore expected to originate from shaft areas.

The pH of the groundwater samples taken by Golder in 2013 (Demmer, T; van der Linde, G;, March 2013) ranged from about 7.4 to 7.7, i.e. slightly above neutral, the concentration of total dissolved solids ranged from about 600 to 1300 mg/ℓ and the water levels from about 7.5 to 24.25 mbgl. Due to the distance from Union Mine and the quaternary catchment divides, it is not expected that the quality of the groundwater at the proposed mining areas will have been affected by the activities at Union Mine.

There are several boreholes used primarily for garden/golf course irrigation and domestic purposes by communities surrounding the proposed mining areas. Access to monitoring boreholes on Anglo American Platinum's Union mine property to the south-east was not possible during the hydrocensus.

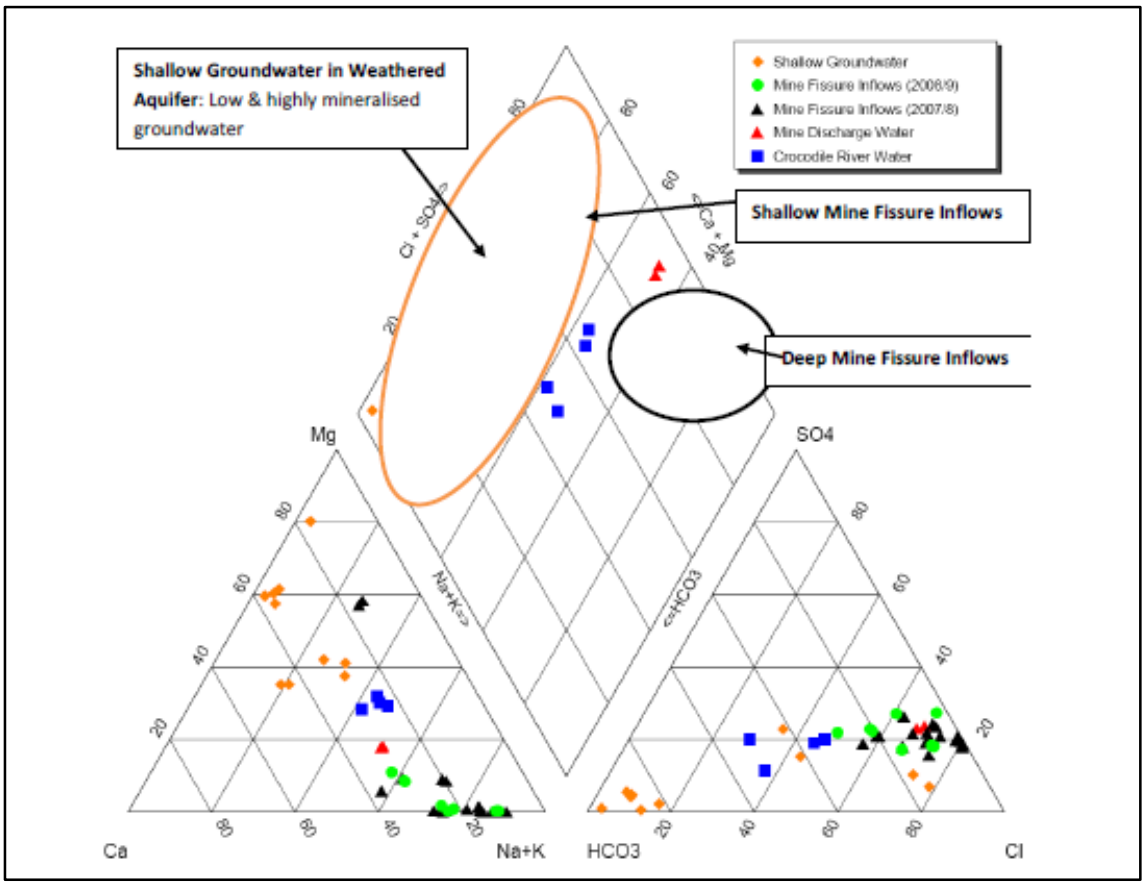


Figure 4-29: Piper Diagram showing shallow groundwater as well as deep mine fissure water composition in terms of major ions in solution

4.9.3.2 Groundwater investigation by Golder Associates (2015)

Samples from seven boreholes were sent to UIS Analytical Services, a SANAS accredited laboratory, for chemical analysis. The results are listed in Table 4-17.

The quality of the groundwater in the sampled boreholes generally meets water quality criteria for domestic use (SABS, 2011), although there were elevated levels of magnesium (Mg) in five of the boreholes, which is ascribed to the local geology.

The Piper Diagram in Figure 4-30 illustrates the different hydrochemical compositions of the groundwater samples from the sampled boreholes. The nature of the groundwater quality encountered in the boreholes does not appear to have been negatively affected by mining or other industrial activities.

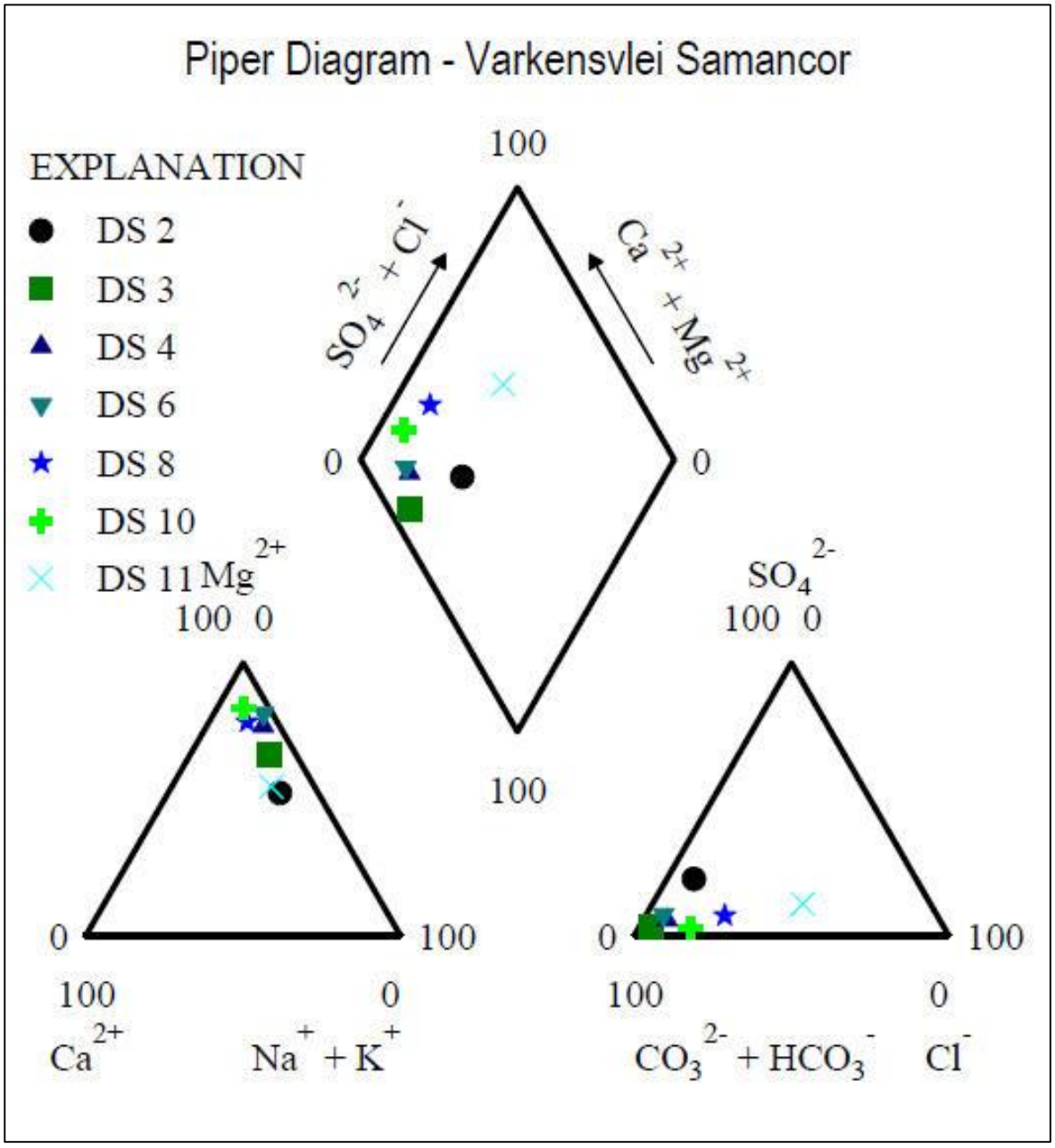


Figure 4-30: Piper diagram showing the hydrochemical composition of the groundwater

The Piper diagram illustrates the Mg ion dominance in most of the boreholes except DS 11, which is not dominated by any particular major anion or cation. The hydrochemical composition of the samples collected is fairly typical of Mg-Ca-HCO_3 dominated shallow groundwater attributed to silicate weathering processes associated with the Bushveld Complex.

The seven groundwater samples range in total dissolved solids (TDS) concentration from approximately 430 to 1100 mg/L, which is very similar to the concentrations in the four boreholes sampled during the hydrocensus in 2013 (Demmer, T; van der Linde, G;, March 2013). The pH in the boreholes varies between 7.65 and 8.54 which is slightly higher than the range in the boreholes sampled in 2013. The elevated Mg concentrations were also noted during the 2013 hydrocensus.

4.9.4 Conceptual groundwater model

As described in section 4.9.1 of this EIA/ERMPr report, the proposed Varkensvlei mining area is located in the north-western sector of the BIC, with the geological formations comprising of norites and pyroxenites and the groundwater regime is affected by the following features:

- An unweathered and intact rock matrix with negligible matrix porosity and permeability;
- Planes of discontinuity in the rock matrix, including both faults and joint planes (collectively referred to as fractures); and
- Northwest-southeast orientated semi-vertical dolerite dykes.

The infiltration and flow of groundwater in such systems is controlled by the prevailing complex fracture network. The fractures are often in-filled by precipitates from late-phase fluids (i.e. vein infill). Section 4.9.1 also describes a conceptual two-layer aquifer model on a regional scale.

The drilling described in section 4.9.2.2 focused on intersecting the contact zones near the intrusive dolerite dykes that would provide the most likely flow paths for groundwater at shallow (<20m) and intermediate (<50m) depth and that could potentially supply water for the wet ore processing plant.

The test pumping has shown T values to vary between 0.6 (DS2) and 53 (DS6) m^2/day close to the contacts of the dykes, whereas slug testing has shown slightly less permeable zones varying over several orders of magnitude from approximately 0.001 m/day (DS10) to 0.04 (DS4). Assuming an aquifer thickness of 1-10 m, this would imply an overall range of T values spanning several orders of magnitude from 0.001 to 53 m^2/day.

Groundwater flow in the proposed mining area appears to be influenced strongly by two factors:

- Compartmentalisation by dykes to form flow barriers
- Dewatering of the neighbouring Union Mine

Initial assessment suggests that natural groundwater flow is towards the north-west and the Bierspruit, located a few hundred metres to the north of the proposed mining area, however, this appears to have been influenced by the capture of flow towards the south-east by the dewatering of Union Mine.

Figure 4-31 is a schematic of the conceptual shallow groundwater regime that will be intersected by the mining operations. In order to maintain safe and dry working conditions, the proposed pit and underground mine will have to be dewatered by either in-pit drains or sumps and possibly by boreholes DS3, DS 4 and DS6, which could also act as relatively low yielding (0.6 – 2.8 L/s) water supply boreholes to supplement the mine's water requirements.

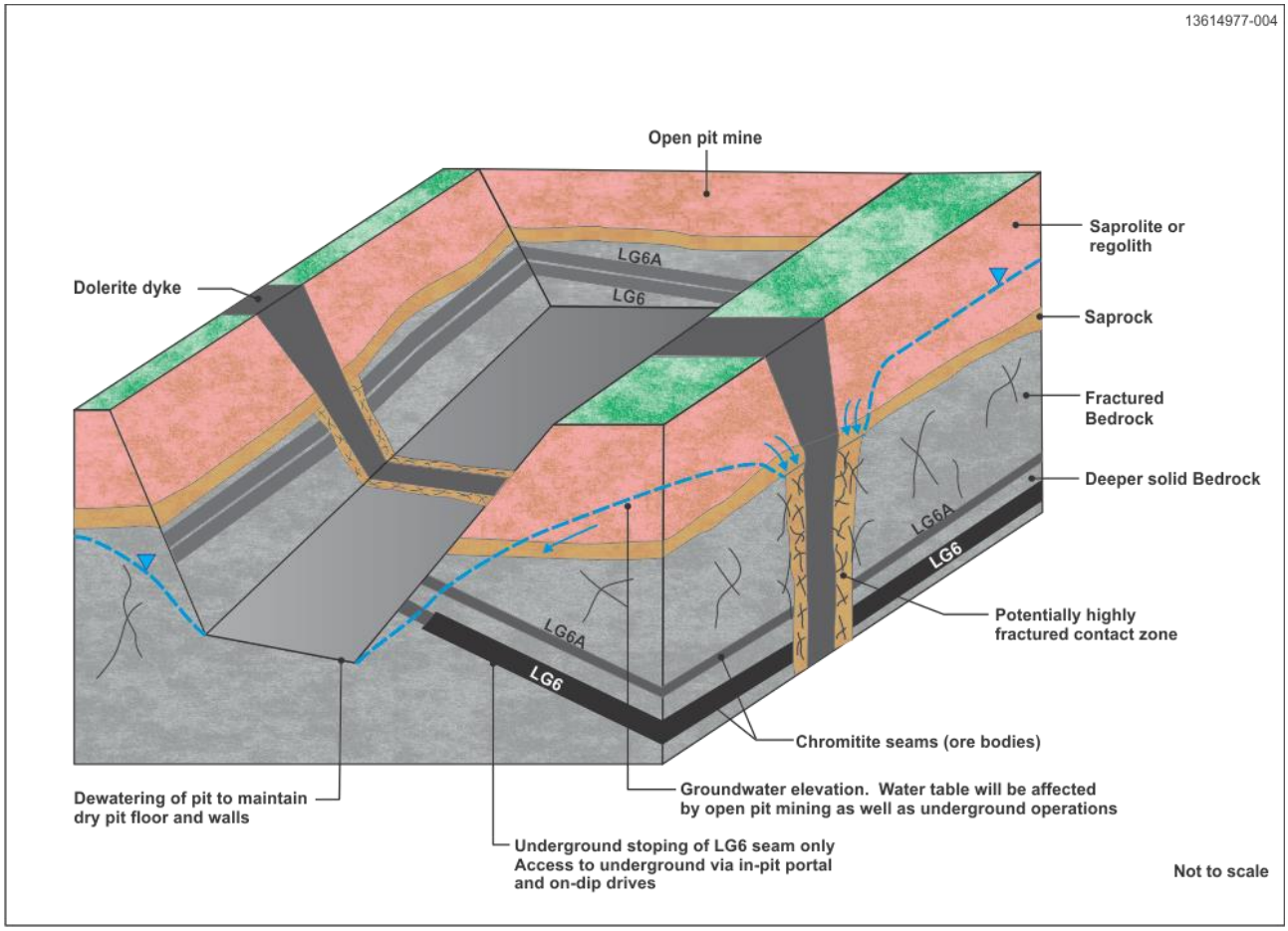


Figure 4-31: Conceptual understanding of the groundwater regime in the vicinity of the proposed open pit and underground mine on Varkensvlei/Nooitgedacht

4.10 Noise

Current, pre-project baseline noise levels were measured by dBAcoustics (van der Merwe, B;, March 2013) at the receptor points shown in Figure 4-32. These receptor points were chosen with reference to the project area and adjacent developments shown in Figure 4-32.

There are existing mining areas to the south of the proposed opencast area, an existing feeder road and railway line to the north and residential areas to the north and the south. The people living in some of these areas are already exposed to some mining activity noise such as ventilation fans, blasting, trains, ore processing, and other mining activity noises.

The measured daytime and night time noise levels are listed in Table 4-18. These are the background noise levels against which the noise impacts of the new mining operations at the noise sensitive areas will be determined.

The work was performed in accordance with:

- SANS 10103 of 2008 – the measurement and rating of environmental noise with respect to land use, health, annoyance and speech communication;
- Gauteng Noise Control Regulations;
- International Finance Corporation's Environmental Health and Safety Guidelines – Noise Guideline; and
- National Environmental Management Act, 1998 (Act 107 of 1998) – Section 28.

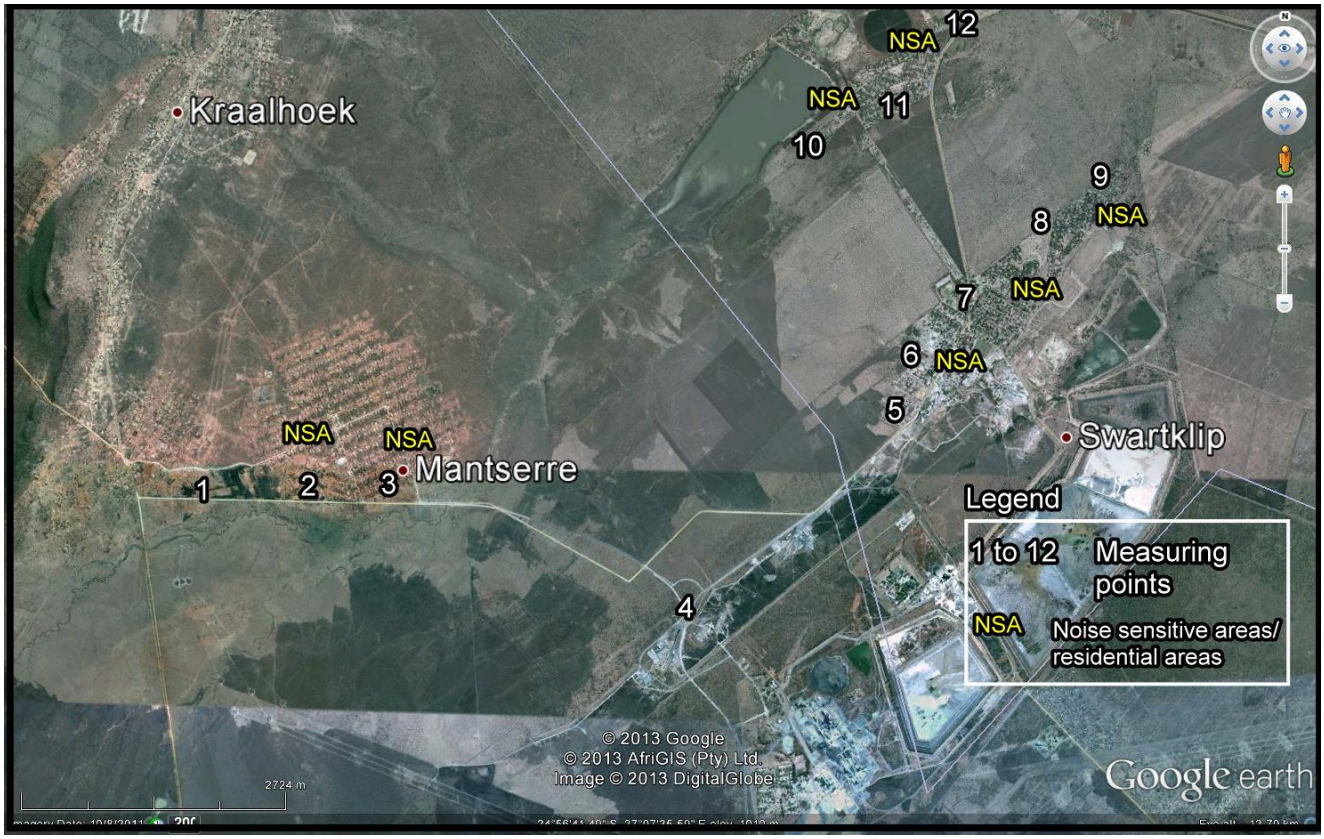


Figure 4-32: Potential noise sensitive areas

Table 4-18: Measured baseline noise levels in project area

Measuring point	Daytime Leq – dBA	Night time Leq - dBA
1	44.1	48.4
2	44.9	47.6
3	42.2	46.6
4	61.5	52.3
5	38.7	44.7
6	38.1	44.6
7	41.9	44.0
8	40.5	44.8
9	41.7	48.1
10	42.1	41.4
11	44.5	47.1
12	43.4	41.3

The prevailing noise levels at the noise sensitive areas are typical of residential areas in the vicinity of roads and distant mining activities. The higher noise levels during the night time periods were due to insects such as crickets and beetles. The higher noise level at measuring point 4 is from traffic noise and ore silo operations.

The distances between the noise sensitive areas and the 600 m blast zone boundary are listed in Table 4-19.

Table 4-19: Distances between blast zone boundaries and noise sensitive areas

Noise sensitive area	Distance of noise sensitive area from mine boundary
A	50 to 340m
B	60 to 80m
C	3 740m
D	340 to 580m
E	3 850m

The prevailing ground vibration levels at all the measuring points are well below 0.050mm/s, which is insignificant.

4.11 Visual Aspects

The visual impact assessment was undertaken by a professional landscape architect and visual impact specialist (Bothma, J;, March 2013).

4.11.1 Visual Characteristics of the Project Area

The current visual characteristics of the project area were determined by means of a site visit during which a number of photographs were taken and visual observations were made by the specialist.

The regional visual character is largely rural, consisting of wilderness/conservation and agricultural uses, contrasted in various locations by extensive mining, human settlements and linear infrastructure. The visual character of the study area is largely similar to that of the greater region and is illustrated in Figure 4-33.

The general topography is slightly sloping to flat, but punctuated by several isolated ridges and outcrops, which are located northwest and southeast respectively of the project area. Much larger landforms and

mountain ranges are located further north and outside of the study area. They are too distant from the site to be visually dominant.

Various artificial landforms such as the tailings dams and slag dumps at the adjacent Anglo American Union mine tend to dominate short-range views. Due to their unnatural appearance, these largely geometric, mostly flat elements also contrast with the surrounding natural landforms.

There are no large watercourses located within the project study area, although the Bierspruit and several of its tributaries, which drain the project area, traverse the area directly north of the site. Even the larger rivers and streams in the region are not particularly wide, and hence watercourses are identified in the landscape by taller and denser vegetation growing along them rather than by visible water.

The largest surface water resource near the project area is the Bierspruit dam, located north-east of the proposed mine. The dam and the Bierspruit itself were both dry during the site visit, with no surface water in evidence, despite recent rain. A number of smaller pollution control and return water dams also occur within the Union mine premises, but these are only visible in short-range views.

The vegetation cover in the study area consists largely of Acacia-dominated veld and has varying levels of visual density, depending on the growth forms and spacing of individual specimens. The appearance of the vegetation cover varies greatly across the study area, depending on the level of disturbance caused by human activities. Relatively large areas of intact natural vegetation still remain in parts of the study area, but they are somewhat homogenous in appearance due to the limited diversity of the woody species component. By contrast, the outcrops and ridges are generally characterised by taller plant species and visual diversity.

Typically, the relatively undisturbed areas along ridges and watercourses have denser, larger trees and shrubs and a higher degree of visual screening, whereas areas disturbed by human settlement, mining and historic agriculture are usually characterised by smaller, more sparsely spaced plants.

Most of the study area retains a rural sense of place, due to the relatively low levels of transformation and limited degree of land use. However, the mine infrastructure at Union and adjacent operations southeast of the site, as well as a quarry located approximately 7 km north of the site, are visually prominent and intrusive in terms of the surrounding visual context. Furthermore, large areas have been degraded by agriculture and linear infrastructure, which includes high mast power lines and asphalt and gravel roads that traverse the region.

The local topography is slightly sloping to flat, punctuated by several isolated ridges and outcrops, with more prominent landforms located further north of the study area

Artificial landforms such as tailings dams and slag dumps at the adjacent Anglo American Union mine dominate short range views

Watercourses are not visually prominent and are usually identifiable over distance by the taller and denser vegetation growing along them

The study area vegetation consists largely of Acacia dominated veld of varying visual density, which has in places been disturbed by human settlement, mining and agriculture

Large sections of the study area have a rural character, with low levels of development and transformation

The existing Union mine constitutes the most prominent human element within the study area

Figure 4-33: Visual character of the project area

4.11.2 Value of the Visual Resource

The visual resource value of a landscape is determined by its aesthetic appeal and visual quality, which in turn depend on the manner in which combinations of its components appeal to the senses. Studies in perceptual psychology have shown human preferences for landscapes with a higher visual complexity, rather than homogeneous ones. Landscape quality and aesthetic appeal increase when:

Prominent topographical features and rugged horizon lines exist;

Water bodies such as streams or dams are present;

Untransformed indigenous vegetation cover dominates; and

Visible evidence of human activity is limited and confined to land uses that are not visually intrusive.

Table 4-20 summarises criteria used for visual resource assessment. The assessment combines visual quality attributes (views, sense of place and aesthetic appeal) with landscape character and gives the landscape a high, moderate or low visual resource value, within the context of its location.

Table 4-20: Visual resource value criteria

Visual Resource Value	Criteria
High	Pristine or near-pristine condition, little to no visible human intervention, characterised by highly scenic or attractive features that combine to provide an experience of unity, richness and harmony. These are landscapes that may be sensitive to change and particularly worthy of conservation.
Moderate	Partially transformed or disturbed landscape, with noticeable presence of incongruous elements. Human intervention visible but does not dominate the view. Scenic appeal partially compromised. These landscapes are less important to conserve, but may include certain areas or features worthy of conservation.
Low	Extensively transformed or disturbed landscape, with visual prominence of widely disparate or incongruous land uses and activities. Human intervention dominates available views. Scenic appeal greatly compromised, with few, if any, valued features remaining. Scope for positive enhancement.

Based on the findings of the baseline assessment and the above criteria, the visual resource value of the study area is summarised as follows:

Topography - The natural topographical features that contrast with the predominantly flat topography make a positive contribution to the visual resource value of the study area, but the large tailings dams and other mining landforms detract from the visual resource value, due to their unnatural, geometric shapes and contrasting colours;

Hydrology - The Bierspruit and Bierspruit dam are the only potentially significant hydrological features in the study area, but they appear to be dry most of the time. The mine impoundments are artificial in appearance and located within an extensively transformed environment. Hence, the surface water bodies in the study area do not contribute significantly to its visual resource value;

Vegetation cover - Due to their relatively unvaried appearance, most of the remaining semi-natural areas contribute only moderately to the visual resource value of the study area. The denser, more varied vegetation cover along the watercourses, ridges and outcrops have a higher level of visual resource value. The vegetation cover on the mining, settlement and old agricultural areas are of limited to no visual resource value.

When the results of the visual resource value assessment are mapped (Figure 4-34), it is evident that most of the areas with a high visual resource value are located several kilometres north, northwest and east of the proposed open pit mining site. There are large areas of moderate value directly north of the site. The areas surrounding the site and especially south and east of the site are of low visual resource value. The site itself has only low to moderate visual resource value and the proposed mining activity is not located within or adjacent to areas of high visual resource value.

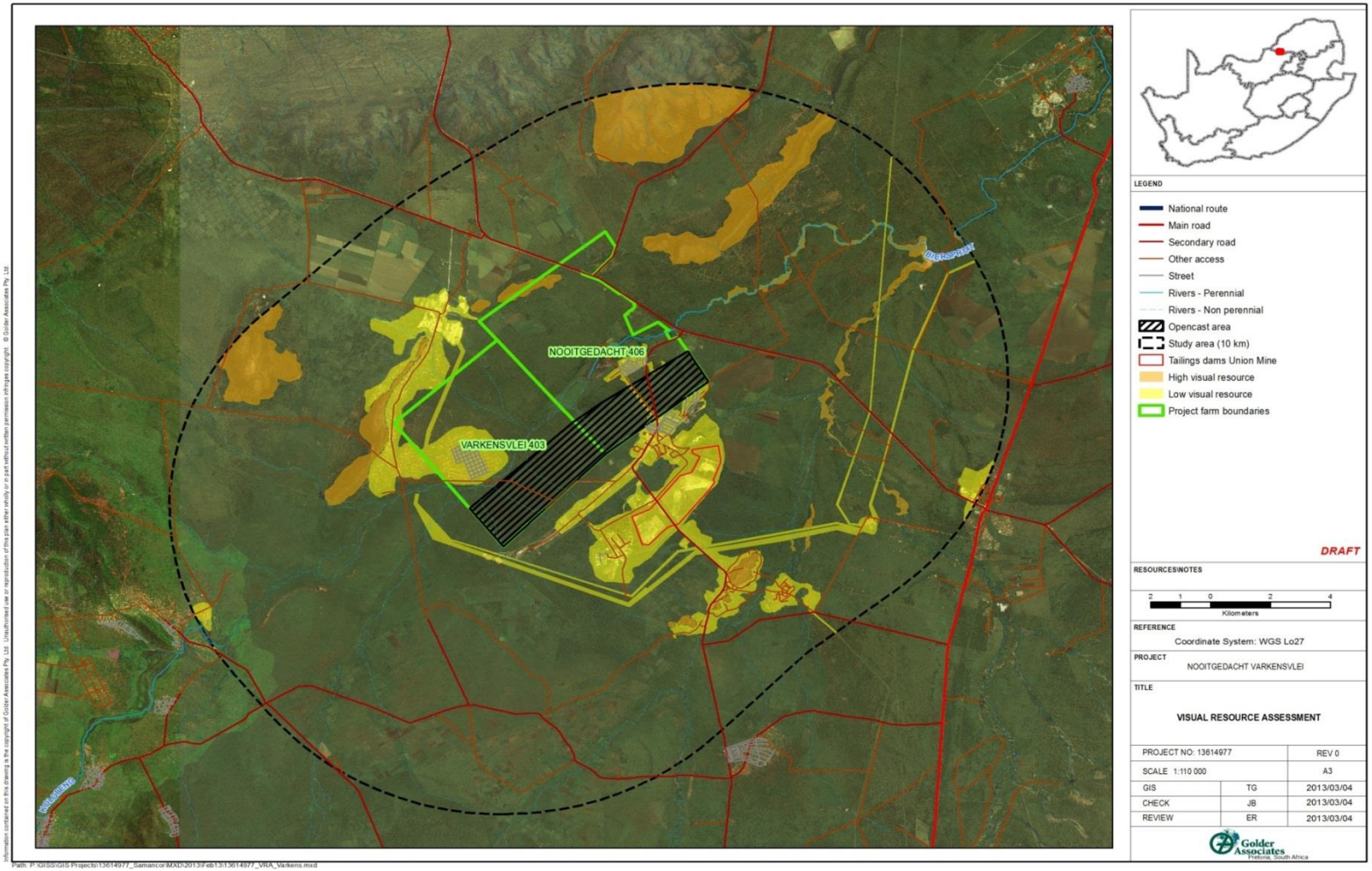


Figure 4-34: Visual resource value of the project area

4.12 Sites of Archaeological and Cultural Significance

A phase I heritage impact assessment (HIA) study, as required in terms of Section 38 of the National Heritage Resources Act (Act 25 of 1999), was undertaken on the portions of the farm Varkensvlei 403 KQ where Samancor Chrome has applied for a mining right (Pistorius, March 2013).

4.12.1 Methodology

The study encompassed a survey of available literature, followed by a field survey and interviewing people living in the area. The largest part of the project area is covered with agricultural fields and areas that have been subjected to agriculture in the past. These areas were surveyed from a vehicle. Relatively undisturbed bush and some cleared surface areas were surveyed on foot. Points along the survey routes, as recorded on a GPS device, are shown in Figure 4-35.

Figure 4-35: Heritage survey routes on Varkensvlei and surrounding areas

4.12.2 Historical background

The Limpopo and North-West Provinces are rich in heritage resources that include remains dating from the pre-historical and from the historical (or colonial) periods of South Africa. Pre-historical and historical remains in the Limpopo and North-West Provinces constitute a record of the heritage of most groups living in South Africa today. The project area is surrounded by cultural landscapes of significance, some of which have been researched and documented in the past.

These include the Thabazimbi-Rooiberg area further to the north, which is known for the presence of early tin mines (possibly Late Iron Age) as well as for Late Iron Age settlements which were occupied by specialist metal working groups who occupied the mountain range near Thabazimbi. The Pilanesberg region to the south is where the Kgatla Kgafêla established a sphere of influence at capitals such as Moruleng and Boretele along the north-eastern perimeter of the Pilanesberg as early as the seventeenth century. Descendants of the original Kgatla Kgafêla clan who contributed to the historical and cultural significance of this group still occupy the larger area today.

Madibeng and Rustenburg further to the south-west and south-east were both home to various pre-historical and historical Tswana clans such as the Kwena and Kgatla. Some of these settlements were occupied by Mzilikazi's Ndebele.

Ramakoka, east of the Project Area, today is still home to the Kwena Phalane, a pre-historical and historical Tswana clan whose origins, earlier abodes and settlement history have not yet received any thorough attention from researchers. Members of the Kwena Phalane community are prominent occupants of the larger project area, but the project area itself is not known to contain a diverse range of heritage resources. The most common heritage resources in this region are the presence of Late Iron Age stone walled sites which occur near randjes and kopjes in the larger area.

The earliest Iron Age settlers who moved into the larger project area were Late Iron Age Sotho-speaking groups who belonged to the Moloko tradition. These Kgatla and Kwena communities are associated with stone walled settlements which date from AD1600 although earlier settlements, devoid of any stone walls, probably also occurred in the region. Moloko sites have been recorded in Rooiberg, north of the project area, at the Pilanesberg, in Madibeng and in Rustenburg further to the south where these sites are associated with kopjes and randjes. Iron Age settlements occur in the Ben Alberts Nature Reserve and elsewhere in the Thabazimbi district.

It is considered to be highly unlikely that the project area itself was occupied by Early Iron Age people from the Limpopo, Mpumalanga, KwaZulu-Natal and North-West Provinces of South Africa during the 3rd to 9th centuries AD.

4.12.3 Findings of the heritage study

The Phase I HIA study did not find any archaeological or pre-historical remains of the types and ranges of heritage resources outlined in Section 3 of the National Heritage Resources Act (No 25 of 1999) within the project area.

There is a large formal graveyard with hundreds of graves near the southern perimeter of the village of Mantserre, the location of which relative to the proposed mining area on Varkensvlei is shown in Figure 2-2. Many of the graves are older than sixty years. The coordinates of the graveyard are 24° 56' 54.2'' S 27° 06 11.3'' E. It has a very ***high*** significance as a heritage resource, but it is located well outside of the 600 metre blast radius of the proposed opencast mine and is unlikely to be affected by the mining activities. The graveyard is shown in Figure 4-36.

Figure 4-36: Formal graveyard located in the village of Mantserre

4.13 Socio-economic

4.13.1 Administrative Setting

Varkensvlei falls within the Bojanala District Municipality (DM) and the Moses Kotane Local Municipality (LM) in the Northwest Province.

The Moses Kotane LM has a total population of 242,554, with an average household size of 3.2, (see Table 4-21).

Table 4-21: Population and Household Size

	Population	Number of Households	Average Household Size
Northwest Province	3,509,953	1,062,000	3.3
Bojanala DM	1,507,505	501,696	3.0
Moses Kotane LM	242,554	75,193	3.2
Total	5,260,012	1,638,889	3.1

Land use in the District Municipalities surrounding the proposed project area is characterized by crop production and small scale farming as well as large scale mining operations. There are supporting economic contributions from tourist activities from the Pilanesberg National Park and Sun City in the Bojanala DM.

The proposed project is located approximately 14 km west from Northam and 80 km north of Rustenburg, with the nearby villages of Mantserre, Kraalhoek and Kameelhoek located within about 1.5 km from the proposed project area. The operational activities of the proposed opencast operations include a new opencast area on Varkensvlei 403 KQ (on portion 1, portion 2 and the Remaining Extent of the farm). The land is owned by the Bakgatlabakgafela traditional authority under Chief JM Pilane.

The settlement of Mantserre on Varkensvlei farm is within the mine lease application and as such this community may be the most affected. According to an aerial imagery count, Mantserre is host to an estimated 1,081 households. Two neighbouring communities, namely Kraalhoek (approximately 1 km from the farm boundary) and Mopyane (approximately 500 metres - 1 km from the farm boundary) are located adjacent to the proposed project site.

4.13.2 Economic Activities

Mining accounts for 30.4% of provincial gross domestic product (PGDP) of the North West Province, employs more than 60 000 people and makes up 15.5% of the mining industry's contribution to South Africa's gross domestic product[1]. The Bojanala DM includes the main economic sectors of mining, trading, manufacturing and financial and community services.

4.13.3 Employment Levels

As illustrated in Figure 4-37, the Moses Kotane LM has a 30% employment rate, which is lower than the overall employment rate for North West Province.

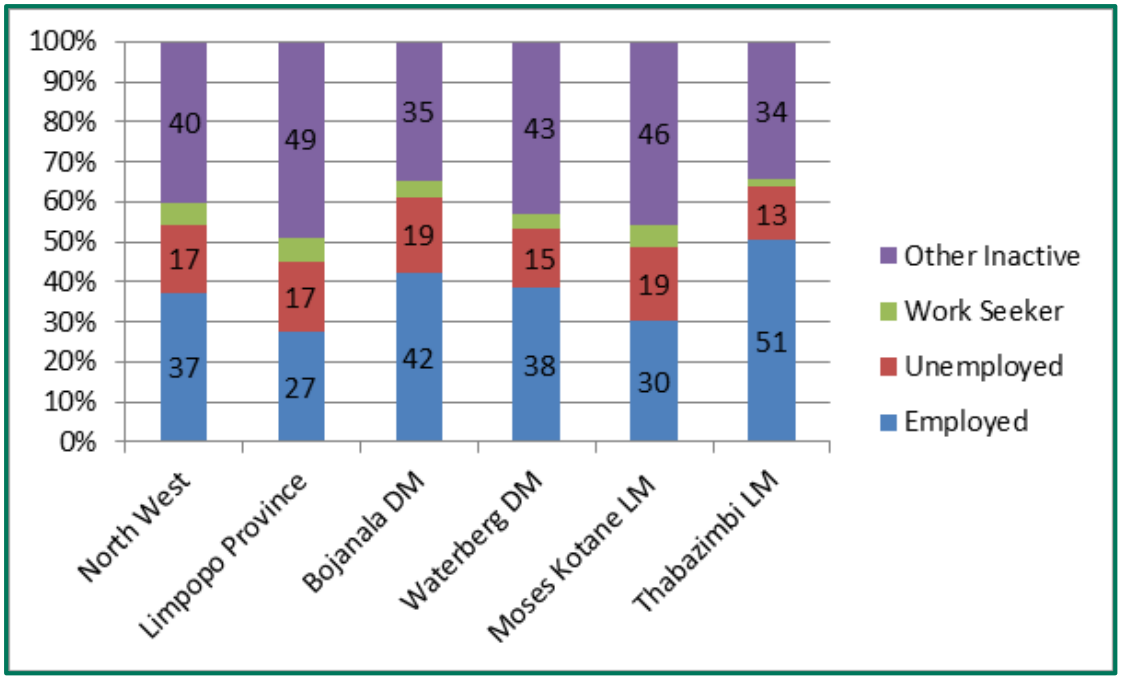


Figure 4-37: Employment Status (SA Census 2012)

Most of the labour force is employed in the formal sector throughout the LM, DM and Province (see **Table 4-22**).

Table 4-22: Distribution of labour force sectors

Labour Force Sector	North West (%)		Bojanala DM (%)		Moses Kotane LM (%)	
Formal sector	68		71		76	
Informal sector	15		13		13	
Private households	15		13		9	
Unknown	2		2		1	

[1] http://www.northwestbusiness.co.za/pls/cms/ti_secout.secout_prov?p_sid=19&p_site_id=138

Labour Force Sector	North West (%)		Bojanala DM (%)		Moses Kotane LM (%)	
TOTAL	**100**		**100**		**100**	

Source: SA Census 2012

5.0 POTENTIAL IMPACTS AND RISKS IDENTIFIED

The following potential impacts were identified during the scoping phase:

1) **Groundwater**: Abstraction of groundwater to provide safe mining conditions and water for use in the mine and plant will result in a cone of depression (lowering of the groundwater table) around the mine. The use of explosives and spillages of hydrocarbons could cause groundwater pollution. The profile of this cone of depression will change as the mining front advances. The project may be expected to have an impact of ***moderate*** significance on the groundwater regime and groundwater users during the life of the mine;

12) **Surface water**: Runoff from the overburden, waste rock and tailings storage areas could have a high silt load and runoff from the plant and workshop areas could be contaminated with hydrocarbons. Such dirty runoff from the project area could cause surface water pollution in the Bierspruit. Without appropriate mitigation measures, the project could have a ***high*** impact on the surface water regime during the life of the mining operations;

13) **Ecology**: The project will result in the temporary removal of vegetation from the combined footprint area (opencast mine and infrastructure) of about 1285 ha over time. Due to ongoing rehabilitation in accordance with the rollover method of mining (see section 2.5.1), less than half of the aforementioned surface area will be bare at any particular time during the life of the mine. Due to the destruction of their habitat, the current faunal population in the project area will have to relocate until suitable habitat has been restored by the rehabilitation programme. The long term impact is expected to be ***moderate to low;***

14) **Air Quality**: Particulate mobilisation by drilling, blasting, loading, hauling, stockpiling, backfilling and tailings storage has the potential for an impact of ***moderate*** significance on air quality within and in the vicinity of the project area, particularly in the downwind direction. Gaseous emissions due to blasting and the diesel engines on mining vehicles are expected to have an impact of ***low*** significance on air quality.

15) **Noise**: The noise impact could range from ***high to moderate*** significance during the operational life of the mine. The noise from the mining machinery will be audible, but will not exceed the daytime level for urban districts, beyond the 600 m blast zone boundary and at some sensitive areas along the way as the mining front moves along the length of the ore deposit. If opencast mining operations are undertaken during the night time, exceedances of all but the guidelines for industrial districts would be experienced and the noise levels at the nearest sensitive receptors would be objectionable;

16) **Blasting and vibration**: High air blast sound pressure levels of may be expected in some parts of Bierspruit Village, Union Mine Village and Mantserre as the opencast mining operations progress from the north-east to the south-west along the orebody. The duration at any particular receptor will depend on the detailed mining operations at the time. Blasts will have to be designed and monitored with the objective of avoiding any damage from fly rock, air blast and ground vibration at these or any other identified potentially vulnerable receptors. Some sensitive receptors may experience impacts of ***high*** significance. Vibration levels experienced at surface from underground blasting are expected to be well below the levels at which structural damage could occur;

17) **Visual**; Due to the flat terrain and the screening vegetation on adjacent areas, the opencast mine and infrastructure will have a ***high*** visual impact at close range only;

18) **Cultural and heritage**; The large formal cemetery at Mantserre is located well outside of the 600 metre blast radius of the proposed opencast mine and is unlikely to be affected by the mining activities.

Unless unknown graves are unearthed during construction or mining, the expected impact on cultural and heritage resources is likely to be of ***negligible*** significance; and

19) **Socio-economics**: The mine will provide employment for about 16 skilled and 106 semi-skilled and unskilled workers and the wage bill will be about R31 million per annum. Given the levels of unemployment in the area, the impact is expected to be of ***moderate*** significance.

6.0 IMPACT ASSESSMENT PROCESS AND METHODOLOGY

The overall process and methodology that was followed during the EIA was based on best practice guidelines and the requirements of South African legislation (specifically NEMA and MPRDA).

The scoping phase included the following activities:

- Gap Analysis of existing information against the Project compliance criteria;
- Project Definition and Analysis of Alternatives – inclusive of data review, red flag and constraints mapping, input to alternatives analysis and preferred layout planning and project description;
- Screening (legal and process review) – review of all applicable compliance criteria;
- Environmental and Social Baseline Studies – carrying out monitoring, data collection and fieldwork to determine the baseline conditions of the environment that could be affected by the Project;
- Stakeholder Engagement – was undertaken throughout the Scoping process to record issues and comments received from the public. These issues and comments are integrated into the process and will be considered in the impact assessment phase of the EIA.
- Scoping (identification of key issues and development of plan of study for carrying out the impact assessment). During August/September 2016 the Scoping Report was presented to the public and the South African Government departments dealing with mining and environmental authorisations for comment. The final Scoping Report was submitted to the DMR on 23 September 2016 and it was accepted by the DMR on 12 January 2017.

The following activities were undertaken during the impact assessment phase of the EIA:

- Impact Assessment – evaluation of potential impacts and benefits of the Project utilising qualitative and quantitative evaluation on environmental aspects and issues identified during the scoping phase;
- Environmental and Social Management Systems Development – establishment of a system for the management of environmental, social impacts supported by action plans;
- Preparation of an EIA/EMPr report – documenting all processes and presenting the findings of the impact assessment. The EIA/EMPr report was made available to the public and the relevant South African Government departments for comment from 3 February until 6 March 2017. The final EIA/EMPr report will be submitted to the DMR on or before 13 March 2017 for a decision on whether the project may proceed and if so under what conditions; and
- Stakeholder Engagement – will continue throughout the remainder of the EIA process to record issues and comments received from interested and affected parties. All issues and comments will be integrated into the process and considered during the EIA.

The overarching principles that guide the EIA include:

- Sustainability – development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs;
- Mitigation hierarchy – The mitigation hierarchy describes a step-wise approach that illustrates the preferred approach to mitigating adverse impacts as follows (the governing principle is to achieve no net loss and preferably a net positive impact on people and the environment as a result of the Project):

1) The preferred mitigation measure is **avoidance;**
2) Then **minimisation;**
3) Then **rehabilitation** or **restoration**; and
4) Finally **offsetting** residual, unavoidable impacts.

- Duty of care towards the environment and affected people.

The assessment of the impacts of the proposed activities will be conducted within the context provided by these principles and objectives.

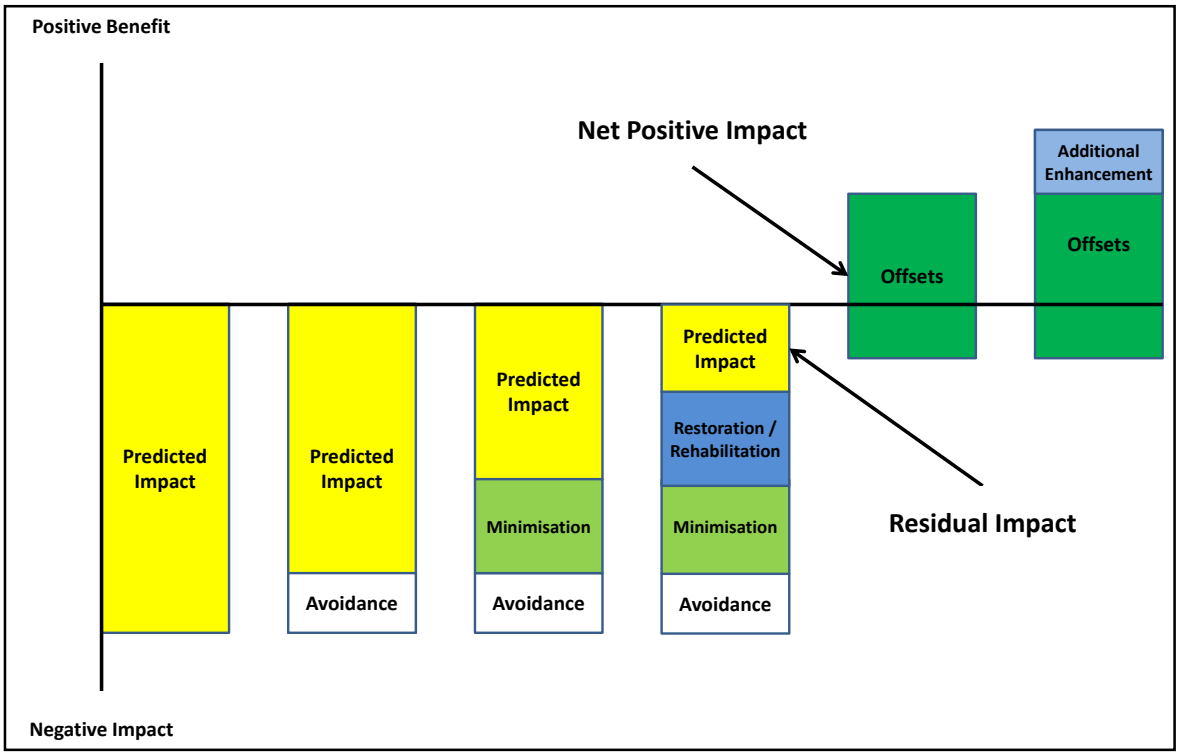


Figure 6-1: Mitigation Hierarchy Adapted from BBOP, 2009

6.1 Scoping Methodology

The methodology specifically adopted for the scoping phase included the following:

- Stakeholder consultation as described in section 3.7.2;
- Review of existing data;
- Fieldwork by the EIA specialist team to obtain additional baseline data;
- Workshops with the specialist team to identify key impacts and issues and to outline the plan of study; and
- Compiling the Scoping report.

6.2 Impact Assessment Methodology

The specialist studies that were undertaken over the project area appear in APPENDIX G to this report. The significance of each identified impact was determined using the approach outlined below (terminology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998). This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Scale / extent of impact	Magnitude (severity) of impact

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

Probability	Duration
5 - Definite/don't know	5 - Permanent
4 - Highly probable	4 - Long-term
3 - Medium probability	3 - Medium-term (8-15 years)
2 - Low probability	2 - Short-term (0-7 years) (impact ceases after the operational life of the activity)
1 - Improbable	1 – Immediate
0 - None	
SCALE	**MAGNITUDE**
5 - International	10 - Very high/don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	

Once these factors are ranked for each impact, the significance of the two aspects, occurrence and severity, is assessed using the following formula:

SP (significance points) = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). The impact significance will then be rated as follows:

SP >75	Indicates high environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30 – 75	Indicates moderate environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP <30	Indicates low environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.
+	Positive impact	An impact that constitutes an improvement over pre-project conditions

6.3 Assessment of potential impacts and risks

The findings of the specialist studies, which guided the selection of the preferred site and final site layout, are presented in section 7.0 of this EIA/EMPr report. The complete specialist reports are attached as APPENDIX G. The specialists' findings were used to assess the project's impacts and risks during its complete life cycle, from the construction phase, through the operational phase, to the closure and rehabilitation phase.

6.4 Positive and negative impacts of initial site layout and alternatives

All infrastructure site layouts must avoid the sterilisation of the opencast minable chrome ore reserves. They must therefore be located adjacent to, but not on the footprint of such reserves. The position of the infrastructure site as shown on Figure 2-4 on the north-western side of the proposed chrome ore mining area was chosen in preference to the south-eastern side, where it would be closer to a residential area associated with Anglo Platinum's mining complex. There are no residents within 1 500 metres of the preferred site.

See section 6.7 for a discussion on the alternative layouts and their positive and negative impacts.

6.5 Possible mitigation measures and levels of risk

The issues discussed with I&APs during the scoping process were as follows:

1) **Air Quality:** The project's main potential effect on air quality will be particulate mobilisation by drilling, blasting, loading, hauling, dumping, stockpiling, and crushing of the chrome ore and by tailings storage. Wet suppression will be employed in the mine, on haul roads at stockpiles and on the tailings storage facility. The objective will be to maintain a ***low*** risk of exceeding national standards for PM_{10} concentrations and rates of dust fall.

2) **Soil, Land Capability and Land Use:** The risk of causing a significant degradation of topsoil quality and associated loss of land capability after rehabilitation will be minimised to a ***low*** level by:

3) Taking care to strip and stockpile topsoil, subsoil and overburden layers selectively and to prevent mixing of especially topsoil with any of the other layers;

4) Backfilling the opencast void with discard material, overburden, subsoil and topsoil, in that order;

5) Analysing the topsoil, fertilising it appropriately and re-vegetating it with locally indigenous flora to re-establish the pre-project land use, which was natural veld suitable for grazing.

6) **Ecology:** Successful restoration of the land capability will encourage natural re-colonisation of the rehabilitated area by mammals, birds, reptiles and insects, but it may require re-introduction of some species over time in order to reduce the risk of a low-functioning or unbalanced ecosystem to a ***low*** level.

7) **Surface water:** There are no perennial watercourses within the project area. The Bierspruit and Bierspruit Dam are located about 1 300 metres to the north of the proposed mining operations and the risk of contaminated runoff from the project area reaching the Bierspruit is ***moderate***. It will be reduced to a ***low*** level by constructing clean water diversion berms to divert uncontaminated runoff around potential sources of contamination and collection channels to transport contaminated water to a pollution control dam, as required by Regulation 704 under the National Water Act.

8) **Groundwater levels, availability and quality:** The abstraction of groundwater *via* boreholes for mine dewatering purposes will be aimed at controlling, but not eliminating, seepage into the opencast and underground workings. Safe and acceptable working conditions will be maintained by pumping out the seepage. This approach will minimise the cone of depression around the mine, but it will increase the risk of flooding if undetected pockets of groundwater are encountered. Chrome ore in this area is generally not acid forming and the risk of significant pollution of groundwater as a result of the project is considered to be ***low***. Mitigation measures such as the following could be required.

    a. Geochemical investigation on representative ore and waste rock samples, alternatively regular pH monitoring of runoff from waste rock and ore stockpiles;

    b. Monthly monitoring of monitoring boreholes with regard to water levels and water quality;

    c. Placing drip trays under vehicles when parked;

    d. Servicing vehicles in a workshop, not in the field;

e. If in-field refuelling is done from a tanker, doing it in a designated dirty area and keeping a spill kit and clean-up team available on site; and

f. Providing environmental awareness training for workers on site

9) **Noise:** Noise levels along the length of the opencast mine will change as the mining front advances to within about 600 metres of the village of Mantserre. There are no sensitive receptors within 1 500 metres of the proposed location of the ore beneficiation plant and supporting infrastructure The risk of people being exposed to unacceptable levels of noise is therefore ***low.*** Off-site noise levels will be mitigated by:

g. Selection of mining vehicles and ore beneficiation equipment for lower sound levels;

h. Regular maintenance of sound attenuation equipment;

i. Locating topsoil and overburden stockpiles to act as acoustic barriers between the opencast mine and receptors where practical; and

j. Enclosing noisy equipment, such as crushers, in buildings clad with sound-absorbing materials where necessary.

10) **Blasting and vibration:** Blasts will be monitored and each blast will be designed to avoid exceedances of guidelines for air blast, fly rock and ground vibration. Vibration levels experienced depend on distance from the blast, the energy density of the blast and the characteristics of rock formations between the blast and the observer. The ground vibration levels will be controlled by monitoring each blast and taking the results into account when designing subsequent blasts. Residential buildings of sound construction can safely withstand a peak particle velocity (PPV) of 50 mm/s. Poorly constructed buildings should not be subjected to PPVs of more than 10 mm/s. There are no residential areas on or in close proximity to the proposed mining area, but the blasts will be designed for off-site PPVs < 50 mm/s. Underground blasts will not result in any air blast effects on the surface.

The risk of causing injuries or vehicle damage by fly rock will be minimised by closing off sections of public road within 600 metres of a blast immediately prior to each blast.

11) **Visual aspects:** The terrain is quite flat and not much of the opencast mine will be visible from the local roads. The haul trucks traveling over the haul roads along the perimeter of the mine to and from the ore beneficiation plant will be visible from the local public roads. Judicious placement of topsoil and overburden stockpiles can screen the mine from certain viewshed areas, but the stockpiles would also be visually prominent and potentially intrusive, unless they were vegetated to mitigate the visual impact. The main visibility risk is inadequate dust suppression, when dust plumes will be highly visible above the mine from distances of up to 7 km. Diligent application of wet suppression or chemical binders on unpaved roads would reduce this risk to a ***low*** level.

12) **Cultural and Heritage aspects:** The large formal cemetery at Mantserre is located well outside of the 600 metre blast radius of the proposed opencast mine and is unlikely to be affected by the mining activities. Unless unknown graves are unearthed during construction or mining, the expected impact on cultural and heritage resources is likely to be of ***negligible*** significance; and

13) **Socio-economics**: The mine will provide employment for about 16 skilled and 106 semi-skilled and unskilled workers and the wage bill will be about R31 million per annum. Given the levels of unemployment in the area, the impact is expected to be of ***moderate*** significance.

6.6 Motivation where no alternative sites were considered

Not applicable. See section 3.7.1 and section 6.7 below.

6.7 Site selection matrix and final site layout plan

Alternative site layouts to the one illustrated in Figure 2-4 were evaluated on the basis of the following criteria:

- Sterilisation of chrome ore reserves. If infrastructure is placed on an area that contains ore that can be mined by opencast methods, Samancor Chrome will be unable to mine the reserves underneath the footprint of the infrastructure;
- Size of area available for infrastructure. At least 26 ha is needed to accommodate the run-of-mine (RoM) ore stockpile, product stockpile, ore beneficiation plant, workshop, load-out system, weighbridge, access road etc.;
- Environmental features. The aim is to minimise the environmental impacts; and
- Traffic considerations for transport of equipment and personnel to the mine and plant and for transporting chrome ore from the mine to the nearest main road connecting to Northam.

6.7.1 Mine layout

The layouts of the proposed opencast and underground mining areas and the surface infrastructure as shown on Figure 2-4, Figure 2-5 and Figure 2-6 are dictated by the mining costs, which are in turn determined by the thickness of the overburden, the thickness and grades of the chrome ore seams the required environmental management measures and, to a lesser extent, by the mining equipment chosen.

Opencast mining will be done to a depth of about 50 metres. Opencast mining will commence in the north-western part of Varkensvlei and progress towards the south-east. After about seven years, a decline shaft will be constructed from the open pit and underground mining will commence.

The in-pit haul roads will move around as the pit geometry develops, but the locations of the exterior haul roads are dictated by the perimeter of the final open pit shown on Figure 2-4. Topsoil and overburden berms will be constructed between the perimeter of the open pit and adjacent public roads.

6.7.2 Site Location and Layout

Alternatives to the preferred site and layout shown on Figure 2-4 included:

- A site on the northern side of the opencast mine closer to Mantserre Village;
- A site on the southern side of the opencast mine, directly opposite the preferred site; and
- A site on the southern side of the opencast mine, directly opposite Mantserre Village

Table 6-1: Site and layout selection matrix

Site	Available area	Environmental	Transport considerations	Cost of Access road	Total score
Preferred site	8	8	8	3	27
Closer to Mantserre Village	3	2	7	2	14
Opposite preferred site	3	2	2	7	14
Opposite Mantserre Village	5	3	2	7	17

Transport to and from a site on the southern side of the opencast mine would need to pass through the Swartklip mine village, which would impact negatively on current road users and residents in the village, but Samancor Chrome would incur lower cost of road construction.

6.8 Motivation for not considering alternative sites

Not applicable. Alternative sites were considered as discussed in section 6.7.2 above.

6.9 Statement motivating the preferred site and layout

The site and layout shown on Figure 2-4 and Figure 2-6 represent the best overall option as determined *via* the site selection and layout matrix – see Table 6-1.

7.0 ENVIRONMENTAL IMPACT ASSESSMENT

The proposed mining of the chromite ore reserves on portion 1, portion 2 and Remaining Extent of the farm Varkensvlei could potentially impact on some biophysical and socio-economic aspects of the local environment.

One of the main purposes of the EIA process is to understand the significance of these potential impacts and to determine to what extent they can be minimised or mitigated. Based on experience with and past studies on similar mining operations, supported by site-specific specialist studies, the impacts on soils, surface water, groundwater, air quality, the ecology and the local socio-economic fabric can be predicted and appropriate mitigation measures can be formulated.

The EIA process for this project has been designed to comply with the requirements of the MPRDA and the EIA Regulations that commenced on 8 December 2014 (See section 3.2). Cognisance has also been taken of the following key principles contained in the National Environmental Management Act (Act 107 of 1998) (NEMA), which is South Africa's framework environmental legislation:

- Sustainability – development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs;
- Mitigation hierarchy – avoidance of environmental impact, or where this is not possible, minimising the impact and remediating the impact; and
- The duty of care of developers towards the environment as embodied in the NEMA (section 28) and the NWA (section 20).

The assessment of the impacts of Samancor Chrome's proposed mining operations on Varkensvlei was conducted in accordance with these principles.

Based on the findings of the EIA, a comprehensive Environmental Management Programme (EMPr) has been developed to control and minimise the impacts during construction, operation and decommissioning of the proposed mine – see sections 10.0 to 13.0 in Part B of this report.

7.1 Project Phases and Activities

The environmental impacts of the project were assessed for the:

- Construction phase;
- Operational phase; and
- Closure and rehabilitation phase.

Potential cumulative impacts were also identified and assessed for each component, where applicable.

7.1.1 Construction

The **Construction Phase** marks the beginning of physical changes to the site. During this phase, the following activities will take place:

- Surveying and pegging out of the construction areas for the ore processing plant and infrastructure, such as diesel storage, workshops, office and ablution facilities, access routes, power supply, diversion berms, dirty water collection routes and pollution control dam;
- Clearing of vegetation where necessary;
- Construction of upslope berms to divert clean runoff around the site;
- Construction of the "dirty water" collection channels;
- Excavation and shaping of the pollution control dam;

- Temporary stockpiling of excavated topsoil and spoil;
- Construction of facilities for production, machine maintenance and administration;
- Demarcation of the area to be mined and the storage areas for topsoil, overburden and waste rock; and
- Construction of the waste rock dump and tailings storage facility (TSF).

It is anticipated that the construction phase will take approximately 12 to 18 months to complete.

7.1.2 Operation

During the **Operational Phase**, the project components will be commissioned and mining, ore processing and product delivery will commence. Activities will comprise:

- Clearing of vegetation, followed by stripping and stockpiling of topsoil and overburden, ahead of the opencast mining front;
- Drilling and blasting;
- Opencast mining of the LG6 and LG6A chromitite seams;
- Developing twin declines from a portal in the highwall of the opencast mine to access the deeper chrome ore reserves;
- Underground mining of the LG6 chromitite seam;
- Hauling the ore to the processing plant;
- Crushing, screening, and processing the run-of-mine ore by means of spiral separators and dense media cyclones to separate the commercial grade chrome-containing material as product from the waste rock and tailings;
- Transporting the product off site;
- Continuous backfilling of the mined out opencast voids with waste rock, overburden and topsoil, followed by re-vegetation; and
- Maintenance of mining equipment and infrastructure.

The operational phase will comprise about 7 years of opencast mining, followed by more than 20 years of underground mining.

7.1.3 Closure and rehabilitation

The activities during the **Closure and rehabilitation Phase** will include:

- Dismantling of the ore processing plant and removal of all metal structures;
- Demolition of buildings and other infrastructure and disposal of the rubble;
- Sealing off the access to the underground mining area in accordance with the DMR’s requirements;
- Backfilling the last opencast area with waste rock, overburden and stored topsoil, shaping and re-vegetating with locally indigenous plant species;
- Shaping the remaining exposed surface of the TSF to be free-draining and covering it with an evapo-transpirative cover of subsoil, topsoil and locally indigenous grass to minimise the potential for water ingress that could lead to the leaching of contaminants from the TSF;
- Emptying and backfilling of the pollution control dam and “dirty” water collection channels;
- Ripping and shaping all compacted areas to be free draining, followed by re-vegetation; and

- Monitoring until vegetation has re-established properly and a lack of groundwater pollution attributable to the mining project has been demonstrated.

7.2 Geology

7.2.1 Construction

Construction associated with the proposed mining activities will disturb only the near-surface geology in a relatively small area and the impact is assessed as being of ***low (SP = 25)*** significance. No mitigation is possible during the construction stage, but careful separation of topsoil and subsoil during stripping and stockpiling is necessary to effect mitigation during the closure and rehabilitation phase.

7.2.2 Operation

The LG6 and LG6A chromitite seams will be removed by the mining operations, resulting in a permanent impact of ***high (SP = 80)*** significance on the geology of the project area. Application of the rollover method of opencast mining as described in section 2.5.1, will place the waste rock and overburden back in more or less their original positions and reduce the geological impact to one of ***moderate (SP = 70)*** significance.

7.2.3 Closure and rehabilitation

The closure and rehabilitation phase will have ***no impact*** on the geology of the project area ***(SP = 0).***

7.3 Air Quality

7.3.1 Ambient air quality standards

National standards for ambient air quality were set in terms of the National Environmental Management: Air Quality Act 2004 (Act 39 of 2004) (NEMAQA) by the publication of Government Notice 1210 in Government Gazette no 32816 on 24 December 2009. The relevant standards are shown in Table 7-1 and Table 7-2.

The earthmoving and blasting activities involved in the construction phase will cause particulate mobilisation, leading to an increase in atmospheric PM_{10} and $PM_{2.5}$ concentrations and dust fall at and in the vicinity of the site.

PM_{10} and $PM_{2.5}$, being particulates with an effective aerodynamic diameter of 10 and 2.5 microns respectively, are suspended in the atmosphere and travel past the cilia and mucous membranes in the respiratory tract to enter the lungs, where they can cause adverse health effects.

Table 7-1: National Ambient Air Quality Standards for Particulate Matter (PM10)

Averaging Period	Concentration	Frequency of Exceedence	Compliance Date
24 hours	120µg/m^3	4	Immediate – 31 December 2014
24 hours	75 µg/m^3	4	1 January 2015
1 year	50 µg/m^3	0	Immediate – 31 December 2014
1 year	40 µg/m^3	0	1 January 2015
The reference method for the determination of the suspended particulate matter shall be EN 12341			

Table 7-2: National Ambient Air Quality Standard for Particulate Matter ($PM_{2.5}$)

Averaging Period	Concentration	Frequency of Exceedence	Compliance Date
24 hours	65 µ/m3	4	Immediate – 31 December 2015
24 hours	40 µ/m3	4	1 January 2016 – 31 December 2029
24 hours	25 µ/m3	4	1 January 2030
1 year	25 µ/m3	0	Immediate – 31 December 2015
1 year	20 µ/m3	0	1 January 2016 – 31 December 2029

Averaging Period	Concentration	Frequency of Exceedence	Compliance Date
1 year	15 µ/m3	0	1 January 2030
The reference method for the determination of $PM_{2.5}$ fraction of suspended particulate matter shall be EN14907			

Acceptable dust fall rates In terms of the National Dust Control Regulations (GN R. 827 of 1 November 2013) are presented in Table 7-3. In terms of these regulations, the local Air Quality Officer may prescribe a dust fall monitoring programme, the implementation of dust control measures and continuous ambient air quality monitoring for PM_{10}.

Table 7-3: Acceptable dust fall rates

Restriction Areas	Dust fall rate (D) (mg/m^2/Day, 30-day average)	Permitted frequency of exceeding dust fall rate
RESIDENTIAL AREA	D < 600	Two within a year, not sequential months
NON-RESIDENTIAL AREA	600 < D < 1 200	Two within a year, not sequential months

The method to be used for measuring dust fall rate and the guideline for locating sampling points shall be ASTM D1739: 1970, or equivalent method approved by any internationally recognized body.

It is important to note that people experience dust deposition as a nuisance effect, and that there are no direct human health implications because the dust is not inhaled. Indirect effects on human and animal health may result from the deposition of dust containing toxicants onto edible plants. Heavy dust deposition can have detrimental effects on plants if the leaves are smothered to the extent where transpiration and photosynthesis are affected.

Receptors down-wind of the opencast mine and the TSF may experience increased PM_{10} and $PM_{2.5}$ concentrations and increased dust fall on windy days. See Figure 4-5 to Figure 4-7 for the prevailing seasonal and diurnal wind directions. Due to the prevailing wind directions as shown in Figure 4-5 to Figure 4-7, Samancor Chrome's proposed operations will not affect Bushveld Chrome Resources or Anglo Platinum's Union Mine, but residents in Mantserre Village may experience an increase in particulates unless the recommended mitigation measures are applied.

7.3.2 Construction

The construction activities described in section 7.1.1 will give rise to the mobilisation of particulates (dust and PM_{10}) and emission of exhaust gases from construction vehicles.

Considering the number of vehicles involved in comparison with the existing level of vehicular activity in the area and the relatively short duration of the construction period, the exhaust emissions from the construction vehicles will make a negligible contribution to the ambient air quality and their contribution does not warrant any further consideration.

Mobilisation of particulates will be due to the earthmoving activities (excavation of the basin for the pollution control dam, storm water collection channels and pipeline trenches and the construction of the earthen berms), and entrainment by the wheels of the excavators and loaders and the trucks transporting excavated material on unpaved roads to build the berms. Wind erosion of exposed areas will also make a minor contribution on dry, windy days.

While PM_{10} can travel considerable distances, depending on climatic conditions, the concentration of PM_{10} originating from the relatively small area source representing the construction activities would fall rapidly with distance from the source due to dispersion, and the PM_{10} concentration as a result of these activities is very

unlikely to be exceeded at any public receptor points. Coarser particles will settle as dust within a few metres of the source.

Based on the site characteristics, the nature and duration of the construction work to be undertaken, the ease with which particulate emissions can be controlled, the location of public receptors, and extensive experience on similar construction projects, dispersion modelling for the construction activities was not considered to be necessary, and only a qualitative assessment has been done.

Without mitigation, the air quality impact during the construction phase is rated as being of ***moderate (SP = 55)*** significance.

The following mitigation measures are recommended:

- Wet suppression, applied sparingly, to ensure the absence of visible dust;
- Enforce low vehicle speeds on unpaved roads (< 30 km/h); and
- Vegetate the berm and other surfaces that were laid bare as a result of construction with a locally indigenous grass species where possible.
- Wet suppression is very effective, but for roads chemical binders such as Dustex or Dust-A-Side may also be used.

Application of appropriate mitigation measures would reduce the impact to one of ***low (SP = 12)*** significance.

7.3.3 Operation

The operational activities described in section 7.1.2 will result in the mobilisation of particulates (dust and PM_{10}) and the emission of exhaust gases from mining and road transport vehicles.

Considering the number of vehicles involved in comparison with the existing level of vehicular activity in the area, the exhaust emissions will make a negligible contribution to the ambient air quality in the area.

Mobilisation of particulates will be due to blasting, ore loading and haulage, crushing and screening, entrainment by the wheels of the trucks transporting product from the site and the continuous backfilling and rehabilitation activities. Wind erosion of exposed areas will also make a minor contribution on dry, windy days.

Based on the site characteristics, the nature of the operations, the ease with which particulate emissions can be controlled, the location of public receptors, and extensive experience on similar mining projects, dispersion modelling was not considered to be necessary, and only a qualitative assessment has been done.

Without mitigation, the potential air quality impact during the operational phase is rated as being of ***high (SP = 75)*** significance.

The following mitigation measures are recommended:

- Wet suppression, applied sparingly, to ensure the absence of visible dust;
- Enforcement of low vehicle speeds on unpaved areas (< 30 km/h);
- Vegetate the backfilled areas and other bare surfaces with a locally indigenous grass species as soon as possible;
- Measurement of dust fall by means of dust fall collection buckets as per the prescribed method and

Application of the above mitigation measures may be expected to reduce the impact to one of ***moderate (SP = 30)*** significance.

7.3.4 Closure and rehabilitation

The closure and rehabilitation activities described in section 7.1.3 will result in the mobilisation of particulates (dust and PM_{10}) and the emission of exhaust gases from vehicles.

Considering the number of vehicles involved in comparison with the existing level of vehicular activity in the area, the exhaust emissions will make a negligible contribution to the ambient air quality in the area.

Particulate mobilisation can be caused by the demolition of buildings and handling of the rubble, backfilling of the storm water dam and "dirty" water collection channels and ripping and shaping of compacted areas.

Without mitigation, the potential air quality impact during the operational phase is rated as being of ***moderate (SP = 55)*** significance, which can be reduced to one of ***low (SP = 24)*** significance by implementation of the following mitigation measures:

- Wet suppression, applied sparingly, to ensure the absence of visible dust;
- Enforcement of low vehicle speeds on unpaved areas (< 30 km/h);
- Vegetation of bare surfaces with a locally indigenous grass species as soon as possible;
- Measurement of dust fall by means of dust fall collection as per the prescribed method until vegetation cover is well established.

7.4 Topography

7.4.1 Construction

Excavation of the dirty water collection channels and the basin of the storm water control dam and construction of the diversion berm, office and workshops will result in topographical changes of ***moderate (SP = 40)*** significance, which cannot be mitigated.

7.4.2 Operation

Opencast mining usually results in permanent topographical changes of ***high (SP = 85)*** significance by leaving behind large mining voids and stockpiles of overburden and waste rock. The rollover mining method, by continuous backfilling and rehabilitation, will result in much smaller temporary topographical changes over the life of the mine, thereby reducing the impact to one of ***moderate (SP = 45)*** significance.

7.4.3 Closure and rehabilitation

When the last section of the opencast void has been backfilled with the last of the stockpiled overburden and covered with topsoil, the surface of the opencast site will be restored to its original topography, resulting in ***no impact (SP = 0).*** Underground mining could affect the surface topography if subsidence occurs after extraction of the LG6 chromitite seam. The degree of subsidence, if any, would depend on the dimensions of the void, its depth below the surface, supporting structures left behind and the characteristics of the overlying strata. Samancor intends undertaking the underground mining operations in a manner designed to avoid subsidence.

7.5 Soil, Land Use and Land Capability

7.5.1 Construction

The construction activities described in section 7.1.1 could lead to loss of topsoil by wind and surface runoff, mixing of topsoil with subsoil and contamination of topsoil by spillages of cement, fuel and lubricants, resulting in an impact of ***moderate (SP = 55)*** significance.

The following mitigation measures are recommended to reduce the impact to one of ***moderate (SP = 36)*** significance:

- Avoid mixing topsoil with subsoil, taking into account that the effective depth of the Avalon, Clovelly and Bainsvlei soils exceeds 300mm, inclusive of the *Orthic A and Yellow & Red Brown Apedalic B – Horizons*, but it is less than 300mm for the Mispah and Rensburg soils;
- Stockpile topsoil and subsoil separately;
- The stockpiles should not exceed 3 metres in height and their side slopes should not exceed 25°;

- As soon as the diversion berms have been constructed, topsoil should be spread evenly over their entire surfaces, fertilised and seeded with a mixture of hardy, locally indigenous grasses;
- Drip trays should be placed under vehicles that are parked on unpaved areas for more than 3 hours;
- Mixing of cement and concrete should take place in appropriate equipment or on mortar boards and not on open ground; and
- Spillages of hydrocarbons and/or cement should be cleaned up immediately and the contaminated soil should be either remediated *in situ* or disposed at an appropriately licensed landfill site.

7.5.2 Operation

Inappropriate stripping and storage of topsoil could result in contamination and/or loss of a substantial quantity of topsoil, representing an impact of ***high (SP = 65)*** significance. The impact can be reduced to one of ***moderate (SP = 36)*** significance by continuous backfilling in accordance with the rollover method of mining described in section 2.5.1, in addition to the mitigation measures described in section 7.5.1 above.

7.5.3 Closure and rehabilitation

Backfilling the last mining void, water collection channels and the basin of the storm water control dam and ripping, top-soiling, fertilising and re-vegetating the compacted areas as described in sections 7.1.3 and 7.3.4 will restore the soil function in the project area to a large extent, leaving a residual impact of ***moderate (SP = 50)*** significance.

Proper monitoring and maintenance of the re-vegetated areas until they have become self-sustaining would restore the soil function closer to its original condition, leaving a residual impact of ***low (SP = 24)*** significance.

7.6 Ecology

7.6.1 Construction

The construction activities will require stripping of essentially all vegetation on an area of about 26 hectares, which will disturb fauna in the vicinity of the construction area and which could potentially increase the sediment loading of the Bierspruit, which is the major source of drinking water for local fauna. It could also cause loss of roosting habitat for bats. The potential impact on the local ecology has been assessed as being of ***moderate (SP = 45)*** significance.

The following mitigation measures are recommended to reduce the impact to one of ***moderate (SP = 35)*** significance:

- Minimisation of the area to be cleared by proper planning of the site layout and demarcation of the laydown and construction areas;
    - Targeted searches for roosting bats should be conducted by an ecologist immediately prior to commencement of any clearance of the mature woodland in the northern part of the study area:
    - If a bat roost in a tree is suspected, the tree should be dismantled in sections and left on the ground for 24 hours to allow any roosting bats to escape.
- Constructing the pollution control systems first;
- Although no red data or protected species were observed in the project area, the removal of indigenous trees should be minimised by careful site layout and trees that are not to be removed should be clearly marked with barrier tape;
- If any protected faunal species are discovered within the project area they should be relocated under the supervision of a suitably qualified specialist; and
- Samancor's personnel and contractors' staff must be made aware of the requirements of the construction EMP, undergo training in environmental awareness and be prohibited from causing

damage to any plants other than those that have to be removed and from hunting, capturing or harassing of fauna in any manner.

7.6.2 Operation

The mining operations will involve the stripping of vegetation in advance of the mining front and the temporary stockpiling of run-of-mine ore, overburden and topsoil. The operations will also disturb fauna in the surrounding areas and will result in an impact of ***moderate (SP = 70)*** significance, which can be mitigated to one of ***moderate (SP = 36)*** significance by continuous backfilling and re-vegetation with locally indigenous species in accordance with the rollover method of mining described in section 2.5.1. Mitigation of impacts on bats includes the installation of artificial bat roosts on suitable trees and buildings within the surrounding area and installing the type of site lighting described in sections 7.11.1 and 7.11.2.

7.6.3 Closure and rehabilitation

Backfilling the mining voids, water collection channels and the basin of the storm water control dam and ripping, top-soiling, fertilising and re-vegetating the compacted areas as described in sections 7.1.3 and 7.3.4 will restore the floral characteristics of the project area to a large extent and promote the re-colonisation of the area by local fauna, leaving a residual impact of ***moderate (SP = 36)*** significance.

Monitoring and maintenance of the re-vegetated areas until they have become self-sustaining would restore the ecological function of the project area closer to its pre-project condition, leaving a residual impact of ***low (SP = 16)*** significance.

7.7 Surface Water

The dirty water, being seepage and runoff from the various stockpiles and mine infrastructure, will be routed to the pollution control dam (PCD), from where it will be recycled to the mine and plant as process water. Any shortfalls will be made up by abstraction of groundwater, water make in the mine and/or water sourced from Magalies Water.

The ground slopes northwards towards the Bierspruit from the project area and, even without mitigation measures, the proposed Samancor operations on Varkensvlei and Nooitgedacht will not have any impact on surface water resources at Anglo Platinum's Union Mine 2 km to the south or Bushveld Chrome Resources about 4 km to the east. The Samancor operations will also not impact on surface water resources in Mantserre on the other side of the Bierspruit. Without mitigation measures, surface water resources in the Bierspruit Village could be impacted.

7.7.1 Water Balance

The following aspects were taken into consideration in developing a high level conceptual mine and site water balance:

- **Mining:** Initially, chrome ore will be mined from an opencast pit, which will be mined to about 40 m below ground level across a width of approximately 1.7 km over a length of some 7 km. After about seven years an underground mine will be developed from a portal in the highwall of the opencast mine. Water from the mine will be pumped to the pollution control dam (PCD) and used as process water and for dust suppression;
- **Ore processing plant:** As described in section 2.5.2, Samancor will use a wet ore beneficiation process comprising crushing, screening, spiral concentrators and dense media separation; Chrome ore concentrate will go to a product stockpile, discard to a waste rock dump and tailings to a tailings storage facility (TSF).
- **Stockpiles:** There will be temporary stockpiles of: topsoil, subsoil, overburden and waste rock along the length of the opencast mine and run-of-mine ore, discard and chrome ore concentrate (product) near the beneficiation plant;
- **Tailings storage facility (TSF):** The tailings from the ore beneficiation plant will be stored in a tailings dam near the plant. Based on extensive past experience with chrome ores in the western part of the

Bushveld Complex, Samancor believes the chrome ore and waste rock to have a very low content of sulphide minerals and therefore little to no potential for acid formation, but this has not been confirmed by a detailed geochemical investigation on materials sourced from Varkensvlei. Accordingly, it is recommended that the TSF and the pollution control dam be lined and that water pumped out of the mine workings be stored in the PCD, tested for acidity and neutralised if necessary before it is used as a dust suppressant. If the tailings is demonstrated over time to be benign, it can be back-filled into the opencast void;

- **Pollution Control Dam (PCD):** Dewatering of the opencast and underground workings will take place continuously throughout the life of the mine and this water will be pumped to the PCD. All runoff from the infrastructure site will be routed to the PCD. Some of the water in the PCD will be used for dust suppression on the haul roads and at the stockpiles, some as process water in the ore beneficiation plant and some will be lost to evaporation. Excess water, if any, will be stored or treated and released;
- **Buildings:** Potable water will be used in the offices, workshop, change house, lamp room, explosives delivery bay, diesel bay, compressor room and sub-station. The estimated potable water use was based on the consumption of a moderately developed area as per the Guidelines for Human Settlement Planning and Design (CSIR Building and Construction Technology, 2005); and
- **Sewage Treatment Plant (STP):** Treated effluent water from the STP will be sent to the beneficiation plant to be used as process water.

The water balance was developed for the minimum, mean and maximum annual rainfall. A schematic illustration of the water balance under average annual rainfall conditions is shown in Figure 7-1.

7.7.2 Stormwater Management Plan

In terms of Regulation 704 under the National Water Act, the mine must identify “clean” and “dirty” areas and maintain a separation of runoff from the clean and dirty areas. Samancor will construct berms around the open pit area and up-gradient of the infrastructure site to divert clean runoff around the pit and infrastructure site towards the Bierspruit. Trapezoidal shaped channels will be constructed around the plant, RoM stockpile, waste rock stockpile and TSF to convey “dirty” runoff to the PCD. Water make pumped out of the opencast and underground mines will be routed to the PCD. Regulation 704 also requires containment of the “dirty” runoff from the 50 year 24 hour storm in an appropriately sized impoundment.

The entire site layout as shown in Figure 2-6 and Figure 7-2 was considered to be “dirty” and the appropriate PCD size was calculated as 24 066 m^3 with a surface area of 15 000 m^2 and a maximum depth of 2m. The clean and dirty areas and the proposed dirty water collection channels, which have been sized to convey the 50 year return period flood peak, are shown on Figure 7-3.

The dimensions of the channels, the channel slopes and the maximum velocity are listed in Table 7-4. Allowable freeboard standards used are 0.3 m freeboard for flow less than 10 m^3/s and 0.6 m for flows above 10 m^3/s.

Once the project has been commissioned, it is recommended that the water circuit be monitored on a regular basis to gain a good understanding of the flow rates involved. This will enable optimisation of the water circuits and provide input to a water conservation and demand management (WCDM) plan.

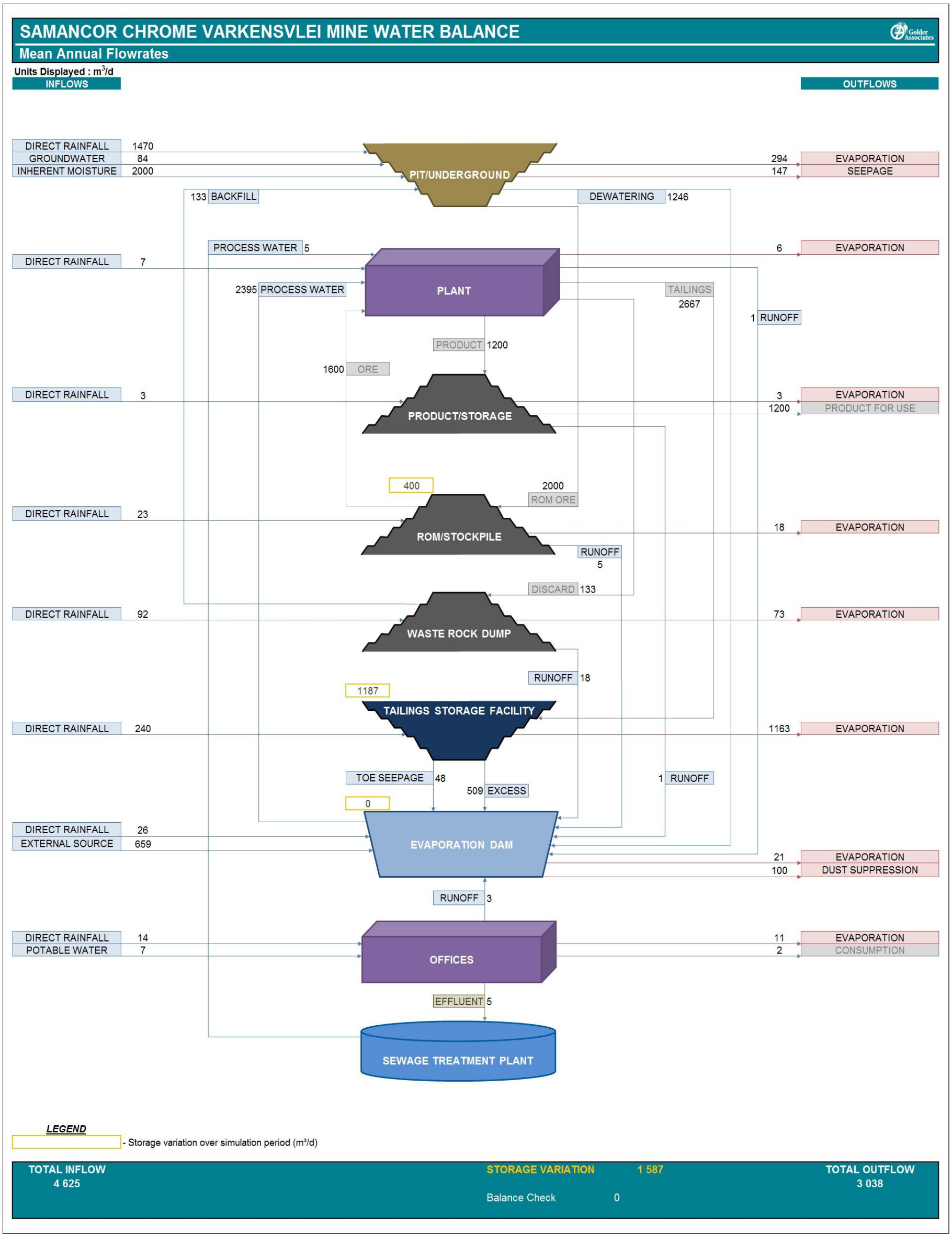


Figure 7-1: Water Balance for proposed Varkensvlei Mine

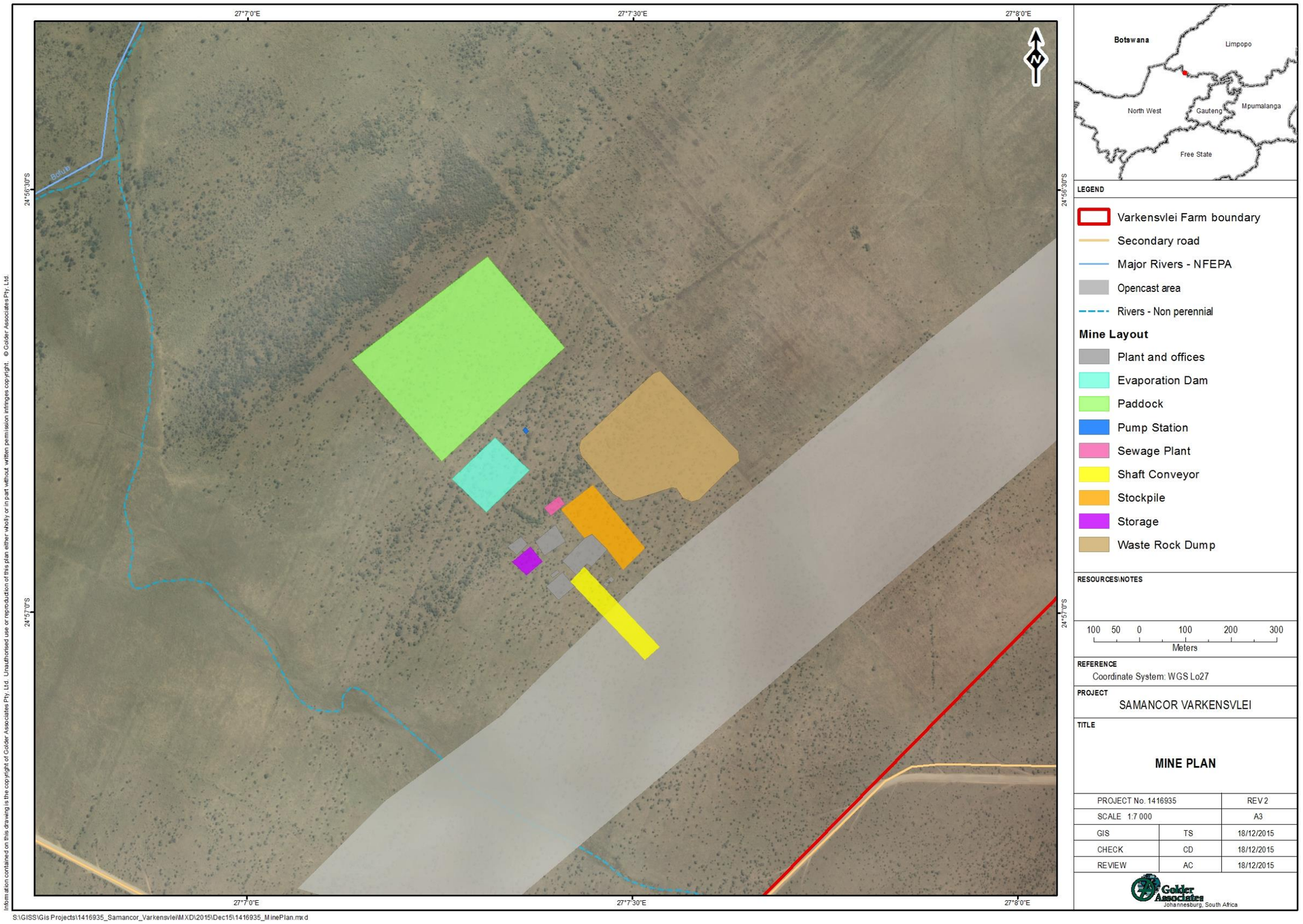


Figure 7-2: Proposed mine and infrastructure layout for the Samancor Varkensvlei Mine

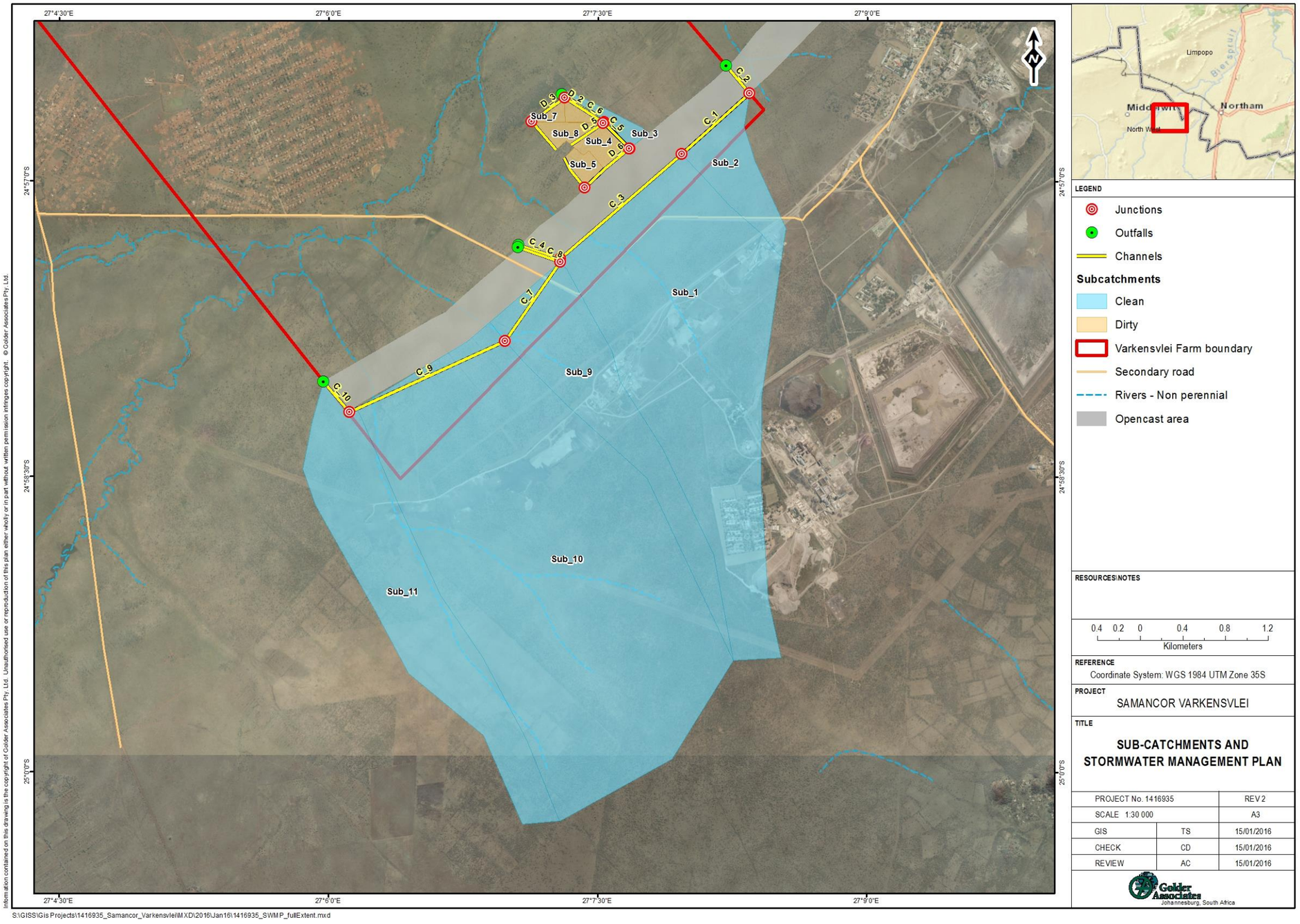


Figure 7-3: Proposed stormwater management layout for the Samancor Varkensvlei Mine

Table 7-4: Clean and dirty water runoff diversion channels sized for 50 year return period flood peak

Channel ID	Length (m)	Roughness	Height (m)	Bottom width (m)	Side slopes (m/m)	Channel slopes (m/m)	Maximum velocity (m/s)
C_1	856	0.035	1.3	1	1.5	0.00924	1.9
C_2	338	0.035	1.3	1	1.5	0.00789	1.8
C_3	1503	0.035	2	1.5	1.5	0.00643	2.2
C_4	408	0.035	1.8	1.5	1.5	0.00883	2.4
C_5	341	0.035	0.9	0.5	1.5	0.00985	1.3
C_6	477	0.035	0.9	0.5	1.5	0.00804	1.3
C_7	870	0.035	1.8	1	1.5	0.00192	1.2
C_8	419	0.035	1.3	1	1.5	0.00878	2.0
C_9	1567	0.035	2	6	1.5	0.00266	1.5
C_10	379	0.035	2	5	1.5	0.00452	2.3
D_1	341	0.035	0.5	0.5	1.5	0.01023	0.0
D_2	438	0.035	1.1	1	1.5	0.00753	1.2
D_3	383	0.035	1.5	1	1.5	0.00711	1.0
D_4	347	0.035	1.5	1	1.5	0.00355	1.5
D_5	361	0.035	1	1	1.5	0.01985	2.1
D_6	557	0.035	1	1	1.5	0.01583	0.0
D_7	339	0.035	1	1	1.5	0.00571	1.5
C_1	856	0.035	1.3	1	1.5	0.00924	1.9

7.7.3 Construction

The construction activities described in section 7.1.1 could lead to runoff with a high silt load and contaminants such as fuel, hydraulic fluids, degreasing and other chemicals and cement. The land slopes at a gradient of about 1 in 100 towards the Bierspruit River and the potential impact on local surface water users is assessed as being of ***moderate (SP = 65)*** significance. The following measures are recommended to reduce the potential impact further to one of ***low (SP = 27)*** significance:

- Construct pollution control dam, clean water diversion berms and dirty water collection channels first, before undertaking any other activities;
- Undertake construction during the dry season (May to September) if possible;
- Place drip trays under vehicles when parked;
- Service vehicles in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it should be done in a designated dirty area and a spill kit and clean-up team must be available on site; and
- Spillages should be cleaned up immediately and contaminated soil must either be remediated *in situ* or disposed of at an appropriately licensed landfill site.

7.7.4 Operation

The operational phase activities described in section 7.1.2 could result in runoff with a high silt load and contaminants such as fuel, hydraulic fluids, and chemicals. The topsoil and overburden stockpiles could contribute to the silt load. Runoff from the TSF may also contain elevated concentrations of the major cations

Na, K, Ca, and Mg and the anions SO_4 and Cl. The pollution control dam may overflow during very high rainfall events, but under such conditions the concentration of contaminants in the runoff would be diluted.

Taking all factors into account, the potential impact on surface water users is assessed as being of ***moderate (SP = 52)*** significance. The following measures are recommended to reduce the potential impact to one of ***moderate (SP = 33)*** significance:

- Construct clean water diversion berms up-gradient of waste rock, ore, topsoil and overburden stockpiles and channel runoff from stockpiles towards the PCD;
- Limit height of topsoil and overburden stockpiles to 3 metres and slope to 1 in 4 or 25 degrees;
- Vegetate topsoil stockpiles with locally indigenous grass species if stockpiles need to remain in place for more than a month during the rainy season;
- Remove silt from the PC dam on a regular basis to maintain its storage capacity;
- Maintain a freeboard of at least 0.8 metres at all times;
- Monitoring of water quality in PCD;
- Place drip trays under vehicles when parked;
- Service vehicles in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it should be done in a designated dirty area and a spill kit and clean-up team must be available on site; and
- Spillages should be cleaned up immediately and contaminated soil must either be remediated *in situ* or disposed of at an appropriately licensed landfill site.

7.7.5 Closure and rehabilitation

Decommissioning could leave barren areas that may cause erosion and lead to an increase in the silt content of runoff, but the total area that would have been disturbed is relatively small (about 1285 ha). The potential impact on surface water users is assessed as being of ***moderate (SP = 52)*** significance. The following measures are recommended to reduce the impact to one of ***moderate (SP = 33)*** significance:

- The clean water diversion berms, dirty water collection channels and PCD must be the last structures to be demolished;
- Place drip trays under vehicles when parked;
- Service vehicles in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it should be done in a designated dirty area and a spill kit and clean-up team must be available on site;
- Spillages should be cleaned up immediately and contaminated soil must either be remediated *in situ* or disposed of at an appropriately licensed landfill site;
- Rip compacted areas, analyse soil and fertilise appropriately;
- Shape rehabilitation areas to be free draining; and
- Re-vegetate disturbed areas with locally indigenous grasses, shrubs and trees.

7.8 Groundwater

7.8.1 Construction

The construction activities described in section 7.1.1 could lead to contamination of soil and subsequently groundwater through spillages of fuels, lubricants, hydraulic fluids and chemicals such as solvents,

degreasers and cement. Groundwater may also be impacted by poor sanitation practices of construction workers.

The potential impact is assessed as being of ***moderate (SP = 48)*** significance. The following measures are recommended to reduce it to one of ***low (SP = 21)*** significance:

- Drilling and sampling of monitoring boreholes up-gradient and down-gradient of the proposed construction and mining areas;
- Monthly monitoring of the boreholes with regard to water levels and water quality;
- Place drip trays under vehicles when parked;
- Service vehicles in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it should be done in a designated dirty area and a spill kit and clean-up team must be available on site;
- Spillages should be cleaned up immediately and contaminated soil must either be remediated *in situ* or disposed of at an appropriately licensed landfill site;
- Provide adequate sanitation facilities in the form of chemical toilets that are serviced regularly; and
- Provide environmental awareness training for workers on site.

7.8.2 Operation

The operational phase activities described in section 7.1.2 will result in a lowering of the local groundwater table due to necessary mine dewatering and groundwater contamination with nitrates due to blasting. The effects of dewatering will be in addition to that caused by the mining operations of Bushveld Chrome Resources (BCR) and Anglo Platinum's Union Mine, respectively located approximately 4km to the east and 2 km to the south of the proposed Varkensvlei – Nooitgedacht mining area.

Samancor's mining activities could also result in groundwater contamination due to spillages of fuels, lubricants, hydraulic fluids and chemicals unless appropriate mitigation measures are implemented. Although the content of sulphide minerals in the ore is low and the potential for acid generation is believed to be very low, this has not been confirmed by detailed geochemical testing on materials sourced from Varkensvlei.

Accordingly, the potential groundwater impact is conservatively assessed as potentially being of ***high (SP = 75)*** significance. The following mitigation measures are recommended to reduce the predicted impact to one of ***moderate (SP = 39)*** significance:

- Monthly monitoring of the boreholes with regard to water levels and water quality;
- Place drip trays under vehicles when parked;
- Service vehicles in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it should be done in a designated dirty area and a spill kit and clean-up team must be available on site;
- Spillages should be cleaned up immediately and contaminated soil must either be remediated *in situ* or disposed of at an appropriately licensed landfill site;
- Provide adequate sanitation facilities; and
- Provide environmental awareness training for workers on site.

7.8.3 Closure and rehabilitation

The decommissioning and closure activities described in section 7.1.3 will have a groundwater pollution potential similar to that of the construction phase, but with some enhancement due to the disturbance of the natural stratigraphy, geological and soil conditions caused by the mining and backfilling operations.

Residual impacts after the pit has been backfilled include interference with natural groundwater flow and recharge of the groundwater system. Backfilling of the pit will result in higher hydraulic conductivity of that area. Local groundwater recharge would increase if the rehabilitated area forms a depression. Groundwater would then be more sensitive to pollution from the surface. This risk can, however, be minimised through positive land and water management initiatives during the operational and decommissioning phases of the project. Correct rehabilitation of the mining void is very important to mitigate lasting impacts on the groundwater regime.

The potential impact on the groundwater regime is assessed as being of ***high (SP = 85)*** significance. The following mitigation measures are recommended to reduce the impact to one of ***moderate (SP = 39)*** significance:

- During backfilling with overburden, followed by covering with topsoil, the backfilled area should be shaped to be free-draining, after allowing for settling;
- Place drip trays under vehicles when parked;
- Service vehicles in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it should be done in a designated dirty area and a spill kit and clean-up team must be available on site;
- Spillages should be cleaned up immediately and contaminated soil must either be remediated *in situ* or disposed of at an appropriately licensed landfill site;
- Provide adequate sanitation facilities;
- Provide environmental awareness training for workers on site; and
- Maintain monthly monitoring of the boreholes with regard to water levels and water quality for 12 months after closure, thereafter quarterly for three years.

7.9 Noise

The noise impact assessment was undertaken by dBAcoustics (van der Merwe, June 2013).

7.9.1 Standards and guidelines

The time-varying characteristics of environmental noise are described in terms of the following statistical noise descriptors:

- Leq: The Leq is the constant sound level that would contain the same acoustic energy as the varying sound level, during the same period of time;
- LMax: The instantaneous maximum noise level for a specified period of time; and
- LMin: The instantaneous minimum noise level for a specified period of time.

The following relationships occur for increases in A-weighted noise levels:

- The trained healthy human ear is able to discern changes in sound levels of 1 dBA under controlled conditions in an acoustic laboratory;
- It is widely accepted that the average healthy ear can barely perceive noise level changes of 3 dBA;
- A change in sound level of 5 dBA is a readily perceptible increase in noise level; and

- A 10-dBA change in the sound level is perceived as twice as loud as the original source.

The World Bank in its Environmental Health and Safety Regulations applies the following noise level guidelines:

- Residential area – 55 dBA for the daytime and 45 dBA for the night-time period; and
- Industrial area – 70 dBA for the day- and night-time periods.

Some of the noise levels that a person is exposed to on a daily basis in the work place and/or in the home environment are listed in Table 7-5.

Table 7-5: General noise levels of daily exposure

Activity	Dba
Whisper	30
Normal conversation	55 – 65
Shouted conversation	90
Baby crying	110
Computer	37 – 45
Radio playing in background	45 – 50
Microwave oven	55 – 60
Washing machine	50 – 75
Clothes dryer	56 – 58
Alarm clock	60 – 80
Television	70
Flush toilet	75 – 85
Ringing telephone	80
Hairdryer	80 – 95
Vacuum cleaner	84 – 89
Maximum output of stereo	100 – 110

In South Africa, the noise impact on human receptors is evaluated in terms of the SANS 10103 guidelines for sound pressure levels as listed in Table 7-6 and the typical responses as listed in Table 7-7.

Table 7-6: Noise level standards for various districts

Type of District	Equivalent continuous rating level $L_{Req.T}$ for ambient noise - dBA					
	Outdoors			Indoors with windows open		
	Day-night L_{Rdn}	Daytime L_{Rd}	Night-time L_{Rn}	Day-night L_{Rdn}	Daytime L_{Rd}	Night-time L_{Rn}
Rural districts	45	45	35	35	35	25
Suburban districts with little road traffic	50	50	40	40	40	30
Urban traffic	55	55	45	45	45	35

Type of District	Equivalent continuous rating level $L_{Req.T}$ for ambient noise - dBA					
	Outdoors			Indoors with windows open		
	Day-night L_{Rdn}	Daytime L_{Rd}	Night-time L_{Rn}	Day-night L_{Rdn}	Daytime L_{Rd}	Night-time L_{Rn}
Urban districts with some workshops, business premises and main roads	60	60	50	50	50	40
Central business districts	65	65	55	55	55	45
Industrial districts	70	70	60	60	60	50

Daytime and night-time refer to the hours from 06h00 - 22h00 and 22h00 - 06h00 respectively.

Table 7-7: Typical community response to increase in ambient noise level

Excess $L_{Req.T}$ dBA	Response
0	No reaction
0 -10	Sporadic complaints
5 -15	Widespread complaints
10 - 20	Threats of community/group action
>15	Vigorous community/group action

Excess $L_{Req.T}$ is calculated from the appropriate of the following:

a) Excess $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation *minus* $L_{Req,T}$ of the residual noise (determined in the absence of the specific noise under investigation).

b) Excess $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation *minus* the typical rating level for the applicable district as determined from Table 7-6

7.9.2 Construction

Typical noise levels generated by various types of construction equipment are provided in **Table 7-8**. Conservative attenuation conditions, related to intervening ground conditions and screening, have been applied.

Table 7-8: Typical noise levels generated by construction equipment

Plant/Equipment	Typical Operational Noise Level at Given Offset (dBA)							
	5m	10m	25m	50m	100m	250m	500m	1000m
Air Compressor	91	85	77	71	65	57	51	46
Compactor	92	86	78	72	66	58	52	46
Concrete Mixer	95	89	81	75	69	61	55	49
Concrete Vibrator	86	80	72	66	60	52	46	40
Mobile Conveyor Belt	77	71	63	57	51	43	37	32
Crusher (Aggregate)	90	84	76	70	64	56	50	44
Crane (Mobile)	93	87	79	73	67	59	53	47
Dozer	95	89	81	75	69	61	55	49

Plant/Equipment	Typical Operational Noise Level at Given Offset (dBA)							
	5m	10m	25m	50m	100m	250m	500m	1000m
Loader	95	89	81	75	69	61	55	49
Mechanical Shovel	98	92	84	78	72	64	58	52
Pile Driver	110	104	97	91	85	77	71	65
Pump	86	80	72	66	60	52	46	40
Pneumatic Breaker	98	92	84	78	72	64	58	52
Rock Drill	108	102	94	88	82	74	68	62
Roller	84	78	70	64	58	50	44	38
Trucks	87	81	73	67	64	60	57	54

The highest noise level at 960m from the site during the construction phase will be 37.5 dBA for short periods when up to four drilling rigs are in operation. Traffic of up to 4 trucks and 4 lighter vehicles per hour would cause a sporadic noise level of about 52 dBA at the access road.

From the attenuation with distance of the noise levels generated by various types of construction equipment as listed in **Table 7-8** and the distance between noise sources as listed in Table 4-19, it is evident that the construction activities described in section 7.1.1 are not likely to cause exceedances of the daytime guidelines for industrial districts at any of the sensitive areas indicated in Figure 4-32 and Table 4-19. The guidelines for suburban districts might be exceeded at area A in Figure 4-32 if construction is undertaken during the night time (see position of infrastructure on Figure 2-2).

Accordingly, the potential impact of the construction activities is rated as being of ***moderate (SP = 50)*** significance. The following mitigation measures are recommended to reduce the impact to one of ***low (SP = 24)*** significance:

- The construction camp and other noisy fixed facilities should be located well away from noise sensitive areas adjacent to the proposed construction areas;
- All construction vehicles and equipment must be kept in good repair;
- Where necessary, stationary noisy equipment (e.g. compressors, pumps, pneumatic breakers) should be encapsulated in acoustic covers, screens or sheds. Proper sound insulation can reduce noise by up to 20 dBA. Portable acoustic shields should be used where noisy equipment is not stationary (e.g. angle grinders, chipping hammers, poker vibrators);
- Construction activities, and particularly the noisy ones, should be limited to reasonable hours during the day and early evening (e.g. 06h00 to 20h00);
- With regard to unavoidable noisy construction activities in the vicinity of noise sensitive areas, the mine should liaise with local residents on how best to minimise the impact;
- Machines in intermittent use should be shut down or throttled down to a minimum whenever possible;
- In general, construction activities should meet the noise standard requirements of the Occupational Health and Safety Act (Act No 85 of 1993); and
- Construction staff working in areas where the 8-hour ambient noise levels exceed 75dBA should wear hearing protection equipment.

7.9.3 Operation

The calculated noise contours for the opencast mining operations are illustrated in Figure 7-4. The noise from the mining machinery will be audible, but will not exceed the daytime level for urban districts, beyond the 600 m blast zone boundary and at some sensitive areas along the way as the mining front moves along the length of the ore deposit. If opencast mining operations are undertaken during the night time, exceedances of all but the guidelines for industrial districts would be experienced and the noise levels at the nearest sensitive areas, such as Mantserre Village and Union Mine Village, would be objectionable.

The potential environmental noise impact of the mining operations (excluding blasting) is therefore assessed as being of ***high (SP = 85)*** significance, which can be reduced to one of ***moderate (SP = 48)*** significance by implementing the following mitigation measures:

- All major mining equipment should incorporate noise reduction designed to ensure that the overall noise level does not exceed an equivalent continuous day/night rating level (L_{Rdn}) of 70 dBA at the property boundary of the mine, as specified for industrial districts in SANS 10103. Equipment selection should also take into account the maximum allowable equivalent continuous day and night rating levels of the potentially impacted sites outside the mine property. Where the noise level at an external site is presently lower than the maximum allowed (see Table 7-6), the maximum should not be exceeded. Where the noise level at an external site is presently at or exceeds the maximum, the existing level must not be increased by more than indicated as acceptable in SANS 10103;
- The latest technology incorporating maximum noise mitigation measures for components of the complex should be designed into the system. When ordering plant and machinery, manufacturers should be requested to provide details of the sound power level (SPL). Where possible, those with the lowest SPL should be selected;
- Machinery to comply with the IFC's Environmental Health & Safety standards ;
- The site layout and design should consider, *inter alia*, the following aspects:
  - The position and orientation of buildings on the site;
  - The design of the buildings to minimise the transmission of noise from the inside to the outdoors;
  - The acoustic insulation of particularly noisy plant and equipment;
  - The temporary dumps of topsoil and overburden from the opencast operations should, where possible, be placed between the mine and sensitive receptors to act as noise attenuation barriers.
- All plant, equipment and vehicles should be kept in good repair;
- Where possible, very noisy activities should not take place at night (between the hours of 20h00 to 06h00); and
- Develop a formal system for receiving and responding to complaints.

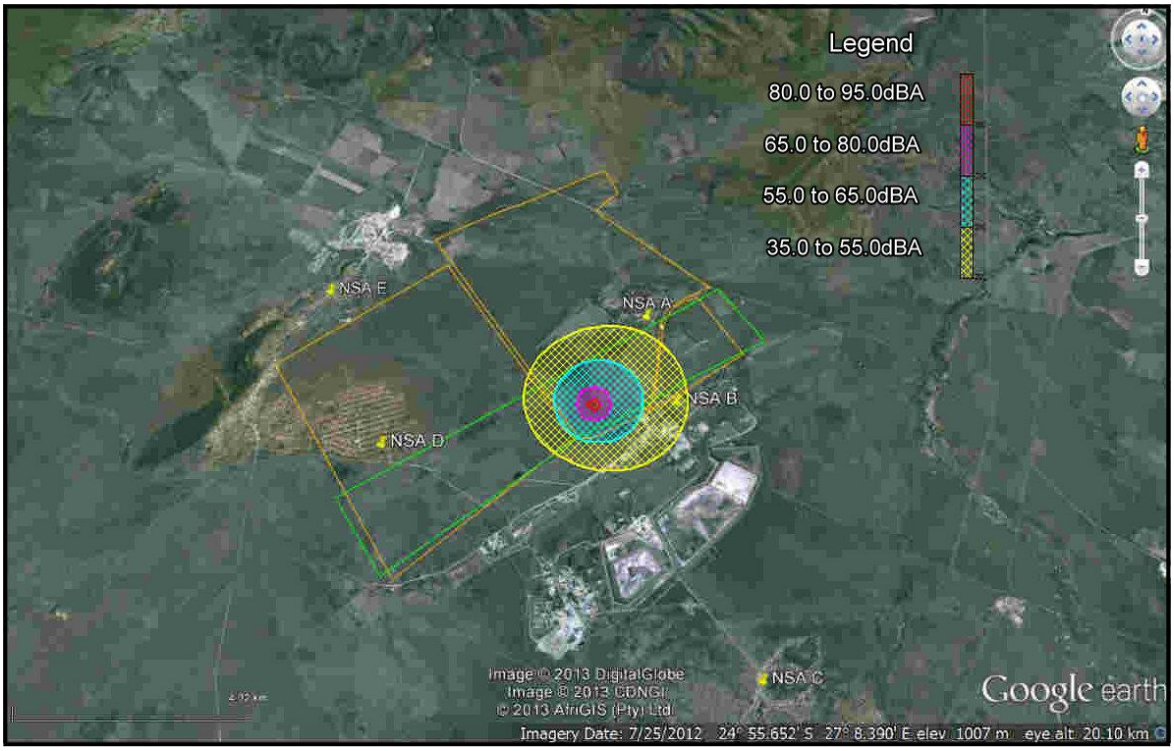


Figure 7-4: Noise contours for the opencast mining activities

7.9.4 Closure and rehabilitation

The activities associated with the closure and rehabilitation phase of the opencast mining operations will generate similar, but probably lower, noise levels than those experienced during the construction phase. The duration will also be similar, except for post closure monitoring of vegetation and groundwater, which will continue for several years, but will not have any noise impacts.

Without mitigation, the noise impact during closure and rehabilitation is assessed as ***moderate (SP = 50)***. The following mitigation measures are recommended:

- Sound-absorbing berms and other barriers to be demolished last;
- No noisy activities to be undertaken during night-time (22h00 to 06h00);
- Selecting equipment with lower sound power levels; and
- Maintaining noise abatement equipment in good condition.

Application of the recommended mitigation measures is expected to reduce the noise impact to a level of ***low (SP = 24)*** significance.

7.10 Blasting

A blast in an opencast mine typically causes ground vibration, air over-pressure, and fly rock.

7.10.1 Ground vibration

Ground vibration, which is expressed as peak particle velocity (PPV), measured in millimetres per second (mm/s), can come from various sources, both human (compaction, traffic, drilling and blasting) and natural (earthquakes, meteor strikes). In the built environment, ground vibrations may constitute a risk of cosmetic or structural damage to buildings. Humans feel and can be alarmed by vibration at much lower levels than those that can cause structural damage.

Whole body vibration is experienced when walking, travelling in vehicles and using machinery. Prolonged excessive vibration can cause discomfort, fatigue and physical pain.

Individuals may respond differently, but the average human response to levels of ground vibration (e.g. from a mining blast) is summarised in Table 7-9.

Table 7-9: Ground vibration levels and human responses

Ground Vibration Range (mm/s)	Response
0.05- 2.54	Barely to distinctly perceptible
2.54 – 12.7	Distinctly perceptible to strongly perceptible
12.7 – 25.0	Strongly perceptible to mildly unpleasant
25.0 – 50.0	Mildly unpleasant to distinctly unpleasant
50.0 – 200.0	Distinctly unpleasant to intolerable

U.S Department of the Interior, Bureau of Reclamation – State Water Resources Control Board – Noise

The level of vibration experienced as a result of blasting or other point sources diminishes with distance as the shock wave radiates outwards, but the degree of attenuation depends on the ground conditions between the source and the recipient.

Typical levels measured at various distances from construction activities are listed in Table 7-10.

Table 7-10: Ground vibrations due to construction machinery

Construction Activity	Ground Vibration Level – mm/s
Vibratory roller	Up to 1.5mms @ 25m
Hydraulic rock breaker	4.5 mm/s @ 5m, 0.4 @ 20m, 0.1 @ 50m
Compactor	20mm/s @ 5m, <0.3mm/s @30m
Pile driver	1-3mm/s @ 50m depending on soil conditions and piling technique
Bulldozer	1-2mm/s @ 5m, 0.1 @ 50m
Truck traffic (smooth surface) Truck traffic (rough surface)	<0.2mm/s @ 20m <2mm/s @ 20m

USBM R1 8507 the United States Bureau of Mines vibration standards

Ground vibration levels at the perimeter of an opencast mine during a blast typically range from 25mm/s to 50mm/s. Well-constructed buildings may show structural damage at 25mm/s, but cheaply constructed buildings could suffer damage at 10mm/s.

Ground vibration levels at various distances from a blast can vary greatly, depending on the blast design, the geology, and the soil characteristics. Ground vibration is not expected to exceed 10 mm/sec, the level at which poorly constructed buildings may begin to suffer structural damage, at any off-site structures.

Vibration measurements undertaken during construction and initial blasting operations can be used to design subsequent blasts and develop mitigation measures.

7.10.2 Air blast

Air blast is experienced as air over-pressure by a receptor and is due to the propagation of the shock wave through the air. It is normally associated with frequency levels less than 20 Hz, which is the threshold for human hearing. It is measured in pascals, but the pressure range is very wide and the pressure levels are converted to dB for reporting purposes. The level experienced at a given point is influenced by meteorological

conditions, blast layout, timing, stemming, accessories used, and the topography between the blast and the receptor. Typical effects of various levels of air blast are summarised in Table 7-11.

Table 7-11: Air blast thresholds

Level	Description
120 dB	Rattling of windows and crockery
130 dB	Resonant response of large surfaces (roofs, ceilings). Complaints start.
150 dB	Some windows break
170 dB	Most windows break
180 dB	Structural Damage

The human response of annoyance to blast vibrations is aggravated by secondary noises such as the rattling of crockery, furniture and walls. Meteorological conditions such as wind speed and direction, temperature, cloud cover and humidity will affect the intensity of the air over-pressure levels experienced at a given distance from the blasting area. In a motionless atmosphere a doubling of the distance from the blast will result in the air over-pressure level (experienced as a shock wave) being attenuated by 6dB.

The recommended limit for air blast currently applied in South Africa is 134 dB, but every effort should be made to keep air blast levels below 120 dB in order to minimise the annoyance factor.

Air blast levels as a function of charge and distance can be calculated for flat topographical conditions from the following formula:

$$L = 165 - 24 \log 10 \frac{\mathrm{D}}{\mathrm{E}^{1/3}}$$

Where:

L = Air blast level (dB)

D = Distance from source (m)

E = Charge mass per delay (kg)

7.10.3 Fly rock

It is possible to blast with little or no fly rock by means of adequate confinement of the explosive charges within the blast holes through the use of proper stemming procedures and materials. Free blasting with no control on stemming will result in poor blast results and possible damage to nearby structures.

Typical causes of fly rock are:

- Burden too small;
- Burden too large;
- Stemming length too short;
- Out of sequence initiation of blast holes;
- Drilling inaccuracies;
- Incorrect blast hole angles; and
- Excessively charged blast holes.

Proper blast design is expected to make fly rock beyond a distance of 600 metres from the mine unlikely.

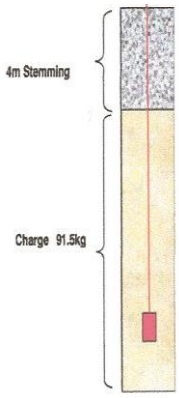
7.10.4 Construction

The construction activities described in section 7.1.1 will not require blasting, i.e. there will be ***no (SP = 0)*** impact due to blasting.

7.10.5 Operation

Blasting will be done in the pits with an emulsion of ammonium nitrate and fuel oil, using a typical blast design such as currently used at the Northam Platinum and illustrated in Table 7-12.

Table 7-12: Typical blast design parameters

Average geometry values		**Charging Instructions**
Number of holes	155	
Hole diameter (mm)	127mm	
Hole depth (m)	3m - 10m	
Sub-drill depth (m)	0	
Burden and spacing (m)	3m x 3m	
Stemming length (m)	4m	
Average charge mass values		
Charge mass/hole (kg)	91.2kg	
Charge/meter of hole (kg)	15.2kg/m	
Average energy measures		
Powder factor (kg/m^3)	0.75 – 0.8	
Energy factor (Rel.energy/m^3)	0.65	
Scaled Burden (m/(kg/m)$^{0.5}$)	0.66	1) All holes drilled to 127mm in diameter. 2) All holes to be primed and charged as in FIG.1. 3) All holes must be primed using 400g Boosters and MS 500ms Detonators. 4) All primary boosters must be weighed down. 5) All holes to be twined to the correct stemming length. 6) All holes to be stemmed using drill chips.
Quantities		
Bench volume (m^3)	18 135 m^3	
Total charged mass	7 068kg	

At a distance of 900 metres from the blast a sound level of about 70dB would be experienced for about 3 seconds. Calculated sound level contours based on a sound pressure level of 130 dB at the blasting area are shown in Figure 7-5 to Figure 7-7. Blasting will take place once a week and the contours illustrate the noise levels that would be experienced for about three seconds at a time. Fly rock is unlikely to occur beyond the 600 metre buffer zone shown in Figure 2-2.

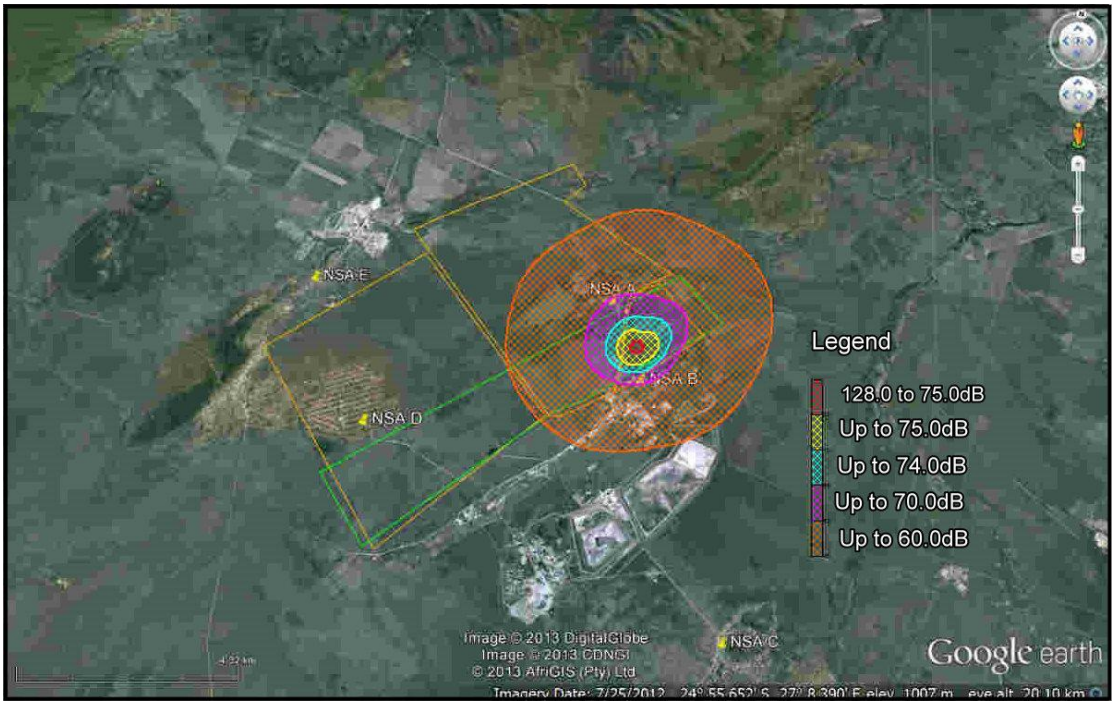


Figure 7-5: Predicted sound level contours due to blasting in north-eastern portion of opencast mine

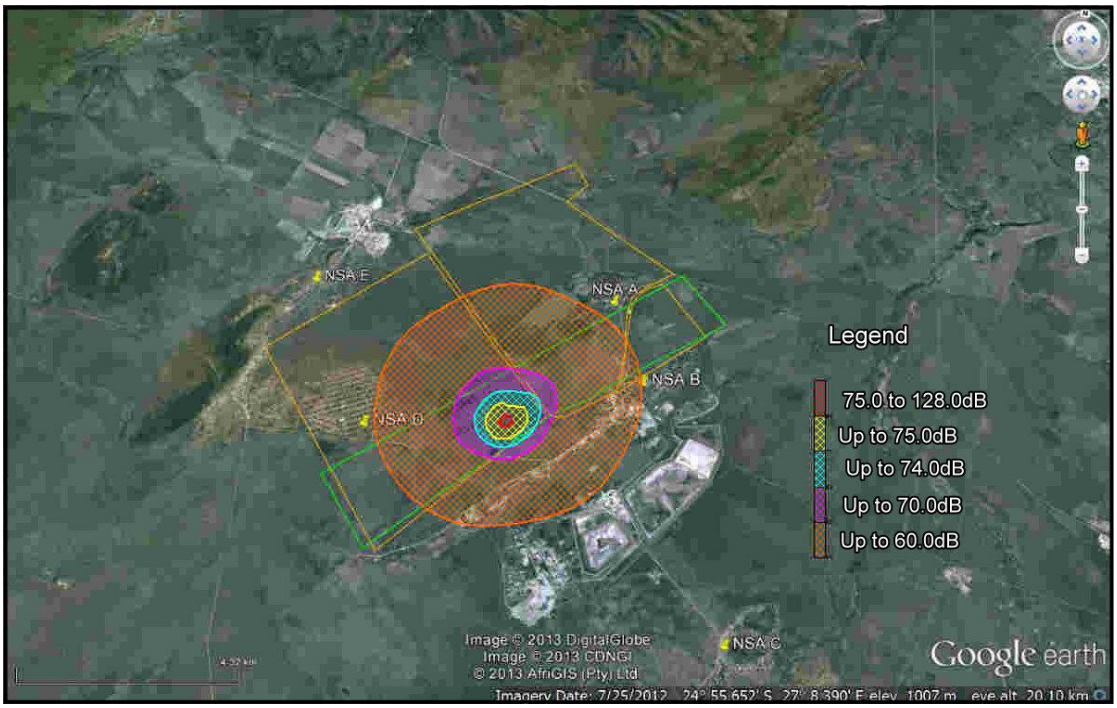


Figure 7-6: Predicted sound level contours due to blasting in middle portion of opencast mine

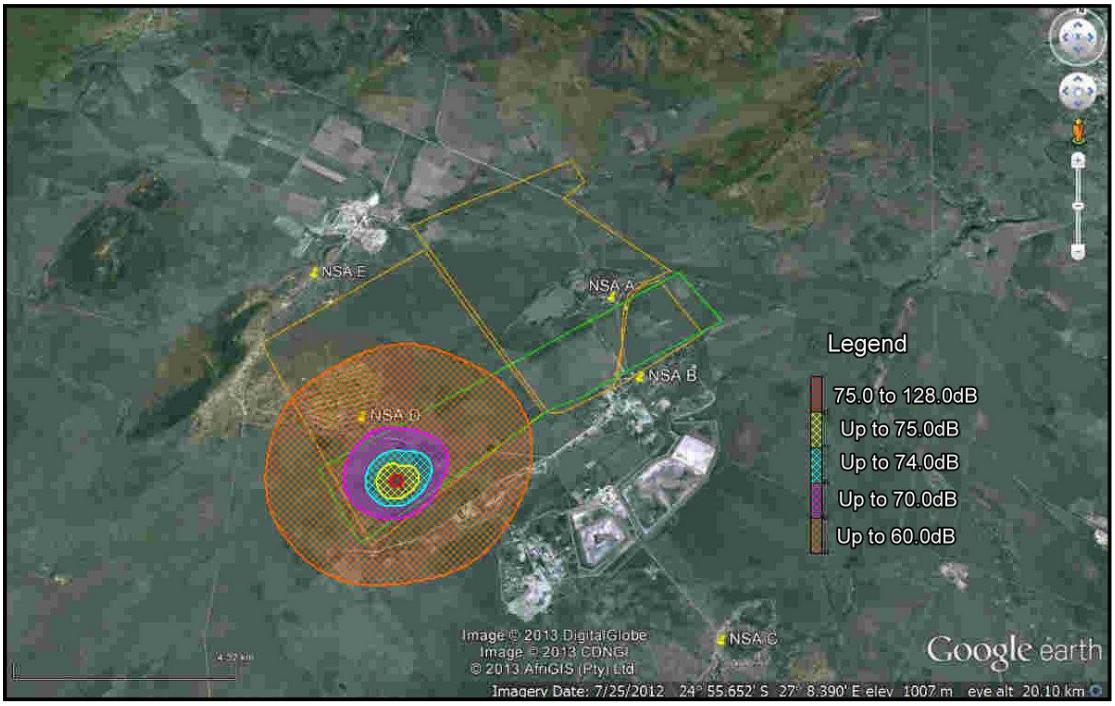


Figure 7-7: Predicted sound level contours due to blasting in south-western portion of opencast mine

From Figure 4-32 and Figure 7-5 to Figure 7-7 it can be seen that air blast sound pressure levels of 60 to 70 dB may be expected in some parts of Bierspruit Village, Union Mine Village and Mantserre as the opencast mining operations progress from the north-east to the south-west along the orebody.

Underground blasting will cause ground vibration, but no fly rock or air blast effects.

The potential impact of the blasting operations is predicted to be of ***high (SP = 85)*** significance.

The following mitigation measures are recommended to reduce the impact to one of ***moderate (SP = 52)*** significance:

- Blasts should be designed so that:
  - Ground vibration levels do not exceed 12.5mm/s at off-site structures; and
  - The air over-pressure level does not exceed 130dB at the blast and 70dB at any of the sensitive receptor sites indicated in Figure 4-32.
- Vibration and air over-pressure should be monitored at sensitive areas and the measured values should be taken into account in the design of subsequent blasts;
- Blasting days and times of blasting must be established and communicated to local residents;
- Ensure that the correct design relationship exists between burden, spacing and hole diameter;
- Ensure that the maximum amount of water resistant emulsion on any one day delay interval, the maximum instantaneous charge, is optimized by considering a reduction in the:
  - Number of holes per detonator delay interval;
  - Instantaneous charge by in-hole delay techniques;
  - Bench height or hole depth;

- Borehole diameter.

- Be aware that the perception of blasting events occurs at levels of vibration well below those that can cause structural damage, but nevertheless at levels that can cause concern amongst residents in the vicinity of the mine;
- Take into account that relatively small changes in blast design can produce noticeable differences in effects experienced by local residents. Complaints are often made in response to changes in the effects experienced rather than their absolute value;
- The design of the blast should be in line with the blast design chart illustrated in Figure 7-8.

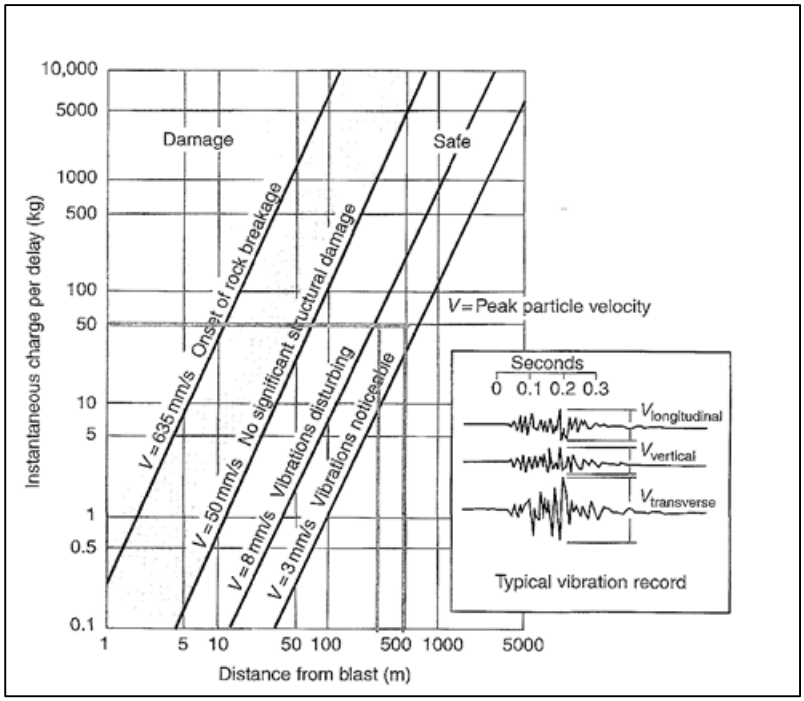


Figure 7-8: Blast design chart (Wyllie and Mah, 2006)

7.10.6 Closure and rehabilitation

The activities described in section 7.1.3 will not require blasting, i.e. there will be ***no (SP = 0)*** impact due to blasting.

7.11 Visual Aspects

Some activities on the Samancor site and mine will be visible to observers travelling on local roads and residing in the villages of Mantserre, Bierspruit and Union Mine.

7.11.1 Construction

The potential for a daytime visual impact during the construction phase is expected to be associated mainly with the erection of infrastructure, such as the ore beneficiation plant on Varkensvlei, and with the generation of dust due to the vegetation clearing and excavation activities and vehicles travelling over unpaved surfaces. The night-time visual impact will be due to security lighting at the construction site and the headlights of vehicles. The impact is assessed as one of ***moderate (SP = 65)*** significance and it can be further reduced to ***low (SP = 27)*** significance by dust suppression with water or chemicals, by limiting vehicle movement at night and by installing motion-sensitive lighting that is directed downwards and inwards towards the site.

7.11.2 Operation

The operational phase will involve earth-moving and night-time operations on a larger scale than the construction phase and has the potential to create a visual impact of ***high (SP = 85)*** significance, which can be mitigated to one of ***moderate (SP = 52)*** significance by;

- Dust suppression with water or chemicals;
- Directing fixed lighting downwards and inwards towards the site, and not towards residential receptors or roads;
- Leaving as much natural vegetation in place as possible; and
- Erecting screens where practicable.

7.11.3 Closure and rehabilitation

This phase will have the same potential for visual impact as the construction and operational phases combined, but it will be of shorter duration (6 to 9 months) than the operational phase (about 8 years as an opencast mine, followed by more than 20 years as an underground mine). The visual impacts are therefore expected to be of ***moderate (SP = 65)*** significance without mitigation and ***low (SP = 27)*** significance with mitigation. The mitigation measures listed in sections 7.1.3 and 7.3.4 should be applied.

7.12 Sites of Archaeological and Cultural Significance

As noted in section 4.12, there is a large formal graveyard (Figure 4-36) with hundreds of graves near the southern perimeter of the village of Mantserre, the location of which relative to the proposed mining area on Varkensvlei is shown in Figure 2-2. It has a very ***high*** significance as a heritage resource, but it is located well outside of the 600 metre blast radius of the proposed opencast mine and is unlikely to be affected by the mining activities.

7.12.1 Construction

The construction phase as described in section 7.1.1 will have ***no (SP = 0)*** impact on the formal graveyard, but it is always possible that an unknown grave or other buried cultural/archaeological items could be unearthed when excavations are being undertaken. In such an event the following chance find procedure must be implemented to mitigate the potential impact from one of ***high (SP = 80)*** to one of ***low (SP = 21)*** significance:

- Cease all work in the immediate vicinity of the find;
- Demarcate the area with barrier tape or other highly visible means;
- Notify the South African Heritage Resources Authority (SAHRA) immediately;
- Commission an archaeologist accredited with the Association for Southern African Professional Archaeologists (ASAPA) to assess the find and determine appropriate mitigation measures. These may include obtaining the necessary authorisation from SAHRA to conduct the mitigation measures; and
- Prevent access to the find by unqualified persons until the assessment and mitigation processes have been completed.

7.12.2 Operation

When opencast mining is undertaken in the south-western portion of the orebody, noise levels of up to 65 dBA from mining operations may be experienced at the Mantserre graveyard (see Figure 7-4). Sound levels in the region of 60 dB may be experienced from air blast (see Figure 7-7) for about 3 seconds once a week. Although unlikely, the potential for damage from fly rock and/or ground vibration cannot be ruled out entirely, but it can be minimised by diligent application of the mitigation measures described in section 7.10.5.

The earthmoving operations *per se* associated with the operational phase will have ***no (SP = 0)*** impact on the graveyard at Mantserre, but it is always possible that an unknown grave or other buried cultural/archaeological items could be unearthed while topsoil and subsoil stripping and removal of overburden are being undertaken. In such an event the chance find procedure described in section 7.12.1 above must be implemented to mitigate the potential impact from one of ***high (SP = 80)*** to one of ***low (SP = 21)*** significance.

7.12.3 Closure and rehabilitation

The closure and rehabilitation phase as described in section 7.1.3 will have ***no (SP = 0)*** impact on any identified cultural and heritage resources and no mitigation measures are required.

7.13 Socio-economic

The proposed project will create employment and business opportunities for residents of Mantserre and Bierspruit Village, but also further afield, e.g. in the towns of Northam and Rustenburg.

7.13.1 Construction

Considering the relatively small amount of construction work required (see section 7.1.1) and the short period of construction (12 to 18 months), the impact on the local economy will be positive, but very small. The work will be undertaken by one or more contractors. If they need to hire local labour, it would be a small number.

It is possible that some local residents may be inconvenienced by noise, dust and increased traffic during the construction period. The presence of construction workers will increase the local population briefly and create the potential for friction with local residents. An influx of work seekers is possible, but the numbers are likely to be small.

Considering the above potential positive and negative impacts in combination and within the context of the current, pre-project environmental and social conditions described in chapter 4.0, the overall impact could be ***negative of low (SP = 21)*** significance, which could be changed to one of ***positive, but low (SP = +14)*** significance by implementing the following mitigation measures:

- Use local contractors if practicable;
- Encourage the use of local labour and the purchase of local goods, materials and services by contractors;
- Implement mitigation measures described in the rest of chapter 7.0 above;
- Include local community skills development as part of the mine's social and labour plan (SLP).

7.13.2 Operation

The operational phase will provide employment for 16 skilled and 106 semi-skilled and unskilled workers and the wage bill will be about R31 million per annum. Given the levels of unemployment and the age distribution of the local population, a potential workforce is available in the area.

Operational cost is projected at about R96 million in year 1, and R815 million per annum under steady state conditions after 5 years. The initial capital expenditure will be about R740 million and steady state annual replacement capital will be R59 million.

Samancor will introduce a skills development scheme for community learners to undergo institutional and/or workplace training and assessment. Upon successful completion a learner will receive a competency certificate. It is Samancor's intention that 10% of the total workforce will be employed from the local community in the first year of operations, increasing to 20% in year 2 and 30% by the end of year 3.

The mining operations will sterilise grazing and agricultural land within the 600 metre blast zone until the affected areas have been rehabilitated. The road connecting Mantserre Village with Union Mine may also be affected. Stakeholders have voiced concerns about the increased traffic on the local roads and the generation

of noise and dust. With reference to Figure 7-4 and Figure 7-7, people attending funerals may experience intrusive noise levels, especially during a blast, although the effect of the latter will last for a few seconds only.

The proposed chrome ore mining operation on Nooitgedacht and Varkensvlei is a relatively small operation within the context of the socio-economic characteristics of the North West Province and the Bojanala District Municipality as described in section 4.13 and, taking all factors into consideration, the potential socio-economic impact is assessed as being ***positive of low (SP = +18)*** significance. The following measures are recommended to enhance the positive impact to one of ***moderate (SP = +39)*** significance:

- Maintain communication and consultation with local residents;
- Establish and maintain a complaints procedure and complaints register;
- Employ local people as far as practicable; and
- Purchase materials, goods and services locally as far as practicable.

7.13.3 Closure and rehabilitation

The negative impact of the loss of jobs and the sharp reduction of local expenditure at mine closure will be countered over time by the rehabilitation of the mined out areas. The overall impact is assessed as ***negative and of moderate (SP = 60)*** significance. The following mitigation measures are recommended to change it to a ***positive*** impact of ***moderate (SP = +33)*** significance:

- Proactive skills development and training of employees to enhance their value in the labour market and thereby their chances of finding employment after mine closure;
- Development of a retrenchment plan in consultation with employees, starting at least five years before closure;
- Assisting redundant employees to find alternative employment as far as practicable;
- Focusing specifically on sustainable community projects in the SLP, i.e. projects that will remain viable without continued support from Samancor;
- Leaving intact such infrastructure as can be used by local communities, after consultation with the communities;
- Diligent application of the rehabilitation plan as set out in the mine's closure plan and as recommended in section 7.6.3;
- Monitoring the results of land rehabilitation for at least five years after closure or until the vegetation has become demonstrably self-sustaining.

7.14 Waste Management

The construction, operational and closure/rehabilitation activities will give rise to waste materials which, if not properly managed, could cause pollution of air, soil, surface water and groundwater.

Wastes other than mining residues are typically generated in small enough quantities to be stored in skips until they can be removed for recycling or disposal, and there will be no need to construct lined waste management facilities at Varkensvlei for such wastes.

7.14.1 Construction

Typical wastes produced during construction activities include unused concrete mix, oils, lubricants, paints, solvents, packaging materials, general domestic waste and offcuts of building materials such as steel, wood, glass and tiles. If stored or discarded on open ground, hydrocarbons will cause soil contamination and possibly groundwater pollution, an impact rated as being of ***moderate (SP = 64)*** significance.

The following mitigation measures are recommended to reduce the impact to one of ***Low (SP = 10)*** significance:

- Sort the wastes and store in separate skips or other containers for hydrocarbons, recyclable materials and non- recyclable materials. Recyclable materials should be sorted into wood, steel, glass, plastic, paper and used oil, and stored in separate containers;
- Have recyclable wastes removed by responsible recyclers; and
- Have non-recyclable wastes removed by reputable contractors for disposal at appropriately licensed landfills.

7.14.2 Operation

In terms of the National Environmental Management Amendment Act 2014 mining residues are classified as wastes and must be managed as prescribed by the National Environmental Management: Waste Act of 2008 and its Regulations GN R.632 and R.633, which commenced on 24 July 2015. The wastes referenced in section 7.14.1 above will also be produced during the operational phase and must be managed as described above.

No representative samples of the ore, waste rock or tailings expected to emanate from the mining operations on Varkensvlei were available for geochemical testing and characterisation, but Samancor Chrome provided extensive chemical analyses for similar materials from their Western Chrome Mines.

Based on the assumption that the Varkensvlei materials will have similar chemical analysis, a tentative classification of the mining residues at Varkensvlei has been undertaken, See Table 7-13 and Table 7-14.

Table 7-13: Classification of mining residues based on total concentrations

	Units	GN R.635 levels of thresholds for total concentrations			Total Concentration (TC)		
		TCT0	TCT1	TCT2	Waste Rock	Silt	Tailings
Cr^{6+}	mg/kg	6.5	500	2000	0.3	0.3	0.3
Cu	mg/kg	16	19500	78000	26	43	28
Ni	mg/kg	91	10600	42400	60.2	237.3	100.9
Pb	mg/kg	20	1900	7600	5	21	5

Notes

Grey: >TCT0; Yellow: >TCT1; Red: >TCT2

Table 7-14: Classification of mining residues based on leachable concentrations

PCOC	Unit	GN R.635 levels of thresholds for leachable concentrations				Leachable Concentration (LC)		
		LCT0	LCT1	LCT2	LCT3	Waste Rock	Silt	Tailings
TDS	mg/l	1000	12500	25000	100000	5392	6602	5710
SO_4	mg/l	250	12500	25000	100000	1.58	29.88	9.25
Cr^{6+}	mg/l	0.05	2.5	5	20	0.04	0.009	0.031
Ni	mg/l	0.07	3.5	7	28	0.094	0.392	0.204
Pb	mg/l	0.01	0.5	1	4	0.005	0.016	0.006

PCOC	Unit	GN R.635 levels of thresholds for leachable concentrations				Leachable Concentration (LC)		
		LCT0	LCT1	LCT2	LCT3	Waste Rock	Silt	Tailings
Mn	mg/l	.5	25	50	200	0.385	3	0.943

Notes:

Grey: >LCT0; Yellow: >LCT1; Orange: >LTC2; Red: >LCT3

All of the mining residues have at least one constituent with total and/or leachable concentrations in excess of the initial concentration thresholds (TC > TCT0 and/or LC > LCT0), meaning that they classify as Type 3 wastes, which would normally require the waste storage facilities to be constructed with a Class C liner, which includes finger drains, a HDPE geomembrane, a clay layer and an under-drainage system – see schematic illustration in Figure 7-9.

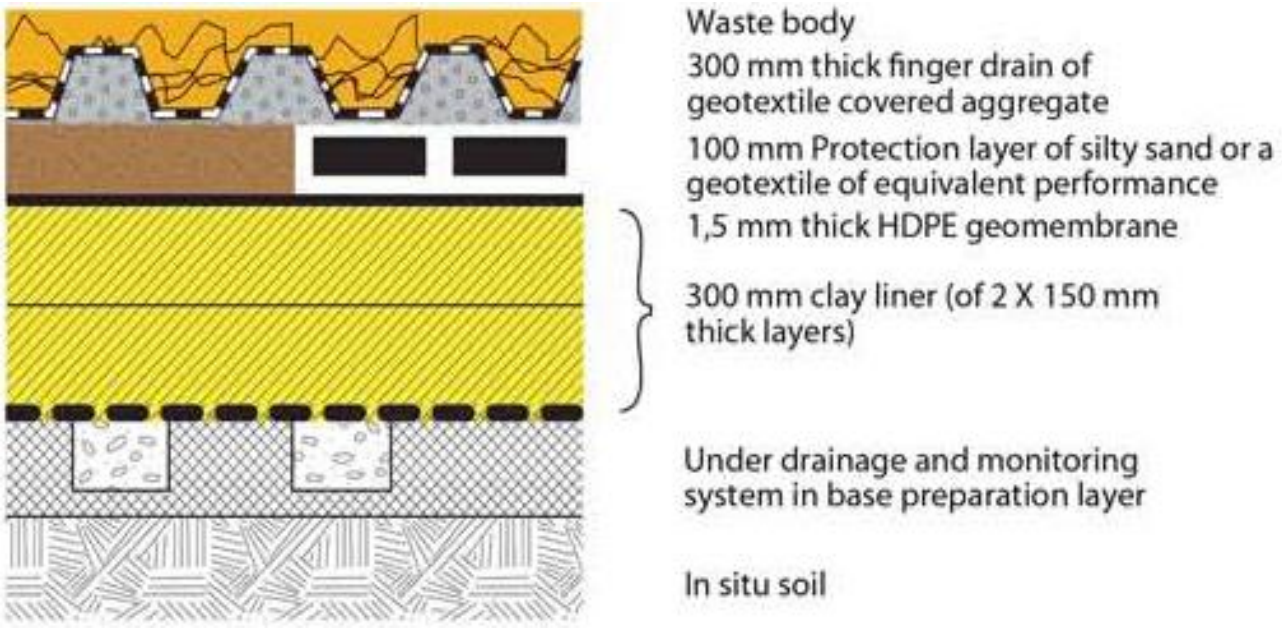


Figure 7-9: Class C barrier design

Based on the above tentative waste classification, the potential for pollution of the soil, surface water and groundwater is assessed as being of ***high (SP = 75)*** significance. The following mitigation measures are recommended to reduce the impact to one of ***low (SP = 22)*** significance:

- Manage waste in accordance with Regulation GN R.634;
- Undertake regular inspection and maintenance of waste management facilities;
- Monitor groundwater and surface water quality down-gradient of waste management facilities; and
- Take such corrective action as may be required.

7.14.3 Closure and rehabilitation

Wastes expected to result from the decommissioning and rehabiltation activities include scrap metals, building rubble, oils, lubricants, paints, solvents, contaminated soils, PCD dam silt and liners, tailings dam, waste rock dump and potentially recyclable materials such as steel, wood, plastics, glass and tiles. If stored or discarded on open ground, hydrocarbons will cause soil contamination and possibly groundwater pollution, an impact rated as being of ***moderate (SP = 64)*** significance.

The following mitigation measures are recommended to reduce the impact to one of ***Low (SP = 10)*** significance:

- Identify areas of possible soil contamination, sample such areas, analyse and determine degree of soil contamination. Remove and dispose of soil with contamination levels exceeding then prevailing standards/gudelines;
- Remove silt, synthetic liners and contaminated non-synthetic liner materials from PCD and dispose at appropriately licenced landfill. Liner materials and building rubble with contamination levels below prevailing standards/gudelines may be backfilled into the last portion of the opencast void;
- Sort the remaining wastes and store in separate skips or other containers for hydrocarbons, recyclable materials and non- recyclable materials. Recyclable materials should be sorted into wood, steel, glass, plastic, paper and used oil, and stored in separate containers;
- Have recyclable wastes removed by responsible recyclers; and
- Have non-recyclable wastes removed by reputable contractors for disposal at appropriately licensed landfills.

8.0 SUMMARY OF ENVIRONMENTAL IMPACTS

8.1 Construction Phase

Table 8-1 below summarises those impacts directly related to the Construction Phase of the proposed project, and provides a significance rating for each impact before and after mitigation.

Table 8-1: Environmental Impact Assessment Matrix for the construction phase of the proposed mining project on the farm Varkensvlei 403 KQ

POTENTIAL ENVIRONMENTAL IMPACT: CONSTRUCTION PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	SP	Rating	M	D	S	P	SP	Rating
1. Geology												
Excavation of dam basin and water conveyance channels will disturb near- surface geology	2	2	1	5	25	Low	2	2	1	5	25	Low
2. Air Quality												
Excavation of dam basin and channels, clearing of vegetation, topsoil stripping and construction of the diversion berms, haul road and general infrastructure will cause mobilisation of particulates and emissions from vehicles	6	2	3	5	55	Mod	2	2	2	2	12	Low
3. Topography												
Establishment of diversion berms and excavation of dirty water collection channels and the storm water control dam will cause localised changes in the topography of the project area	4	3	1	5	40	Mod	4	3	1	5	40	Mod
4. Soil, Land Use and Land Capability												
Establishment of surface infrastructure will change the land use over an area of about 26 ha and could potentially cause loss of soil and contamination with hydrocarbons.	6	4	1	5	55	Mod	4	4	1	4	36	Mod
5. Ecology												
Essentially all vegetation will be stripped from an area of about 26 hectares and fauna will be disturbed in adjacent areas	4	4	1	5	45	Mod	2	4	1	5	35	Mod
6. Surface water												

POTENTIAL ENVIRONMENTAL IMPACT: CONSTRUCTION PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	SP	Rating	M	D	S	P	SP	Rating
Potential for pollution of Bierspruit due to runoff contaminated by silt and accidental spillage of hydrocarbons and chemicals	8	2	3	5	65	Mod	4	2	3	3	27	Low
7. Groundwater												
Contamination through spillages and poor sanitation practices by construction workers	6	3	3	4	48	Mod	2	2	3	3	21	Low
8. Noise												
Increase of noise levels at public receptor points due to noise generated by construction equipment	6	2	2	5	50	Mod	4	2	2	3	24	Low
9. Blasting												
No blasting required, no impact	0	0	1	0	0	None	0	0	1	0	0	None
10. Visual Aspects												
Earthmoving activities can cause highly visible dust plumes in daytime and lighting could cause visual impact at night	8	2	3	5	65	Mod	4	2	3	3	27	Low
11. Sites of Archaeological and Cultural Significance												
No impacts expected, but chance finds with potentially high impacts could occur	10	5	1	5	80	High	4	2	1	3	21	Low
12. Socio-economic												
Limited local spend and job creation potential; potential inconvenience due to dust, noise and traffic	2	2	3	3	21	Low	2	2	3	2	+14	Low
13. Waste Management												
Quantities will be small and will be safely stored in skips until removed for disposal	8	4	2	4	56	Mod	2	2	1	2	10	Low

8.2 Operational Phase

Table 8-2: Environmental Impact Assessment Matrix for the operational phase of the proposed infrastructure on the farm Varkensvlei 403 KQ

POTENTIAL ENVIRONMENTAL IMPACT: OPERATIONAL PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	SP	Rating	M	D	S	P	SP	Rating
1. Geology												
The mineable chromitite seams will be removed by the mining operations, resulting in a permanent geological impact, reduced to some degree by backfilling if done correctly.	10	5	1	5	80	High	8	5	1	5	70	Mod
2. Air Quality												
Drilling, blasting, ore haulage, crushing, screening, product transport, backfilling and rehabilitation will cause PM_{10}, dust fall and small quantities of SO_2 and NO_x to be emitted	8	4	3	5	75	High	4	4	2	3	30	Mod
3. Topography												
The usual large and permanent changes caused by opencast mining will be greatly reduced by the rollover method of mining	10	5	2	5	85	High	4	3	2	5	45	Mod
4. Soil, Land Use and Land Capability												

POTENTIAL ENVIRONMENTAL IMPACT: OPERATIONAL PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	SP	Rating	M	D	S	P	SP	Rating
Inappropriate stripping and storage of topsoil could result in contamination and/or loss of a substantial quantity of topsoil	8	4	1	5	65	None	4	4	1	4	36	Mod
5. Ecology												
The mining operations will involve the stripping of 1285 ha of vegetation, temporary covering of 28 ha with stockpiles, and cause disturbance of fauna in the surrounding areas	8	4	2	5	70	Mod	6	4	2	3	36	Mod
6. Surface water												
Contaminated runoff due to spillages of hydrocarbons and/or chemicals, overflow of PC dam, silt wash from topsoil and overburden stockpiles.	8	2	3	4	52	Mod	6	2	3	3	33	Mod
7. Groundwater												
Mine dewatering will lower groundwater table and blasting may cause contamination with nitrates. Spillages of fuels, lubricants, hydraulic fluids and chemicals may cause contamination and acid formation has not been ruled out. Although the content of sulphide minerals in the ore is low and the potential for acid generation is believed to be very low, this has not been confirmed by detailed geochemical testing on materials sourced from Varkensvlei.	8	4	3	5	75	High	6	4	3	3	39	Mod
8. Noise												
Noise typical of opencast mining operations will be generated at the pit, haul road and ore beneficiation plant	10	4	3	5	85	High	6	4	2	4	48	Mod
9. Blasting												
Sound pressure levels exceeding 70 dB for 3 seconds at 900 m. Fly rock unlikely but possible at 600 m. Vibration exceeding 12.5 mm/sec at structures possible	10	4	3	5	85	High	6	4	3	4	52	Mod
10. Visual Aspects												
The operational phase will involve earth-moving and night-time operations on a larger scale than the construction phase and could potentially have a greater visual impact	10	4	3	5	85	High	6	4	3	4	52	Mod
11. Sites of Archaeological and Cultural Significance												
No impacts expected, but chance finds with potentially high impacts could occur	10	5	1	5	80	High	4	2	1	3	21	Low
12. Socio-economic												
Creation of 122 jobs and annual expenditure of R815 million (of which R96 million in wages). Noise, dust, traffic and temporary loss of grazing and cropland	2	4	3	2	+18	Low	6	4	3	3	+39	Mod
13. Waste management												
If waste classification is correct, inappropriate waste management is likely to result in soil, groundwater and surface water pollution	8	4	3	5	75	High	4	4	3	2	22	Low

8.3 Decommissioning, closure and rehabilitation phase

Table 8-3: Environmental Impact Assessment Matrix for the decommissioning, closure and rehabilitation phase of the proposed infrastructure on Varkensvlei 403 KQ

POTENTIAL ENVIRONMENTAL IMPACT: CLOSURE AND REHABILITATION PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	SP	Rating	M	D	S	P	SP	Rating
1. Geology												
The closure and rehabilitation phase will not have any impact on the geology	0	5	2	0	0	None	0	5	2	0	0	None
2. Air Quality												
Particulate mobilisation can be caused by the Demolition of buildings, handling of rubble, backfilling of storm water dam and dirty water collection channels and ripping and shaping of compacted areas have potential for particulate mobilisation .	6	2	3	5	55	Mod	4	2	2	3	24	Low
3. Topography												
Backfilling the last void with the last of the stockpiled overburden and covering with topsoil will restore the original topography	0	5	1	0	0	None	0	5	1	0	0	None
4. Soil, Land Use and Land Capability												
Backfilling the last void, water collection channels and basin of the storm water control dam and ripping, top-soiling, fertilising and re-vegetating the compacted areas will largely restore soil function	4	5	1	5	50	Mod	2	5	1	3	24	Low
5. Ecology												
Backfilling voids, and ripping, top-soiling, fertilising and re-vegetating compacted areas will largely restore ecology of project area	4	4	1	4	36	Mod	4	3	1	2	16	Low
6. Surface water												
Erosion from barren surfaces, spillage of hydrocarbons and other contaminants	8	2	3	4	52	Mod	6	2	3	3	33	Mod
7. Groundwater												
Spillage of hydrocarbons and other contaminants. Changed hydraulic conductivity can make groundwater more susceptible to pollution.	10	4	3	5	85	High	6	4	3	3	39	Mod
8. Noise												
Similar activities and noise levels as during construction phase	6	2	2	5	50	Mod	4	2	2	3	24	Low
9. Blasting												
No blasting required, no impact	0	0	1	0	0	None	0	0	1	0	0	None
10. Visual Aspects												
Similar activities and visual effects as during construction and last mining cut	8	2	3	5	65	Mod	4	2	3	3	27	Low
11. Sites of Archaeological and Cultural Significance												
Closure and rehabilitation activities cannot affect any sites of archaeological or cultural significance	0	0	1	0	0	None	0	0	1	0	0	None
12. Socio-economic												

POTENTIAL ENVIRONMENTAL IMPACT: CLOSURE AND REHABILITATION PHASE	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	SP	Rating	M	D	S	P	SP	Rating
Negative impacts of job losses and reduced local expenditure will be countered by mitigation measures and rehabilitation	8	4	3	4	60	Mod	4	4	3	3	+33	Mod
13. Waste management												
If waste classification is correct, inappropriate waste management during the decommissioning and closure phase could lead to soil, groundwater and surface water pollution	8	4	3	5	75	High	4	4	3	2	22	Low

9.0 ENVIRONMENTAL IMPACT STATEMENT

9.1 Key findings: Potential cumulative environmental impacts

The following potential cumulative impacts were identified and assessed:

9.1.1 Geology

The LG6 and LG6A chromitite seams will be removed by the mining operations, resulting in a significant, permanent and irreversible impact on the local subsurface geology. This may be viewed as a cumulative geological impact on the remaining chrome ore deposits in the region. No mitigation is possible or required.

9.1.2 Air quality

As stated in section 4.4, daily SO_2 and PM_{10} concentrations in the region frequently exceed the National Ambient Air Quality Standards (NAAQS), but dust fall is well within the regulated standards. As noted in section 7.3.3, the proposed mining operations will contribute mainly particulates, which are relatively easy to keep under control and dispersion modelling was not considered to be necessary. The operations are not expected to have a significant cumulative effect on the year-round regional air quality or the dust fall at off-site locations.

9.1.3 Soil, land use and land capability

As described in sections 5.0 and 7.6.2, vegetation and topsoil will be stripped from some 1 285 ha of land over the life of the mine, at about 102 ha per boxcut, but the application of the rollover method of mining, with continuous concurrent rehabilitation, will provide significant mitigation and it is expected that the entire area can be restored to a condition fit for grazing.

9.1.4 Ecology

The area was used for crop cultivation and grazing about 20 to 35 years ago and is dominated by pioneer grass species, exotic herbaceous species and *Acacia mellifera* in some parts. Field observations indicate that fire has been used unsuccessfully to try and control bush encroachment by *Acacia mellifera*. Previous and current mining activities have impacted slightly upon the south eastern part of the site.

The proposed mining operations will have a significant cumulative ecological impact. Due to the destruction of their habitat, the current faunal population in the project area will have to relocate until suitable habitat has been restored by the rehabilitation programme. However, ongoing rehabilitation in accordance with the rollover mining method will result in less than half of the aforementioned 1 285 ha being bare at any particular time during the life of the mine.

9.1.5 Surface water

The mining and ore processing activities could result in runoff with a high silt load and contaminants such as fuel, hydraulic fluids, and chemicals. The topsoil and overburden stockpiles could contribute to the silt load. Runoff from the TSF may also contain elevated concentrations of the major cations Na, K, Ca, and Mg and

the anions SO_4 and Cl. The pollution control dam may overflow during high rainfall events, but under such conditions the concentration of contaminants in the runoff would be diluted

9.1.6 Groundwater

The mining activities described in section 7.1.2 will result in a lowering of the local groundwater table due to necessary mine dewatering and groundwater contamination with nitrates due to blasting. The effects of dewatering will be in addition to that caused by the mining operations of Bushveld Chrome Resources (BCR) and Anglo Platinum's Union Mine.

Samancor's mining and ore processing activities could also result in groundwater contamination due to spillages of fuels, lubricants, hydraulic fluids and chemicals unless appropriate mitigation measures are implemented. The content of sulphide minerals in the ore is low and the potential for acid generation is believed to be very low, but this has not been confirmed by detailed geochemical testing.

9.1.7 Noise

The proposed mining operations will contribute to the existing noise levels in the area. The noise from the mining machinery will be audible, but will not exceed the daytime level for urban districts, beyond the 600 m blast zone boundary and at some sensitive areas along the way as the mining front moves along the length of the ore deposit. If opencast mining operations are undertaken during the night time, exceedances of all but the guidelines for industrial districts would be experienced and the noise levels at the nearest sensitive areas would be objectionable.

9.1.8 Blasting and vibration

Blasting impacts due to the proposed mining operations would be cumulative to impacts of blasting at the nearby Union and BCR mines. At a distance of 900 metres from the blast a sound level of about 70dB would be experienced for about 3 seconds. Blasting will take place once a week and air blast sound pressure levels of 60 to 70 dB may be expected in some parts of Bierspruit Village, Union Mine Village and Mantserre as the opencast mining operations progress from the north-east to the south-west along the orebody.

Vibration measurements taken during construction and initial blasting operations will be used to design subsequent blasts with the objective of avoiding PPVs in excess of 10 mm/sec, the level at which poorly constructed buildings may begin to suffer structural damage, at any off-site structures.

Underground blasting will cause ground vibration, but no fly rock or air blast effects. Blasts will be designed to minimise the potential for fly rock and standard safety measures will be applied.

9.1.9 Visual

The project will add to the existing visual impact due to human activities in the area. The mine's surface infrastructure, moving vehicles and occasional dust plumes will be visible during the daytime and both fixed and moving lights will be visible during the night-time.

9.1.10 Heritage

No impact on heritage resources is expected. There are no known heritage resources within the mine-affected area, but the possibility of unearthing buried resources during construction and mining operations cannot be ruled out, nor can the possibility of vibration or fly rock damage at the graveyard in Mantserre Village.

9.1.11 Socio-economic

Local residents will experience negative cumulative impacts such as noise, dust, traffic, visual and population influx, but also modest positive impacts resulting from job creation and expenditure on local goods and services.

9.1.12 Waste management

The mining residues (waste rock and tailings) arising from mining operations on Varkensvlei would add to the impacts from existing mining residues from the nearby Bushveld Chrome Resources (BCR) and Anglo

Platinum's Union Mine. If the Varkensvlei mining residues are similar to those at Samancor's Western Chrome Mines near Mooinooi, they will classify as Type 3 wastes and the storage facilities would need to be appropriately lined to protect against the potential contamination of the soil and the groundwater with Na, K, Ca, Mg, SO_4 and Cl.

Other wastes will be stored in skips until they can be removed for recycling or disposal, and there will be no need to construct lined waste management facilities at Varkensvlei for such wastes.

9.2 Final site maps

See Figure 2-2, Figure 2-4, Figure 2-5 and Figure 2-6.

9.3 Summary of positive and negative implications and risks of proposed activity and alternatives

As described in section 7.0 of this EIA/EMPr report, the proposed mining project will, if properly managed, have a nett positive socio-economic impact within the Moses Kotane Local Municipality and the Bojanala District Municipality, and negative, but acceptable impacts on the local ecology, soil, groundwater, surface water, visual aspects and noise regime. The risks include inadequate restoration of soil properties and ecological function, and contamination of surface water and groundwater.

9.4 Impact management objectives and outcomes for inclusion in the EMPr.

The impact management objectives and outcomes for the proposed Varkensvlei mining project are as follows:

- To maximise the positive and minimise the negative socio-economic impacts;
- To capture, contain, treat and recycle all contaminated water arising from the mining and ore processing operations on site and to prevent the discharge of contaminated water to the environment;
- To prevent the ingress of leachate from the waste rock stockpiles and tailings storage facility into the soil and groundwater by appropriate engineering design, construction and management in terms of GN R.633 to R.636;
- To avoid surface subsidence due to roof collapse in the underground workings by taking the physical characteristics of the overlying rock into account when designing the underground mine layout in order to ensure long term stability of the overlying rock by an adequate safety factor. More detailed geological and rock mechanical studies will be undertaken ahead of the advancing front of the underground operations and adequate underground pillars will be left to provide the required stability.
- To carry out blasting in a manner that will avoid fly rock damage, air blast noise exceeding 120 dB and surface vibrations with a particle acceleration of more than 12 mm/second at any receptor. Blasts will be monitored and the results will be taken into account when designing subsequent blasts;
- To avoid PM_{10} concentrations exceeding 75µg/m^3 in the local airshed for reasons of public health and to avoid exceeding the national standards for ambient air quality that were set by the publication of Government Notice 1210 in Government Gazette no 32816 on 24 December 2009. Wet suppression will be applied during drilling, after blasting and during transport over unpaved surfaces, and air quality will be monitored;
- To manage the stripping, stockpiling and re-placement of topsoil, subsoil, overburden and waste rock in such a manner that the original layering sequence is restored, while the loss of topsoil is minimised and its essential properties are retained;
- To rehabilitate the disturbed areas to a condition fit for grazing and the resumption of ecological function;
- To soften the visual impact of the project by applying the recommended mitigation measures; and

- To maintain cordial relationships with local residents, authorities and other stakeholders *via* sustained open communication.

9.5 Final proposed alternative

The final preferred site location and layout as shown in Figure Figure 2-2, Figure 2-4 and Figure 2-6 was chosen to minimise the cost of accessing the chrome ore, to avoid placing structures near floodlines and to minimise the impacts on sensitive receptors and the biological environment. As described in section 6.7, a site and layout selection process considering all relevant factors was undertaken.

9.6 Aspects for inclusion as conditions of authorisation

The conditions of authorisation should include:

- Adherence to the EMPr in sections 10.0 to 13.0 of this document;
- Annual internal auditing of environmental performance; and
- Bi-ennial external auditing of environmental performance and providing the DMR with a copy of the audit report.

9.7 Assumptions, uncertainties and gaps in knowledge

The EIA was limited to the scope of the assessment described in detail in sections 4.0 and 7.0 of this document.

Information on the mineral resources, reserves, projected capital and operating costs, mine life and production rates was sourced from Samancor's Mining Work Programme (MWP), which was prepared by Samancor (McManus, D; Thabo, E F;, 2015) in terms of the MPRDA.

Some information sourced from the Social and Labour Plan compiled by Samancor was used to inform the socio-economic impact study.

Although all efforts were made by the EIA project team to identify all environmental, social and health aspects, impacts and mitigation measures, errors and omissions may have occurred. The Environmental and Social Management System (ESMS) that was developed as part of the EIA process encompasses a live database that can be adapted and updated should additional information, aspects or impacts be identified. The objective of the ESMS will be for the Samancor project team to continually improve environmental and social performance. In addition, according to South African legislation, the EMPr will need to be updated or amended with new information whenever significant changes are made during the life of the Project.

Every effort has been made to engage stakeholders to the extent possible, however not every stakeholder may have been consulted or their comments may not have been recorded accurately. A grievance mechanism will be established through which stakeholders are able to raise grievances and continue to contribute their concerns and issues to the Samancor Project team.

9.8 Opinion on whether the activity should be authorised

Provided that all the environmental management measures described in the EMPr are applied diligently, the proposed mining and processing of chrome ore within the area shown on Figure Figure 2-2 will have no environmental impacts that cannot be adequately mitigated to protect the environment and local human receptors, and authorisation of Samancor's application would be justified on the basis that the positive effects of the project are likely to outweigh the remaining negative impacts.

Not granting this authorisation will not necessarily result in the chrome ore reserves remaining in the ground permanently. As long as there is a demand for chrome ore, coupled with economically viable mineability of these reserves, there will be a drive to mine them.

9.9 Conditions that must be included in the authorisation

9.9.1 General conditions

Samancor must:

- Implement all aspects of the EMPr in sections 10.0 to 13.0 of this document;
- Comply with all relevant legislation at all times;
- Undertake bi-annual internal auditing of environmental performance and annual reporting to the DMR; and
- Undertake bi-ennial external auditing of environmental performance and provide the DMR with a copy of the audit report.

9.9.2 Specific conditions

Samancor must:

- Undertake numerical modelling of groundwater movement to estimate ingress of groundwater into the mine and the surrounding cone of depression resulting from mine dewatering. The results must be submitted to the DMR and the DWS in the form of a supplementary groundwater report.
- Provide engineering designs for the TSF and pollution control dam, waste rock dumps, RoM storage pad, and pollution control dam, based on solute transport modelling and risk assessment; The design report must be submitted to the DMR and the DWS;
- Capture, contain, treat and recycle all contaminated water arising from the mining and chrome ore processing operations on site and prevent the discharge of contaminated water to the environment;
- Prevent the ingress of leachate from the waste rock stockpiles and the tailings storage facility into the soil and groundwater by appropriate engineering design, construction and management in terms of GN R.633 to R.636;
- Avoid surface subsidence due to roof collapse in the underground workings by taking the physical characteristics of the overlying rock into account when designing the underground mine layout in order to ensure long term stability of the overlying rock by an adequate safety factor. More detailed geological and rock mechanical studies must be undertaken ahead of the advancing front of the underground operations and adequate underground pillars must be left to provide the required stability;
- Undertake blasting in a manner that will avoid fly rock damage, air blast noise exceeding 120 dB and surface vibrations with a particle acceleration of more than 12 mm/second at any off-site receptor. Blasts must be monitored and the results must be taken into account when designing subsequent blasts;
- Apply wet suppression during drilling, after blasting and during transport over unpaved surfaces, and monitor air quality in the vicinity of the site; and
- Manage the stripping, stockpiling and re-placement of topsoil, subsoil, overburden and waste rock in such a manner that the original layering sequence is restored, while the loss of topsoil is minimised and its essential properties are retained.

9.9.3 Rehabilitation requirements

Samancor must seal off the decline and ventilation shafts and rehabilitate the project- affected area on the surface to a self-sustaining state that is fit for grazing and the resumption of ecological function.

9.10 Period for which environmental authorisation is required

The planned life of the mine, based on the proven chrome ore reserves, is estimated to be 30 years, which will involve about 7years of opencast mining, followed by about 22 years of underground mining. To

accommodate the time needed for construction, mine development, production ramp up, closure and rehabilitation, the authorisation is required for a period of 35 years.

9.11 Undertaking

It is confirmed that the undertaking required to meet the requirements of this section is provided at the end of the EMPr and is applicable to both the EIA Report and the EMPr Report

9.12 Financial Provision

The complete closure plan (Bothma, J; Brown, S A P;, January 2016), without financial amounts, is attached in APPENDIX G to this report. The amount will be included in the report submitted to the DMR.

The approach to the determination of the closure costs can be summarised as follows:

- Background information, including aerial images, layout drawings and technical studies, was gathered from Samancor;
- The battery limits and most likely closure situation were confirmed with Samancor;
- Closure costs were determined for the scheduled closure situation only, as this will be a greenfield project and no site activities have taken place yet. The base date for scheduled closure was taken as 2047;
- It was assumed that the decommissioned and rehabilitated site will be returned to a state fit for grazing, consistent with the adjacent areas;
- It was assumed that a third party contractor would undertake the closing, dismantling and rehabilitation-related work, i.e. market-related contractor rates were applied;
- Allowance was made for specialist contractors and consultants to conduct post-closure care and maintenance work as well as compliance monitoring;
- In accordance with the DMR guideline, no cost off-sets due to possible salvage values were considered and only gross closure costs are reported;
- Fixed ratios for Preliminary and General costs were applied in accordance with the DMR guidelines;
- No allowance was made for post closure water treatment, as groundwater inflow into the mine is expected to continue for many years. During this time there would not be any outward migration of contaminated groundwater from the mine into the shallow aquifer that is currently tapped for groundwater and it is uncertain to what extent it will be necessary to abstract and treat contaminated mine water;
- No allowance was made for the removal and disposal of underground infrastructure.
- It was assumed that all non-provincial paved roads constructed for the project and that are not access roads to residential areas will have to be rehabilitated;
- Allowance was made to shape and level disturbed areas to be free draining and contoured to minimise erosion.
- It was assumed that waste rock and tailings will be backfilled into the opencast void;
- It has been assumed that growth medium for the rehabilitation of the infrastructural areas will have been pre-stripped to a depth of 500 mm during the construction phase and that this material will have been stockpiled within 1 km from the site;
- As a precautionary measure, an additional allowance has been made for the establishment of a borrow pit within 5 km from the site to provide additional material for general surface rehabilitation in the event of a shortfall of pre-stripped material;

- It has been assumed that all RoM, waste rock, tailings, PCD sediment and chrome ore product will have been removed prior to decommissioning;
- It is assumed that demolition waste, such as concrete and building rubble, will be largely inert and that it will be disposed of on the discard dump or at a registered waste site;
- As a precautionary measure it has been assumed that no beneficial reuse of the asphalt recovered from the paved roads is possible and this material has to be safely disposed off-site at a hazardous waste facility;
- Hydrocarbon contaminated soil from the plant area, for example diesel spillages at workshops and storage facilities will be disposed at Holfontein Hazardous Waste Disposal Facility; and
- Allowance has been made for care and maintenance as well as surface and groundwater quality monitoring to be conducted for a minimum period of 5 years to ensure and assess success of the implemented rehabilitation and closure measures.

Ongoing concurrent rehabilitation during the operational life of the project is included in the budget for operating costs and is included in the Mining Work Programme. The estimated closure cost at the end of the project's life will be reflected as a liability in the company's financial accounts and financial provision for immediate closure will be funded by means of a bank guarantee.

9.13 Deviations from approved scoping report and plan of study

There are no deviations from the scoping report and plan of study as submitted to the DMR on 5 November 2015.

9.14 Other information required by the DMR

9.14.1 Impact on socio-economic conditions of any directly affected person

The most directly affected people will be the landowners on whose land the mining will take place and the surface infrastructure will be established (see Table 2-3 for the farm portions and landowners) and the residents of Anglo Platinum's Swartklip mining complex and staff village, located about 900 metres south-east, the village of Mmopyane about 1 100 metres north-west and the village of Mantserre about 600 metres to the north of the proposed mining area on Varkensvlei. The proposed mining operations on Nooitgedacht will affect the residents of Bierspruit Village, about 800 metres to the north and Anglo Platinum's Swartklip mining complex and staff village about 600 metres to the south of the opencast perimeter.

The impacts on the socio-economic conditions of the above receptors are described in detail section 7.0 of this report and are summarised here as follows:

- **Air quality:** Receptors down-wind of the opencast mine and the TSF may experience moderately increased PM_{10} and $PM_{2.5}$ concentrations and increased dust fall on windy days. The prevailing seasonal and diurnal wind directions are shown in Figure 4-5 to Figure 4-7;
- **Soil, land use and land capability:** The landowners will be unable to continue current use of the 26 ha site where Samancor proposes to establish the infrastructure until closure and rehabilitation has been completed after about 30 years. As described in section 2.5 of this report, the opencast pit will be continuously backfilled and rehabilitated as the mining front advances and the loss of land use at any given point along the length of the opencast will last for about 2 years. The land is currently used sparingly for grazing and the overall socio-economic impact of the temporary loss of use will be low;
- **Groundwater:** Eight boreholes, six of which are currently used for domestic purposes, were identified during the hydrocensus (Table 4-15). The users may experience a drop in yield to varying degrees as a result of mine dewatering. Samancor will engage with potentially affected groundwater uses timeously to mitigate such effects;
- **Noise:** As described in sections 7.9 and 7.10 of this report, receptors along the approximately 7 km length of the opencast mine may experience low to moderate noise, air blast and vibration levels. Such

levels are not expected to exceed national or international standards and guidelines, but some individuals may feel that their quality of life is being affected;

- **Visual:** As described in section 7.11 of this report, some residents in the vicinity of the mine and infrastructure site are likely to experience a low to moderate visual impact that some might find disagreeable.
- **Economics:** The above negative socio-economic impacts must be weighed against the low to moderate positive impacts associated with job creation, skills development and expenditure on local goods and services as described in section 7.13 of this report.

9.14.2 Impact on any national estate

No impact is expected. The cultural and heritage specialist (see section 7.12 of this report and the complete specialist report in APPENDIX G) did not find any resources in terms of the National Heritage Resources Act 1999 (Act No. 25 of 1999) on or within 600 metres of the infrastructure site.

9.14.3 Other matters required in terms of section 24(4) of the NEMA

This section requires proof of compliance with section 24(4)(b)(i) of the National Environmental Management Act, which section reads as follows:

"24. Environmental authorisations

(4) Procedures for the investigation, assessment and communication of the potential consequences or impacts of activities on the environment -

(b) must include, with respect to every application for an environmental authorisation and where applicable-

(i) investigation of the potential consequences or impacts of the alternatives to the activity on the environment and assessment of the significance of those potential consequences or impacts, including the option of not implementing the activity;"

Please note: An application for environmental authorisation for listed activities associated with opencast mining on Varkensvlei 403 KQ and Nooitgedacht 406 KQ was submitted to the DEA) on 27 February 2013 and an EIA process was undertaken. The DEA granted the environmental authorisation, with Reference Number 14/12/16/3/3/2/524, on 27 March 2015. An application for a water use licence was also submitted. This application is still pending.

Much of the information in this EIA/EMPr Report was sourced from the previous EIA process. Where necessary, the information has been updated.

PART B
ENVIRONMENTAL MANAGEMENT PROGRAMME REPORT

10.0 DRAFT ENVIRONMENTAL MANAGEMENT PROGRAMME

10.1 Details of Environmental Assessment Practitioner

The required details have been supplied in **PART A**, section 2.2 of this report.

10.2 Description of the Aspects of the Activity

See sections 2.3 to 2.5 of this document.

10.3 Composite Map

See Figure 10-1 below, which shows the preferred infrastructure layout and the identified environmental features in the project area and its surrounding areas. The project area does not coincide with any protected or environmentally sensitive areas.

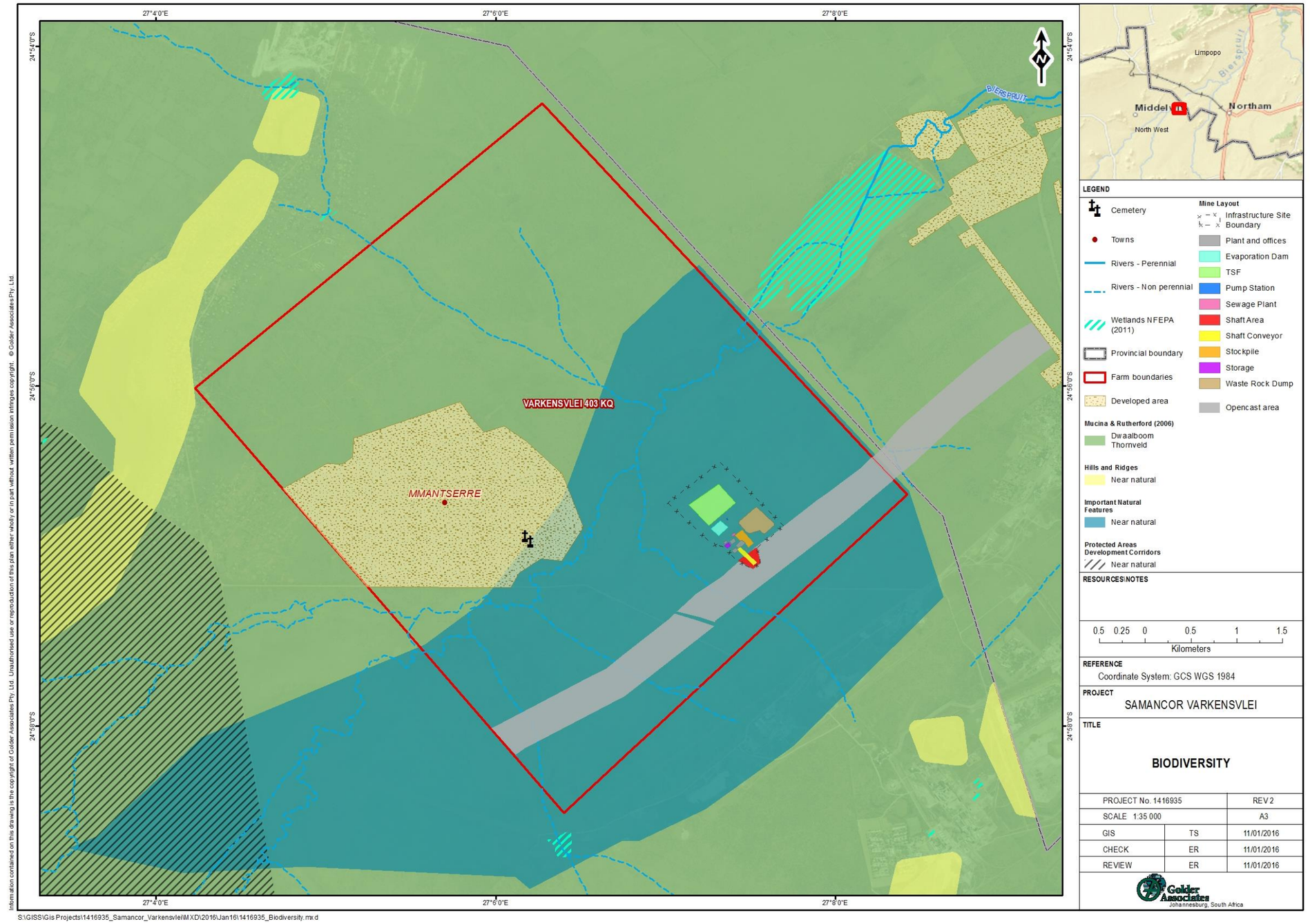


Figure 10-1: Composite map showing environmental features and preferred infrastructure layout

10.4 Impact management objectives and statements

10.4.1 Environmental Quality and managing environmental impacts

Samancor will endeavour to ensure that local environmental quality is not adversely affected by possible physical effects and chemical contamination arising from the mining and ore processing operations, as well as to sustain catchment yield as far as possible following closure, by:

- Limiting dust generation on the rehabilitated infrastructural areas that could cause nuisance and/or health effects to surrounding landowners/communities;
- Conducting dedicated soil surveys over the footprint of the infrastructural site and removing the possible pockets of contaminated soil where it could have occurred;
- Cleaning up of any sources of possible soil contamination still present on the site to protect the downstream receiving environment;
- Monitoring groundwater quality and surface runoff for at least 5 years after closure, longer if warranted by the results; Target water quality objectives will be based on pre-closure groundwater and surface runoff quality up-gradient of the mining and ore processing activities.
- Providing the required measures to limit at source the generation of contaminants which could adversely affect local groundwater quality; and
- Ensuring that the respective rehabilitated areas are free-draining and run-off is routed to local/natural drainage lines.

10.4.2 Potential risk of acid mine drainage

Based on extensive past experience with chrome ores in the western part of the Bushveld Complex, Samancor believes the chrome ore and waste rock will have little to no potential for acid formation, but this has not been confirmed by a detailed geochemical investigation on materials sourced from Varkensvlei. Materials sampled from a similar area showed no potential for acid production. The TSF and the pollution control dam will be lined and water pumped out of the mine workings will be stored in the PCD, tested for acidity and neutralised if necessary before it is used as a dust suppressant. If the tailings are demonstrated over time to be benign, it will be back-filled into the opencast void;

10.4.3 Water Use Licence

Section 21 of the NWA lists the water uses for which a water use licence (WUL) is required. It is expected that the following water uses will be involved at Samancor's Varkensvlei Chrome Mine:

a) *taking water from a water resource* – Groundwater seeping into the opencast and underground workings will be pumped out and used as process water;

b) *storing water* – Runoff from mine-affected areas will be impounded in a pollution control dam and used as process water;

c) *impeding or diverting the flow of water in a watercourse* – The opencast mine will intersect several small drainage lines that exhibit ephemeral flow after heavy rainfall events – see Figure 4-23.

g) *disposing of waste in a manner which may detrimentally impact on a water resource* – Runoff and leachate from the tailings storage facility and the waste rock dump could potentially contaminate surface water and groundwater resources;

i) *altering the bed, banks, course or characteristics of a watercourse* – The opencast mine will intersect several small drainage lines that exhibit ephemeral flow after heavy rainfall events – see Figure 4-23; and

j) *removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people* - Groundwater seeping into the underground workings will be pumped out and used as process water.

10.5 Potential Impacts to be mitigated in their respective phases

The potential impacts and mitigation measures were described in section 7.0. Only those impacts that require mitigation measures are dealt with in this section.

With regard to work outsourced to contractors, e.g. construction, mining, chrome ore transport etc., all contracts will contain clauses committing the contractors and their personnel to adhere to all relevant stipulations of this environmental management programme (EMPr). The contracts will also contain penalty clauses that will allow Samancor to impose fines, recover remediation costs from contractors and to terminate contracts for specified transgressions.

10.5.1 Air quality

10.5.1.1 Construction

The construction activities described in section 7.1.1 will give rise to the mobilisation of particulates (dust and PM_{10}) and emission of exhaust gases from construction vehicles.

The following mitigation measures will be implemented to reduce the assessed impact from one of ***moderate (SP = 55)*** significance to one of ***low (SP = 12)*** significance:

- Wet suppression, applied sparingly, to ensure the absence of visible dust. Chemical binders such as Dustex or Dust-A-Side may also be used, especially on roads;
- Enforcement of low vehicle speeds on unpaved roads (< 30 km/h); and
- Vegetation of the clean water diversion berm and other surfaces that were laid bare as a result of construction with a locally indigenous grass species where possible.

10.5.1.2 Operation

The key emissions during the operational phase will be PM_{10}, $PM_{2.5}$ and TSP (as dust fall) arising from opencast mining and materials handling, transport and stockpiling of RoM ore, and dust entrainment by the wheels of heavy vehicles. Exhaust emissions from the trucks transporting product chrome ore to various destinations will contribute PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO.

The following mitigation measures will be implemented to reduce the assessed impact from one of ***high (SP = 75)*** significance to one of ***moderate (SP = 30)*** significance:

- Wet suppression, applied sparingly, to ensure the absence of visible dust;
- Enforcement of low vehicle speeds on unpaved areas (< 30 km/h);
- The backfilled opencast areas and other bare surfaces will be vegetated with a locally indigenous grass species as soon as possible; and
- Measurement of dust fall by means of dust fall collection buckets as per prescribed methods;

10.5.1.3 Closure and rehabilitation

The closure and rehabilitation activities described in section 7.1.3 will result in the mobilisation of particulates (dust and PM_{10}) and the emission of exhaust gases from vehicles.

Particulate mobilisation can be caused by the demolition of buildings and handling of the rubble, backfilling of the storm water dam and “dirty” water collection channels and ripping and shaping of compacted areas.

The following mitigation measures will be implemented to reduce the assessed impact from one of ***moderate (SP = 55)*** significance to one of ***low (SP = 24)*** significance:

- Wet suppression, applied sparingly, to ensure the absence of visible dust;
- Enforcement of low vehicle speeds on unpaved areas (< 30 km/h);
- Bare surfaces will be vegetated with a locally indigenous grass species as soon as possible; and
- Measurement of dust fall by means of dust fall collection buckets as per prescribe methods until vegetation cover is well established.

10.5.2 Topography

Opencast mining can result in permanent topographical changes of ***high (SP = 85)*** significance by leaving behind large mining voids and stockpiles of overburden and waste rock. Samancor will practice the rollover mining method with continuous backfilling and rehabilitation, which will result in much smaller temporary topographical changes over the life of the mine, thereby reducing the impact to one of ***moderate (SP = 45)*** significance. The surface of the back-filled area will be shaped to be free-draining and to resemble the original contours

When the last section of the opencast void has been backfilled with the last of the stockpiled overburden and covered with topsoil, the surface of the opencast site will essentially have been restored to its original topography. Samancor intends undertaking the underground mining operations in a manner designed to avoid subsidence.

10.5.3 Soil, Land Use and Land Capability

10.5.3.1 Construction

The construction activities could lead to loss of topsoil by wind and surface runoff, mixing of topsoil with subsoil and contamination of topsoil by spillages of cement, fuel and lubricants, resulting in an impact of ***moderate (SP = 55)*** significance. The following mitigation measures will be implemented to reduce the impact to one of ***moderate (SP = 36)*** significance:

- Mixing topsoil with subsoil will be avoided, taking into account that the effective depth of the Avalon, Clovelly and Bainsvlei soils exceeds 300mm, inclusive of the *Orthic A and Yellow & Red Brown Apedalic B – Horizons*, but it is less than 300mm for the Mispah and Rensburg soils;
- Topsoil and subsoil will be stockpiled separately;
- The stockpiles will not exceed 3 metres in height and their side slopes will not exceed 25^{o};
- As soon as the diversion berms have been constructed, topsoil will be spread evenly over their entire surfaces, fertilised and seeded with a mixture of hardy, locally indigenous grasses;
- Drip trays will be placed under vehicles that are parked on unpaved areas for more than 3 hours;
- Mixing of cement and concrete will take place in appropriate equipment or on mortar boards and not on open ground; and
- Spillages of hydrocarbons and/or cement will be cleaned up immediately and the contaminated soil will be either remediated *in situ* or disposed at an appropriately licensed landfill site.

10.5.3.2 Operation

Inappropriate stripping and storage of topsoil could result in contamination and/or loss of a substantial quantity of topsoil, representing an impact of ***high (SP = 65)*** significance. The impact will be reduced to one of ***moderate (SP = 36)*** significance by continuous backfilling in accordance with the rollover method of mining described in section 2.5.1, in addition to the mitigation measures described in section 10.5.3.1 above.

10.5.3.3 Closure and rehabilitation

Backfilling the last mining void, water collection channels and the basin of the storm water control dam and ripping, top-soiling, fertilising and re-vegetating the compacted areas as described in sections 7.1.3 and

7.3.4 will restore the soil function in the project area to a large extent, leaving a residual impact of ***moderate (SP = 50)*** significance.

The re-vegetated areas will be monitored and maintained until they have become self-sustaining. This is expected to restore the soil function closer to its original condition, leaving a residual impact of ***low (SP = 24)*** significance.

10.5.4 Ecology

10.5.4.1 Construction

The construction activities will require stripping of essentially all vegetation on an area of about 26 hectares, which will disturb fauna in the vicinity of the construction area. The following mitigation measures will be implemented to reduce the impact from one of ***moderate (SP = 45)*** significance of to one of ***moderate (SP = 35)*** significance:

- Minimisation of the area to be cleared by proper planning of the site layout and demarcation of the laydown and construction areas;
- Constructing the pollution control systems first;
- Although no red data or protected species were observed in the project area, the removal of indigenous trees will be minimised by careful site layout and trees that are not to be removed will be clearly marked with barrier tape;
- If any protected faunal species are discovered within the project area they will be relocated under the supervision of a suitably qualified specialist; and
- Samancor's personnel and contractors' staff will be made aware of the requirements of the construction EMPr, undergo training in environmental awareness and be prohibited from causing damage to any plants other than those that have to be removed and from hunting, capturing or harassing of fauna in any manner.

10.5.4.2 Operation

The mining operations will involve the stripping of vegetation in advance of the mining front and the temporary stockpiling of run-of-mine ore, overburden and topsoil. The operations will also disturb fauna in the surrounding areas and will result in an impact of ***moderate (SP = 70)*** significance, which will be mitigated to one of ***moderate (SP = 36)*** significance by continuous backfilling and re-vegetation with locally indigenous species in accordance with the rollover method of mining described in section 2.5.1. Mitigation of impacts on bats will include the installation of artificial bat roosts on suitable trees and buildings within the surrounding area and installing the type of site lighting described in sections 7.11.1 and 7.11.2.

10.5.4.3 Closure and rehabilitation

Backfilling of the mining voids, water collection channels and the basin of the storm water control dam, and ripping, top-soiling, fertilising and re-vegetating the compacted areas as described in sections 7.1.3 and 7.3.4 will restore the floral characteristics of the project area to a large extent and promote the re-colonisation of the area by local fauna, leaving a residual impact of ***moderate (SP = 36)*** significance.

The re-vegetated areas will be monitored and maintained until they have become self-sustaining in order to restore the ecological function of the project area closer to its pre-project condition, leaving a residual impact of ***low (SP = 16)*** significance.

10.5.5 Surface water

10.5.5.1 Construction

The construction activities described in section 7.1.1 could lead to runoff with a high silt load and contaminants such as fuel, hydraulic fluids, degreasing and other chemicals and cement. The land slopes at a gradient of about 1 in 100 towards the Bierspruit River and the potential impact on local surface water

users is assessed as being of ***moderate (SP = 65)*** significance. The following measures will be implemented to reduce the potential impact to one of ***low (SP = 27)*** significance:

- The pollution control dam, clean water diversion berms and dirty water collection channels will be constructed first, before undertaking any other activities;
- If possible, construction will be undertaken during the dry season (May to September);
- Drip trays will be placed under vehicles when parked;
- Vehicles will be serviced in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site; and
- Spillages will be cleaned up immediately and contaminated soil will either be remediated in situ or disposed of at an appropriately licensed landfill site.

10.5.5.2 Operation

The operational phase activities described in section 7.1.2 could result in runoff with a high silt load and contaminants such as fuel, hydraulic fluids, and chemicals. The topsoil and overburden stockpiles could contribute to the silt load. Runoff from the TSF may also contain elevated concentrations of the major cations Na, K, Ca, and Mg and the anions SO_4 and Cl. The pollution control dam may overflow during very high rainfall events, but under such conditions the concentration of contaminants in the runoff would be diluted.

The potential impact on surface water users was assessed as being of ***moderate (SP = 52)*** significance. The following measures will be implemented to reduce the potential impact to one of ***moderate (SP = 33)*** significance:

- The clean water diversion berms will be constructed up-gradient of the waste rock, ore, topsoil and overburden stockpiles and runoff from the stockpiles will be channeled towards the PCD;
- The height of the topsoil and overburden stockpiles will be limited to 3 metres and the slope to 1 in 4 or 25 degrees;
- Topsoil stockpiles that need to remain in place for more than a month during the rainy season will be with vegetated with locally indigenous grass species;
- Silt will be removed from the PC dam on a regular basis to maintain its storage capacity;
- A freeboard of at least 0.8 metres will be maintained at all times;
- The water quality in the PCD will be monitored on a monthly basis;
- Drip trays will be placed under vehicles when parked;
- Vehicles will be serviced in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site; and
- Spillages should be cleaned up immediately and contaminated soil must either be remediated *in situ* or disposed of at an appropriately licensed landfill site.

10.5.5.3 Closure and rehabilitation

Decommissioning could leave barren areas that could cause erosion and lead to an increase in the silt content of runoff, but the total area that would have been disturbed is relatively small (about 1285 ha). The potential impact on surface water users was assessed as being of ***moderate (SP = 52)*** significance. The following measures will be implemented to reduce the impact to one of ***moderate (SP = 33)*** significance:

- The clean water diversion berms, dirty water collection channels and PCD will be the last structures to be demolished;
- Drip trays will be placed under vehicles when parked;
- Vehicles will be serviced in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site;
- Spillages will be cleaned up immediately and contaminated soil will either be remediated *in situ* or disposed of at an appropriately licensed landfill site;
- Compacted areas will be ripped, and the soil will be analysed and fertilised appropriately;
- Rehabilitation areas will be shaped to be free draining; and
- Disturbed areas will be re-vegetated with locally indigenous grasses, shrubs and trees.

10.5.6 Groundwater

10.5.6.1 Construction

The construction activities described in section 7.1.1 could lead to contamination of soil and subsequently groundwater through spillages of fuels, lubricants, hydraulic fluids and chemicals such as solvents, degreasers and cement. Groundwater may also be impacted by poor sanitation practices of construction workers.

The potential impact was assessed as being of ***moderate (SP = 48)*** significance. The following measures will be implemented to reduce it to one of ***low (SP = 21)*** significance:

- Drilling and sampling of monitoring boreholes up-gradient and down-gradient of the proposed construction and mining areas;
- Monthly monitoring of the boreholes with regard to water levels and water quality;
- Drip trays will be placed under vehicles when parked;
- Vehicles will be serviced in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site;
- Spillages will be cleaned up immediately and contaminated soil will either be remediated *in situ* or disposed of at an appropriately licenced landfill site;
- Providing adequate sanitation facilities in the form of chemical toilets that are serviced regularly; and
- Workers on site will receive environmental awareness training.

10.5.6.2 Operation

The operational phase activities described in section 7.1.2 will result in a lowering of the local groundwater table due to necessary mine dewatering and groundwater contamination with nitrates due to blasting. The effects of dewatering will be in addition to that caused by the mining operations of Bushveld Chrome Resources (BCR) and Anglo Platinum's Union Mine, respectively located approximately 4km to the east and 2 km to the south of the proposed Varkensvlei – Nooitgedacht mining area.

Samancor's mining activities could also result in groundwater contamination due to spillages of fuels, lubricants, hydraulic fluids and chemicals unless appropriate mitigation measures are implemented. Although the content of sulphide minerals in the ore is low and the potential for acid generation is believed to be very low, this has not been confirmed by detailed geochemical testing on materials sourced from Varkensvlei and

a conservative approach will be followed until sufficient geochemical information has become available to allow for an appropriately tailored approach.

Accordingly, the potential groundwater impact was conservatively assessed as potentially being of ***high (SP = 75)*** significance. The following mitigation measures will be implemented with the objective of reducing the impact to one of ***moderate (SP = 39)*** significance:

- Geochemical investigation on representative ore and waste rock samples, alternatively regular pH monitoring of runoff from waste rock and ore stockpiles;
- Monthly monitoring of the boreholes with regard to water levels and water quality;
- Drip trays will be placed under vehicles when parked;
- Vehicles will be serviced in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site;
- Spillages will be cleaned up immediately and contaminated soil will either be remediated *in situ* or disposed of at an appropriately licenced landfill site;
- Providing adequate sanitation facilities; and
- Workers on site will receive environmental awareness training.

10.5.6.3 Closure and rehabilitation

The decommissioning and closure activities described in section 7.1.3 will have a groundwater pollution potential similar to that of the construction phase, but with some enhancement due to the disturbance of the natural stratigraphy, geological and soil conditions caused by the mining and backfilling operations.

The expected residual impacts after the pit has been backfilled include interference with natural groundwater flow and recharge of the groundwater system. Backfilling of the pit will result in higher hydraulic conductivity of that area. Local groundwater recharge would increase if the rehabilitated area forms a depression. Groundwater would then be more sensitive to pollution from the surface. This risk will be minimised through positive land and water management initiatives during the operational and decommissioning phases of the project. Correct rehabilitation of the mining void is very important to mitigate lasting impacts on the groundwater regime.

The potential impact on the groundwater regime was assessed as being of ***high (SP = 85)*** significance. The following mitigation measures will be implemented with the objective of reducing the impact to one of ***moderate (SP = 39)*** significance:

- During backfilling with overburden, followed by covering with topsoil, the backfilled area will be shaped to be free-draining, after allowing for settling;
- Drip trays will be placed under vehicles when parked;
- Vehicles will be serviced in a workshop, not in the field;
- If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site;
- Spillages will be cleaned up immediately and contaminated soil will either be remediated *in situ* or disposed of at an appropriately licenced landfill site;
- Provide adequate sanitation facilities;
- Providing adequate sanitation facilities; and

- The water levels and water quality in the boreholes will be monitored monthly for 12 months after closure, thereafter quarterly for three years.

10.5.7 Noise

10.5.7.1 Construction

The following mitigation measures will be implemented to reduce the assessed impact from one of ***moderate (SP = 50)*** significance to one of ***low (SP = 24)*** significance:

- The construction camp and other noisy fixed facilities will be located well away from noise sensitive areas adjacent to the construction areas;
- All construction vehicles and equipment will be kept in good repair;
- Where necessary, stationary noisy equipment (e.g. compressors, pumps, pneumatic breakers) will be encapsulated in acoustic covers, screens or sheds. Portable acoustic shields will be used where noisy equipment is not stationary (e.g. angle grinders, chipping hammers, poker vibrators);
- Construction activities, and particularly the noisy ones, will be limited to reasonable hours during the day and early evening (e.g. 06h00 to 20h00);
- Prior to undertaking unavoidable noisy construction activities in the vicinity of noise sensitive areas, the mine will liaise with local residents on how best to minimise the impact;
- Machines in intermittent use will be shut down or throttled down to a minimum whenever possible;
- Construction activities will meet the noise standard requirements of the Occupational Health and Safety Act (Act No 85 of 1993); and
- Construction staff working in areas where the 8-hour ambient noise levels exceed 75dBA will wear hearing protection equipment.

10.5.7.2 Operation

The calculated noise contours for the opencast mining operations are illustrated in Figure 7-4 in section 7.9.3 of this report. The noise from the mining machinery will be audible, but will not exceed the daytime level for urban districts beyond the 600 m blast zone boundary as the mining front moves along the length of the ore deposit. If opencast mining operations are undertaken during the night time, exceedances of all but the guidelines for industrial districts would be experienced and the noise levels at the nearest sensitive areas would be objectionable.

The following mitigation measures will be implemented to reduce the assessed environmental noise impact of the mining operations (excluding blasting) from one of ***high (SP = 85)*** significance to one of ***moderate (SP = 48)*** significance:

- All major mining equipment will incorporate noise reduction designed to ensure that the overall noise level does not exceed an equivalent continuous day/night rating level (L_{Rdn}) of 70 dBA at the property boundary of the mine, as specified for industrial districts in SANS 10103. Equipment selection will also take into account the maximum allowable equivalent continuous day and night rating levels of the potentially impacted sites outside the mine property. Where the noise level at an external site is presently lower than the maximum allowed (see Table 7-6), the maximum must not be exceeded. Where the noise level at an external site is presently at or exceeds the maximum, the existing level must not be increased by more than indicated as acceptable in SANS 10103;
- The latest technology incorporating maximum noise mitigation measures for components of the complex will be designed into the system. When ordering plant and machinery, manufacturers will be requested to provide details of the sound power level (SPL). Where possible, those with the lowest SPL will be selected;
- Machinery will comply with the IFC's Environmental Health & Safety standards ;

- The site layout and design will consider, *inter alia*, the following aspects:
  - The position and orientation of buildings on the site;
  - The design of the buildings to minimise the transmission of noise from the inside to the outdoors;
  - The acoustic insulation of particularly noisy plant and equipment;
  - The temporary dumps of topsoil and overburden from the opencast operations will, where possible, be placed between the mine and sensitive receptors to act as noise attenuation barriers.
- All plant, equipment and vehicles will be kept in good repair;
- Where possible, very noisy activities will not take place at night (between the hours of 20h00 to 06h00); and
- A formal system for receiving and responding to complaints will be implemented and maintained.

10.5.7.3 Closure and rehabilitation

The activities associated with the closure and rehabilitation phase of the opencast mining operations will generate similar, but probably lower, noise levels than during the construction phase. The duration will also be similar, except for post closure monitoring of vegetation and groundwater, which will continue for several years, but will not have any noise impacts.

The following mitigation measures will be implemented to reduce the assessed impact from one of ***moderate (SP = 50)*** significance to one of ***low (SP = 24)*** significance:

- Sound-absorbing berms and other barriers will be demolished last;
- No noisy activities will be undertaken during night-time (22h00 to 06h00);
- Equipment with lower sound power levels will be selected; and
- Noise abatement equipment will be maintained in good condition.

10.5.8 Blasting

10.5.8.1 Construction

The construction activities described in section 7.1.1 of this report will not require blasting.

10.5.8.2 Operation

Calculated sound level contours based on a sound pressure level of 130 dB at the blasting area are shown in Figure 7-5 to Figure 7-7 in section 7.10.5 of this report. Blasting will take place once a week and the contours illustrate the noise levels that would be experienced. Air blast sound pressure levels of 60 to 70 dB may be expected in some parts of Bierspruit Village, Union Mine Village and Mantserre as the opencast mining operations progress from the north-east to the south-west along the orebody. Fly rock is unlikely to occur beyond the 600 metre buffer zone shown in Figure 2-2 of this report.

Underground blasting will cause ground vibration, but no fly rock or air blast effects.

The following mitigation measures will be implemented to reduce the potential impact of the blasting operations from one of ***high (SP = 85)*** significance to one of ***moderate (SP = 52)*** significance:

- Blasts will be designed so that:
  - Ground vibration levels do not exceed 12.5mm/s at off-site structures; and
  - The air over-pressure level does not exceed 130dB at the blast and 70dB at any of the sensitive receptor sites indicated in Figure 4-32 of this report.

- Vibration and air over-pressure will be monitored at sensitive areas and the measured values will be taken into account in the design of subsequent blasts;
- Blasting days and times of blasting will be established and communicated to local residents;
- Ensure that the correct design relationship exists between burden, spacing and hole diameter;
- The maximum amount of water resistant emulsion on any one day delay interval will be optimized by optimising the:
  - Number of holes per detonator delay interval;
  - Instantaneous charge by in-hole delay techniques;
  - Bench height or hole depth;
  - Borehole diameter.
- Maintaining awareness that the perception of blasting events occurs at levels of vibration well below those that can cause structural damage, but nevertheless at levels that can cause concern amongst residents in the vicinity of the mine;
- Taking into account that relatively small changes in blast design can produce noticeable differences in effects experienced by local residents. Complaints are often made in response to changes in the effects experienced rather than their absolute value;
- Blasts will be designed in line with the blast chart illustrated in Figure 7-8 in section 7.10.5 of this report.

10.5.8.3 Closure and rehabilitation

The activities described in section 7.1.3 of this report will not require blasting.

10.5.9 Visual

10.5.9.1 Construction

The main visual impact during the daytime is expected to be associated with the generation of dust due to the vegetation clearing and excavation activities and vehicles travelling over unpaved surfaces. The night-time visual impact will be due to security lighting at the construction site and the headlights of vehicles.

The predicted impact will be reduced from one of ***moderate (SP = 65)*** significance to one of ***low (SP = 27)*** significance by dust suppression with water or chemicals, by limiting vehicle movement at night and by installing motion-sensitive lighting that is directed downwards and inwards towards the site.

10.5.9.2 Operation

The operational phase will involve earth-moving and night-time operations on a larger scale than the construction phase and has the potential to create a visual impact of ***high (SP = 85)*** significance, which will be mitigated to one of ***moderate (SP = 52)*** significance by;

- Dust suppression with water or chemicals;
- Directing fixed lighting downwards and inwards towards the site, and not towards residential receptors or roads;
- Leaving as much natural vegetation in place as possible; and
- Erecting screens where necessary.

10.5.9.3 Closure and rehabilitation

The visual impact will be similar to that of the construction and operational phases combined, but it will be of shorter duration (6 to 9 months) than the operational phase (about 7 years as an opencast mine, followed by more than 20 years as an underground mine). The visual impacts are therefore expected to be of ***moderate***

(SP = 65) significance without mitigation and ***low (SP = 27)*** significance with mitigation. The mitigation measures listed in sections 10.5.9.1 and 10.5.9.2 will be applied.

10.5.10 Sites of Archaeological and Cultural Significance

10.5.10.1 Construction

The construction phase as described in section 7.1.1 of this report will have no impact on the formal graveyard at Mantserrre, which is the only site of cultural and heritage significance identified by the specialist, but it is always possible that an unknown grave or other buried cultural/archaeological items could be unearthed when excavations are being undertaken. In such an event the following chance find procedure will be implemented to mitigate the potential impact from one of ***high (SP = 80)*** to one of ***low (SP = 21)*** significance:

- All work in the immediate vicinity of the find will be suspended;
- The area will be demarcated with barrier tape or other highly visible means;
- The South African Heritage Resources Authority (SAHRA)will be notified immediately;
- An archaeologist accredited to the Association for Southern African Professional Archaeologists (ASAPA) will be commissioned to assess the find and determine appropriate mitigation measures. These may include obtaining the necessary authorisation from SAHRA to conduct the mitigation measures; and
- Access to the find by unqualified persons will be prevented until the assessment and mitigation processes have been completed.

10.5.10.2 Operation

When opencast mining is undertaken in the south-western portion of the orebody, noise levels of up to 65 dBA may be experienced at the Mantserre graveyard (see Figure 7-4 in section 7.9.3 of this report). Sound levels in the region of 60 dB may be experienced from air blast (see Figure 7-7) for about 3 seconds once a week. Although unlikely, the potential for damage from fly rock and/or ground vibration cannot be ruled out entirely, but it can be minimised by diligent application of the mitigation measures described in section 10.5.8.2 of this report.

The mining operations associated with the operational phase will have no impact on the graveyard at Mantserre, but it is always possible that an unknown grave or other buried cultural/archaeological items could be unearthed while topsoil and subsoil stripping and removal of overburden are being undertaken. In such an event the chance find procedure described in section 10.5.10.1 above will be implemented to mitigate the potential impact from one of ***high (SP = 80)*** to one of ***low (SP = 21)*** significance.

10.5.10.3 Closure and rehabilitation

The closure and rehabilitation phase as described in section 7.1.3 will have no impact on any identified cultural and heritage resources and no mitigation measures are required.

10.5.11 Socio-economics

10.5.11.1 Construction

Considering the relatively small amount of construction work required (see section 7.1.1 of this report) and the short period of construction (4 to 6 months), the impact on the local economy will be positive, but very small. The work will be undertaken by one or more contractors. If they need to hire local labour, it would be a small number.

It is possible that some local residents may be inconvenienced by noise, dust and increased traffic during the construction period. The presence of construction workers will increase the local population briefly and create the potential for friction with local residents. An influx of work seekers is possible, but the numbers are likely to be small.

Considering the above potential positive and negative impacts in combination and within the context of the current, pre-project environmental and social conditions described in section 4.0 of this report, the overall impact could be ***negative of low (SP = 21)*** significance. The following mitigation measures will be implemented with the intention of changing it to one of ***positive, but low (SP = +14)*** significance:

- Local contractors will be used where practicable;
- Contractors will be encouraged to make use of local labour and to purchase goods, materials and services locally;
- The mitigation measures described in the rest of section 10.5 above will be implemented;
- Local community skills development will be included in the mine's social and labour plan (SLP).

10.5.11.2 Operation

The operational phase will provide employment for 16 skilled and 106 semi-skilled and unskilled workers and the wage bill will be about R31 million per annum. Operational cost is projected at about R96 million in year 1, and R815 million per annum under steady state conditions after 5 years. The initial capital expenditure will be about R740 million and steady state annual replacement capital will be R59 million.

Samancor will introduce a skills development scheme for community learners to undergo institutional and/or workplace training and assessment. Upon successful completion, a learner will receive a competency certificate. It is Samancor's intention that 10% of the total workforce will be employed from the local community in the first year of operations, increasing to 20% in year 2 and 30% by the end of year 3.

The mining operations will sterilise grazing and agricultural land within the 600 metre blast zone until the affected areas have been rehabilitated. The road connecting Mantserre Village with Union Mine may also be affected. Stakeholders have voiced concerns about the increased traffic on the local roads and the generation of noise and dust. People attending funerals at the graveyard in Mantserre may experience intrusive noise levels, especially during a blast, although the effect of the latter will last for a few seconds only.

The proposed chrome ore mine is a relatively small operation within the context of the socio-economic characteristics of the North West Province and the Bojanala District Municipality as described in section 4.13 of this report and the potential socio-economic impact is assessed as being ***positive of low (SP = +18)*** significance. The following measures will be implemented to enhance the positive impact to one of ***moderate (SP = +39)*** significance:

- Communication and consultation with local residents will be maintained throughout the life of the mine;
- A complaints procedure and complaints register will be established and maintained;
- As far as practicable local people will be employed; and
- Materials, goods and services will be purchased locally as far as practicable.

10.5.11.3 Closure and rehabilitation

The negative impact of the loss of jobs and the sharp reduction of local expenditure at mine closure will be countered by implementing the following mitigation measures with the intention of reducing the assessed ***negative*** impact from one of ***moderate (SP = 60)*** significance to a ***positive*** impact of ***moderate (SP = +33)*** significance:

- Proactive skills development and training of employees to enhance their value in the labour market and thereby their chances of finding employment after mine closure;
- Development of a retrenchment plan in consultation with employees, starting at least five years before closure;
- Assisting redundant employees to find alternative employment as far as practicable;

- Focusing specifically on sustainable community projects in the SLP, i.e. projects that will remain viable without continued support from Samancor;
- Leaving intact such infrastructure as can be used by local communities, after consultation with the communities;
- Diligent application of the rehabilitation plan as set out in the mine's closure plan and as described in section 10.5.4.3;
- Monitoring the results of land rehabilitation for at least five years after closure or until the vegetation has become demonstrably self-sustaining.

10.5.12 Waste Management

10.5.12.1 Construction

Typical wastes produced during construction activities include unused concrete mix, oils, lubricants, paints, solvents, packaging materials, general domestic waste and offcuts of building materials such as steel, wood, glass and tiles. If stored or discarded on open ground, hydrocarbons will cause soil contamination and possibly groundwater pollution, an impact that was rated as being of ***moderate (SP = 64)*** significance.

The following mitigation measures will be implemented to reduce the impact to one of ***Low (SP = 10)*** significance:

- The wastes will be sorted and stored in separate skips or other containers for hydrocarbons, recyclable materials and non- recyclable materials. Recyclable materials will be sorted into wood, steel, glass, plastic, paper and used oil, and stored in separate containers;
- Recyclable wastes will be removed by responsible recyclers; and
- Non-recyclable wastes will be removed by reputable contractors for disposal at appropriately licensed landfills.

10.5.12.2 Operation

In terms of the National Environmental Management Amendment Act 2014 mining residues are classified as wastes and must be managed as prescribed by the National Environmental Management: Waste Act of 2008 and its Regulations GN R.632 and R.633, which commenced on 24 July 2015. The wastes referenced in section 10.5.12.1 above will also be produced during the operational phase and will be managed as decribed above.

Based on the assumption that the chemical analyses of the Varkensvlei tailings, waste rock and silt will be similar to those at Western Chrome Mines, the mining residues at Varkensvlei have been tentatively classifed as Type 3 wastes, but this needs to be checked by performing the prescribed geochemical characterisation tests.

Storage facilities for Type 3 wastes must be constructed with a Class C liner, which includes finger drains, a HDPE geomembrane, a clay layer and an under-drainage system – see schematic illustration in Figure 7-9.

Based on the tentative waste classification, the potential for pollution of the soil, surface water and groundwater was assessed as being of ***high (SP = 75)*** significance. The following mitigation measures will be implemented with the objective of reducing the impact to one of ***low (SP = 22)*** significance:

- Geochemical characterisation tests as stipulated in Regulation GN R.635 will be undertaken and the mining residues will be classified accordingly, as soon as representative materials become available;
- Waste will be managed in accordance with Regulation GN R.634;
- Regular inspection and maintenance of the waste management facilities will be undertaken;
- Monitoring of groundwater and surface water quality down-gradient of the waste management facilities; and

- Such corrective actions as may be required will be taken.

10.5.12.3 Closure and rehabilitation

Wastes expected to result from the decommissioning and rehabiltation activities include scrap metals, building rubble, oils, lubricants, paints, solvents, contaminated soils, PCD dam silt and liners, and potentially recyclable materials such as steel, wood, plastics, glass and tiles. If stored or discarded on open ground, hydrocarbons will cause soil contamination and possibly groundwater pollution, an impact that has been rated as being of ***moderate (SP = 64)*** significance.

The following mitigation measures will be implemented to reduce the impact to one of ***Low (SP = 10)*** significance:

- Areas of possible soil contamination will be identified, sampled and analysed to determine the degree of soil contamination. Soil with contamination levels exceeding then prevailing standards/gudelines will be removed and disposed;
- Silt, synthetic liners and contaminated non-synthetic liner materials will be removed from the PCD and disposed at appropriately licenced landfill sites. Liner materials and building rubble with contamination levels below prevailing standards/gudelines will be backfilled into the last portion of the opencast void;
- The remaining wastes will be sorted and stored in separate skips (or other containers) for hydrocarbons, recyclable materials and non- recyclable materials. Recyclable materials will be sorted into wood, steel, glass, plastic, paper and used oil, and stored in separate containers;
- Recyclable wastes will be removed by responsible recyclers; and
- Non-recyclable wastes will be removed by reputable contractors for disposal at appropriately licensed landfills.

11.0 SUMMARY OF MITIGATION AND MONITORING MEASURES

This section summarises the potential impacts of various aspects of the mining project in all its stages, from construction, through operations to eventual decommissioning, together with the appropriate mitigation measures to manage the identified impacts. Responsibilities for implementing the mitigation measures are identified and the frequencies with which the results of the various measures are to be monitored are stated. The responsibility for monitoring and reporting the results to the appropriate level of management within Samancor Chrome rests with the Environmental Control Officer (ECO)

Note:

This section can be printed and used as a field guide during each phase of the project

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
CONSTRUCTION PHASE								
10.5.1.1	Air Quality	Dust fall,	To remain within national standards at mine perimeter and at sensitive receptors	See Table 3-1 and Table 3-2	Wet suppression to ensure absence of visible dust; Enforcement of low vehicle speeds on unpaved roads (< 30 km/h); and Re-vegetation of disturbed areas with locally indigenous grass species as soon as possible. Chemical binders such as Dustex or Dust-A-Side to be considered for roads; Dust fall to be monitored by dust collection buckets located downwind of construction area.	Samancor Chrome, ECO, Contractors	Weekly, for duration of construction activities (12-18 months)	
10.5.2	Topography	Minor topographical changes due to construction of water management systems, office and workshops	No unnecessary topographical changes	Unavoidable topographic changes only	Design of site layout	Samancor Chrome, ECO, Contractors	Review and Approve initial site layout, monitor monthly for duration of construction activities (12-18 months)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
10.5.3.1	Soil, land use and land capability	Loss of topsoil, mixing with subsoil and contamination by spillages of cement, fuel and lubricants	Preservation of all topsoil stripped from construction areas	No loss of topsoil quantity or quality	Topsoil will be stripped carefully to avoid mixing with subsoil; Topsoil and subsoil will be stockpiled separately; Stockpiles will be limited to 3 metres in height and side slopes to 25°; As soon as the diversion berms have been constructed, topsoil will be spread evenly over their entire surfaces, fertilised and seeded with a mixture of hardy, locally indigenous grasses; Drip trays will be placed under vehicles that are parked on unpaved areas for more than 3 hours; Cement and concrete will be mixed in appropriate equipment or on mortar	Samancor Chrome, ECO, Contractors	Weekly, for duration of construction activities (12-18 months)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					boards, not on open ground; Spillages of hydrocarbons and/or cement will be cleaned up immediately and the contaminated soil will be either remediated *in situ* or disposed at an appropriately licensed landfill site			

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
10.5.4.1	Ecology	Stripping of vegetation on about 26 hectares, disturbance of fauna in the vicinity	Minimisation of ecological impact	Vegetation stripped only where essential; No avoidable harm to fauna	Site layout will be carefully planned; Laydown and construction areas will be demarcated ; Trees that are not be removed will be clearly marked with barrier tape; Protected fauna (if any) will be relocated under supervision of a suitably qualified specialist; Samancor's personnel and contractors' staff will be made aware of the requirements of the construction EMP, undergo training in environmental awareness and be prohibited from causing damage to any plants other than those that have to be removed and from hunting, capturing or harassing fauna in any manner.	Samancor Chrome, ECO, Contractors	Weekly, for duration of construction activities (12-18 months)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
10.5.5.1	Surface water	Erosion, more silt in local watercourses and drainage lines; Potential spillage of hydrocarbons and chemicals	No pollution of water courses	No change in surface water quality	The surface water management systems will be constructed first, before undertaking any other activities; An effort will be made to undertake construction during the dry season (May to September); Drip trays will be placed under vehicles when parked; Vehicles will be serviced in a workshop, not in the field; If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site; and Spillages will be cleaned up immediately and contaminated soil will either be remediated in situ or disposed of at an appropriately licensed landfill site.	Samancor Chrome, ECO, Contractors	Weekly, for duration of construction activities (12-18 months)	

10.5.6.1	Groundwater	Contamination of groundwater through spillages of fuels, lubricants, hydraulic fluids and chemicals, and by poor sanitation practices of construction workers	No contamination of groundwater	No change in groundwater quality	Monitoring boreholes will be drilled up-gradient and down-gradient of the construction and mining areas; Water levels and water quality in boreholes will be monitored monthly; Drip trays will be placed under vehicles when parked; Vehicles will be serviced in a workshop, not in the field; If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site; Spillages will be cleaned up immediately and contaminated soil will either be remediated in situ or disposed of at an appropriately licensed landfill site; Adequate sanitation facilities will be provided in the form of chemical toilets that are serviced regularly; and All workers on site will undergo environmental awareness training.	Samancor Chrome, ECO, Contractors	Weekly, for duration of construction activities (12-18 months)	
10.5.7.1	Noise	Construction activities are not likely to cause exceedances of daytime guidelines for	To remain within the guidelines	No exceedance of guidelines.	Construction camp and other noisy fixed facilities will be located away from noise sensitive areas;	Samancor Chrome, ECO, Contractors	At commencement of noisy construction	

		rural areas at any of the sensitive areas, but guidelines could be exceeded if construction is undertaken during the night time.	provided in Table 7-6	No complaints from receptors	All construction vehicles and equipment will be kept in good repair; Where necessary, stationary noisy equipment will be encapsulated in acoustic covers, screens or sheds. Portable acoustic shields will be used where noisy equipment is not stationary; Construction activities, and particularly the noisy ones, will be limited to reasonable hours (e.g. 06h00 to 20h00); The mine will liaise with local residents on how best to minimise the impact of unavoidable noise; Machines in intermittent use will be shut down or throttled down to a minimum whenever possible; In general, construction activities will meet the noise standard requirements of the Occupational Health and Safety Act (Act No 85 of 1993); and Construction staff working in areas where the 8-hour ambient noise levels exceed 75dBA will wear hearing protection equipment.		activities, thereafter upon receipt of complaints	
10.5.8.1	Blasting	None. The construction activities will not require blasting	Not applicable	None	None required	Samancor Chrome, ECO, Contractors	Not applicable	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
10.5.9.1	Visual aspects	Generation of visible dust by vegetation clearing, excavation activities and vehicles travelling over unpaved surfaces. Night-time visual impact due to security lighting and headlights of vehicles	To minimise visual impact during construction phase	No visible dust No nuisance lighting at night	Dust suppression with water or chemical binders; Limiting vehicle movement at night: and Where possible, installing motion-sensitive lighting that is directed downwards and inwards towards the site	Samancor Chrome, ECO, Contractors	Weekly, for duration of construction activities (12-18 months)	

10.5.10.1	Archaeological, cultural and heritage resources	No impact on the two identified sites, but possibility of unearthing unknown graves or other buried cultural/archaeological items cannot be ruled out	To avoid causing adverse impacts on any archaeological, cultural and heritage resources	Minimal or no adverse impact on any archaeological, cultural and heritage resources	The following chance find procedures will be implemented: ▪ Stop all work in the immediate vicinity of the find; ▪ Demarcate find with barrier tape or other highly visible means; ▪ Inform South African Heritage Resources Authority (SAHRA); ▪ Commission an archaeologist accredited with the Association for Southern African Professional Archaeologists (ASAPA) to assess the find and determine appropriate mitigation measures; and ▪ Prevent access to the find by unqualified persons until assessment and mitigation processes have been completed.	Samancor Chrome, ECO, Contractors	Check weekly, for duration of construction activities (12-18 months)	
10.5.11.1	Socio-economic	Nuisance dust, noise, traffic, population influx, friction with construction crew; Cash injection into local economy	To minimise negative and enhance positive impacts	No complaints from local residents; Neutral to positive attitude	Local contractors will be used where practicable; Use of local labour and purchase of local goods, materials and services by	Samancor Chrome, ECO, Contractors	Weekly, for duration of construction activities (12-18 months)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
				towards project	contractors will be encouraged; Local community skills development will be included as part of the mine's social and labour plan (SLP).			
10.5.12.1	Waste Management	Contamination of soil, surface water and groundwater	To avoid contamination of soil, surface water and groundwater	No contamination of soil, surface water or groundwater	Wastes will be sorted and stored in separate containers for hydrocarbons, recyclable materials and non-recyclable materials. Recyclable wastes will be removed by responsible recyclers; and Non-recyclable wastes will be removed by reputable contractors for disposal at appropriately licensed landfills.	Samancor Chrome, ECO, Contractors	Continuously, for duration of construction activities (12-18 months)	
General	Dangerous activities	Worker safety	To maintain safe work practices in a safe environment and	Documentation of all unplanned incidents and	Toolbox talks/staff briefing sessions Site workers training	Samancor Chrome, ECO,	Duration of mining activities, all phases	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
			to avoid personnel injuries and damage to assets	achievement of target safety performance statistics	programme Training in the use and handling of equipment	Contractors		
OPERATIONAL PHASE								
7.2.2	Geology	Temporary disturbance of topsoil, subsoil and overburden, but the LG4, LG6, MG1, MG2, MG3, MG4 and possibly additional LG and MG seams will be removed permanently	Avoid mixing of topsoil with subsoil or overburden	No mixing of layers	Careful stripping and separate storing of topsoil, subsoil and overburden; The rollover method of mining will place the waste rock and overburden back in more or less their original positions	Samancor Chrome, ECO, Contractors	Monthly, for duration of opencast mining activities (about 8 years)	
7.3.2	Air Quality	Mobilisation of particulates due to blasting, ore loading and haulage, crushing and screening, continuous backfilling and rehabilitation activities, wind erosion and entrainment by wheels of trucks transporting product from site.	Meeting of AQ standards and guidelines; No health risk or nuisance impact to sensitive receptors;	See Table 3-1 and Table 3-2 No complaints	Wet suppression to ensure the absence of visible dust; Low vehicle speeds (< 30 km/h) will be enforced on unpaved areas; Bare surfaces will be vegetated with locally indigenous grass species as soon as possible; Dust collection buckets will be placed immediately up-wind and down-wind of the site and dust fall will be	Samancor Chrome, ECO, Contractors	Monthly, for duration of mining activities (up to 30 years)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					measured as per regulations; If standards are exceeded regularly, additional mitigation measures will be developed.			
7.4.1	Topography	Temporary mining voids and stockpiles of topsoil, overburden, waste rock and product	To minimise topographical changes while mining	Small mining voids and stockpiles, moving along with mining front	Rollover mining method will minimise topographical changes while mining; When backfilling the mining void, the overburden will be placed first and levelled, then the subsoil, and finally the topsoil. The surface will be profiled to be free-draining	Samancor Chrome, ECO, Contractors	Monthly, for duration of opencast mining activities (about 8 years)	
7.5.2	Soil, land use and land capability	Loss of topsoil by inappropriate stripping and stockpiling	Avoid mixing of topsoil with subsoil or overburden; Preserve fertility of stockpiled topsoil	No mixing of layers; No loss of topsoil fertility while stockpiled	Topsoil will be stripped carefully to avoid mixing with subsoil; Topsoil and subsoil will be stockpiled separately; Stockpiles will be limited to 3 metres in height and side slopes to 25°; When backfilling the mining void, the overburden will be placed first and levelled, then the subsoil, and finally the topsoil. The surface will	Samancor Chrome, ECO, Contractors	Monthly, for duration of opencast mining activities (about 8 years)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					be profiled to be free-draining; Backfilling will be done as soon as possible to minimise the topsoil residence time in stockpiles; Drip trays will be placed under vehicles that are parked on unpaved areas for more than 3 hours; Spillages of hydrocarbons and/or cement will be cleaned up immediately and the contaminated soil will be either remediated *in situ* or disposed at an appropriately licensed landfill site			
7.6.2	Ecology	Rehabilitation will restore the floral characteristics of disturbed areas to a large extent and promote the re-colonisation of the area by local fauna	To restore ecology of disturbed areas as far as practicable	Establishment of self-sustaining variety of locally indigenous vegetation and fauna	Topsoil will be stripped carefully to avoid mixing with subsoil; Topsoil and subsoil will be stockpiled separately; Stockpiles will be limited to 3 metres in height and side slopes to 25°; When backfilling the mining void, the overburden will be	Samancor Chrome, ECO, Contractors	Monthly, for duration of opencast mining activities (about 8 years)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					placed first and levelled, then the subsoil, and finally the topsoil. The surface will be profiled to be free-draining; Backfilling will be done as soon as possible to minimise the topsoil residence time in stockpiles; Topsoil will be analysed and fertilised appropriately; Disturbed areas will be re-vegetated with a locally indigenous mix of floral species and monitored until it has become self-sustaining and colonised by small fauna; Drip trays will be placed under vehicles that are parked on unpaved areas for more than 3 hours; Spillages of hydrocarbons and/or cement will be cleaned up immediately and the contaminated soil will be either remediated *in situ* or disposed at an			

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					appropriately licensed landfill site			
7.7.4	Surface water	Runoff with high silt load and contaminants such as fuel, hydraulic fluids, and chemicals could enter local drainage lines and eventually the Bierspruit River after very high rainfall events. Pollution control dam may overflow during high rainfall events.	No contamination of local drainage lines and Bierspruit River	No spillage of contaminated mine water from project area	Clean water diversion berms will be constructed up-gradient of waste rock, ore, topsoil and overburden stockpiles and runoff from stockpiles will be channeled towards the pollution control dam (PCD); The height of topsoil and overburden stockpiles will be limited to 3 metres and the side slopes to 1 in 4; Silt will be removed from the PCD on a regular basis to maintain its storage capacity; A freeboard of at least 0.8 metres will be maintained at all times; The water quality in the PCD will be monitored monthly; Drip trays will be placed under parked vehicles; Vehicles will be serviced in	Samancor Chrome, ECO, Contractors	Monthly, for duration of mining activities (up to 30 years)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					a workshop, not in the field; If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site; and Spillages will be cleaned up immediately and contaminated soil will either be remediated *in situ* or disposed of at an appropriately licensed landfill site.			
7.8.2	Groundwater	Lowering of the local groundwater table due to pit dewatering and groundwater contamination with nitrates due to blasting. Potential groundwater contamination due to spillages of fuels, lubricants, hydraulic fluids and chemicals Potential for acid generation is	No contamination of local groundwater resources	No deterioration of water quality in monitoring boreholes	Regular pH monitoring of in-pit water and runoff from waste rock and ore stockpiles; Monthly monitoring of boreholes with regard to water levels and water quality; Drip trays will be placed under parked vehicles; Vehicles will be serviced in a workshop, not in the field; If in-field refuelling is done from a tanker, it will be done in a designated dirty	Samancor Chrome, ECO, Contractors	Monthly, for duration of mining activities (up to 30 years)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
		believed to be very low, but this has not been confirmed on materials sourced from Varkensvlei			area and a spill kit and clean-up team will be available on site; and Spillages will be cleaned up immediately and contaminated soil will either be remediated *in situ* or disposed of at an appropriately licensed landfill site. Adequate sanitation facilities will be provided; All workers on site will undergo environmental awareness training.			
7.9.3	Noise	Noise levels of about 85 dBA will occur close to mining machinery, but no exceedances of standards are expected at sensitive receptors	To avoid intrusive noise levels at sensitive receptors To reduce air overpressure at sensitive receptors as much as practically possible	See Figure 7-4 No intrusive noise levels experienced by sensitive receptors No complaints from local residents	Equipment will be selected to limit noise level to 70 dBA at mine boundary and to comply with SANS 10103 for increase in off-site noise levels; Machinery will be compliant with the IFC's Environmental Health & Safety standards ; The site layout and design will consider, *inter alia*, the following aspects:	Samancor Chrome, ECO, Contractors	Monthly, for duration of mining activities (up to 30 years)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					▪ The position and orientation of buildings on the site; ▪ Design of buildings to minimise noise transmission from the inside to the outdoors; ▪ Acoustic insulation of particularly noisy plant and equipment; ▪ Topsoil and overburden dumps will be placed between the mine and sensitive receptors to act as noise attenuation barriers. All plant, equipment and vehicles will be kept in good repair; Where possible, very noisy activities will not take place at night (between the hours of 20h00 to 06h00); A formal system for receiving and responding to complaints will be instituted.			

7.10.5	Blasting	Blasting will take place once per week and a sound level of about 70dB would be experienced for about 3 seconds at a distance of 900 metres from the blast Off-site structures and residents are not expected to be at risk from ground vibrations or fly rock	To avoid injuries to people and animals and damage to structures	No injuries and no damage to structures; No complaints from local residents	Blasts will be designed so that: ▪ Ground vibration levels do not exceed 12.5mm/s at off-site structures; and ▪ The air over-pressure level does not exceed 130dB at the blast and 70dB at any of the sensitive receptor sites indicated in Figure 4-32. Vibration and air over-pressure will be monitored at sensitive areas; Blasting days and times of blasting will be established and communicated to local residents; Care will be taken to ensure that the correct design relationship exists between burden, spacing and hole diameter; The maximum instantaneous charge will be optimized by considering a reduction in the: ▪ Number of holes per detonator delay interval; ▪ Instantaneous charge by in-hole delay techniques;	Samancor Chrome, ECO, Contractors	Weekly, for duration of opencast mining activities (about 8 years)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					▪ Bench height or hole depth; ▪ Borehole diameter. Blast designs will consider human reactions to vibration levels below those that can cause structural damage; All blasts will be designed in line with the blast design chart illustrated in Figure 7-8.			

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
7.11.2	Visual aspects	Generation of visible dust by vegetation clearing, mining activities and vehicles travelling over unpaved surfaces. Night-time visual impact due to security lighting and headlights of vehicles The operational phase will involve earth-moving and night-time operations on a larger scale than the construction phase	To minimise visual impact during operational phase	No visible dust No nuisance lighting at night	Enforcement of low vehicle speeds (< 30 km/h) on unpaved roads; Dust will be suppressed with water and/or chemical binders; Where possible, fixed lighting will be directed downwards and inwards towards the site, and not towards residential receptors or roads; As much natural vegetation as possible will be left in place; Disturbed areas will be re-vegetated with locally indigenous species as soon as possible; Screens will be erected if necessary.	Samancor Chrome, ECO, Contractors	Monthly, for duration of mining activities (up to 30 years)	
7.12.2	Archaeological, cultural and heritage resources	No impact on any identified sites, but possibility of unearthing unknown graves or other buried cultural/archaeological items cannot be ruled out	To avoid causing adverse impacts on any archaeological, cultural and heritage resources	Minimal or no adverse impact on any archaeological, cultural and heritage resources	The following chance find procedures will be implemented: ▪ Stop all work in the immediate vicinity of the find;	Samancor Chrome, ECO, Contractors	Check weekly, for duration of opencast mining activities (about 8 years)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					▪ Demarcate find with barrier tape or other highly visible means; ▪ Inform South African Heritage Resources Authority (SAHRA); ▪ Commission an archaeologist accredited with the Association for Southern African Professional Archaeologists (ASAPA) to assess the find and determine appropriate mitigation measures; and ▪ Prevent access to the find by unqualified persons until assessment and mitigation processes have been completed.			

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
7.13.2	Socio-economics	Creation of up to 1290 jobs for up to 30 years; Capital expenditure of about R740 million over the first five years; Annual expenditure of about R344 million on wages, and R365 million on materials, goods and services; The mining operations will sterilise grazing and agricultural land within the 600 metre blast zone until the affected areas have been rehabilitated.	To minimise negative and enhance positive impacts	No complaints from local residents; Positive attitude towards project	Employment of local people and purchase of local goods and services as far as practicable; Samancor will maintain good communication with local residents on the positive and negative aspects of the mining operation; Samancor will also introduce a skills development scheme for community learners to undergo institutional and/or workplace training and assessment. Upon successful completion a learner will receive a competency certificate. Samancor will endeavour to source 10% of the total workforce from the local community in the first year of operations, and increase the percentage to 20% in year 2 and 30% by the end of year 3.	Samancor Chrome, ECO, Contractors	Monthly, for duration of mining activities (up to 30 years)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
10.5.12.2	Waste Management	Contamination of soil, surface water and groundwater	To avoid contamination of soil, surface water and groundwater	No contamination of soil, surface water or groundwater	Waste will be managed in accordance with Regulation GN R.634; Regular inspection and maintenance of the waste management facilities will be undertaken; Monitoring of groundwater and surface water quality down-gradient of the waste management facilities; and Such corrective actions as may be required will be taken.	Samancor Chrome, ECO, Contractors	Continuously, for duration of mining activities (up to 30 years)	
CLOSURE AND REHABILITATION PHASE								
7.2.3	Geology	Incorrect closure procedures could mix topsoil, subsoil and overburden	Restore original condition, except for permanent removal of chrome ore	No mixing of topsoil, subsoil and overburden	Carefully placing and profiling the overburden first, then the subsoil and finally the topsoil	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months)	
7.3.4	Air quality	Mobilisation of particulates due to final backfilling and rehabilitation activities.	Meeting of AQ standards and guidelines; No health risk or nuisance impact	See Table 3-1 and Table 3-2 No complaints	Wet suppression to ensure the absence of visible dust; Low vehicle speeds (< 30 km/h) will be enforced on unpaved areas;	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months)	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
			to sensitive receptors;		Bare surfaces will be vegetated with locally indigenous grass species as soon as possible; Dust fall monitoring will be performed as per regulatory requirements.			
7.4.3	Topography	Incorrect closure and rehabilitation could leave unnecessary humps and depressions	To restore the original topography of the project area	Post-rehabilitation topography closely matches original topography	After re-placing overburden, then the subsoil and finally the topsoil at the final cut, final profiling will be done to restore the original topography and drainage lines.	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months)	
7.5.3	Soil, land use and land capability	Potential loss of topsoil quantity and quality by incorrect closure and rehabilitation	To restore the soil in the disturbed areas as close to its original condition as practicable	Soil function restored to a condition that will support self-sustaining indigenous vegetation	Backfilling the last mining void, water collection channels and the basin of the stormwater control dam and ripping, top-soiling, fertilising and re-vegetating the compacted areas as described in sections 7.1.3 and 7.5.3 will restore the soil function in the project area to a large extent.	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months), thereafter quarterly until self-sustaining vegetation has been established	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					The re-vegetated areas will be monitored and maintained until they have become self-sustaining in an endeavour to restore the soil function closer to its original condition.			
7.6.3	Ecology	Inadequate re-vegetation or re-vegetation with inappropriate species will fail to establish acceptable ecological functioning and result in an unacceptable residual impact	To restore the project-affected land to a self-sustaining, ecologically functioning condition that is fit for grazing	Project-affected land becomes self-sustaining and fit for grazing, with reasonable ecological function, within 4 years after rehabilitation	The mining voids, water collection channels and the basin of the storm water control dam will be backfilled; Compacted areas will be ripped, top-soiled, fertilised and re-vegetated as described in sections 7.1.3 and 7.3.4	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months), thereafter quarterly until self-sustaining vegetation has been established	
7.7.5	Surface water	High silt content of runoff from barren areas	Clean runoff along original drainage lines	No contamination of surface water resources, particularly Bierspruit River;	The clean water diversion berms, dirty water collection channels and PCD will be the last structures to be demolished; Drip trays will be placed under vehicles when	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months), thereafter water quality will be monitored quarterly for at least 5 years	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
				No complaints	parked; Vehicles will be serviced in a workshop, not in the field; If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site; Spillages will be cleaned up immediately and contaminated soil will either be remediated *in situ* or disposed of at an appropriately licensed landfill site; Compacted areas will be ripped. The soil will be sampled, analysed and appropriately fertilised; Rehabilitation areas will be shaped to be free draining; and Disturbed areas will be re-vegetated with locally indigenous grasses, shrubs			

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					and trees.			
7.8.3	Groundwater	Changes in natural groundwater flow and recharge due to changes in stratigraphy, geological and soil conditions caused by the mining and backfilling operations. Groundwater may be at more risk of contamination due to increased hydraulic conductivity;	No contamination of local groundwater resources	No deterioration of water quality in monitoring boreholes	Backfilled areas will be shaped to be free-draining, after allowing for settling; Drip trays will be placed under vehicles when parked; Vehicles will be serviced in a workshop, not in the field; If in-field refuelling is done from a tanker, it will be done in a designated dirty area and a spill kit and clean-up team will be available on site; Spillages will be cleaned up immediately and contaminated soil will either be remediated *in situ* or disposed of at an appropriately licensed landfill site; Adequate sanitation facilities will be provided; All workers on site will undergo environmental	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months), thereafter water quality will be monitored quarterly for at least 5 years	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					awareness training; and Monthly monitoring of the boreholes with regard to water levels and water quality will be undertaken for 12 months after closure, thereafter quarterly for three years.			

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
7.9.4	Noise	Rehabilitation activities are not likely to cause exceedances of daytime guidelines for rural areas at any of the sensitive areas, but guidelines could be exceeded if noisy activities are undertaken during the night time. Post closure monitoring of will continue for several years, but will not have any noise impacts	To remain within the guidelines provided in Table 7-6	No exceedance of guidelines. No complaints from receptors	Sound-absorbing berms and other barriers will be demolished last; No noisy activities will be undertaken during night-time (22h00 to 06h00); Equipment with lower sound power levels will be preferentially selected; and All noise abatement equipment will be maintained in good condition.	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months)	
7.10.6	Blasting	None. The rehabilitation activities will not require blasting	Not applicable	None	None required	Samancor Chrome, ECO, Contractors	Not applicable	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
7.11.3	Visual aspects	Generation of visible dust by surface ripping and profiling activities and vehicles travelling over unpaved surfaces. Night-time visual impact due to security lighting and headlights of vehicles	To minimise visual impact during rehabilitation phase	No visible dust No nuisance lighting at night	Dust suppression with water or chemical binders; Limiting vehicle movement at night: and Where possible, making use of motion-sensitive lighting that is directed downwards and inwards towards the site	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months)	
7.12.3	Cultural and heritage	No impact, as no undiscovered archaeological remains would remain within the mining area	To avoid damage to any archaeological resources	No damage to any archaeological resources	None required	Samancor Chrome, ECO, Contractors	Not applicable	
7.13.3	Socio-economics	Significant negative impact due to loss of jobs and sharp reduction in local expenditure will be countered over time by rehabilitation of the mined out areas	Minimise negative impact	Socio-economic impact acceptable to personnel and local communities	Skills development and training of employees to enhance their value in the labour market and thereby their chances of finding employment after mine closure; Development of a retrenchment plan in consultation with employees, starting at least	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months), thereafter socio-economic conditions of project-affected people will be monitored quarterly for at	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					five years before closure; Assisting redundant employees to find alternative employment as far as practicable; Focusing specifically on sustainable community projects in the SLP, i.e. projects that will remain viable without continued support from Samancor; Leaving intact such infrastructure as can be used by local communities, after consultation with the communities; Diligent application of the rehabilitation plan as set out in the mine's closure plan and as described in section 7.6.3; Monitoring the results of land rehabilitation for at least four years after closure or until the vegetation has become demonstrably self-		least 5 years	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					sustaining.			
10.5.12.3	Waste Management	Contamination of soil, surface water and groundwater	To avoid contamination of soil, surface water and groundwater	No contamination of soil, surface water or groundwater	Areas of possible soil contamination will be identified, sampled and analysed to determine the degree of soil contamination. Soil with contamination levels exceeding then prevailing standards/gudelines will be removed and disposed; Silt, synthetic liners and contaminated non-synthetic liner materials will be removed from the PCD and disposed at appropriately licenced landfill sites. Liner materials and building rubble with contamination levels below prevailing standards/gudelines will be backfilled into the last portion of the opencast void; The remaining wastes will be sorted and stored in	Samancor Chrome, ECO, Contractors	Weekly, for duration of rehabilitation activities (about 6 months), thereafter water quality will be monitored quarterly for at least 5 years	

NO	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Frequency and Timeframe	For Monitoring Purposes only – Successfully Implemented / Corrective action required (To be completed by EC)
					separate containers for hydrocarbons, recyclable materials and non-recyclable materials. Recyclable wastes will be removed by responsible recyclers; and Non-recyclable wastes will be removed by reputable contractors for disposal at appropriately licensed landfills.			

12.0 FINANCIAL PROVISION

12.1 Overall Closure Goal

The overall closure goal for the proposed mining project on Varkensvlei is to leave behind an ex-mining area that is safe, stable and non-polluting, aligned to the Bojanala District Municipality's spatial development framework, as well as current agricultural, tourism and other economic initiatives of the region, towards leaving behind a positive post-mining legacy.

12.2 Closure Objectives

The above closure goal is underpinned by the more specific objectives listed below. These objectives are stated qualitatively and will become more specific as the more detailed closure measures are devised during the life of the mine. The objectives apply to the mine site in its final closed state and not while it is in progress towards this state.

12.2.1 Physical Stability

To remove surface infrastructure, stabilise and make safe underground mining areas and to facilitate the implementation of the planned land use, by:

- Sealing the decline and ventilation shafts in terms of statutory requirements and/or acceptable good practice, after removal of re-usable and/or salvageable equipment from underground;
- Undertaking a stability analysis to identify areas of potentially high subsidence formation, and compile a surface subsidence risk report, including identifying the most suitable method(s) to prevent future subsidence, and incorporate such methods into environmental management systems;
- Re-routing drainage lines away from potential surface subsidence areas to limit ingress into underground workings;
- Closing, dismantling, removing and disposing of all surface infrastructure that has no beneficial post-closure use; and
- Ripping, shaping, and vegetating of reclaimed footprint areas as well as access roads with no beneficial post-closure use and integrating these into the surrounding areas.

12.2.2 Environmental Quality

To ensure that local environmental quality is not adversely affected by possible physical effects and chemical contamination arising from the mine site as well as to sustain catchment yield as far as possible following closure, by:

- Limiting dust generation on the rehabilitated infrastructural areas that could cause nuisance and/or health effects to surrounding landowners/communities;
- Conducting dedicated soil surveys over the footprint of the infrastructure site and removing any identified pockets of contaminated soil;
- Cleaning up of any sources of potential soil contamination present on the site to protect the downstream receiving environment; and
- Ensuring that the rehabilitated site is free-draining and runoff is routed to local/natural drainage lines as far as possible.

12.2.3 Health and Safety

To limit the possible health and safety threats to humans and animals using the rehabilitated site by:

- Plugging and sealing decline and ventilation shafts;

- Shaping and vegetating the discard dump to stable and safe outer slopes and upper surfaces;
- Demonstrating by means of suitable sampling and analysis that the threshold levels of salts, metals and other potential contaminants over the rehabilitated site in terms of the long-term land use planning for human and animal habitation are acceptable;
- Removing, for safe disposal, all potential process-related contaminants to ensure that no hazardous waste is present on the mine site once it has been rehabilitated;
- Demonstrating through a review of monitoring data that no possible surface and/or groundwater contaminant sources remain on the rehabilitated site that could compromise the planned land use and/or pose health and safety threats; and
- Monitoring environmental performance as set out in section 12.5.

12.2.4 Land Capability/Land-use

To re-instate suitable land capabilities over the affected site to facilitate the progressive implementation of the planned land use, by:

- Upfront zoning of the overall mine site and obtaining agreement with stakeholders on this;
- Upfront materials balancing and handling to ensure that the soil types are stockpiled separately and subsequently placed, during site rehabilitation, to allow the desired land capability and end land use to be achieved;
- Ensuring that the rehabilitated site is safe and stable in the long term; and
- Cleaning up and rehabilitating contaminated soil areas.

Currently, the intention is to restore the areas disturbed by the project activities to a condition that is fit for grazing, but that could change during the life of the mine.

12.2.5 Aesthetic Quality

To leave behind a rehabilitated infrastructure site that, in general, is not only neat and tidy, giving an acceptable overall aesthetic appearance, but which in terms of this attribute is also aligned to the respective land use, by:

- Tidying-up the site by removing demolition waste, rubble, etc.;
- Shaping and levelling disturbed areas to create landforms that emulate the surrounding surface topography and would facilitate drainage;
- Re-establishing vegetation on the above areas to be self-sustaining, ecologically functional and aesthetically pleasing.

12.2.6 Biodiversity

To encourage the re-establishment of locally indigenous vegetation on the rehabilitated areas such that the terrestrial biodiversity is largely re-instated over time, by:

- Stabilising disturbed areas to prevent erosion in the short to medium term until a suitable vegetation cover has established;
- Establishing viable self-sustaining vegetation communities that will encourage the re-introduction of local fauna as far as possible;
- Identifying those aspects/obstacles once site rehabilitation has been completed which could inhibit and/or deter animal life from returning to the rehabilitated site; and
- Removing the identified obstacles without compromising the adopted final land use.

12.2.7 Socio-economic Aspects

To ensure that the infrastructure transfers, measures and/or contributions made by the mine towards the long-term socio-economic benefit of the local communities are sustainable, by:

- Identifying buildings and other infrastructure that could be of commercial and/or other value/benefit to the local community and transferring these to third parties as agreed between the mine and these parties and/or the stakeholders;
- Communicating and negotiating with local communities and related civil structures on the closure of the mine and the possible transfer of surface infrastructure to them;
- Ensuring effective hand-over of pre-determined mining-related surface infrastructure for future use by other parties;
- Providing, until hand-over of the mining-related surface infrastructure, training and awareness creation to empower the communities to effectively manage the financial and/or commercial resources transferred from the mine; and
- Clearly defining the roles of the parties responsible for future management of the transferred facilities.

The above closure goals and objectives were developed to restore baseline conditions as far as practically and economically achievable. The mitigation and rehabilitation measures described in section 7.0 of this report are specifically aligned to the closure goals and objectives stipulated in sections 12.1 and 12.2 of this report – see Comments and Responses Report attached as APPENDIX F.

12.3 Closure Costs

The quantum of the financial provision for the closure and rehabilitation costs was estimated in accordance with the South African Department of Minerals and Energy Guideline dated January 2005 (Bothma, J; Brown, S A P;, January 2016) and is shown in detail in the complete closure report that will be submitted to the Department of Mineral Resources.

12.4 Implementation of the EMP

A number of activities must take place before commencement of construction. Certain of these activities are not directly related to physical work on site, but are presented below, as they should be addressed before commencement of, or during the early phases of construction.

12.4.1 Responsibility for EMP implementation

- Responsibility for implementation of the EMPr will rest with the Mine Manager at Samancor's Varkensvlei operations. The Mine Manager will appoint a Safety, Health and Environmental (SHE) Manager, who will be based on site. The Mine Manager / SHE Manager will subscribe to the Samancor safety procedures, which will be implemented at the mine. The SHE Manager will ensure that all environmental activities delegated to contractors operating on site are implemented. Similarly, the SHE Manager will ensure that all conditions of the EMPr are implemented. It will furthermore be the responsibility of the SHE Manager to resolve any conflicts that may arise between Samancor and contracting parties regarding implementation of the EMPr. (Such responsibilities are captured by the legal appointment of the SHE Manager);
- Samancor will ensure that the responsibility for implementing and adhering to the conditions of the EMPr forms part of the conditions of appointment of all contractors;
- Samancor will ensure that all contracting companies tendering for work receive a copy of this EMPr and understand their responsibility to operate within the framework of the measures defined in this EMPr. When adjudicating tenders, Samancor will ensure that contractors have made appropriate allowance for management of environmental matters;

- Samancor will ensure that, upon appointment, all contracting companies operating on the site receive a copy of this EMPr and understand their responsibility to operate within the framework of the measures defined in this EMPr;
- Samancor will ensure that contractor SHE induction includes environmental and social issues and awareness training ("Environmental Awareness Plan", see section 13.0 of this report) to build capacity of Samancor personnel and contract staff regarding management of the environment;
- The SHE Manager will brief contractors about no development / no go areas. These will include:
  - No access to neighbouring properties without prior approval; and
  - No access to fenced-off sensitive areas.
- Samancor to appoint a responsible person to audit the implementation of, and adherence to, this EMPr. This party will be an independent environmental practitioner; and
- The SHE Manager will bring to the attention of the Mine Manager any major environmental incident or breach of the conditions of the EMPr, within 24 hours of occurrence of such event. If the environmental incident constitutes a breach of any permit or licence condition, the Mine Manager will notify the controlling authority within 48 hours of such an incident.

12.4.2 Responsibility of contractors

- Each contracting company will receive a copy of the EMPr at time of tender. Each contractor must familiarise himself with the required environmental management measures and ensure that contracting prices allow for environmental costs;
- Appointed contractors must keep their copies of the EMPr on site. It is the responsibility of the contractors to ensure that all of their staff are aware of the measures applicable to their area of work; and
- It is the responsibility of the contractors to bring to the attention of the Samancor SHE Manager any environmental incident or breach of the conditions of the EMPr, within 24 hours of occurrence of such event through the company's Incident Reporting System.

12.5 Environmental performance monitoring

Table 12-1 lists the main environmental aspects that will be subjected to performance monitoring during all phases of the project. The monitoring requirements, frequencies and responsible parties are also listed.

Table 12-1: Environmental Monitoring Programme

SOURCE/ACTIVITY	IMPACTS TO BE MONITORED	MONITORING FUNCTIONAL REQUIREMENTS	ROLES AND RESPONSIBILITIES	FREQUENCIES
Site preparation, contract mining and decline shaft construction	Dust fall and PM_{10}	Dust buckets	Samancor, Contractor, ECO	Continuous, reporting monthly
Drilling, blasting, materials handling (topsoil, subsoil, overburden, waste rock) transport of RoM to stockpile at plant, transport of product to destination	Dust fall and PM_{10}	Dust buckets	Samancor, ECO	Continuous, reporting monthly
Site preparation	Preservation of topsoil	Soil stripping equipment, observation of stripping and stockpiling practices	Samancor, Contractor, ECO	Continuous, reporting monthly
Rehabilitation	Correct use of topsoil	Use light agricultural machinery, observe use of topsoil	Samancor, Contractor, ECO	Continuous, reporting monthly
Site preparation	Vegetation stripping	Demarcate stripping areas	Samancor, Contractor, ECO	Continuous, reporting monthly
Rehabilitation	Re-vegetation	Plant appropriate vegetation, observe progress, take remedial action where necessary	Samancor, ECO	Continuous, reporting quarterly until self-sustaining
Construction & Operations	Surface water quality	Sample upstream and downstream of site	Samancor, ECO	Monthly
Closure & rehabilitation	Surface water quality	Establish sampling points, equipment and protocols	Samancor, ECO	Quarterly for at least 5 years after closure
Construction & Operations	Groundwater levels and quality	Sampling pumps and protocols	Samancor, ECO	Quarterly
Closure and rehabilitation	Groundwater levels and quality	Sampling pumps and protocols	Samancor, ECO	Quarterly for at least 5 years after closure

SOURCE/ACTIVITY	IMPACTS TO BE MONITORED	MONITORING FUNCTIONAL REQUIREMENTS	ROLES AND RESPONSIBILITIES	FREQUENCIES
Construction	Noise	Monitoring equipment and protocols	Samancor, ECO	When noisy activities reach steady state, thereafter when complaints received
Operation	Noise	Monitoring equipment and protocols	Samancor, ECO	When production reaches steady state, thereafter when complaints received
Closure and rehabilitation	Noise	Monitoring equipment and protocols	Samancor, ECO	When noisy activities reach steady state, thereafter when complaints received
Construction	Air blast and vibration	Measuring equipment and protocols	Samancor, ECO	Each blast
Operation	Vibration	Measuring equipment and protocols	Samancor, ECO	Each blast
Construction	Traffic patterns and adherence to regulations and rules	Unannounced observation, tachymeter readouts, complaint reports	Samancor, ECO	Weekly, until relaxation to monthly and quarterly justified
Operation	Traffic patterns and adherence to regulations and rules	Unannounced observation, tachymeter readouts, complaint reports	Samancor, ECO	Weekly, until relaxation to monthly and quarterly justified
Closure and rehabilitation	Traffic patterns and adherence to regulations and rules	Unannounced observation, tachymeter readouts, complaint reports	Samancor, ECO	Weekly, until relaxation to monthly and quarterly justified
Construction	Local employment and procurement	Observation, complaint reports	Samancor, ECO	Quarterly
Operation	Local employment and procurement and sustainability of local economic development projects	Observation, complaint reports	Samancor, ECO	Annually

SOURCE/ACTIVITY	IMPACTS TO BE MONITORED	MONITORING FUNCTIONAL REQUIREMENTS	ROLES AND RESPONSIBILITIES	FREQUENCIES
Closure and rehabilitation	Local employment and procurement, sustainability of local economic development projects, placement of ex-employees	Observation, complaint reports	Samancor, ECO	As required

13.0 ENVIRONMENTAL AWARENESS PLAN

As stipulated in section 12.4 above, environmental conditions will be included in all operational contracts, thereby making contractors aware of the potential environmental risks associated with the project and the necessity of implementing good environmental and housekeeping practices.

The following principles and training will apply to the Environmental Awareness Plan training and the Environmental Management System (EMS) training:

- All personnel, including contactors will, at a minimum, undergo general safety, health and environmental (SHE) induction and environmental management system (EMS) training;
- The Safety, Health, Environmental and Quality (SHE) Manager will identify the SHE training requirements for the mine's personnel and contractors. The training requirements will be recorded in a training needs matrix indicating particular training that must be undertaken by identified personnel and contractors. The training matrix will be administered by Samancor's Human Resources Department (HRD); and
- Development of the Training Programme, which will include:
  - Job-specific training – training for personnel performing tasks which could cause potentially significant environmental impacts;
  - Assessment of extent to which personnel are equipped to manage environmental impacts;
  - Basic environmental training;
  - EMS training;
  - Comprehensive training – on emergency response, spill management, etc;
  - Specialised skills;
  - Training verification and record keeping; and
  - Periodic re-assessment of training needs, with specific reference to new developments, newly identified issues and impacts and associated mitigation measures.

13.1 General Awareness Training

- The HRD Manager, together with the SHE Manager, will be responsible for the development of, or facilitating the development of, the required general SHE induction and awareness training. A general environmental awareness training module will be developed and integrated into the general induction programme. The general awareness training must include the Environmental Policy, a description of the environmental impacts and aspects and the importance of conformance to requirements, general responsibilities of Samancor personnel and contractors with regard to the environmental requirements and a review of the emergency procedures and corrective actions; and
- A Training Practitioner or the Environmental Control Officer (ECO) will conduct the general awareness training. The training presenter will keep a record of the details of all persons attending general awareness training. Such attendance registers shall indicate the names of attendants and their organisations, the date and the type of training received.

13.2 Specific Environmental Training

- Specific environmental training will be in line with the requirements identified in the training matrix; and
- Personnel whose work tasks can impact on the environment will be made aware of the requirements of appropriate procedures/work instructions. The SHE Manager will communicate training requirements to responsible supervisors to ensure that personnel and contractors are trained accordingly.

13.3 Training Evaluation and Re-training

- Effectiveness of the environmental training will be reflected by the degree of conformance to EMPr requirements, the results of internal audits and the general environmental performance achieved at the mine;
- Incidents and non-conformances will be assessed through an internal incident investigation and reporting system, to determine the root cause, including the possible lack of awareness/training;
- Should it be evident that re-training is required, the SHE Manager will inform the Heads of Departments of the need and take the appropriate actions;
- General awareness training of all personnel shall be repeated annually; and
- The re-induction shall take into consideration changes made in the EMPr, changes in legislation, the mine's current levels of environmental performance and areas of improvement.

13.4 Emergency Procedures

The following emergency procedures are relevant to the project:

- The SHE Manager shall define emergency reporting procedures for the mine;
- All personnel shall be made aware of emergency reporting procedures and their responsibilities;
- Any spills will be cleaned up immediately in accordance with relevant legislation; and
- Telephone numbers of emergency services, including the local firefighting service, shall be conspicuously displayed.

14.0 UNDERTAKING

The environmental assessment practitioner hereby confirms:

- The correctness, to the best of his knowledge, of the information provided in the specialist reports and of information provided by Samancor Limited. The information was accepted as being as reliable as information generated during an EIA and a feasibility study, and provided in good faith, can be;
- The inclusion of comments and inputs from stakeholders and I&APs;
- The inclusion of inputs and recommendations from the specialist reports where relevant; and
- The acceptability of the project in relation to the finding of the assessment and level of mitigation proposed.

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APPENDIX A

Database of Potentially Interested and Affected Parties

APPENDIX B

Letter of Invitation and Registration, Comment and Reply Sheet

APPENDIX C

Newspaper Advertisements

APPENDIX D

List of Registered I&APs

APPENDIX E

Site Notices

APPENDIX F

Comment and Response Report

APPENDIX G

Specialist Studies

February 2017
Report No. 1416935-298836-2

APPENDIX H

Correspondence with Authorities

APPENDIX I

Document Limitations

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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