PROPOSED ESTABLISHMENT OF AN OPEN CAST PGM MINE ON THE FARM VOLSPRUIT 326 KR AND THE FARM ZOETVELD 294 KR, MOKOPANE DISTRICT, LIMPOPO PROVINCE

PAN PALLADIUM LTD

SYLVANIA PLATINUM LIMITED

ENVIRONMENTAL IMPACT REPORT

DMR Ref No LP30/5/1/2/2/10068MR

LEDET EIA Ref No: 12/1/9/2-W11
DEA waste licence Ref No: 12/9/11/L582/5

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EXECUTIVE SUMMARY

Introduction:

Sylvania Platinum Limited (hereinafter referred to as 'Sylvania', or the 'proponent') has commissioned the services of EScience Associates (hereinafter referred to as 'ESA') to undertake a scoping and Environmental Impact Assessment (S&EIA) process to assess the environmental impact of the possible establishment of a new open cast Platinum Group Metals (PGMs) mine near Mokopane in the Limpopo Province. The environmental impact assessment, and associated development of an environmental management programme (EMP), are being undertaken in support of *inter alia* applications to the Limpopo Department of Economic Development, Environment and Tourism (LEDET), Department of Environmental Affairs (DEA), Department of Mineral Resources (DMR) and Department of Water Affairs (DWA) for environmental authorisation, a waste management licence, a mining licence and water use licence, respectively.

This report (i.e. the Environmental Impact Assessment Report - EIR) presents the findings of the second phase of the aforementioned S&EIA process (i.e. the environmental impact assessment phase); where the scoping phase was 'completed' with the acceptance of the final Scoping Report and Plan of Study for EIA by LEDET and the DEA on the 2nd of February and 4th of April 2012 respectively. This report further builds on the Draft EIR that was issued on 12 November 2012 and which was augmented with additional specialist studies that was deemed to be necessary to provide further information.

Whereas the scoping phase was aimed primarily at identifying the more pertinent project issues and potential environmental impacts from a wider range of potential impacts and issues, the EIA phase aimed to then assess and evaluate the identified impacts, in terms of their potential significance, with the goal of ultimately allowing for informed comment by interested and affected parties (IAPs) and defensible decision-making competent authorities respectively.

An EIA of a proposed mining operation should consist of:

- An assessment of the environment likely to be affected by the proposed mining operation, including cumulative environmental impacts;
- An assessment of the environment likely to be affected by the identified alternative land use or developments, including cumulative environmental impacts;
- An assessment of the nature, extent, duration, probability and significance of the identified potential environmental, social and cultural impacts of the proposed mining operation, including the cumulative environmental impacts;
- A comparative assessment of the identified land use and development alternatives and their potential environmental, social and cultural impacts;
- A determination of the appropriate mitigatory measures for each significant impact of the proposed mining operation;
- Details of the engagement process of interested and affected persons followed during the course of the assessment and an indication of how the issues raised by interested and affected persons have been addressed;
- An identification of knowledge gaps and report on the adequacy of predictive methods, underlying assumptions and uncertainties encountered in compiling the required information;

- A description of the arrangements for monitoring and management of environmental impacts; and
- Technical and supporting information as appendices, if any.

History of Application

Sylvania has previously applied, in terms of the MPRDA (application ref no LP30/5/1/2/2/10016MR), for the establishment of a mine on the Farms Volspruit and Zoetveld. The scoping phase has been concluded with the acceptance of the final Scoping Report, and the Plan of Study for EIA by LEDET and the DEA on the 2nd of February and 4th of April 2012 respectively, followed by the DMR on 24 July 2012. In terms of the MPRDA EIA Regulations this required the EAP to submit a Scoping Report by the 23rd of August 2012. It also required the EMPR, together with the results of stakeholder consultation, to be submitted to the DMR by the 20th of January 2013 (i.e. 180 days from their acceptance of the mining licence application).

In order to comply to the requirements of the MPRDA Regulations, and the performance requirements of the DMR, a draft EIA Report including EMPR and other supporting appendices (including full specialist assessment reports), was made available to key commenting authorities and I&APs for review and comment from the 30th of November 2012 to the 15th of January 2013. Furthermore, a number of focus group workshops/meetings were undertaken with directly affected farmers, landowners and conservation groups in the first week of December 2012, in addition, a public meeting was held on the 7th of December in Mokopane.

Comments received during the aforementioned comment period, as well as, from the referenced meetings and workshops were reviewed and registered in a Comments and responses report. These comments have been addressed and responded to in the development of the EIA Report and EMPR for submission. The Draft EIA and EMPR documentation was submitted to the DMR on the 18th of January 2013.

As a result of the complexity of additional work required, and the lack of a flood event occurring within the constraints of the MPRDA EIA timeframes, the EIA process could not be concluded to the extent that an informed and defensible decision could be recommended by the EAP and specialists in terms of the MPRDA Application Ref No LP30/5/1/2/2/10016MR within required timeframes.

Although both the proponent and EAP sought to obtain extension in terms of MPRDA application ref no LP30/5/1/2/2/10016MR, as a result of the restrictive provisions of the MPRDA EIA Regulations the DMR could only allow extension to the 4th of June 2013, as a result of the lack of a flood materialising in this new time frame, as well as delays in the study of the clay layer separating the Nyl from groundwater systems, the specialist studies required to be able to make an informed decision, could not be completed within the timeframes as stipulated by the MPRDA.

As the specialist studies required to provide adequate information to allow informed decisions to be made Sylvania had no choice but to withdraw the application and resubmit an application, starting the application process afresh in terms of the MPRDA whilst the NEMA application was kept open.

Project Overview:

Sylvania proposes the mining of two (2) separate ore bodies through open cast mining on the farm Volspruit 326 KP, Mokopane, Limpopo Province. In addition, areas of the remaining extent of the Farm Zoetveld 294 KR are proposed for the establishment of supporting above ground infrastructure (e.g. tailings storage facility and waste rock dump). The mining of these two (2) ore bodies will result in the establishment of two separate opencast pits, the so-called 'north pit' and the 'south pit'. It is estimated that the targeted ore reserves underlying the site equal approximately 56 million tonnes, which suggests that the mine will be in operation for approximately 18-20 years; where the mining of the respective pits will occur in a phased manner. The north pit will be mined between years 1-13, and the south pit between years 13-19. It is proposed that PGMs will be mined to a depth of approximately 180m at the north pit and south pit respectively.

Sylvania's proposal also includes provision for the establishment of an ore processing plant (frother flotation) and smelter complex including a fluidised bed ore roasting plant, a 5MW DC Arc furnace (and an additional 5MW furnace toward ramp up a couple of years into operations) and a Chemical Vapour Metal Recovery Plant for the beneficiation of metal produced.

These plants aim to further process the mined mineral baring ore into saleable PGM mineral fractions and beneficiate the ore to high value pure metals. This process will produce significant volumes of waste rock and minerals residues which will require waste rock and tailings disposal facilities. The 'plant site' is proposed to be established on the farm Volspruit 326 KP, at a site centrally located to the opencast pits and away from the Nyl River and associated wetland.

The site is currently a 'Green-fields' site under intense agriculture, as well as having large tracts of undisturbed natural vegetation. All relevant surface infrastructure and other infrastructural requirements for the project will thus need to be developed on the site. Further to the structures and infrastructure mentioned above, the mine's development will include provision for, *inter alia*, access roads, administration buildings, workshops, storage/lay-down yards, sewage treatment plants, return water- and storm water dams, explosives store, electricity sub-stations, as well as supporting electrical, sewage and water reticulations.

Overview of main Legal Requirements:

The proposed project would entail several so-called 'listed activities', which may not commence prior to obtaining an environmental authorisation in terms of Section 24 of the National Environmental Management Act, 1998 (Act No. 107 of 1998)[NEMA]. An application for environmental authorisation, in terms of NEMA, for activities listed in Government Notices R.544 and R.545 of 18 June 2010, was submitted to LEDET on 11 March 2011. The reference number 12/1/9/2-W11 has been issued by LEDET for the subject EIA.

Furthermore, the National Environmental Management: Waste Act (Act No. 59 of 2008) [NEM:WA] requires so-called listed 'waste management activities' to be licensed. Various waste management activities in terms of GN. R.718 of 3 July 2009, promulgated under the NEM:WA, will be 'triggered' by the project proposal and a waste management licence application has accordingly been lodged with the National Department of Environmental Affairs (DEA). An application to this effect was submitted to the DEA on 23 March 2011. The reference number 12/9/11/L582/5 has been assigned by the DEA to this application for a waste management license. GN. R.921 of 29 November 2013 has subsequently replaced GN. R.718 but the application still stands, guided by certain transitional provisions listed in GN. R.921.

In terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)[MPRDA], a comprehensive Environmental Management Programme Report (EMPR) must be compiled in support of the proponent's application for a mining licence. The attached EMPR has been compiled in terms of section 39 of the MPRDA and section 51 of Regulation 527 of 2004 thereunder. The MPRDA also required a scoping and EIA process to be undertaken to inform the compilation of the EMPR. The objectives and reporting format for the required MPRDA scoping and EIA process are largely mirrored by those required for the environmental authorisation and waste licensing procedures. A single scoping and EIA process was thus administered by ESA to meet the objectives of both Acts, and the resulting reports have been compiled to conform to the regulatory requirements of NEMA, NEM:WA and the MPRDA. An application for a mining right was submitted to the Limpopo DMR in early September 2011.

In addition, an Integrated Water Use Licence application, in terms of section 21 of the National Water Act, 1998 (Act No. 36 of 1998)[NWA], will be completed and submitted to the Limpopo Department of Water Affairs. In support of this water use licence application, a comprehensive Integrated Water and Waste Management Plan (IWWMP) for the proposed Mine will be compiled.

Due to the proposal to establish a smelter and CVMR Plant at the Volspruit mine, certain air emissions will be generated, which are regulated and controlled in terms of emission standards set in Regulations promulgated under the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)[NEM:AQA]. Accordingly, an Atmospheric Emission Licence (AEL), as contemplated in NEM:AQA, will also be applied for, for the proposed establishment of the smelter complex and CVMR Plant.

Receiving environment of the Project Site / Site Sensitivities:

The farms Volspruit and Zoetveld are located approximately 15km south of Mokopane (Limpopo Province), within the Mogalakwena Local- and Waterberg District Municipalities respectively. Approximately 200ha of the farm Volspruit constitutes irrigated croplands, of which approximately 100ha on Ptn. 1 of the farm Volspruit would be directly affected / sterilised by the proposed mining activities. The remainder of the study area is comprised predominantly of one of three major vegetation types, namely i) Central Sandy Bushveld, ii) Subtropical Freshwater Wetlands and iii) Springbokvlakte Thornveld, with Central Sandy Bushveld being dominant amongst the three. Immediately adjacent to and forming the western boundary of the site is the Nyl River and its associated floodplain wetland.

The study site lies on the flats to the east of the Nyl River, which is very gently sloping from the south-east towards the river in the west. There is also a small koppie along the northern boundary of the site. The geology of the study area is dominated by Melanorite of the Bushveld Igneous Complex. The Zebediela Fault passes approximately east to west just to the south of the study area and crosses the Nyl River up-stream of the site.

The Nyl River floodplain is located within the Limpopo River Catchment (Primary Catchment A), with the Nyl River being a direct tributary of the Limpopo River (catchment A61). The Nyl Floodplain itself stretches across four quaternary catchments, with the proposed mining area being located in catchment A61E. According to DWAF Eco-classification (PES/EIS) data (1999), quaternary catchments A61C-E were classified as being of High Ecological Importance and Sensitivity. This can largely be attributed to the Nyl River floodplain (including the Nylsvley Nature Reserve) which provides valuable feeding, breeding and refuge habitats for terrestrial vertebrates (e.g. otter), amphibians, wetland birds and fish. The Nyl River and associated flood plain is characterised by periodic flooding.

The Nylsvley Ramsar Site, which constitutes the 'Nylsvley Nature Reserve', is located within the middle reaches of the floodplain, approximately 40km up-stream of the proposed mining area (as the crow flies). The reserve protects around 3000ha of the floodplain (based on the figures quoted, this represents more than 11 % of the floodplain). To be listed as a Ramsar site the floodplain needed to comply with at least one of 11 listed criteria of the Ramsar Convention. Nylsvley Nature Reserve qualified to be listed because it complies with eight of the criteria. At least six of these criteria are directly related to biodiversity and the importance of the floodplain in supporting a diverse array of birds, mammals and plants.

Other factors that may lead to parts of the study area having high ecological sensitivity are the presence of a major wetland system on site and the potential presence of at least one plant species of conservation concern, the Vulnerable *Oryza longistaminata*. This species was confirmed during detailed field surveys to occur within the wetland area on site. There are eight protected tree species that occur in the area and it has been evaluated that at least six of them have a possibility of occurring on site. It was confirmed during the field survey that *three of these species occur in or around the site, namely Acacia erioloba, Boscia* albitrunca and *Sclerocarya* birrea subsp. *caffra.* If any individuals of these trees are affected by proposed infrastructure, a permit will be required. A large proportion of the study area appears to be in a natural condition, although significant areas are cultivated or were previously cultivated. Degraded areas on site are classified as having low sensitivity and conservation value. Terrestrial vegetation is classified as having medium sensitivity and wetland vegetation as having high sensitivity. The ore bodies are within previously disturbed areas or within untransformed terrestrial vegetation.

Agricultural land-uses dominate the area, and vary from irrigated cropland (maize, sugar beans, wheat, etc.) and citrus plantations to cattle/game farms and piggeries. The non-operational Grass Valley Mine is located on the farm 'Grass Valley' north of the site. Other prominent landscape features include the N1 national highway almost immediately north north west of the site, as well as the N11 road to the east of the site. The study area could be described as a quiet rural farming district.

Households residing in the Mogalakwena Local Municipality have relatively the same level of income as the average household in the country and are better off than an average household in the Limpopo Province. A considerably lower percentage of households in the Mogalakwena have no income compared to that of the Limpopo Province. This is related to the fact that the unemployment rate in the Local Municipality is better than the unemployment rate in the Province. All of the above suggests that households residing in Mogalakwena have on average better access to employment opportunities than households in the rest of the Province. This could be explained by the fact that the Local

Municipality has a very well developed mining sector and is strategically located between Pretoria and Polokwane.

Households living in the primary study area generally have better access to formal dwellings and electricity. Their access to water and sanitation, however, differs significantly from that observed in the country and in Gauteng. Although most of the households have access to water and sanitation in Mogalakwena, a great share of them have these services outside their dwellings. This is though indicative of the settlement pattern and dwelling structure that are observed in rural areas throughout the country.

The labour market in the primary study area comprises of 61 442 employed and 20 443 unemployed people. It has a bigger labour participation rate (39.2%) than in Limpopo but significantly lower participation rate than in South Africa. This however could be explained by the fact that a significant number of working age population is encouraged job-seekers. These people are not considered to be economically active and are not included in the calculation of the unemployment rate. Therefore, the actual unemployment rates are deceiving and do not reflect the actual need to create new employment opportunities for people in the primary study area, as well as the rest of the country.

The economy of the Municipality is relatively small (R10.7 billion of GDP-R), but since 1996 its average performance was slightly better than in other study areas under analysis, particularly Limpopo. This was attributed to the sharp increase of the mining sector in the area in the beginning of the century and supported by the growth of the transport industry.

The mining sector is the largest sector in the primary-study area's economy. It contributes 35% to the Municipality's economy in nominal prices. Such a dependency on mining, however, is not ideal as any fluctuations in commodity prices and demand for commodities would have a notable impact on the local economy. The global recession in 2009 had exactly the same effect on the economy, when the value added of the mining sector dropped by 19%.

From the employment perspective, the sectors that create the majority of jobs in the Municipality are the services sectors, such as community services and trade. Given the employment creation targets set by government in its New Growth Path and assuming that it is matched by investment, the economy of Mogalakwena could be growing at a higher rate in the future than it did over the past few years.

Environmental impact significance summary:

The tables that follow provide a concise overview of the relative impact significance of potential biophysical impacts that may result from the establishment, operation and decommissioning/closure of the proposed Volspruit Mine.

<u>Construction</u>

It is evident that the construction phase impacts with greatest potential significance are impacts on site biodiversity; where the impact would result predominantly from large-scale clearance of indigenous vegetation (i.e. direct impacts on biodiversity through habitat loss), as well as indirect impacts of construction on site biodiversity (i.e. noise, vehicular movement, water pollution, etc.). The relative impact significance of impacts associated with these activities is deemed high. This is predominantly by virtue of the habitat destruction and potential impact to highly sensitive nature of the wetland habitat on site, as well as ecological linkages (direct and indirect) thereof with the greater Nylsvlei wetland and the Nylsvley Nature Reserve (Ramsar site), and the location of the site within an internationally recognised important birding area (IBA).

No identified construction phase impacts are identified to pose a fatal flaw to the project, provided that the mitigation put forward in this EIA and the attached EMPR are complied with by the proponent during mine establishment.

Table 1-1: Tabular Summary of construction phase Impact Assessment

Aspect	Impact Significance (No mitigation)	Impact Significance (mitigation)
Construction		
Noise	Moderate	Low
Cultural / Heritage Resources	Moderate	Moderate
Biodiversity	High	High
Avi-fauna (Habitat loss)	High	High
Avi-fauna (Noise)	Moderate	Moderate
Agricultural Potential / Land use	High	Moderate
Surface Water Hydrology	Low	Low
Ground- & Surface Water Quality	Moderate	Low
Traffic	Low	Low

Operation

The operational phase too has the potential to result in impacts with high relative impact significance on site-, as well as regional biodiversity (both directly and indirectly). This is again by virtue of the highly sensitive nature of the Nylsvlei wetland (ecological and hydraulically) and the linkage of the 'Volspruit' wetland both up- and down-stream with the remainder of this system [incl. the Nylsvley Nature Reserve up-stream (a Ramsar site)]. The aforementioned impacts are a potential indirect consequence of groundwater drawdown to be created around the opencast pits as a result of pit dewatering.

Pit dewatering (north and south pits) has been modelled to undercut the Nylsvlei wetland during the mining thereof (which may last between 3 and 10 years depending on the exact geohydrological conditions, abstraction rates and grouting). As flooding is somewhat erratic (on average, three times in ten years and some flooding occurs in six out of ten years) there were concerns about potential hydraulic linkage/connectivity between the 'dewatered' aquifer beneath the wetland and surface flows (predominantly in the form of seasonal sheet flow/flooding) as it was feared that dewatering may cause a decrease in depth and extent of inundation in the Nylsvlei wetland during a flood event; where floodwater may act to recharge the 'dewatered' aquifer, thereby reducing the effective volume of down-stream flow. Such impacts to the flood dynamic could inter alia result in changes to the floral and faunal species composition of the wetland, as well as the ability of migratory aquatic species (fish) to move from down-stream areas up to the Nylsvley Nature Reserve to breed.

Accordingly as part of the expanded specialist studies the potential impact of groundwater dewatering on flood dynamics was investigated through an integrated hydrological model, transient groundwater modelling as well as an investigation into the clay layer characteristic of the Nyl floodplain.

A large volume of empirical evidence and academic research exists that indicates the presence of a clay layer over the wetland floor that acts to hydraulically separate it from the underlying aquifer.

No other potential fatal flaws have been identified for the project during the operational phase thereof, provided that the full range of mitigation and monitoring requirements put forward in this EIA and the attached EMPR are complied with by the proponent during mining and processing activities.

Table 1-2: Tabular Summary of operation phase Impact Assessment

Aspect	Impact Significance (No mitigation)	Impact Significance (With mitigation)
Operation		
Noise	Moderate	Moderate
Blasting	High	Moderate
Groundwater Quality	Moderate	Moderate
Groundwater Quantity – aquifer and borehole yields)	Moderate	Moderate
Groundwater Quantity - wetland hydrology / flooding 2013 precautionary rating)	High/Severe	Moderate
Groundwater Quantity - wetland hydrology / flooding 2013 precautionary rating)	High	Moderate
Biodiversity (2013 precautionary rating)	High/Severe	Moderate
Biodiversity (2014 after additional study)	High	Moderate
Avi-fauna (Nyl hydrology impacts)	High / Severe	Moderate
Av-fauna (Light illumination / collisions)	High	Moderate
Visual & Aesthetic Character	High	Moderate
Air Quality	Moderate to High	Moderate
Traffic	Low	Low

Decommissioning

The most notable potentially negative impact identified for the decommissioning and closure of the mine is for potential decant from the flooded pits post mine closure, as well as the development of a potential sulphate pollution plume within the adjacent aquifer following the flooding of the pits; where such is modelled not to reach any adjacent boreholes at up to a 100 years post mining. The pollution plume has, however, been modelled to undercut the Nyl river at approximately 25 years following the flooding of the north. The impact is deemed to have potential moderate significance, providing that the mitigation put forward in this EIA, as well as the attached EMPR are complied with by the proponent.

The remaining impacts would act to partially restore pre-mining conditions over the site, with positive consequences (i.e. relative to the operational phase); where rehabilitation would act to revert as much of the mine site footprint as possible back to Central Sandy Bushveld as is feasible / practical.

Table 1-3: Tabular Summary of Decommissioning (Post closure) Phase Impact Assessment		
Aspect	**Impact Significance (No mitigation)**	**Impact Significance (mitigation)**
Operation		
Groundwater Quality and Quantity	High	Moderate

Socio-economic Impact Summary

The proposed mine and mineral beneficial complex is expected to create both positive and negative impacts during the construction and operational phases. From a socio-economic perspective, the positive effects in terms of export earnings, economic development, job creation, household income, and government revenue that could be derived during both construction and operations by far outweigh the negative impacts that could ensue as a result of the mine's establishment and operation in the area.

However, the mine will be associated with a number of other negative effects that are more challenging to quantify and to offset. These are associated with the sense of place, property values, loss of family ties, crime situation and pressure on socio-economic infrastructure. Some of the impacts would only last during the construction period (such as crime and impact on socio-economic infrastructure), while others will extend into the operational period and will therefore be of a considerable longer term. While the economic benefit of the mine's establishment in the area cannot be faltered, all efforts need to be made to ensure that the establishment and operation of the mine is conducted in the most sustainable way with the primary objective of minimising and where feasible completely eliminating the potential for altering human livelihoods in the area.

Table 1-4: Tabular Summary of Construction Phase Impact Assessment (Socio-economic)		
Aspect	**Impact Significance (No mitigation)**	**Impact Significance (mitigation)**
Positive		
Temporary stimulation of the national and local economies	High	High
Creation of temporary employment opportunities nationally and locally	High	High
Temporary increase in household income during construction	High	High
Contribution to skills development during construction	Negligible	Negligible
Temporary increase in government revenue	Negligible	Negligible
Negative		
Negative impact on the balance of payments	Negligible	Negligible
Loss of agricultural production due to land sterilisation	High	High
Negative changes to the sense of place	High	Moderate
Negative impact on surrounding	Low	Negligible

agricultural and game farming activities		
Negative impact on households due to potential negative impacts on land sterilisation and surrounding economic activities	Moderate	Moderate
Pressure on social and economic infrastructure	Low	Low
Temporary increase in crime and social conflicts associated with influx of people	High	Moderate
Potential negative impact on property values	High	Moderate
Potential loss of family ties	High	Moderate

Table 1-5: Tabular Summary of Operational Phase Impact Assessment (Socio-economic)

Aspect	**Impact Significance (No mitigation)**	**Impact Significance (mitigation)**
Positive		
Effects on balance of payment due to production of PGM alloy	Moderate	Moderate
Sustainable increase in production and GDP-R in national and local economies	High	High
Creation of sustainable employment opportunities nationally and locally	High	High
Improved living standards of positively affected households	Moderate	Moderate
Sustainable increase in government revenue	Moderate	Moderate
Skills development of permanently employed workers	Moderate	Moderate
Local economic development benefits derived through mine's social responsibility programme	Moderate	Moderate
Negative		
Potential losses of sustainable revenue by agricultural activities and game farming industry	Moderate	Moderate
Reduced opportunity to earn foreign exchange due to environmental impacts on surrounding farms	Low	Negligible
Negative impact on the livelihoods of people dependent on the affected agricultural and game farming activities	Moderate	Moderate

SUMMARY OF CONSIDERATIONS

The potential socio-economic benefits of the proposed project have been demonstrated to be significant; where the positive effects in terms of export earnings, economic development, job creation, household income, and government revenue that could be derived during both construction and operations are deemed by a socio-economic specialist to outweigh the potentially negative socio-economic impacts that could ensue as a result of the mine's establishment and operation in the Mokopane area. The need and desirability of the project has further been demonstrated, in terms of inter alia the alignment thereof with the following development growth plans, policies and strategies:

- New Growth Path;
- IPAP 2011/2012-2013/2014;
- Industrial Development Corporation (IDC) and Development Bank of South Africa (DBSA) financing plans;
- Mineral Beneficiation Strategy for South Africa;
- Limpopo Economic Development Plan;
- Waterberg LED; and
- Waterberg Mining Strategy.

A project of this nature cannot, however, be motivated solely on socio-economic grounds alone, and needs to take due consideration of the potentially negative environmental impacts that may result from the project in order for defensible, sustainable, decision-making to occur at the hand of the respective competent authorities. In this regard, the following points are noteworthy for decision-makers:

- The farms on which the proposed Volspruit Mine fall (i.e. the Farms Volspruit and Zoetveld) are located in Zones one 1 and 10 of the Waterberg environmental management framework (EMF).
  - The EMF describes Zone 1 as an area where “Protection of natural vegetation, scenic landscape and rock painting areas, with limited appropriate tourism” should exist, and Zone 10 as: “Agriculture areas with commercial focus”. The EMF goes further to list ‘undesirable activities’ for each zone, as described above, where mining is listed as an ‘undesirable activity’ in both Zone 1 and Zone 10.
  - When discussing undesirable activities the EMF does state the following: “It does not however mean that undesired activities for example will not be allowed under any circumstances but rather that such activities will have to meet very high standards and be considered very carefully by the relevant competent authorities before they are allowed”
  - The EIA process followed addresses the extreme standards to which the mine will need to perform specifically with respect to managing impact to water including grouting and pollution control system performance.

- The Waterberg District Municipality SDF, 2009 states that: “While mining is recognised as a pillar of the local economic base and key job provider, the long term impact thereof should be carefully considered. Current indications are that with the exception of one or two protected areas there is no direct conflict between mining and prospective mining activities and the major tourism and conservation areas in the municipality”.
  - The preceding statement clearly indicates that mining is recognised in the SDF as an economic pillar, however, the impact thereof should be carefully considered. The EIA process followed has indeed sought to better understand and quantify these

potential impacts through a series of linked models as the EIA process has highlighted that issues relating to water supply and wetland integrity and protection demanded detailed analysis careful consideration.

- The Mogalakwena SDF (2009) states that: "The increasingly important role of mining in the local economy is recognised by the Council. However, mining is driven by international commodity prices and economic conditions. The Council will therefore support the mining sector in terms of land and services availability but in such a way that it does not take on responsibilities in terms of business risks of the mines".
  - The Mogalakwena SDF contains various sections on water; Land use; biospheres etc. and the SDF requires protection of 'Environmental Features' as follows: *"The environmental features of the municipal area are dominated by the river (Nyl) and specifically the river buffer along it… River buffers are ecologically important for the protection of ecosystems and should, therefore, be avoided and not disturbed through development. In this respect, river buffers should be protected"*.
  - Significant efforts have been made with the siting of infrastructure and development of pollution control systems to ensure the Nyl River is protected.

Although mining is recognised as an important economic activity locally, regionally and nationally, the potential impacts thereof in appropriate mining activity is pertinently cautioned against and accordingly the sensitive components of the receiving environment need to be well understood before allowing informed decision-making around mining applications.

Importantly, the presence of the Nyl River and its ecological importance in the region is recognised in the aforementioned frameworks and thus need to be addressed to consider whether a project can operate within the framework of the above guidelines. In this respect the framework within which decision making need to place need to consider that:

- The Nyl River wetland system (also referred to as Nylsvlei wetland system) and associated wetland/aquatic habitat it offers [including the Nylsvley Nature Reserve in the upper reaches thereof (a Ramsar site)], a section of which traverses immediately west of the proposed mining operations, is deemed by ecological and avi-faunal specialist to be highly sensitive to potential disturbances from the proposed mining activities.
- Accordingly the potential impacts of mining on this sensitive habitat that formed a key focus of the EIA. The EIA and various specialist studies assessed the potential environmental impacts of the project across all relevant environmental aspects and over the full project life cycle, with the attached EMPR documenting the mitigation and monitoring measures required to ensure that such impacts are reduced to within acceptable levels of significance.
- The EIA finds none of the environmental impacts identified are deemed to be of such significance that they constitute a fatal flaw to the project (when adequate mitigation measures are implemented):
  - Mine dewatering will lead to the groundwater cone of depression undercutting the Nyl River (and concerns in respect of potential impact to the Nyl River flood dynamic prevented the EAP to favourably recommend the development in terms of prior MPRDA application), specialist studies have indicated that the Nyl flood event is divorced from the regional aquifer by a comprehensive clay layer; furthermore, current groundwater abstraction for crop irrigation already undercuts the Nyl River and allows the continued function of the surface flood event.

- The Nyl River catchment and associated groundwater aquifer is water stressed and volumes of water estimated to be abstracted for crop irrigation is significantly higher than water uses registered with the Department of Water Affairs. The dewatering of the mine will produce more water than the mine will required for its own operations. Limited additional groundwater abstraction from the mine over and above what is currently abstracted for crop irrigation on the site will lead to marginal reduction in Mean Annual Runoff. The specialist studies undertaken cannot substantiate claims that inadequate water resources exists to allow the mine and catchment wide approach to water use and water use licensing is recommended.

BACKGROUND TO CONSIDERATION

Given the sensitive nature of the receiving environment within which the mine is proposed, as well as the complexity of the associated hydrological regime associated therewith, a cautionary approach was taken the preliminary EIA issued found that there was inadequate information for authorities to make an informed and defensible decision and recommended that additional work be undertaken to address uncertainty around the prediction of impacts relating to dewatering and potential disruption of flood dynamic and wetland habitat.

The preliminary EIA further made the recommendation that no decision-making in respect of this project should be undertaken by competent authorities until such time as specialist investigations have been undertaken so as to allow predictions about the impact of mine related aquifer dewatering with adequate certainty, and until the findings of such studies have been integrated into an updated EMPR and EIA.

It is the view of the EAP that the work undertaken to address uncertainty around the prediction of impacts relating to dewatering and potential disruption of flood dynamic and wetland habitat allows the prediction of impacts relating to dewatering and potential disruption of flood dynamic and wetland habitat with adequate certainty to make a defensible decision as the links between surface flood events, groundwater and mine water consumption are understood on various scales ranging from

- the level of the Nyl catchment A61, to
- the quaternary catchment A61E and its sub-catchment A61E2 corresponding with the groundwater modelling domain; to
- pit dewatering models and dynamic water balances

The refinement of conceptual understanding of the clay layer associated with the nyl wetland as well as the development of integrated hydrological models and their verification against hydrograph data alongside the refinement of groundwater models and their coupling has provided a clear understanding of the links between aquifers and surface flows and the extent of separation between floods the underlying aquifer. Furthermore, catchment hydrological models have successfully been linked with groundwater models and catchment water balances, the output of which in turn have been linked with mine drainage models and dynamic water balances.

RECOMMENDATION ON PROJECT PROPOSAL

The preliminary EIA indicated that approval is only to be considered by competent authorities if separation of the Nylsvlei wetland from the underlying aquifer is found to be such that the function of the wetland is not destroyed or disrupted through the interruption of the flood dynamic through aquifer dewatering.

The EIA process followed has concluded that the proposed mine will not destroy the wetland or disrupt it through aquifer dewatering and limited additional water demands can be accommodated by the system, however it is noted that the system is already under significant pressure.

The EAP accordingly recommends that the respective applications be viewed favourably subject to certain key requirements being fulfilled most importantly that water use would need to be minimised and water conservation would need to be optimised. In this respect the WULA application process should seek to identify opportunities to save water not only at the mine but also in the study domain (the A61E2 catchment/ groundwater modelling domain). Considering that agriculture uses approximately $6Mm^3/a$ opportunities must exist where the proposed mine can seek to further water conservation practises within the agricultural community that is proposed to receive it.

Further work that should be undertaken before mining is to commence

In a study with such complexity, an investigation more often than not highlights aspects of interaction between environmental systems to adequately cater for the management during the design of a potential mine.

The following follow-up work around surface and groundwater management is recommended before mining may commence:

- Establishment of a Volpsruit /Mokopane Chapter of the Mogalakwena Water Users Association Water Forum with representation from conservation, agriculture, and local authority, amongst others; the funding of the water forum administration to be carried by the applicant (Volspruit Water Forum).
- The establishment of an Environmental Control Officer team comprised of at least three independent specialist competent by training education and experience with backgrounds in groundwater, wetland management and mining environmental management that will audit the project on a quarterly basis against the EMPR, IWWMP, EIA Authorisation, Atmospheric Emission License and Waste Management license during construction at least on a 2 monthly basis and during operational phase at least on a six monthly basis and reporting to DMR, LEDET, DWA, Volspruit Water Forum and Environmental Monitoring Committee if such an entity is formed by I&APs
- A detailed hydrocensus of boreholes within modelled cone of depression utilising the cone of depression as modelled in steady state (a wider area surveyed as precautionary measure). All boreholes utilised for groundwater production by Volpsruit mine as well as those of farmers on neighbouring farms that irrigate crops should have electronic level measurement equipment installed so as to allow for more holistic aquifer management to be undertaken by all water users through the Volspruit Water Forum
- Access to water abstraction rates and groundwater levels of existing boreholes located within pits and neighbouring properties to be secured through Volspruit Water Forum;
- Improved knowledge of the variation of hydraulic conductivity with depth is needed, and several additional packer tests are recommended to enable grouting design; and
- Additional shallow boreholes must be drilled along the Nyl identified by the clay layer investigation as an area of potential decant where flooding may recharge

aquifer (depending depth and period of inundation) so as to further improve knowledge of surface water/groundwater interaction and connectivity.

- Further groundwater and dynamic water balance modelling from which detailed design of all water pollution control infrastructure including grouting can be designed and mine water management programmes are to be developed (which will also form basis of Water Use Licence application).

Further attention also needs to be given to the closure plan (at the end of the lifespan of the proposed mine) of specifically the northern pit as a unique opportunity would then exist to create additional suitable habitat and expand the existing wetland habitat. The following follow-up work around mine closure is recommended before mining may commence:

- The closure landscape should be designed and constructed so as to create a mosaic of habitats that closely approximate the Nyl River habitats including riverine floodplains, flooded basins, seasonally flooded grassland, groundwater fed woodland savannah and open savannah with open shallow shoreline to reed fringed open water and refuge areas such as islands with tall dead trees.
- Avifaunal and wetland biodiversity monitoring at quarterly intervals to determine a comprehensive pre-mining baseline form which mining impact can be measured and from which further mitigation measures

<u>Key recommendations as key conditions for authorisation</u>

1. The mine will establish a 'precautionary environmental buffer zone' of at least 110m in extent from the delineated eastern edge of the Nyl wetland into the proposed North pit (as shown in the sequential mining diagram in Appendix 8.1); although this buffer may be considered for extraction in a final 'cut-back' in the north pit, any opencast mining within this buffer will be made conditional to an EMPR amendment and application for exemption from NWA Reg. GN704 for approval by DMR and DWA respectively. The mining of the ore body that falls within the buffer area (i.e. the western extremities of the north pit) must be done at the end of the north pit life, when adequate understanding of the ore body and mining impacts has been gained from inter alia:

   a) Comprehensive ground- and surface water monitoring prior to establishment of, and during the operational life of mine;
   b) A geo-technical pit wall failure risk assessment for the final pit wall position within the buffer, based on detailed pit design; and

   This buffer aims to provide a margin of safety with respect to potential groundwater flood induced pit wall instability along the north pit perimeter in close proximity to the Nyl River and its associated floodplain wetland. If a grouted 'curtain' is constructed in weak material e.g. (soil, or weathered rock) around an opencast pit (as is understood to be the case at Volspruit, with such material extending to approximately 30m below surface), it can lead to geotechnical instability unless a suitable barrier is left between the 'curtain' and the edge of the pit wall.

   - The width of such a barrier/cut-back depends on the thickness and properties of the material in which it has been created.

- For weathered rock, the width of the barrier should typically be at least twice its thickness (hence the 2 X 30m = 60m buffer proposed as a precaution).

Although surface floods will not affect the pit as a result of the flood protection berm, although seen as unlikely, a rapid rise in groundwater levels associated with a flood event may affect pit wall stability and due to the sensitivity of the adjacent wetland the buffer is proposed as a precautionary measure.

2. Further attention also needs to be given to the water management and closure plan of the mine as part of IWWMP:
   - Post-mining, water levels will return to normal levels and groundwater abstraction within mine in general should be managed and in North Pit specifically should limited terminated to achieve a groundwater dynamic with little more than natural seasonal fluctuation, this will allow the establishment of a mosaic of habitat types such that bird species under pressure may be optimally provided with refuge feeding and breeding habitat.
   - The viability of establishing and maintaining the desired habitats under the hydrological regime likely to occur with the 'open water body' should also be assessed in detail, specifically:
   - Water levels that are likely to fluctuate by several meters and the implications thereof on establishing and maintaining a vegetated shoreline abstraction should be limited with the possible exception of limited abstraction for human use or as part of water quality management measures within the mined-out pit
   - Expected water quality within the 'open water body'. In this regard the threat of excessive algal growth due to potentially high background nitrate levels within groundwater needs to be assessed.
   - It is proposed that this land use or similar mix of extensive agricultural and conservation also be adopted as the final end land use and be stipulated as a condition of approval.

3. A number of water management scenarios have been identified and modelled in the dynamic water balance and it was established that the mine will initially be a producer of excess water, a number of options have been identified for management of excess water:
   - Base Case (Conservative inflows to the pit areas (grouted, no faults – conservative water take) utilising Grassvally as buffer (both sourcing and recharging – with sourcing at sustainable yield levels as identified in Grassvally WULA) with irrigation of excess water to farmers apply (irrigation stepped to provide constant supply)
   - Base case with 20% saving on TSF seepage water losses
   - Base case with no irrigation and all excess water recharged to Grassvally

   The scenarios should be further investigated alongside closure planning for the North Pit and report to Volspruit /Mokopnae Water Forum and I&APs so as to form the basis for IWWMP and WULA
   - It is recommended that the mine should achieve 20% saving on TSF seepage water losses (this may be through optimal combination of tailings cut-off trench, herringbone drain, seepage recovery well field and thickened talings disposal)

- It is recommended that excess water irrigated to croplands Subject to the approval thereof by the Department of Water Affairs through the WULA process) in the area, to the extent that surplus water dewatered from the pits beyond their own process water requirements allows them to do so sustainably with a targeted saving of 20% of tailings seepage losses to be recovered as per Dynamic Water Balance; and

4. The proponent must comply with all mitigation and monitoring measures put forward in this EIA, as well as the attached environmental management programme report (EMPR);

5. The proponent must comply with any additional conditions of authorisation / approval by the respective competent authorities, and other reasonable measures that may be stipulated by authorities that have jurisdiction in matters relevant to this application and update the EMPR accordingly.

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ABBREVIATIONS

APPA:	Atmospheric Pollution Prevention Act, No. 45 of 1965
BAT:	Best Available Technique
BEP:	Best Environmental Practice
BID	Background Information Document
BFD:	Bag Filter Dust
BM:	Before Mitigation
BPEO:	Best Practicable Environmental Option
CDM	Cleaner Development Mechanism
CER	Certified Emission Reduction
CO:	Carbon monoxide
CO_2:	Carbon dioxide
CRR	Comments and Responses report
CVMR:	Chemical Vapour Metal Refining
DEA:	Department of Environmental Affairs
DMR	Department of Mineral Resources
DWA:	Department of Water Affairs
EAP	Environmental Assessment Practitioner
ECO:	Environmental Control Officer
EIA:	Environmental Impact Assessment
EMP	Environmental Management Plan
EMPr	Environmental Management Programme report
IA:	Iron Age (EIA – early iron age, MIA- middle iron age & LIA – late iron age)
IAPs:	Interested and Affected Parties
IPWM:	Integrated Pollution and Waste Management
IWWMP	Integrated Water and Waste Management Plan
IWUL	Integrated Water Use Licence
LED	Local Economic Development
LDEDET:	Limpopo Department of Economic Development, Environment and Tourism
LOM	Life of Mine
Mamsl:	Metres above mean sea level
MAR	Mean Annual Runoff
MBGL	metres below ground level
MDL:	Minimum Detection limit
MPRDA	Minerals and Petroleum Resources Development Act
NEMA:	National Environmental Management Act, No. 107 of 1998
NEMA EIA Regulations:	Regulations GN R.453, R.454, 455 and R.456 (18 June 2010), as amended. promulgated in terms of Section 24(5) read with Section 44, and Sections 24 and 24D of the National Environmental Management Act, 1998
NEM:AQA:	National Environment Management: Air Quality Act, No. 39 of 2004
NEMWA:	National Environment Management: Waste Act, No. 59 of 2008
NEMBA	National Environmental Management Biodiversity Act (Act 10 of 2004)
NO_X:	Nitrogen oxides (NO & NO2)
NWA:	National Water Act, No 36 of 1998
O_2:	Oxygen
PES	Present Ecological State
PM:	Particulate matter
PoSEIA:	Plan of Study for EIA
RDL:	Red Data Listed
ROM	Run of Mine

SA:	Stone Age (ESA – early stone age, MSA- middle stone age & LSA – late stone age)
SANBI	South African National Biodiversity Institute **SO_2:** Sulphur dioxide
SO_3:	Sulphur trioxide
SO_X:	Sulphuric oxides
SR:	Scoping Report
TCLP:	Toxicity Characteristic Leaching Procedure
TOC:	Total Organic Carbon
TSF:	Tailings Storage Facility
UNESCO	United Nations Educational, Scientific and Cultural Organization
VOC:	Volatile Organic Compounds
WEEE:	Waste Electrical and Electronic Equipment
WHO	World Health Organisation
WULA	Water Use Licence Application
'The Mine':	Proposed Volspruit Opencast PGM Mine

1. INTRODUCTION

1.1 BACKGROUND

Sylvania Platinum Limited (hereinafter referred to as 'Sylvania') commissioned the services of EScience Associates (hereinafter referred to as 'ESA') to undertake a scoping and Environmental Impact Assessment (S&EIA) process, in terms of the 2010 EIA Regulations promulgated under the National Environmental Management Act (Act 107 of 1998)[NEMA], to assess the potential environmental impact(s) of establishing a proposed opencast Platinum Group Metals (PGMs) mine near Mokopane in the Limpopo Province.

The proposed opencast mining activities will be undertaken exclusively on the farm Volspruit 326 KR. The establishment of surface structures and infrastructure supportive of the aforementioned mining will take place on both the farm Volspruit 326 KR, as well as on the farm Zoetveld 294 KR (Figure 1-1). A detailed project description is provided in Section 2 of this report.

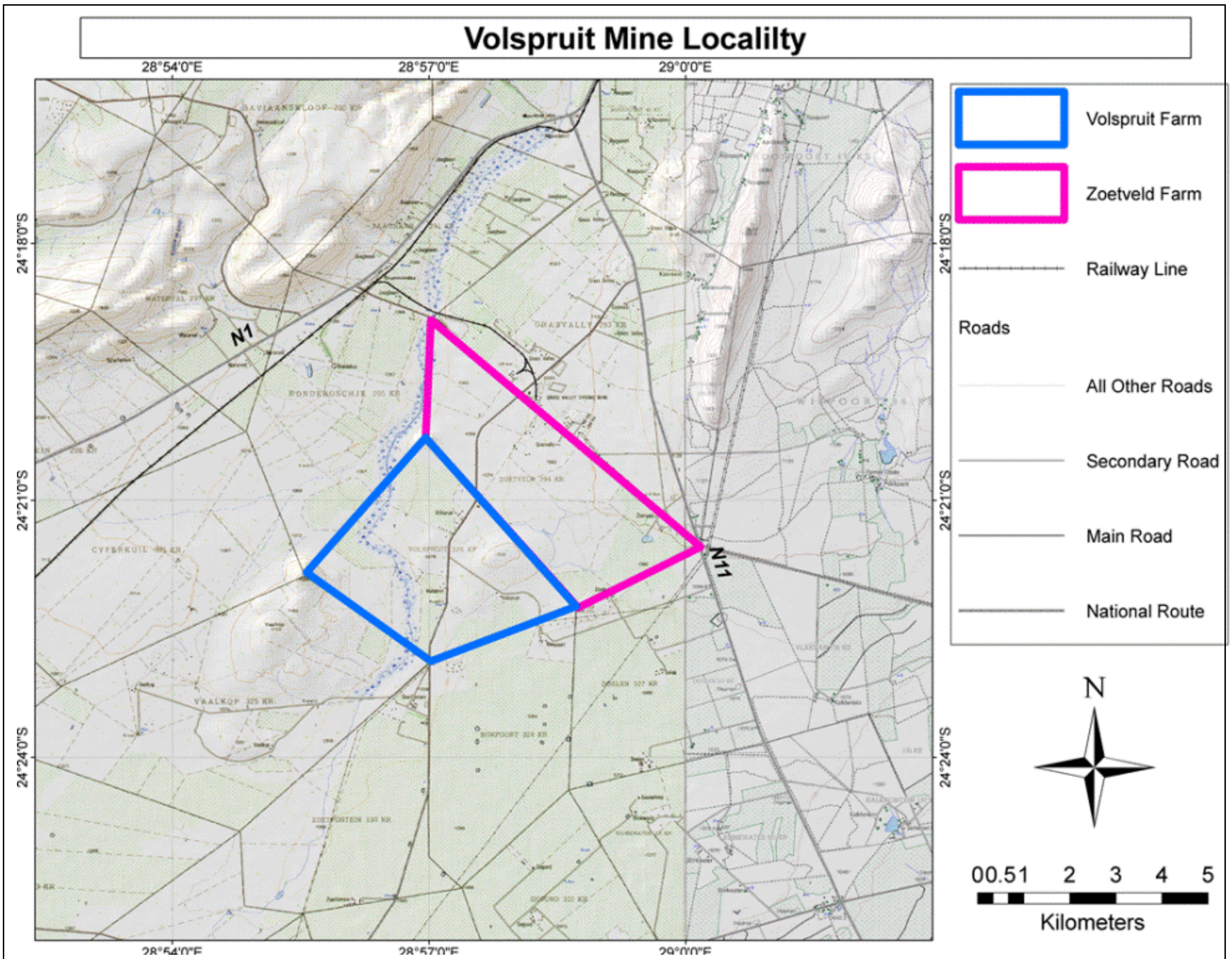


Figure 1-1: Locality Map, Proposed Volspruit Mine

The nature of the mining activities proposed by Sylvania, as well as the onsite activities supportive thereof, have the potential to negatively impact on the environment; where the 'environment' is defined in the NEMA as, *"The surroundings within which humans exist and that are made up of –*

I. *The land, water and atmosphere of the earth;*
II. *Micro-organisms, plant and animal life;*
III. *Any part or combination of (i) and (ii) and the interrelationships among and between them; and*
IV. *The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing*".

The commencement of mining activities or any activities incidental thereto, furthermore requires Sylvania to ensure due compliance with the provisions of South African legislation relevant to the proposed project (Section 3 refers). The S&EIA process and supporting specialist assessments have thus been undertaken in support of numerous requisite 'environmental' applications, in terms of applicable South African environmental legislation, for environmental authorisations, licences and approvals, *inter alia* as follows:

Table 1-1: Tabular Summary of Required Authorisations, Licences and Approvals

Requirement	**Relevant Legislation**	**Competent / Decision-making Authority**
Environmental Authorisation	National Environmental Management Act, 1998 (Act 107 of 1998)[NEMA]	Limpopo Department of Economic Development, Environment and Tourism
Waste Management Licence	National Environmental Management: Waste Act, 2008 (Act 59 of 2008)[NEM:WA]	Department of Environmental Affairs
Atmospheric Emission Licence	National Environmental Management: Air Quality Act, 2004 (Act 39 of 2004)[NEM:AQA]	Waterberg District Municipality
Protected Tree Removal Permit	National Forests Act, 1998 (Act 30 of 1998)[NFA]	Department of Agriculture, Forestry and Fisheries
Water Use Licence	National Water Act, 1998 (Act 36 of 1998)[NWA]	Department of Water Affairs
Environmental Management Programme Approval	Minerals and Petroleum Resources Development Act, 2002 (Act 22 of 2002)[MPRDA]	Department of Mineral Resources

1.2 WHAT IS AN EIA?

The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "*the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made.*" Environmental Impact Assessment (EIA) in South Africa is predominantly undertaken in response to, and within the bounds of, a well-defined and robust legal framework (Aucamp, 2010). A myriad of 'environmental' Acts, Regulations, Policies and Guidelines have relevance in this regard (Section 3 refers), all of which aim at giving effect to the fundamental environmental rights enshrined upon all South African Citizens within section 24 of the constitution, 1996 (Act No. 108 of 1996)(Fugle and Rabie, 2009).

An EIA is a methodical and systematic process to identify potential positive and negative impacts on the bio-physical, socio-economic and /or cultural environment that may result from an activity (i.e. opencast mining operations in this instance). The minimum requirements for EIA practice in South Africa are largely prescribed in Regulations (GN. R.543 of 18 June 2010) under the National Environmental Management Act (Act N0. 107 of 1998)[NEMA]. The 2010 NEMA EIA Regulations lay out clear enviro-legal administrative requirements for EIA process, public participation (stakeholder engagement) and reporting alike.

The EIA aims to ensure effective compliance and governance concerning the sustainable use of environmental resources, while simultaneously focusing on key issues such as stakeholder empowerment, and providing access to relevant and concise information to enable informed decision-making by competent authorities exercising a regulatory role in any aspect of the project proposal.

The EIA process is also used to examine alternatives and management measures to minimise negative- and optimise positive impacts resulting from a project, or activity. The ultimate objectives of the EIA process are to prevent significant detrimental impact on the environment and to ensure sustainable development into the future. An EIA should not aim to stop, hinder or obstruct development, but should rather act as a 'green-filter' to development proposals, that seeks to ensure that developments / activities proceed in an environmentally acceptable and sustainable manner (unless of course significant impact may result from an activity that truly renders the undertaking of that activity 'fatally flawed').

The EIA has to consider the different perspectives and requirements of all role players, who derive different benefits from participating in the EIA process. These include the following:

- <u>Decision-making Authorities:</u>
  - Enables informed decision making;
  - Ensuring protection of environmental quality;
  - Supporting the management, monitoring and sustainable utilisation of resources; and
  - Understanding demands on bulk services, waste disposal sites, etc.

- <u>Project proponents:</u>
  - Pro-actively considering environmentally sustainable design and management principles in all that they undertake;
  - Investigating natural resource opportunities and constraints;
  - Identifying the risks and opportunities associated with environmental and operational aspects;
  - Evaluating the potential for pollution and the prevention thereof; and
  - Optimising energy, water and other resource use.

- <u>Interested and affected parties (IAPs):</u>
  - Providing an opportunity to be informed and give comment / express concerns;
  - Protecting environmental rights;
  - Utilising local and indigenous knowledge;
  - Increasing knowledge and environmental awareness; and
  - Informing the decision-making process.

The 'Scoping and EIA' process prescribed in the 2010 NEMA EIA Regulations (GN. R.543 of 18 June 2010), as the name suggests, is divided into two main phases. These are the initial 'scoping-' and the subsequent 'EIA phase' (Figure 1-2). The scoping phase of this environmental assessment sought to identify the key issues and potential impacts, from the project proposal that warranted further detailed investigation during the EIA phase of the process. In broad terms, 'scoping' aimed to isolate the more pertinent impacts and issues pertaining to the project, from a broader list of potential impacts and issues, for further detailed assessment in the EIA phase of the process (Aucamp, 2010).

The scoping phase of the EIA process concluded with the approval of the final Scoping Report and plan of study for EIA (PoSEIA) by the Limpopo Department of Economic Development, Environment and Tourism (LEDET) and the National Department of Environmental Affairs (DEA) on the 2nd of February and 4th of April 2012 respectively (copies provided under Appendix 1: AUTHORITY CORRESPONDENCE AND COMMENTS). Copies of the final Scoping Report were submitted to the Department of Mineral Resources (DMR) on the 3rd of August 2012, in line with the provisions of the DMR's Mining Licence Acceptance on 24th of July 2012 (copy provided under Appendix 1).

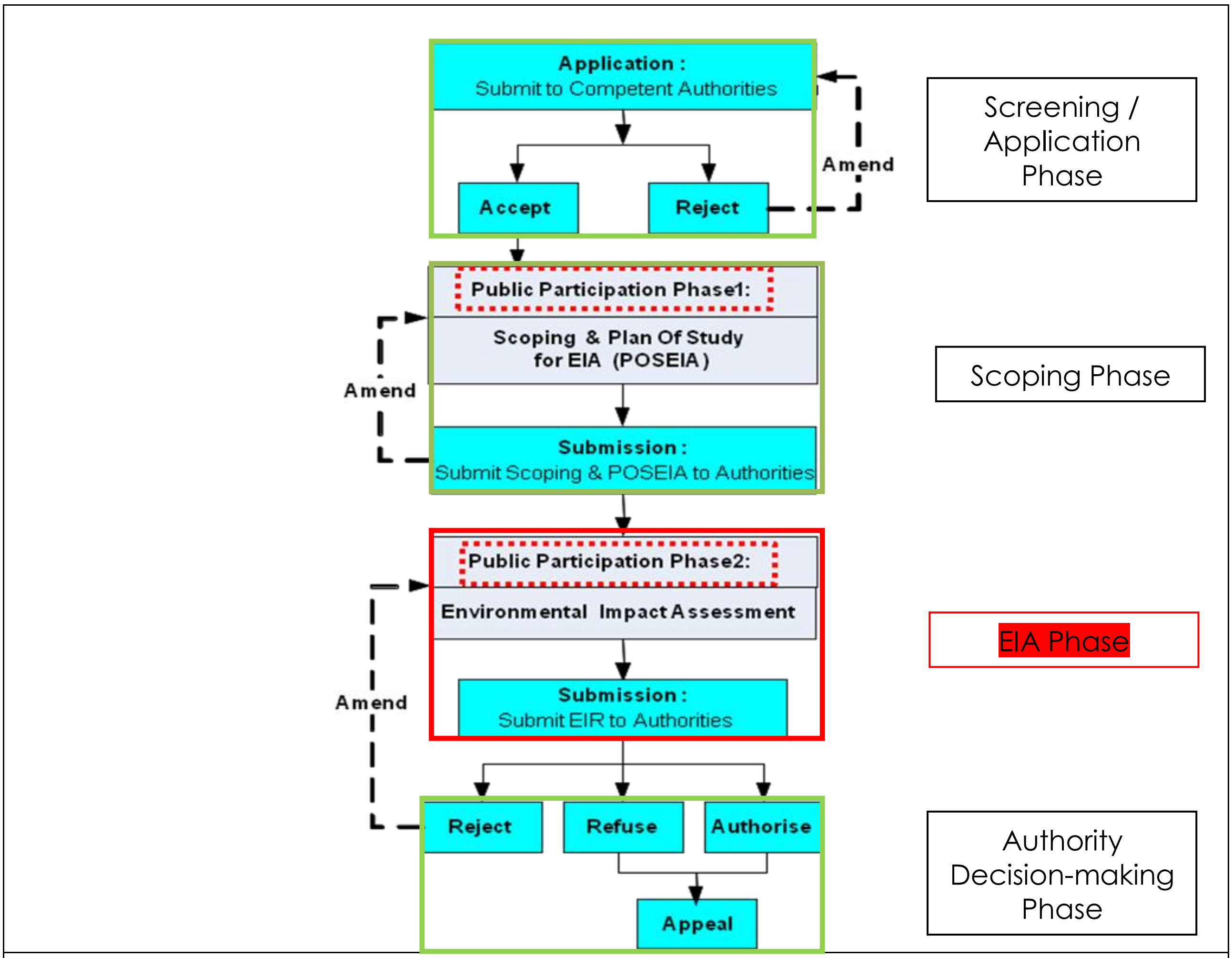


Figure 1-2: Generic Scoping & EIA Process Flow Diagram

The preceding scoping report thus resulted in the establishment of the technical terms of reference (ToR), in the form of a Plan of Study for EIA (PoSEIA,) for this EIA phase. The PoSEIA has, therefore, been used as the basis for defining the nature and extent of the investigations and specialist assessments undertaken as part of the EIA phase. This impact significance assessment thus involves the execution of those ToR; where it aims to assess in detail, and quantify as far as possible, the significance (in respect of the nature, duration, extent, intensity and probability of occurrence thereof) of the identified environmental impacts posed by the proposed mine.

One needs to, however, bear in mind that the natural environment is the most threatened and irreplaceable resource upon which all the other human aspects depend. The analysis of impact significance for potential project impacts, furthermore, needs to consider impacts that may be realised through all project phases, as follows:

- Construction/establishment;
- Operation; and
- Decommissioning & closure.

Impact analysis is, in a sense, the core of the EIA process. It is the phase where all relevant project information that has been gathered is manipulated and distilled – *it is the Environmental Impact Assessment*. The impact analysis has two major goals, starting with listing and describing all possible environmental impacts and then proceeding to give some perspective on the relative significance of the various impacts. The predicted effects of mitigation measures also need to be factored into the impact analysis (DEA, 2009).

1.3 DETAILS OF THE PROPONENT

Sylvania Platinum is a fast-growing PGMs producer located in South Africa's PGM-rich Bushveld Igneous Complex with a medium-term focus on low-cost tailings retreatment operations that are already contributing revenues and, in the longer term, a focus on shallow mining exploration interests. (From www.sylvaniaplatinum.com).

1.3.1 SYLVANIA'S VISION

STATED VISION:
To be the leading mid-tier, lowest unit-cost, platinum group metals (PGMs) mining company.

STATED MISSION:
We generate wealth for all of our stakeholders using safe and innovative processes with a focus on PGMs whilst exploiting any value-adding associated minerals.

STATED VALUES:

- We value the safety and health of all; where employees are at the heart of our company; and we place their safety and health above all else in everything that we do;
- We value the fundamental rights of people; where we treat all people with dignity and respect;
- We value honesty and integrity; where we act honestly and show integrity by continually striving towards "doing what we say we are going to do" and showing commitment towards our accountabilities of delivering high performance outcomes thus projecting an image of professionalism and meeting the expectations of our colleagues, investors, business partners and social partners;
- We respect the environment; where we act in a manner that is sustainable and environmentally friendly, applying professional and innovative methods; and

- We value the culture, traditional rights and society in which we operate; where our actions will support the communities in which we work whilst honouring their heritage and traditions.

The above mission and value statements are those of the proponent, as provided by the proponent

1.4 DETAILS OF EAP

The Environmental Impact Assessment for this proposed mining project was undertaken by EScience Associates (Pty) Ltd. (ESA), as independent Environmental Assessment Practitioners (EAP) to Pan Palladium/ Sylvania. The Environmental Impact Assessment study team was led by Mr. Theo Fischer, senior environmental scientists with more than 10 years' experience in environmental management, with Hanre Crous and Bradley Thorpe in EIA project management roles (see Appendix 7: CVs of EAPs).

Table 1-2: Details of the EAPs

Name	***Qualification***
Theo Fischer	BSc. Chemistry & Geography
Bradley Thorpe	BSc (Hons) Wildlife Management / MSc Environmental Management (in progress)
Hanre Crous	MSc. Zoology
Abdul Ebrahim	B Eng (Hons) Environmental Engineering

2. PROJECT DESCRIPTION

2.1 REGIONAL LOCATION AND ADMINISTRATIVE INFORMATION

The proposed mine will be located on numerous portions of the farms Volspruit 326 KR and Zoetveld 294KR, located approximately 15km south of Mokopane in the Limpopo Province (Table 2-1, Figure 2-1). The N1 national highway between Pretoria and Polokwane is located approximately 2km north west of the site. The Nyl River is located immediately west of the site.

Table 2-1: Farm Portions Affected by Mining and Placement of Surface Structures and Infrastructure

No.	Farm Portion and Surveyor General 21 Digit Code																				
1	Portion 1 of the Farm Volspruit 326 KR																				
SG code	T	O	K	R	0	0	0	0	0	0	0	0	0	3	2	6	0	0	0	0	1
2	Portion 2 of the Farm Volspruit 326 KR)																				
SG code	T	O	K	R	0	0	0	0	0	0	0	0	0	3	2	6	0	0	0	0	2
3	Portion 5 of the Farm Volspruit 326 KR																				
SG code	T	O	K	R	0	0	0	0	0	0	0	0	0	3	2	6	0	0	0	0	5
3	Portion 7 of the Farm Volspruit 326 KR																				
SG code	T	O	K	R	0	0	0	0	0	0	0	0	0	3	2	6	0	0	0	0	7
4	The remainder of the Farm Zoetveld 294 KR (NOTE: Portion 1 of the farm Zoetveld 294 KR has been incorporated into the Remainder)																				
SG code	T	O	K	R	0	0	0	0	0	0	0	0	0	2	9	4	0	0	0	0	R

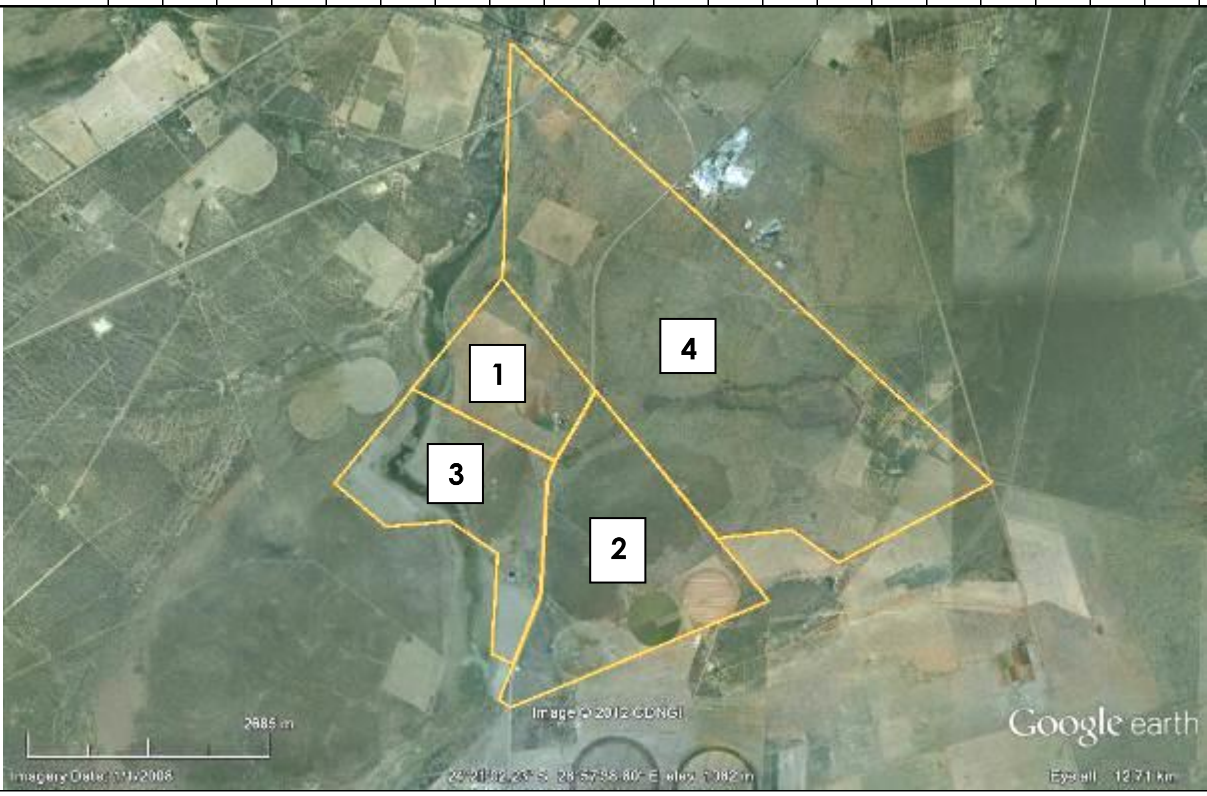


Figure 2-1: Aerial Locality Plan of Subject Farm Portions

2.2 PROJECT OVERVIEW

The proposed project can be broadly grouped into three constituent components, as described in the sections that follow (Figure 2-2). These are:

1. Opencast mining of two target PGM ore bodies;
2. Processing and beneficiation of the mined ore; and
3. Undertaking of activities, and establishment of structures and infrastructure, supportive of 1 and 2 above.

2.2.1 OPENCAST PIT MINING

Volspruit Mine is proposed to include two opencast pits, which are otherwise referred to as the 'North pit' and the 'South pit', due to their geographical location on the farm Volspruit 326 KR. Mining of these opencast pits will entail initial topsoil stripping and stockpiling thereof, with subsequent rock blasting and ore handling with large front-end loaders and trucks at the rock face thereafter.

Waste rock (i.e. all material with no resource value that needs to be removed in order to access the targeted ore bodies) from the North pit will be hauled to surface and disposed of above ground to a single, dedicated, waste rock dump on the farm Zoetveld 294 KR. Waste rock from the South pit will be used to partially back-fill the North pit; where mining of the South pit will only commence approximately 10 years after mining commences at the North pit.

The target ore will also be transferred to surface by haul trucks, but will be stockpiled separately from any waste rock as a ROM (Run of Mine) stockpile. This stockpiled ROM will then be crushed at a primary crusher and transferred *via* conveyor to a concentrator plant (processing plant).

2.2.2 ORE PROCESSING AND BENEFICIATION

Once at the concentrator plant, ore is washed, crushed, screened and sorted/floated to separate and concentrate the target minerals from the remaining ore. The resultant ore 'concentrate' will then be transported to the proposed smelter complex, for smelting.

The concentrator plant process results in the generation of waste tailings, which will be deposited as 'thickened' paste tailings to a single, dedicated tailings storage facility (TSF) on the farm Zoetveld 294 KR.

The ore concentrate will be smelted onsite to further concentrate the target PGM minerals and remove remaining impurities in the form of a waste slag. The slag will be disposed of to a slag dump at the smelter complex, with the resultant smelter alloy product being transferred to the proposed chemical vapour metal recovery plant (CVMR), which acts to extract and separate the valuable base metals individually from the metal alloy thus leaving all the PGMs in saleable metallic alloy.

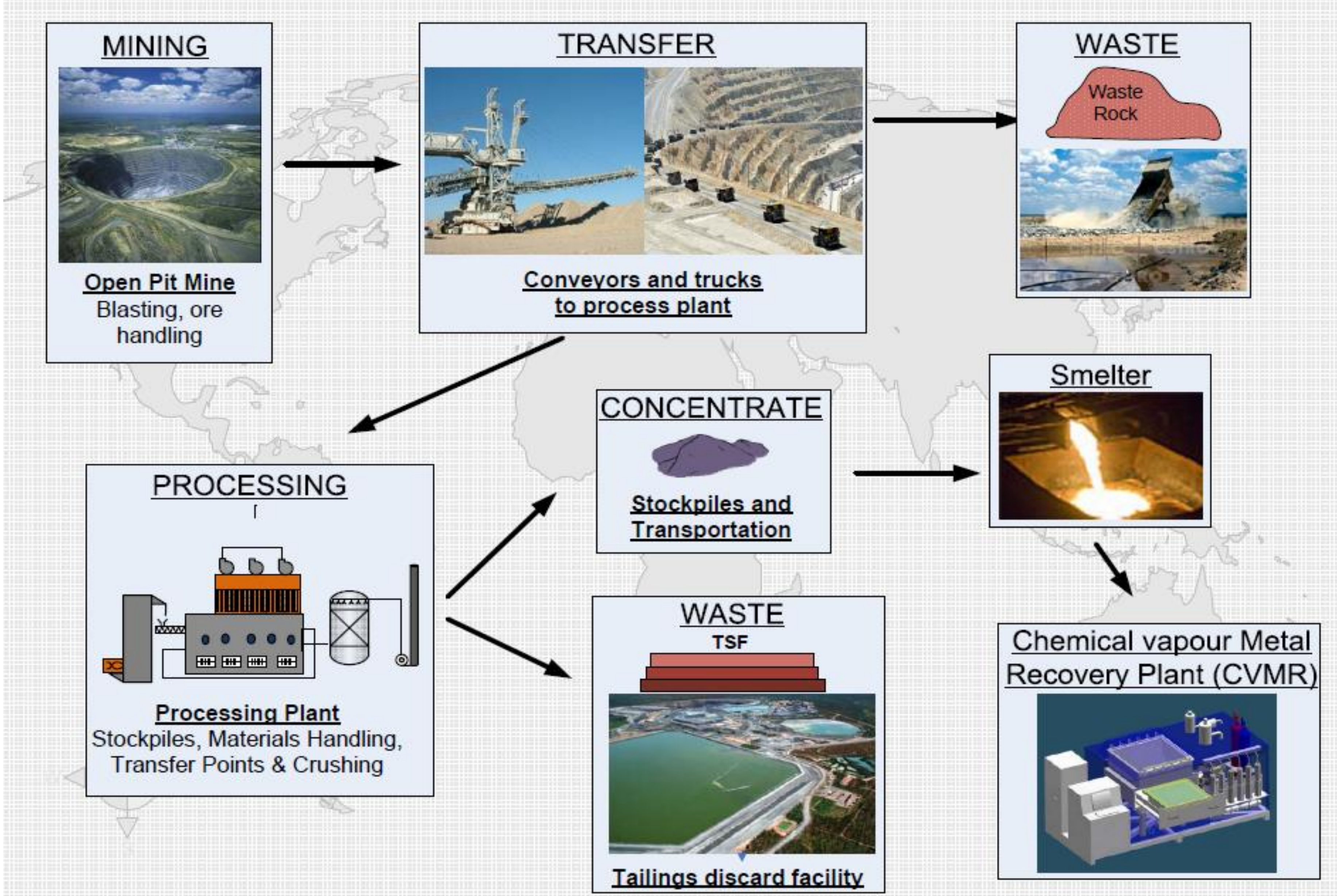


Figure 2-2: Generic Diagram Showing the Proposed Mine Process Flow.

2.3 PROJECT MOTIVATION, NEEDS AND DESIRABILITY

Mining in South Africa is the single biggest economic driver and much of South Africa's wealth lies in precious metals. The Bushveld Igneous Complex has a wealth of valuable minerals including platinum group metals. The proposed Volspruit mine lies on the southern edge of the northern limb of the Bushveld Igneous Complex, with metals such as platinum, palladium, nickel and copper all being prevalent in economically recoverable quantities.

The Mokopane area already has one large PGM mine to the north of the town of Mokopane, which is a major contributor to the economic stability to the Mogalakwena Local Municipality and provides a number of jobs and stable incomes to families in the area.

The proposed Volspruit mine is proposed to further boost the economy of the Mogalakwena area, Limpopo Province and the overall South African economy. Platinum prices have been on the increase over the last 10 years, thus making the development of a PGM mine viable, which would contribute positively to economic growth.

In addition to the above, the following section is adapted from Broughton. 2011: Urban-Econ Development Economists – Final scoping phase inputs (contained in Appendix 5.11: Socio-economic Impact Assessment Report), which was commissioned in order to better quantify the needs and desirability of the proposed Volspruit Mine project.

High unemployment rates and the need for increased injection into the national economy resulted in the change of the economic policy in the country in recent years. This creates a need to review the relevant policies and strategies with the purpose of identifying the alignment of the project with these policies and their implications on the proposed activity.

The proposed development is located in the Waterberg District. It involves extraction of PGMs and base metals including Nickel and Iron and their beneficiation on site. For that purpose, the project includes the development of a smelter and a base metal refinery (CVMR) that will beneficiate the nickel and iron into pure powder form thus allowing downstream beneficiation projects to be constructed in and around the area such as tooling plants and mirror / car light manufacturing. The iron powder concentrate into platinum, nickel and copper, whereby the end result will be a chemically pure product of a relatively valuable grade which could be used in the food industry. Given the intended processes and the output product targeted by the project, it can be determined that the level of beneficiation is represented by Stage 1 and Stage 2 operations but certainly will facilitate the construction of stage 4 beneficiation projects with the nickel powder (see Figure 2 5: Stages of Beneficiation below).

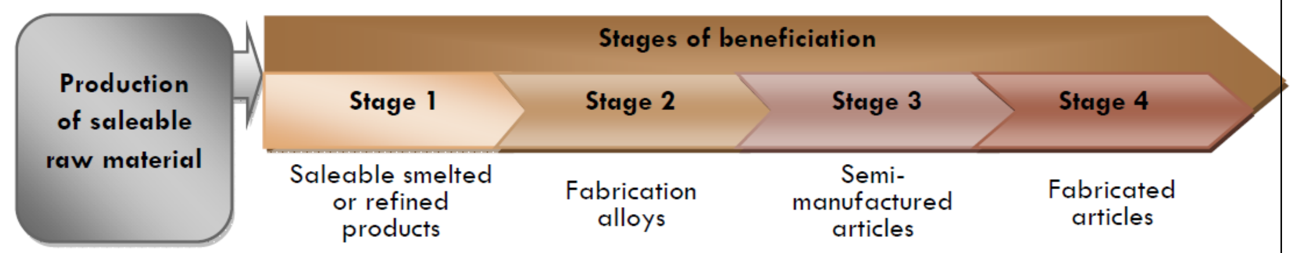


Figure 2-3: Stages of Beneficiation

Given the above description of the proposed activity and the recent changes in the economic policy in the country, the following development growth plans, policies and strategies have been identified to potentially have a significant impact on the project's successful implementation:

- New Growth Path;
- IPAP 2011/2012-2013/2014;
- Industrial Development Corporation (IDC) and Development Bank of South Africa (DBSA) financing plans;
- Mineral Beneficiation Strategy for South Africa;
- Limpopo Economic Development Plan;
- Waterberg LED; and
- Waterberg Mining Strategy.

A brief synopsis of each policy and its relevance to the proposed development, in terms of need and desirability, follows.

2.3.1 NEW GROWTH PATH (2010)

The core focus of the New Growth Path is embedded in the objective to create decent employment, alleviate poverty and support sustainable long-term growth. Through the New Growth Path and the underlying policies and strategies, the government aims to create five million new jobs by 2020. The approach taken in the growth path is to identify areas in which employment creation is viable on a large scale and then to revisit policies that hinder or promote specific industries. Priority has been given to the following sectors due to their ability to create employment opportunities whilst stimulating economic growth:

- Infrastructure;
- Agricultural value chain;
- Mining value chain;
- Green economy;
- Manufacturing sectors; and
- Tourism and high-level services.

In terms of the mining sector, the Growth Path necessitates an effective review of mining policies, rights and regimes in order to stimulate private investment specifically aligned with beneficiation and greater utilisation of mineral resources in the country. Additionally, the New Growth Path gives preference to projects that engage Stage 3 and Stage 4 beneficiation (which entails semi-fabrication and fabrication of extracted minerals) as opposed to ending the value chain on smelting and refining. However, the Department of Mineral Resources (DMR) is currently conducting a value chain study to determine a strategic plan of action addressing stage four beneficiation opportunities of certain minerals in the country. It is, therefore, worthy to note that although Stage 4 beneficiation is most advantageous, projects of lower levels of beneficiation remain highly desirable for the purpose of economic growth and provision of inputs for the downstream beneficiation. In the case of the Volspruit project, the choice of the CVMR refinery in the project stream will allow stage four beneficiation projects to be constructed as the refinery product is not the traditional ingot but rather a pure nano powder producer that is described well on the internet at http://www.cvmr.ca/nanos.html.

The New Growth Path, based on the IDC's projections, set the employment target for the mining industry at 140 000 new jobs by 2020 and an additional 60 000 jobs by 2030. The majority of these employment opportunities are expected to be created from the enhanced PGMs, coal exports and final manufacturing using base metal products.

Since the proposed activity involves the extraction of two valuable minerals, the PGMs and the base metals (especially Nickel and Iron), the project has two levels of beneficiation potential. The extraction of PGMs and its beneficiation at Stage 1 and possibly Stage 2 as is the case with most PGM projects in RSA. The base metals however have the potential to go to stage 4 with minimal capital investment and will be planned once the current investigations are completed. It means that the project is in alignment with the New Growth Path framework and, if implemented, will make a direct contribution towards the achievement of the policy's targets set for the sector. Although it does not include Stage 4 beneficiation activities at present, it would provide valuable upstream support to expanding these types of activities when the project's Nickel and Iron outputs are used further in the local downstream activities instead of being exported as is the case with many other projects that do not employ the CVMR technology.

2.3.2 NEW INDUSTRIAL POLICY ACTION PLAN 2 (IPAP) 2011/2012-2013/2014

The policy reflects collaborative objectives in economic growth and employment opportunities with regard to industrialisation in the country. The updated IPAP constitutes a central tool in the implementation of the New Growth Path job creation strategy. The Action Plan spans three years and is meant to be updated on an annual basis to assist the New Growth Path in achieving its target of five million jobs to be created by 2020. The interventions for the current IPAP2 2011/2012-2013/2014, though, target the creation of 129 000 jobs, of which 46 000 are expected to be created through direct impacts.

IPAP 2 2011/2012-2013/2014 desegregates targeted sectors into various clusters. The proposed project is mostly aligned with Cluster 2 interventions that aim at scaling up and breeding the existing IPAP sectors. The cluster targets existing sectors with high potential to positively impact industrialisation in the country through expansion in the relative industry and innovative ways to unleash the potential of the sector.

With respect to mineral beneficiation, IPAP 2 2011/0212-2013/2014 states that opportunities in this sector have already been operationalized, including the use of PGMs in manufacturing of catalytic converters for application in emission control in the auto industry. The immediate actions set up for the active three-year period include, *inter alia*:

- setting minimum beneficiation levels for the key value chain through up-scaling the relevant strategy and programme; and
- the development of a gold-loan scheme to promote jewellery production.

Based on the above, the PGM aspect of the proposed project does not form part of any immediate actions set up for implementation within the mineral beneficiation industry. Nevertheless, it falls within the PGMs value chain that has been prioritised for development.

2.3.3 SUPPORT OF JOB CREATION BY IDC AND DBSA

The achievement of the New Growth Path targets and implementation of IPAP's interventions requires commitment from both public and private organisations. Some of the main vehicles that are charged with the objective to assist government in contributing to the achievement of the job creation target include the Industrial Development Corporation and the Development Bank of South Africa.

- The IDC has been identified as one of the key instruments in the successful implementation of the government's target of creating five million jobs over a decade. It is anticipated that about R102 billion will be lent to support government policies over the next five years and particularly for the implementation of initiatives set out in the current and later IPAPs. Mining and beneficiation will be allocated R22 billion of the above-mentioned amount, whilst the rest will be spent as follows:

    - Green industries – R22.4 billion;
    - Manufacturing – R20.8 billion;
    - Agricultural value chain – R7.7 billion;
    - Tourism and creative industries - R14.8 billion;
    - Funding to distressed companies - R2.5 billion;
    - Strategic high-impact projects - R11 billion; and
    - Venture capital - R500 million.

  As part of its effort to support employment, the IDC has also launched a R10 billion scheme that would offer funding to developers of high-employment effect projects at prime less 3%.

  The specific areas that the IDC has identified for funding and technical assistance (where applicable) in accordance with the New Growth Path and the IPAP are as follows:

    - Mining, beneficiation and metal projects domestically and in the rest of the continent;
    - Facilitating acquisition of assets by historically disadvantaged people;
    - Developing the local jewellery manufacturing industry and other value-added beneficiation projects.

The role of the IDC in mining and mining beneficiation lies primarily the funding of capital investment for mining-related activities at all levels, i.e. funding is available for (emerging) mining houses and enterprises focusing on mining beneficiation. This means that the proposed project could potentially also apply for funding from the IDC.

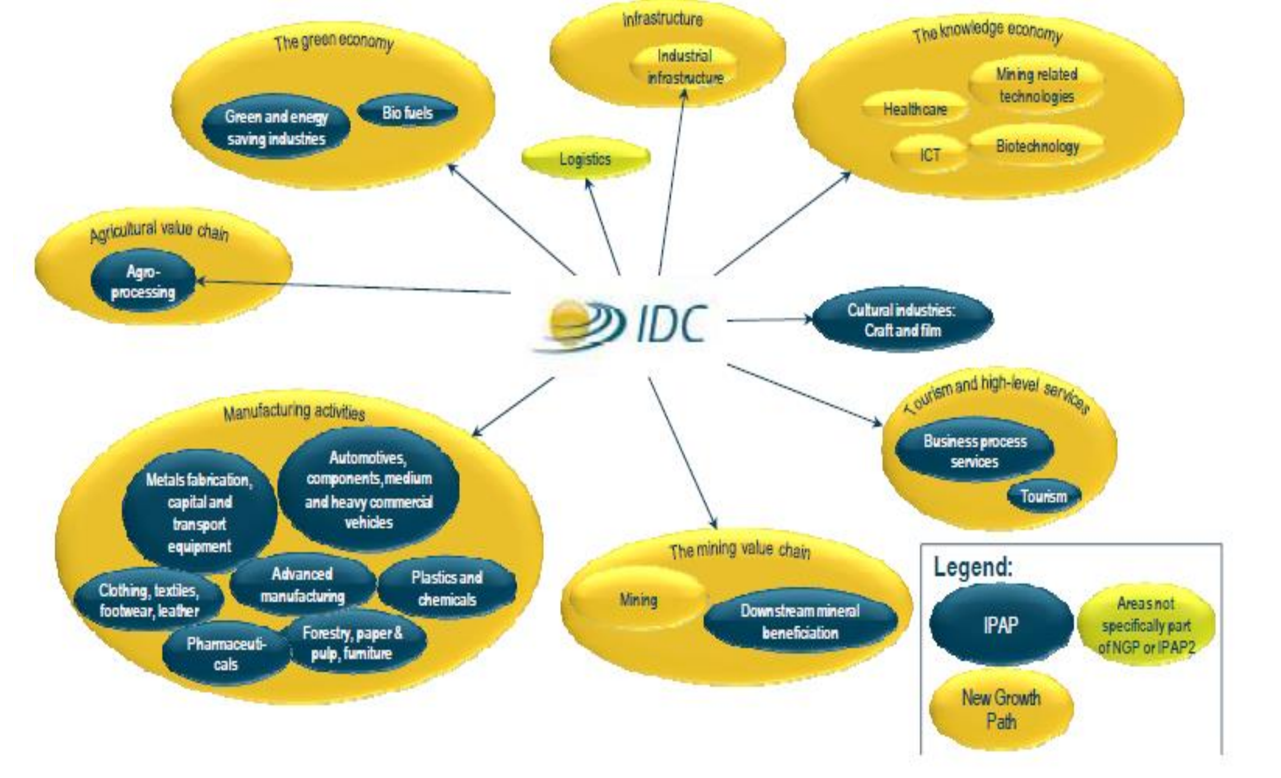


Figure 2-4: IDC target sectors – sectorial focus

- Another initiative by government aimed at supporting employment creation and economic growth is the allocation of R9 billion towards grants through a Jobs Fund, which is overseen by the Development Bank of South Africa (DBSA). The funding is available to both public and private sector agents which stimulate long-term job creation and have the potential to boost other local industries, i.e. high indirect and induced effects. The following sectors have been identified as key focus areas when selecting potential beneficiaries:

    - Enterprise development, which includes assistance to local procurement, marketing support, equipment upgrading or enterprise franchising
    - Infrastructural development, which includes the funding of light manufacturing zones and communication links to market goods
    - Support to job seekers, which includes setting up networks and projects that can provide training and career guidance
    - Institutional capacity building, which includes funding, internships and mentorship programmes

The mining industry has not been given a specific preference by the Job Fund; however, innovation, competitiveness and sustainability are the core criteria for the selection of projects. In the case of the CVMR technology, the doors are open to world leading products and beneficiation projects.

CVMR® processes and technologies have many applications that serve a variety of industries, in addition to the refining industry. By varying the process parameters at the end of the refining, a wide range of metal forms are created, such as:

- The production of pure metal powders and metal foams, used for batteries, catalysts, capacitors, or for alloys which require ultra-pure metals;
- The application of pure metal coatings on a wide range of substrates, including non-metallic materials such as powders, fibres, resins, composites, polymers, ceramics, and metallic coatings inside porous substrates;

- The production of solid metal net shapes and mould inserts directly on the master with perfect replication. These tool inserts require no polishing;
- The manufacture of seamless net shapes, such as uniformly deformable cans ("HIP cans") used for iso-static pressing;
- The production of nickel moulds made for the manufacture of plastic light-wave guides, for hand-held computer touch screens. These use etched silicon wafers as the master forms; and
- The manufacture of thin nickel parts as fuel cell focusing devices for NASA's deep space program.

2.3.4 BENEFICIATION STRATEGY FOR THE MINERALS INDUSTRY OF SOUTH AFRICA (2011)

The government has developed a Mineral Beneficiation Strategy for South Africa. In June 2011 government approved mineral beneficiation as an official policy.

The beneficiation strategy aims at promoting employment, poverty alleviation and improving the overall welfare of South Africans through mining and more specifically through the enhancement of mining beneficiation to the extent that mineral beneficiation is done up to the last stages of the value chain. Given the level of expertise and industry strength in the country, the strategy proposes the development of technological excellence and domestic know-how in beneficiation, in order for higher stages of beneficiation to be actively targeted.

The vision behind the beneficiation strategy is to identify innovative usage of mineral resources to enable the optimisation of the mineral resource base for the longer term benefit of the nation. The strategic goals in support of beneficiation are implemented through infrastructural development, investment promotion and facilitation, skills development, enabling a regulatory environment and research and development.

The strategy focuses on commodities such as gold, PGMs, diamonds, iron ore, chromium, manganese, vanadium, nickel, titanium, coal and uranium. It promotes the creation of five key value chains on the bases of the above-mentioned commodities, such as energy, steel/stainless steel, pigment production, auto-catalyst and diesel particulates, diamond processing and jewellery. These value chains have been chosen due to their potential to develop to the last stages of downstream beneficiation, such as fabricated articles as outlined in Figure 2 1. The use of PGMs is meant for the development of auto-catalysts and easel particulates, as well as jewellery production.

The strategy emphasised that the success of development of the PGMs-based value chain is based on, amongst others, commitment of the PGM mining sector to supply saleable raw materials for the local downstream beneficiation processes versus exporting them as has largely been done in the past. Given the composition of the proposed project, it can thus be stated that it would play an important role in ensuring the supply of necessary materials for the establishment of Stage 3 and Stage 4 beneficiation activities in the country.

2.3.5 LIMPOPO EMPLOYMENT GROWTH AND DEVELOPMENT PLAN (LEGDP) FOR 2009-2014

The Growth and Development Plan for Limpopo is a five-year plan that targets achievement of accelerated growth in terms of increasing sustainable jobs and increased levels of income sources in the Province through structural change in critical areas. The key challenges faced in Limpopo at present include persistent poverty due to a lack of productive capacities, limited fixed capital formation and low levels of skills and education of the population.

The LEGDP recognises the importance of mining in developing the provincial economy and creating new employment opportunities. In this respect, it identified the Dilokong Corridor (in Sekhukhune) and Mokopane (where the proposed mining site is based) as areas in the Province with potential for growth within the mining sector, which shows the optimal selection of a location for the proposed mining activity. The aforementioned high potential areas are likely to realise great benefit from the optimal location of the site varying from positive government assistance and intervention to higher than expected mineral resources.

The combination of the significance and potential of mining in the context of the provincial economy has led to the development of the primary goal to shift the local mining industry from a purely resource-based industry to a knowledge-based industry by 2030. The strategic challenges that need to be overcome and interventions aimed to be implemented to achieve the developmental vision for the mining sector and related beneficiation activities include, *inter alia*:

1. Challenges:
    - Development of Limpopo Mining and Minerals Beneficiation (LMMBI) aimed at acquiring the necessary skilled workforce (more specifically for the tooling and foundry industry) and establishing the Industrial Development Zones which will provide tax incentives, low tariff regimes and relaxed labour laws; and
    - Formation and prioritisation of downstream beneficiation clusters with the primary goal of attracting Foreign Direct Investment (FDI).

2. Interventions:
    - Development of Limpopo Mining Input Suppliers Parks Beneficiation Hubs and a Supplier Development Programme that would focus on the supply of goods and services to the local mining activities;
    - Development of specialised mining skills programmes and schools; and
    - Reviewing policy measures that allow the creation of industrial incentives unique to Limpopo mining beneficiation initiatives.

2.3.6 WATERBERG LOCAL ECONOMIC DEVELOPMENT (LED, 2007)

The main objective of the Waterberg LED is to stimulate economic growth in the district municipality *via* maximising competitive and comparative advantages, as well as optimal usage of local resources. The main aim of the LED is to target poverty alleviation whilst creating sustainable employment for the local people therefore improving the quality of life for all. Although the LED document is somewhat out-dated, it still directs the development of the local economy and indicates the priorities for investments in the area.

The Waterberg LED recognises mining as a key sector in the district municipality followed by agriculture. A mining development strategy focusing on the improvement of the mining value chain has been established in support of the local mining industry. The LED focuses on clusters which have been formed in order to facilitate the specialisation of certain resources, namely PGMs and coal. With the assistance of the public sector, the cluster development aims to maximise the benefits of mineral resources through upstream and downstream activity in the local area.

The Waterberg District Municipality (DM) plays a two-tier role in the mining sector's development, i.e. firstly its role is to facilitate high-impact mining projects and secondly it is to promote small-scale mining among local cooperatives (Waterberg LED 2007). The proposed project could be classified as a high impact project as it does not only include the extraction of PGMs, but also involved their refinement and smelting. Although these stages of beneficiation are not usually assisted with labour-intensive activities and are rather capital-intensive exercises, the project will without doubt stimulate the growth of the local economy, thus making a direct contribution toward achieving a 6% economic growth rate target set by the LED. In addition, it will also provide new employment opportunities for local residents and ultimately improve the local employment situation and skills profiles, which is again in line with the objectives set by the LED.

2.3.7 WATERBERG MINING STRATEGY (2006)

The district economy is highly reliant on agriculture, mining and tourism due to the natural resources inherent to it. The recognition of comparative advantages associated with these sectors have led to the development of sectorial strategies for the district, including one for the mining sector. The Waterberg Mining Strategy aims to achieve a number of significant goals in order to advance economic growth through mining and minerals beneficiation. These goals include achieving increased competitiveness on a sustainable basis, attracting investment resulting in job creation, improving standards of living for communities and regional integration. Overall, the Waterberg mining strategy has set the following objectives:

- Create an environment conducive for mining expansion and new mining developments through, amongst others improved infrastructure (e.g. water, roads, electricity, and rail), skills promotion and small scale mining development;
- Promoting the capacity of BBBEE companies with regard to the supply for local mines; and
- Enhance the capacity of local municipalities and local authorities as well as communities, to maximise the benefit from mining activity in and around their areas.

The Waterberg Mining Strategy highlighted the potential of the Waterberg District to become the major producer of platinum group metals in the world. It further stated that in 2006 no smelting or refining activities were taking place in the District and limited local procumbent was done in 2006. Given these gaps, the strategy calls for the development of downstream beneficiation and increased local procurement practices. The above are suggested to be achieved through a partnership between the local mines and government, whereby government should assist with the development of necessary infrastructure and removing land-use constraints. This suggests that potentially mining households and investors could approach local government to negotiate their involvement and assistance in the successful initiation of the project that would stimulate local economic growth and provide new employment opportunities for the residents.

2.4 OPENCAST MINING

2.4.1 MINING METHOD

The two ore bodies would be mined out through opencast mining methods, through the sequential benching of the pit wall down to the required depth (Figure 2-5). The benching of the pit walls to depth is aimed at providing continued vehicular access to the target ore body, while still ensuring pit wall stability.

Prior to the commencement of mining, indigenous vegetation would need to be stripped from the respective pit surfaces (Figure 2-6 and Figure 2-9 have reference). The topsoil from the exposed soil surfaces would then be stripped from the same surface areas and appropriately stockpiled on the mine site for later re-use in rehabilitation at mine closure, or concurrently thereto wherever possible.

The subsequent vertical development of the pits will require the use of explosives to blast consolidated *in situ* parent material into manageable aggregate sizes, such that –

- waste rock and overburden can then be loaded and either conveyed or hauled to surface for disposal to the proposed waste rock dump; and
- target ore can be loaded and either conveyed or hauled to the proposed run-of-mine (ROM) stockpile at surface, from where it will be crushed and conveyed to the proposed concentrator plant.

Figure 2-5: Conceptual Illustrations of 'Bench and Terrace' Opencast Mining (Harraz, 2011)

2.4.2 NORTH PIT

The proposed North Pit dimensions and key statistics are shown in Figure 2-6 and Table 2-2 below respectively:

Table 2-2: North Pit Statistics	
Approximate area	62ha
Estimated ore yield	46.18 million tonnes
Estimated waste rock	84.71 million tonnes
Stripping ratio (waste rock: ore)	1.83 : 1*
Maximum pit depth (mbgl)	180m
Approximate start of mining	Year 1
Approximate end of mining	Year 13

* Stripping ratio, or strip ratio, refers to the amount of waste rock or overburden removed to recover target ore. For example, a stripping ratio of 3:1 means to recover one ton of ore you must remove three tons of waste rock.

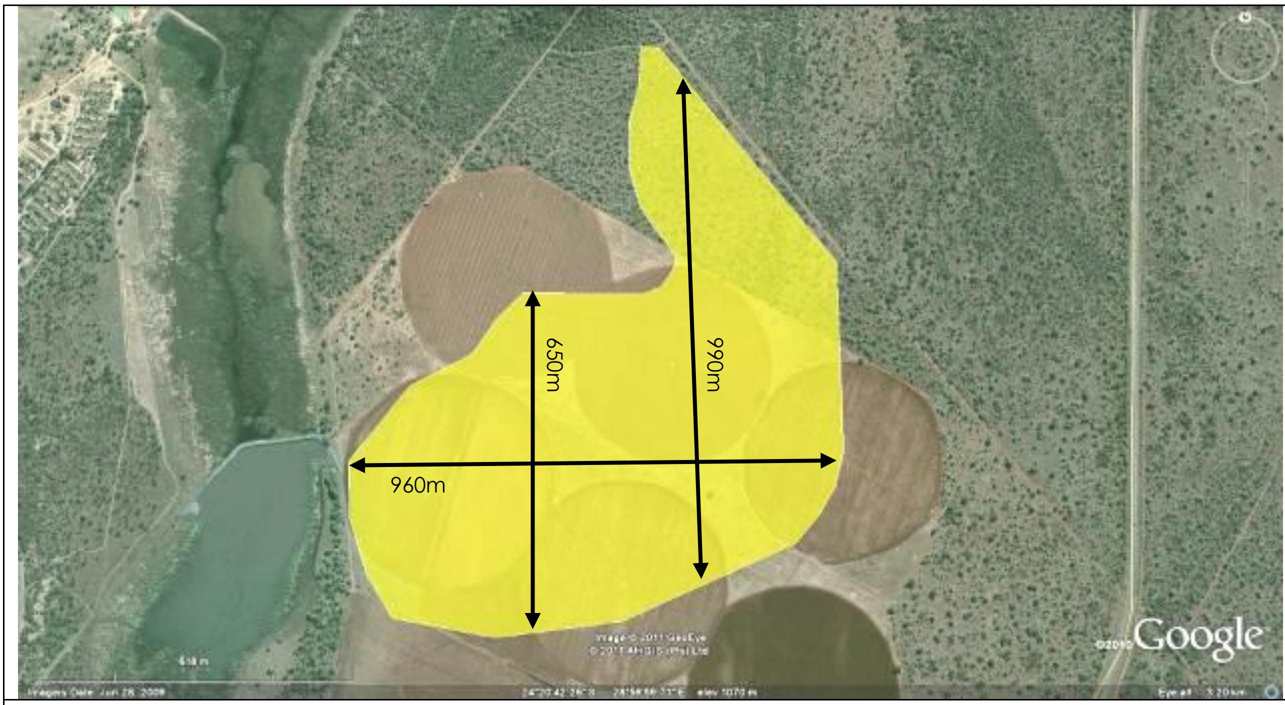


Figure 2-6: North Pit Dimensions

North Pit Buffer

It is Sylvania's intent to ultimately mine the northern ore body up to the western edge thereof, through three consecutive phases of mining from east to west; where the proposed floodwater berm and applicable section of grout curtain along the western edge of the pit would form the western battery limit of the proposed operations. It is, however, proposed that a 'precautionary environmental buffer zone' of at least 110m be established from the edge of the delineated wetland in the interim (Figure 2-7).

The mining of this buffer would then be retained as a proposed last phase to the mining campaign; where the mining of this 110m buffer would be subject to all prior phases of mining being proven (through on-going monitoring and assessment during the operational phase) to have had no significant adverse effects on relevant environmental aspects of the receiving environment, inter alia, as follows:

- Avi-faunal populations within the Nyl River system and associated wetland adjacent to the site; and
- Site hydrology, so far as concerns Sylvania's ultimate achievement of the required technical specifications for 'pit isolation' through 'grouting'".

The mining of the aforementioned buffer would, furthermore, be subject to the Department of Water Affairs' approval of an application for exemption (i.e. by Sylvania) from the provisions of Regulation 4 (b) of GN. R.704, to be supported by an appropriate technical investigation at that time on any aspect aimed at preventing pollution of a water resource or damage to the in-stream or riparian habitat connected with or incidental to the operation or any part of the operation of a mine or activity. Regulation 4 specifically states that -

- *"No person in control of a mine or activity may, except in relation to a matter contemplated in regulation 10, carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-*

line or within a horizontal distance of 100 metres from any watercourse or estuary, whichever is the greatest".

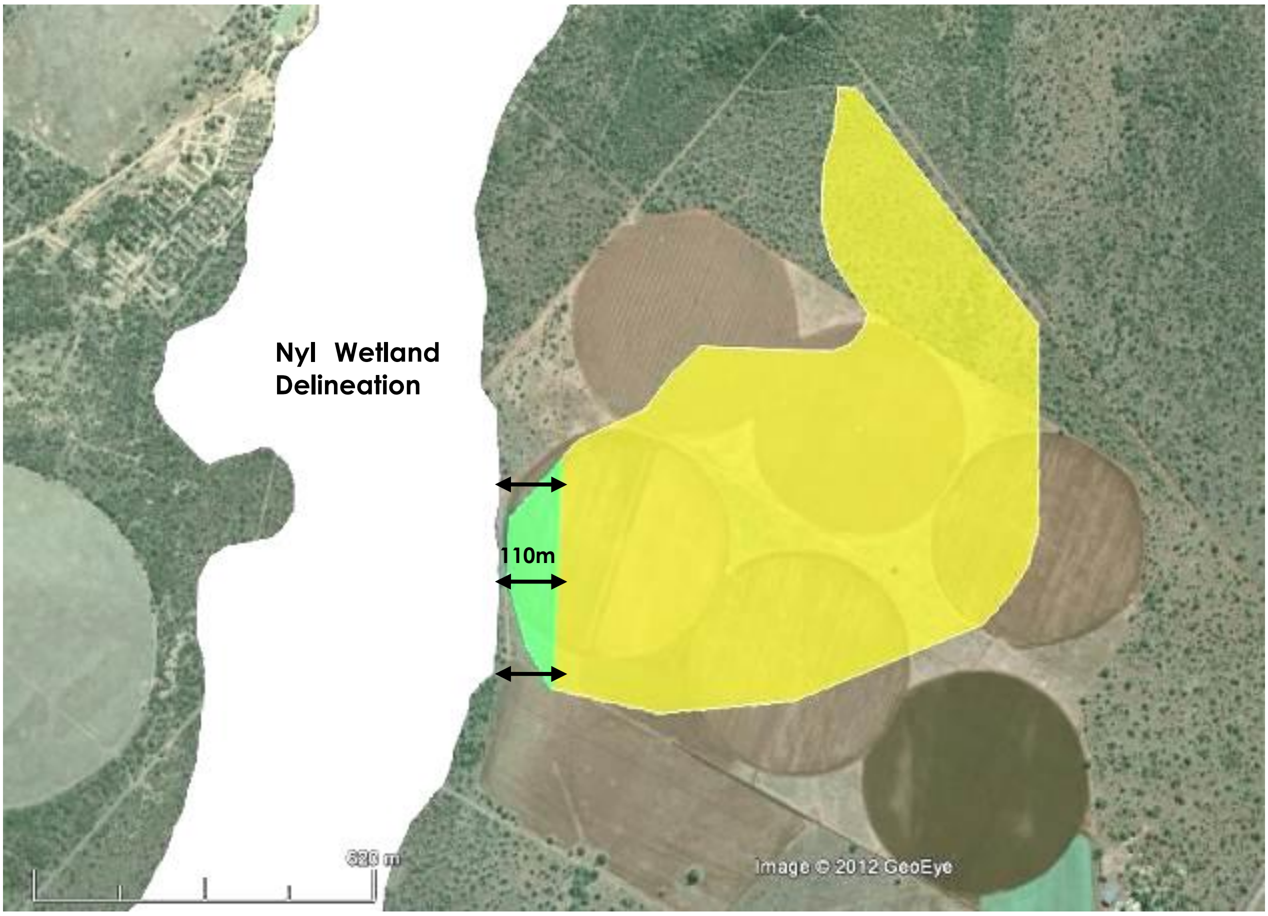


Figure 2-7: Conceptual Layout for North Pit Buffer

Notwithstanding decisions by competent authorities on any other relevant environmental authorisation, approval or licence for the project, and if one accepts that the engineered flood berm (requiring a water use licence itself) places the opencast pit outside of the 1:50 year flood line, the DWA's decision on whether, or not, to grant exemption from Regulation 4 becomes a potentially limiting factor to undertaking mining within 100m of the delineated wetland edge west of the North pit.

North pit flood berm

The proponent proposes the establishment of a 6m high flood diversion berm along the applicable western extent of the north pit perimeter; where the north pit lies within the current 1:50 and 1:100 year flood lines (Figure 2-7). The subject berm will be located outside of, but almost immediately adjacent to the delineated edge of the Nyl river wetland. The berm is largely required to ensure the safety of workers inside the pit during mining operations, as well as to ensure that the pit does not act as a 'sink' to floodwaters in a flood event.

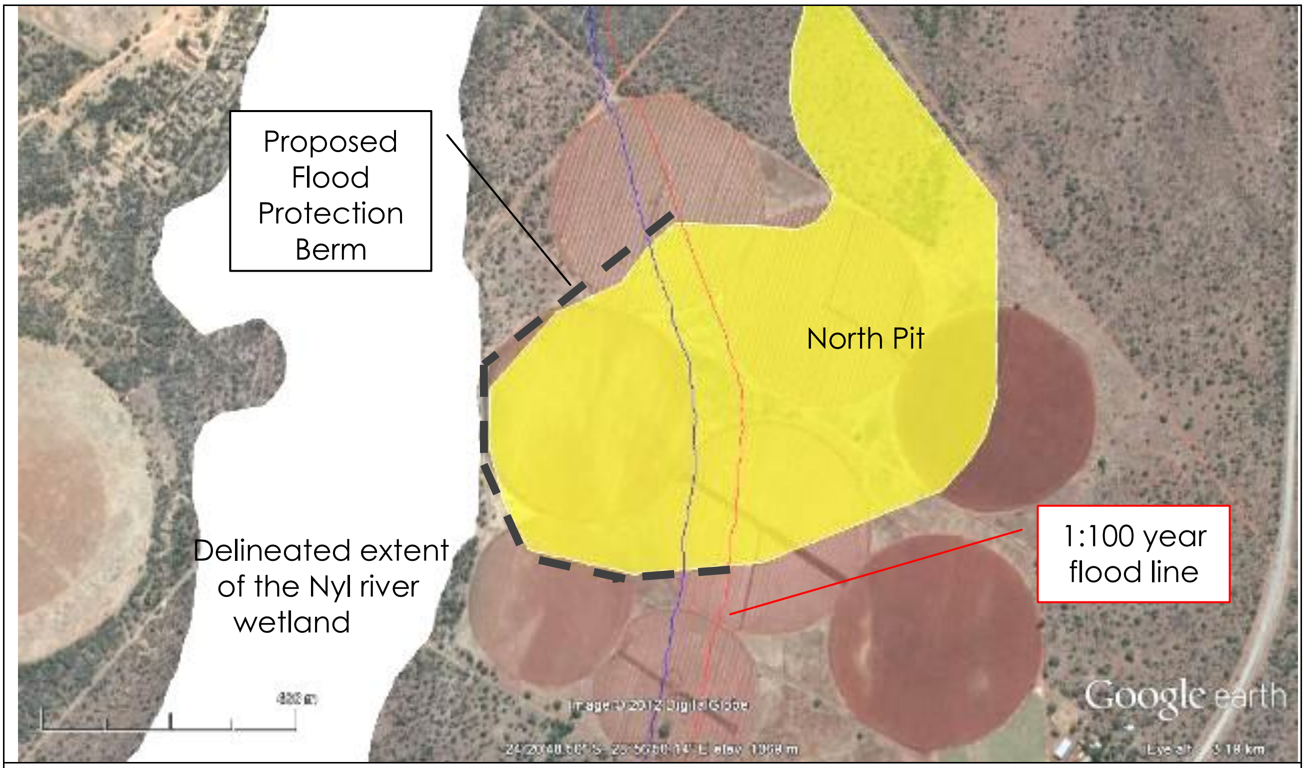


Figure 2-8: Conceptual Aerial Overview of Flood Berm Locality

2.4.3 SOUTH PIT

The proposed South Pit dimensions and key statistics are shown in Figure 2-9 and Table 2-3 below respectively:

Table 2-3: South Pit Statistics

Approximate area	30ha
Estimated ore yield	10.22 million tonnes
Estimated waste rock	40.30 million tonnes
Stripping ratio (waste rock: ore)	3.94 : 1*
Maximum pit depth (mbgl)	180m
Approximate start of mining	Year 13
End of mining	Year 18-20

* Stripping ratio, or strip ratio, refers to the amount of waste rock or overburden removed to recover target ore. For example, a stripping ratio of 3:1 means to recover one ton of ore you must remove three tons of waste rock.

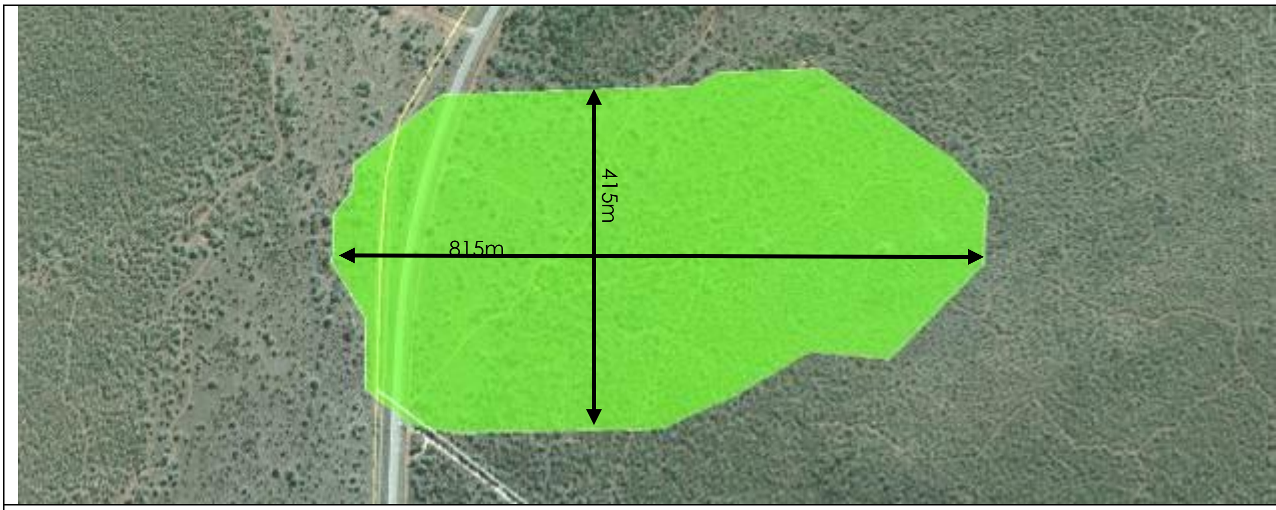


Figure 2-9: South Pit Dimensions

2.4.4 WASTE ROCK

The mining of the pits will result in the generation of significant volumes of waste rock (i.e. that portion of the pits that have no economic value, but that needs to be mined in order to gain access to the target ore). A total of approximately 44Mt of waste rock from the mining of the north pit will be disposed of to a dedicated waste rock dump on the farm Zoetveld 294 KR. This represents approximately one third of the total waste rock to be generated through the mining of both pits.

The above mentioned disposal of waste rock to the waste rock dump will cease at approximately year 8 of the mining campaign. From year 8 onward sufficient space will then be available in the north pit itself to accommodate the back-filling of all subsequent waste rock generated through the remaining life of the mine (incl. the back-filling of all south pit waste rock to the north pit once mining of the south pit commences at approximately year 13 of the mining campaign). Rehabilitation of the waste rock dump can thus commence from year 8 of life of mine.

Approximately 70% of the final north pit void will ultimately be back-filled with waste rock. No back-filling of waste rock to the south pit is proposed by the proponent, and the final south pit void will largely remain as excavated at the end of life and be allowed to flood. A nominal volume of waste rock from the north pit will be used in the construction of the proposed flood water berm along the western perimeter of the north pit.

The proposed waste rock dump locality and key statistics are shown in Figure 2-10 and Table 2-4 that follow respectively:

Table 2-4: Waste Rock Dump Statistics		
Approximate footprint	50ha	
Maximum design height	45m	
Approximate volume	16.5 to18Mm^3	
Approximate years of operation	Years 1 to 8	
Approximate annual rates of deposition	Year	Rate (kiloM^3)
	1	1, 561
	2	1, 289
	3	3, 395
	4	3, 558
	5	3, 281
	6	0
	7	1, 477
	8	1, 988

<u>Geochemical Characterisation of Waste Rock and Tailings</u>

Geochemical characterisation, in the context of the subject EIA process, entailed assessing the geological material (e.g. waste rock) that will be disturbed and/or exposed to the elements during the proposed opencast mining of PGMs at Volspruit, in terms of their potential to generate AMD and leach metals to the environment. The detailed approach toward assessing the geochemical characteristics of the Volspruit waste rock and tailings is provided for in Appendix 5.16 hereto ('*Geochemical Characterisation Report*' – Appendix E to the '*Volspruit Tailings Storage Facility Scoping Study*' by SRK Consulting). The sub-sections that follow aim to provide a concise overview of the whole rock chemistry of the Volspruit Waste Rock.

Figure 2-10: Proposed Waste Rock Dump Locality (preferred position)

Major Elements: The results from major elemental analysis undertaken on representative waste rock samples from the Volspruit site indicated Silicon (Si) and Magnesium (Mg) to occur in the greatest proportions, relative to the remaining elements, with concentrations approximately an order of magnitude higher than the remaining elements (Table 2-5). This was attributed to the mafic rock types (i.e. magma derived rocks rich in ferromagnesium minerals) predominant in the geology of the study area. The major elements that dominate the chemistry of the waste rock include silicon, magnesium, iron and aluminium.

The major element chemistry of the tailings is similar to that of the waste rock, with the dominant elements being Si, Mg, Fe, Al and Ca (Table 2-5).

Trace Elements: The trace elements results, representing both footwall and/or hanging wall lithologies was evaluated to identify potential metals of concern in the waste rock. The concept of geochemical abundance index (GAI) was used to establish the presence of metals of concern [The concept of GAI is detailed in in Appendix 5 hereto ('*Geochemical Characterisation Report'* – Appendix E to the '*Volspruit Tailings Storage Facility Scoping Study*' by SRK Consulting)]. The results of the GAI assessment indicated Nickel (Ni), Cobalt (Co), and Copper (Cu) to be potentially problematic trace elements in the waste rock, for further consideration in respect of the propensity for these elements to leach from the waste rock.

For the tailings, only Mo indicated GAI values of 1 which does not flag any potential of environmental risk.

Table 2-5: Tabular Summary of Major Elemental Analysis for Waste Rock and Tailings Samples (XRF Results)

Mine Facilities	Sample ID	SiO_2	MgO	Fe_2O_3	Al_2O_3	CaO	Cr_2O_3	K_2O	Na_2O	MnO	TiO	VO
		%	%	%	%	%	%	%	%	%	%	%
WASTE ROCKS	HW01	46	30	9.8	2.5	2.2	1.6	0.1	0.1	0.14	0.08	<0.01
	HW02	45	32	10	2	1.1	1.5	0.12	0.09	0.14	0.08	<0.01
	HW03	48	31	10	2.2	1.2	1.3	0.13	0.25	0.17	0.09	<0.01
	HW04	52	30	11	2	1.2	1	0.16	0.12	0.18	0.09	<0.01
	HW06	50	22	8.7	5	1.3	0.76	0.39	0.06	0.11	0.16	<0.01
	HW07	43	24	8.6	4.1	3.4	0.85	0.25	0.11	0.12	0.13	<0.01
	HW08	38	25	8.8	3.1	2.9	1.2	0.05	0.09	0.13	0.09	<0.01
	HW09	46	22	9.3	4.5	3.7	1	0.26	0.13	0.15	0.13	0.01
	HW11	53	24	8.7	4	2.5	0.92	0.89	0.31	0.14	0.11	<0.01
	HW12	48	30	11	2.1	1.1	0.99	0.15	0.08	0.15	0.08	<0.01
	HW13	55	27	9.6	2.9	1.3	0.62	0.45	0.38	0.17	0.12	<0.01
	FW05	53	29	9	2.7	1.3	0.9	0.33	0.24	0.15	0.09	0.01
	FW10	47	26	9.5	4.4	2.5	1.1	0.61	0.22	0.13	0.09	<0.01
	FW14	56	23	7.6	4.3	1.4	0.74	0.56	1.2	0.15	0.1	<0.01
	FW15	52	27	8.3	3	1.4	0.87	0.3	0.48	0.14	0.08	<0.01
TAILINGS	Tailings	52	25	11	4.3	2.5	1.8	0.42	0.47	0.19	0.15	0.03

Propensity for Acid Mine Drainage Generation

Acid mine drainage (AMD) is a specific term given to the process by which certain rock types can produce acids after oxidisation (i.e. following the exposure thereof to air as a result of mining activities). A typical example of this is the exposure of pyrites in rocks to air, followed by its exposure to water. This sequence of events can produce sulphuric acid (H_2SO_4), which can potentially impact on the quality and ecological functioning of ground- and surface water resources, with potentially negative effects on the local environment, depending on the amount of acid generated. Some rock types have the potential to both produce acids, as well as then neutralise them. For example, a sample containing both pyrites (FeS_2) and carbonates (CO_3^{2-}) will produce acids through pyrite oxidation, which may subsequently get neutralised by the carbonates therein. Acid-base accounting (ABA) is an accepted method used to deduce, through a host of laboratory analyses, the ultimate acid forming potential of the waste rock (i.e. by *inter alia* comparison of the acid potential of the sample relative to the neutralising potential thereof).

A series of ABA analyses were performed on waste rock samples deemed to be representative of the waste rock that would be produced by the operational mine (refer Appendix 5.13:Volspruit Acid Mine Drainage Potential Assessment). From the ABA undertaken for the assessment, it was evident that both the waste rock and the tailings samples analysed have little potential for AMD formation, but instead have the tendency to neutralise AMD generation. The Volspruit mine residues themselves are, therefore, expected to have no risk of acid mine drainage formation due to the results obtained through the representative sampling and analyses undertaken for this assessment.

2.4.5 GROUNDWATER INGRESS MANAGEMENT INTO OPENCAST PITS

Background

The relative proximity of the proposed Volspruit opencast pits to the Nyl River and its associated wetland system, as well as the high degree of weathering and fracturing encountered in the *in situ* parent material, require the proponent to implement practical and feasible measures to limit groundwater ingress into the subject pits. Any such management measures would be required to the extent that would mitigate any potentially significant hydrological impacts on the aforementioned system. The need to manage groundwater ingress into the pits furthermore stems from the proponent's need to ensure safe, manageable, operating conditions within the pit from a mine safety and technical perspective alike.

The project proposal, by way of illustration, is comparable to submerging (up-right) an empty, leaky, bucket into a bath of water; where the volume of water that flows under pressure into the bucket would be dependent on the nature and extent of any holes or cracks in the bucket itself. Similarly, the volume of groundwater that is anticipated to flow under pressure into the proposed opencast pits would be dependent on the nature and extent of any fracturing or weathering encountered in the site's parent material; where such fractures or zones of weathering would act as preferential flow paths for groundwater to flow into the 'empty' pit (Figure 2-11).

So far as concerns the proposed vertical establishment of the proposed pits, three broad zones of differentially weathered/fractured parent material have been identified. These are as follows (Figure 2-11):

1. An 'upper zone' of highly permeable/weathered material that extends from ground level down to approximately 30m below ground level (bgl);
2. A 'middle zone' of moderately to highly permeable weathered material that extends from approximately 30 to 60m bgl; and from the base of the middle zone
3. A 'lower zone' of mainly low permeability fractured bed-rock (i.e. rock containing mainly closed fractures and joints) that extends from the bottom of the middle zone to beyond 180m bgl (i.e. below the maximum proposed pit depth).

The management of groundwater ingress into opencast pits established in *in situ* parent material that is largely consolidated, or with fracturing of the type encountered in the 'lower zone' described above, would typically only require the *ad hoc* pit-face grouting of fractures/joints wherever these are encountered through pit development (if at all, depending on the tolerable level of ingress into the pit). The presence of zones of highly weathered/fractured parent material over the Volspruit site (i.e. the defined upper and middle zones) require a more robust '*groundwater ingress management strategy*'; where the management of ingress through the upper zone of highly weathered/alluvial material, in particular, would need to achieve a very low permeability that would abate the potential for 'piping' and associated pit wall failure(s).

A preliminary strategy has been developed for the proposed Volspruit Mine that caters to the specific *in situ* conditions of the subject site. A couple of pertinent definitions follow, that aim to assist ones understanding of the concepts and terminology used in defining this strategy:

Grout: Any product that, after application, reduces or eliminates permeability to fluids.

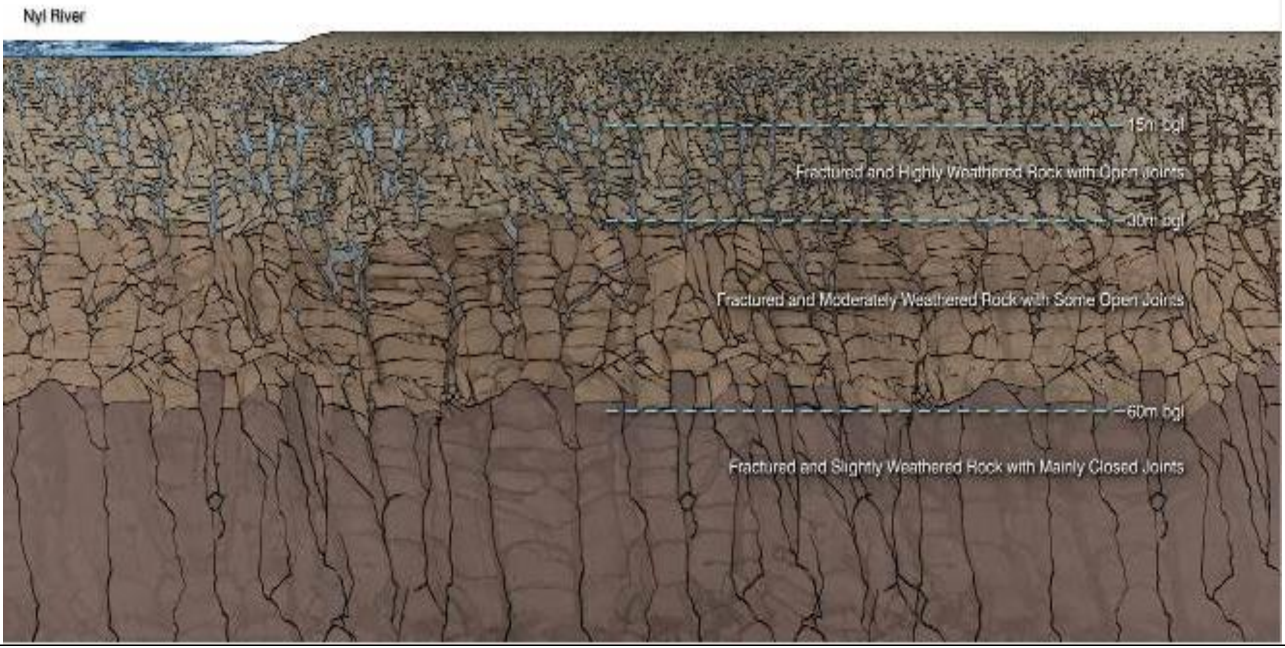


Figure 2-11: Conceptual Illustration of Parent Material Zones and Groundwater Occurrence

Grouting: The injection of a grout under pressure into the ground *via* small diameter (50 mm – 100 mm) boreholes to fill voids and seal cracks, thereby making the ground more stable and less permeable.

Curtain grouting: Method to create a planar zone of lower permeability in the ground by the grouting of closely spaced boreholes drilled along one or more parallel lines (Figure 2-12 and Figure 2-13 refer).

Jet grouting: Figure 2-12 & Figure 2-13): Method of creating a planar zone of lower permeability in the ground by drilling a line of closely spaced boreholes and injecting a mixture of soil and water under very high pressure via a nozzle that is rotated and at the same time gradually raised. The grout mixes with the *in situ* soil to create circular columns of grouted soil. If constructed close enough together, these columns form a "wall" of low permeability material.

Permeability / Lugeon values: The Lugeon test provides a rough measure of the permeability of a jointed rock mass. The test is performed by injecting water under pressure into a section of a borehole that is sealed off at both ends by means of expandable packers. The Lugeon value is calculated as the water loss in litres per minute, per metre length of borehole under an excess pressure of 1 MPa. The test in each section is repeated five times using increasing and decreasing pressures in order to determine the flow patterns (e.g. laminar, turbulent, dilation, wash-out or blockage).

Piping: The phenomenon that occurs when fluids start to flow through ground at such a rate that erosion of the host material occurs to create a pipe or visible stream of fluid. Piping through soil material takes place when water moves through a soil mass at a velocity (gradient) that is high enough to move particles of soil. Seepage water removes soil from the exit point of flow, and erosion advances up-gradient. As more soil particles escape the flow path becomes shorter and the erosion process accelerates until a pipe or void is formed, resulting in a collapse of the surrounding soil.

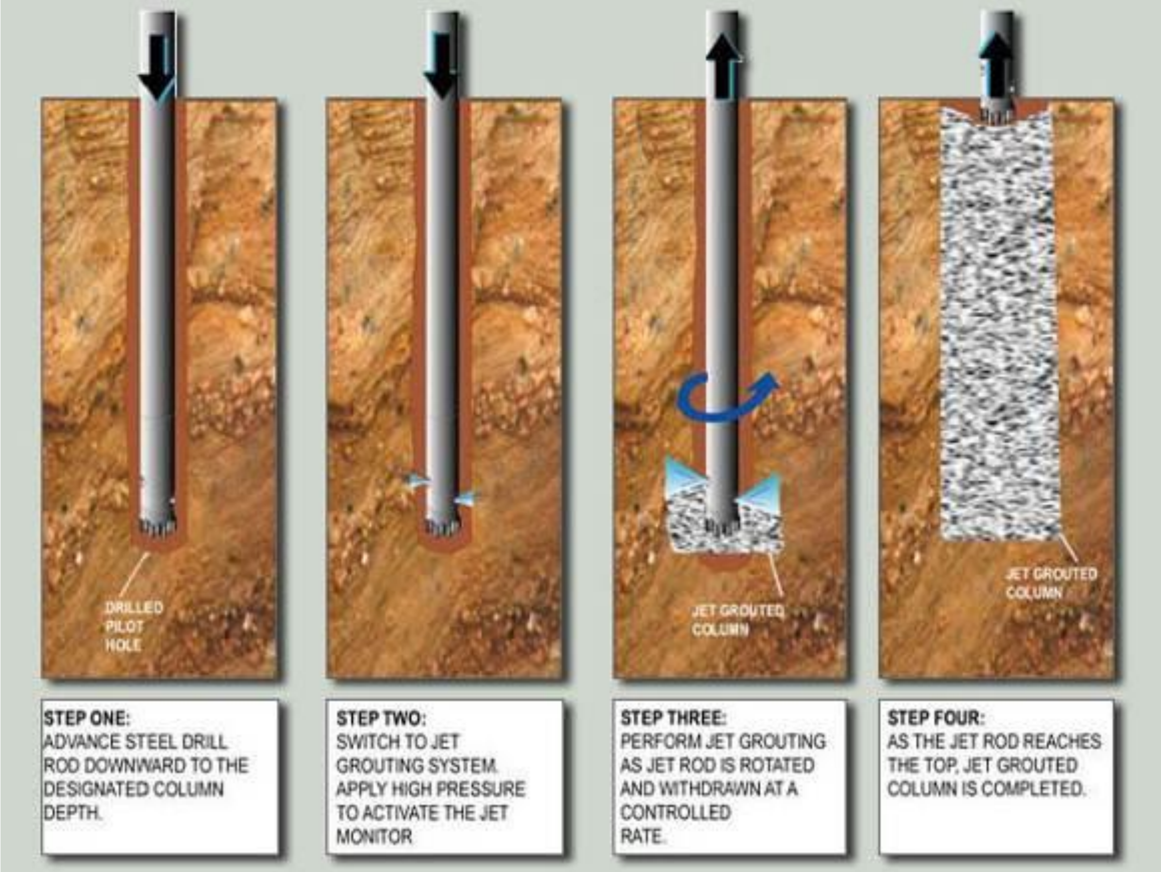


Figure 2-12: Diagrammatic Illustration of Jet Grouting (Bahia Azul, August 2012)

Figure 2-13: Diagrammatic illustration of jet lateral, continuous jet-grouted columns (Ascon Construction, August 2012)

Groundwater Ingress Management Strategy

The development of the preliminary Volspruit Mine's groundwater ingress management strategy has been an iterative process involving inputs from an engineering geologist (grouting specialist), specialist geo-hydrologist, the proponent, as well as the EAP. The management actions proposed under the plan have been tailored toward the *in situ* permeability, as well as the degree of weathering/fracturing and alluvium, encountered within each respective zone (Appendix 8.1: Grouting Strategy & 'Buffer' Illustrations).

The upper zone, according to specialist professional opinion, cannot be grouted through conventional curtain grouting means. This is due to the highly weathered, highly permeable, nature of the material encountered within this zone. The middle zone can feasibly be grouted through conventional curtain grouting, with the nature of the weathered rock in this zone being tolerable to such. In the lower zone, where the weathering/fracturing that is encountered is not as extensive as that encountered in the upper- and middle zones, *ad hoc* pit-face grouting can be implemented as and when fractures are encountered during vertical pit establishment to depth.

1. Upper zone

The management of groundwater ingress along the respective pit perimeters in the upper zone will comprise a combination of (Figure 2-14, Appendix 8.1) –

a) The excavation of a trench with an approximate 18° slope to a depth of approximately 15m bgl. The surface of this slope will then be lined with a clay wedge, or other highly impermeable geo-synthetic clay(s) / geo-composites; where this would act as a largely impermeable barrier toward preferential groundwater ingress across this zone. The 18° slope angle, as well as a proposed protective toe berm, are proposed to ensure the slope stability of the protective 'clay' layer and prevent it from subsiding. The protective barrier would then also be covered with waste rock and back-filled to ground level to add further stability to the installed protective barrier *****; and
b) Interlinking vertical, jet-grouted columns at an approximate depth of 15 to 30m below, but essentially continuous with, the above mentioned trench; where the *in situ* material is still highly weathered / fractured.

***** The proposed flood protection berm (to be established at approximately 5-6m above ground level at its highest point) along the applicable river side section of the proposed North Pit will be established by placing further waste rock on top of the back-filled trench material. The mine perimeter road will be established on top of the berm itself in order to accommodate the space constraints in establishing the trench between the subject pit and the Nyl River. Back-filed 'trench sections' of pit perimeter not affected by the proposed flood berm will largely remain back-filled to ground level. Instead, a 1m high storm water protection berm (i.e. to prevent ingress into the pit of normal surface flows during rainfall events) and mine perimeter road will be established within a 30m corridor above the back-filled trench.

2. Middle Zone

The management of groundwater ingress along the respective pit perimeters in the middle zone will be managed through the establishment of a largely impermeable, conventional, grout curtain from a depth of approximately 30 to 60m bgl (Figure 2-14, Appendix 8.1). The boreholes required to implement the injection of the grout curtain will be drilled from 15m, through the established jet grout columns, down to the lower zone at an approximate depth of 60m bgl. This will ensure the continuity of the pit-groundwater barrier between the surface and the lower zone.

3. Lower Zone

The parent material in the lower zone (60m to 180m+) is significantly more consolidated than that of the upper- and middle zones. The management of groundwater ingress into the pits within this zone will thus be implemented through the *ad hoc* traditional grouting methods for faults and fractures encountered by the proponent as the pits develop to depth (Figure 2-14, Appendix 8.1).

General Matters

Measures to achieve pit isolation from the surrounding groundwater (conceptual illustration provided in Figure 2-14) will need to be implemented along the entire north- and south pit perimeters. The water entering the pit through the semi-permeable, 'continuous', pit perimeter barrier would be pumped back to surrounding agricultural sites and also used in the mining operations. It is estimated that the pit perimeter barrier would need to achieve the following specification, in respect of hydraulic conductivity, of 0.001 (m/d) from ground level to 30m bgl, 0.013 (m/d) from 30 to 60m bgl and 0.043 (m/d) from 60m to depth. It is important to note that the strategy documented here is not a final design, but that any such engineered strategy capable of achieving the required permeability to restrict groundwater ingress into the acceptable range would suffice (i.e. the EIA sets the targets / threshold limits for permeability and ingress volumes rather than a standard for engineering design to achieve such targets).

The barrier to groundwater ingress to be created along the pit perimeters will not be impermeable (i.e. groundwater ingress into the pits will still occur, but this will be significantly reduced from a scenario where no such measures were to be implemented). Groundwater ingress into the pits will occur through both the walls and from the pit floors and will be handled using pumping and *ad hoc* grouting methods. The groundwater modelling undertaken in support of the EIA modelled the pit water ingress accordingly (i.e. hydraulic conductivity along the respective pit perimeters at the specified depths, with ad hoc ingress management over the respective pit floors).

The proponent proposes to maintain a small benched section within each pit (i.e. vertical rock section of approximately 5m in width, from 15 to 180m in depth, immediately inside of the proposed trench and grouting columns/curtain. This section may be mined last, in terms of the proposed mine works programme, in order to provide additional stability to the groundwater ingress management barrier until the end of life of mine. Furthermore, and once the above mentioned bench is indeed mined out, the back-filled waste rock in the aforementioned trench will be pushed back into the pits, to the extent that this is feasible, and sloped to an angle of approximately 10°. The proposed 10° angle is aimed at facilitating the establishment of a rehabilitated 'beach' head at closure; where the rising water levels in the pit are proposed to settle along this beach, with the beach extended at least 3m vertically beneath the final water level in the pit. A series of illustrations that show the phased implementation of the proposed pit grouting strategy, in the context of the life of the mine, are provided for in Appendix 8.1: Grouting Strategy & 'Buffer' Illustrations.

2.4.6 PIT DEWATERING

In order for the proponent to viably and safely mine the respective pits, the pits will need to be 'dewatered' for the greater part of the operational lifespan thereof. Groundwater will ingress into the pit voids from the adjacent groundwater environment as the pit voids are mined out below the static ground water levels of the subject sites. The proponent proposes the installation of an engineered grouting strategy along the respective pit perimeters in order to manage/curb the volumes of groundwater that enter into each of the respective pits, but this will not render the pits totally impermeable to groundwater ingress and pit dewatering will remain an operational imperative for the operational life of mine.

Table 2-6: Maximum Modelled Requirements for Pit Dewatering (Steady state)	
Pit	**Inflow(m^3/day)**
North Pit (No grouting)	4300
North Pit (With grouting)	4100
South Pit (No grouting)	4400
South Pit (With grouting)	4000

The water that is dewatered from the pits will be pumped to surface and stored in a 300Ml, HDPE lined earth embankment, pollution control dam, located centrally to the respective pits and the proposed concentrator plant. From there, the water will be transferred predominantly as make-up water supply to the TSF return water dam, in order to maintain a constant level in this dam for supplying the concentrator plant's water demand.

Pit dewatering in excess of the demand for TSF return water dam make-up water will be used to supply irrigated cropland water demand for the fields to be established by the proponent north of the fields to be sterilised through the mining of the north pit, domestic water supply, discharge to the Nyl river and/or a combination of these uses.

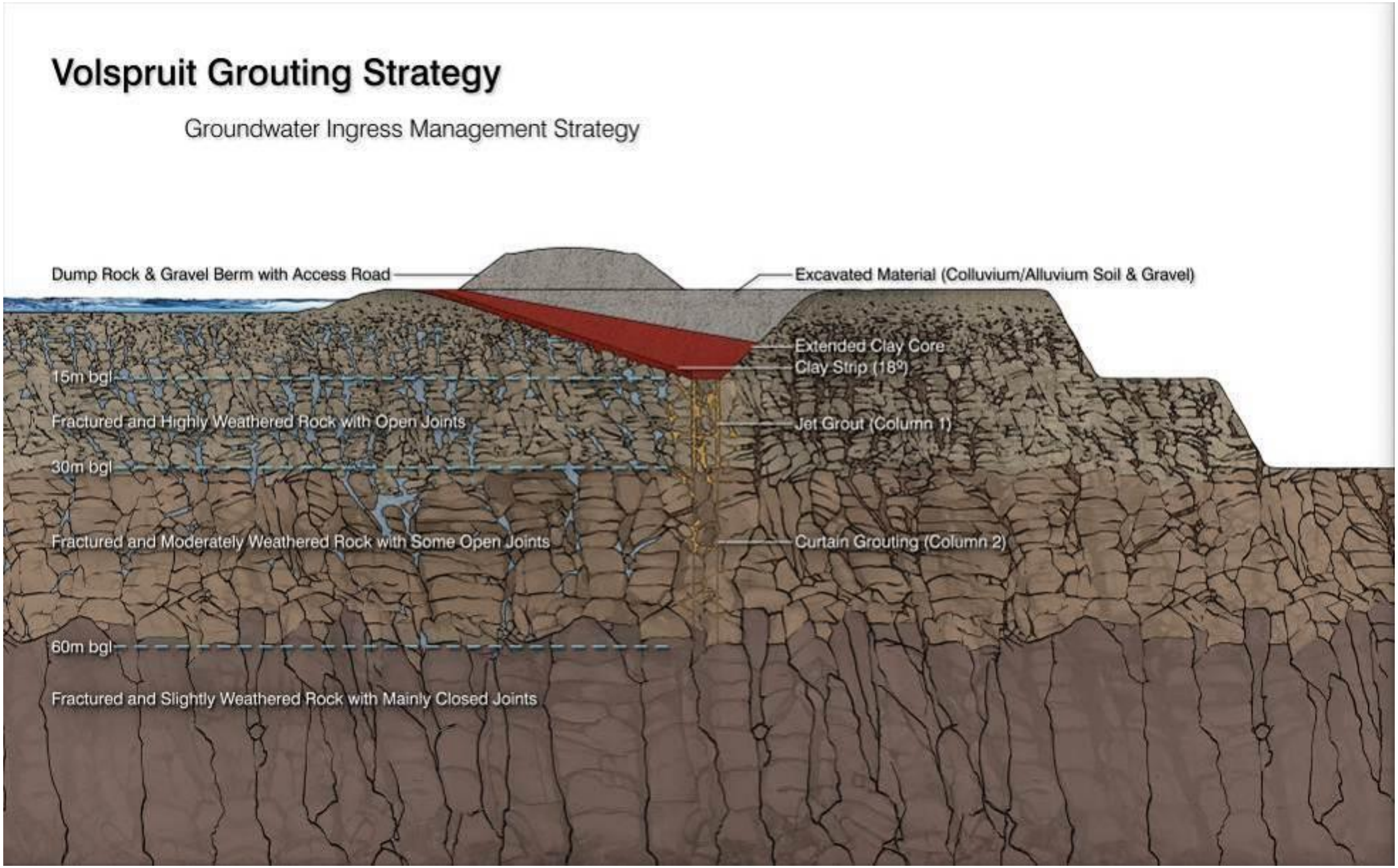


Figure 2-14: <u>Conceptual</u> Illustration of the Proposed Volspruit Mine Pit Grouting Strategy

2.5 ORE PROCESSING AND BENEFICIATION

2.5.1 CONCENTRATOR PLANT

Mineral processing entails the separation of commercially valuable minerals [PGMs and Base Metals (Ni, Cu and Fe)in this instance] from their mined ores. This is essentially the aim of the proposed Volspruit concentrator plant proposed for establishment on Ptn. 2 of the farm Volspruit 326 KR; where 'slurried' ore will be subjected to 'frother flotation' to separate a valuable mineral concentrate (PGM concentrate) leaving the remaining material as waste tailings, or ore residues. It is this mineral concentrate that is transferred to the smelter for smelting (following concentrate slurry dewatering at a filter-press), and the tailings that will be disposed of to the proposed TSF as thickened paste tailings.

Crushed ore from the run of mine stockpile is subjected to further crushing, screening and milling at the concentrator plant. The aim of which is to reduce the aggregate size of the mined ore to the point that it can be effectively 'slurried' [i.e. the creation of a mixture (suspension) of water and the finely ground, insoluble, ore]. The fine ore is 'slurried' through the addition of water. Approximately 1.5m^3 of water are required per kiloton (1000tons) of ore to effect this (at steady state production of 300kt/month – to be effective by year 5 of mining).

The flotation process requires the addition of chemical reagents (e.g. frothing agents, collectors, depressants) to the ore slurry, as well as the pumping of air through the slurry mix. The PGM containing particles are floated to the top of the sequential flotation tanks through the process and skimmed off the top of the tanks to produce the mineral concentrate. The final underflow slurry from the tanks is ultimately pumped to the TSF as waste tailings. Flocculating agents are also used in dewatering the mineral concentrate prior to transfer thereof to the smelter. The chemical reagents to be used in the proposed Volspruit concentrator are listed in Table 2-7 to follow.

Table 2-7: Chemical Reagents to be used in the Flotation Process

Reagent	Delivery / Containment	Dose / Usage
Collector 1 – Dry SiBY	Drums containing liquid collectors	1m^3/hour (100% make up) – 8 000 drums / annum
Collector 2 – ACRO 3477B		
Activator – Dry powder $CuSO_4$	Delivered as dry powder in bags	Not yet confirmed
Liquid Depressant	Drums containing liquid depressant	0.5m^3/hour (100% make up) – 4 000 drums / annum
Liquid Frother	Drums containing liquid frother	0.5m^3/hour (100% make up) – 4 000 drums / annum
Dry powder flocculent	Delivered as dry powder in bags	Not yet confirmed

The concentrator plant will process approximately 59million tons of mined ore (run of mine) over the anticipated 19 year life of mine. The estimated annual throughput tonnages will vary from 0.5million tons in year one, to a maximum of approximately 7.2million tons in years 11 and 12.

Flotation Plant

Ball Mill

Figure 2-15: Photographic Examples of Key Elements of the Processing Plant

Concentrate analysis and estimated concentrate mineralogy

In late 2010, Sylvania commissioned Mintek to undertake an analysis of the concentrate that would emanate from the concentrator plant. Mintek was provided with an ore sample representative of that to be obtained from the opencast mining operations. Mintek then put this ore through its pilot processing/concentrator plant to obtain a concentrate representative of that to be produced at the actual onsite processing plant.

A concentrate analysis was undertaken and the following results were obtained (Table 2-8):

Table 2-8: Mintek Grassvalley (Volspruit Mine) report (9 Nov 2010) – concentrate analysis

Element	**%**
Ni	4.87
Cu	1.65
Fe	15.0
Co	0.17
S	12
PGM, 4E, ppm	50
Cr	0.29
Si	20.00
Mg	11.50
Ca	1.20
Al	1.13

From the above given concentrate elemental composition, the mineralogy composition was estimated assuming that all Ni (Nickel) forms pentlandite $Ni_9Fe_8S_{15}$, all Cu forms chalcopyrite $CuFeS_2$, all Co forms CoS, the remaining S forms phyrotite Fe_7S_8 and the remaining Fe forms FeO.

From the above results shown, the estimated concentrate mineralogy could be determined (Table 2-9):

Table 2-9: Estimated concentrate mineralogy	
Volspruit concentrate	**Wt%**
$CuFeS_2$	4.74
$Ni_9Fe_8S_{15}$	13.37
CoS	0.26
Fe_7S_8	14.81
FeO	0.62
Cr_2O_3	0.42
CaO	1.68
MgO	19.15
SiO_2	42.82
Al_2O_3	2.13
PGM's ppm	0.0050
Total	100.00

2.5.2 TAILINGS STORAGE FACILITY (TSF)

Tailings generated from the proposed concentrator plant will be disposed of to a single, dedicated, tailings storage facility (TSF) on the remaining extent of the farm Zoetveld 294 KR. The tailings will be pumped from the concentrator plant to the TSF as a high-density slurry, or paste. The services of SRK consulting were commissioned for the subject EIA to *inter alia* inform the placement of the required TSF and associated return water dam (Full specialist report attached under Appendix 5.16: Volspruit Tailings Storage Facility Assessment Report). The proposed TSF locality and key statistics are shown in Figure 2-16 and Table 2-10 respectively.

Table 2-10: TSF Statistics	
Approximate footprint area	97ha
Approximate final height	40m
Approximate disposal capacity	56 million tons
Averaged annual rate of deposition over 19 years	2.95 million tons per annum
Disposal/Deposition method	Thickened Paste Tailings
Type of facility	Self-raising wall behind a starter wall
Approximate tailings dry density	2.2 tons /m^3
Approximate tailings slurry (wet) density	1.9 tons /m^3
Approximate slurry water pumped to TSF	126 611m^3 / month
Approximate water recovery to Return Water Dam	53 418 m^3 / month

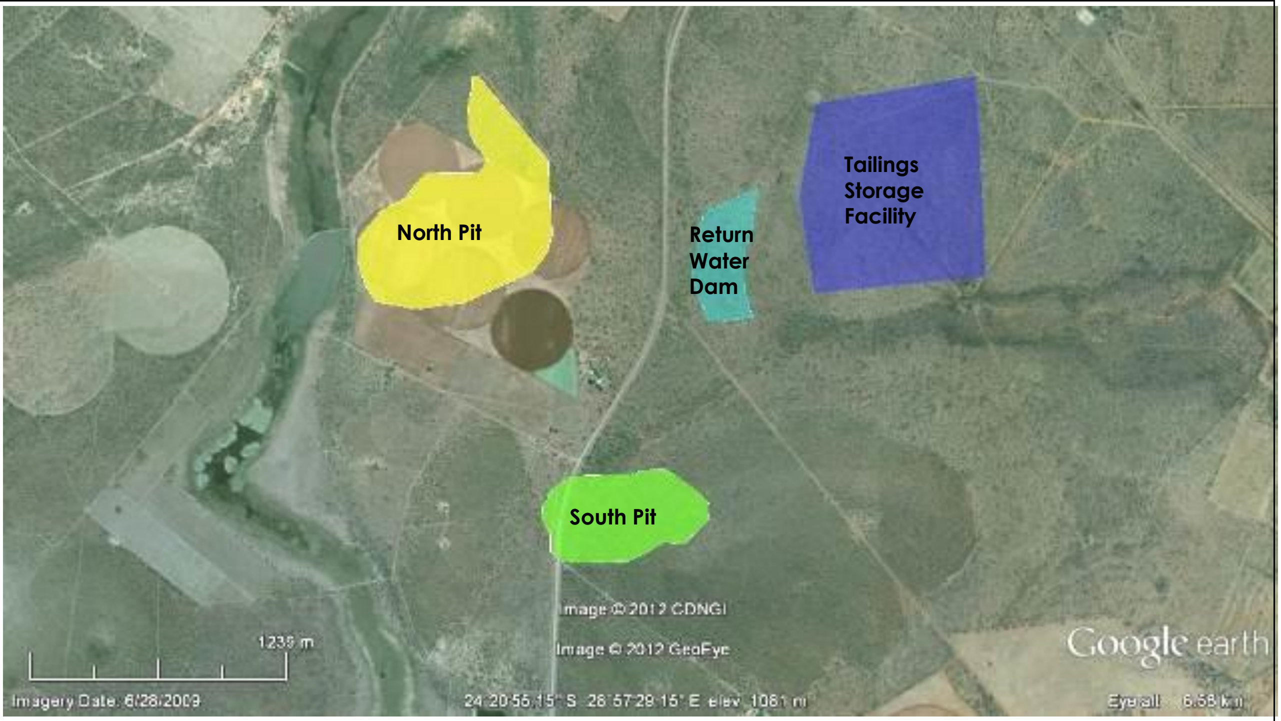


Figure 2-16: Proposed TSF and Return Water Dam Locality (Preferred Positions)

TSF Return Water Dam

Rainfall and process water decant (i.e. water present in the thickened tailings) need to be removed from the TSF to maintain safe operating conditions. As such, the proponent proposes to establish a return water dam to the west of the TSF itself. The proposed return water dam has been designed to accommodate:

- normal operating volumes from the TSF (i.e. tailings water decant);
- storm water run-off from the TSF in a 1:50 year rainfall event; and
- rainfall to the actual return water dam surface in a 1:50 year rainfall event.

Water from the TSF would be drained to the return water dam via three (3) proposed penstocks to be built into the TSF design. The return water dam would be situated immediately west of the TSF itself on the farm Zoetveld 294 KR. The proposed return water dam locality and key statistics are shown in Figure 2-16 and Table 2-11 respectively.

Table 2-11: Key TSF Return Water Dam Statistics	
Approximate footprint	15ha
Max. normal operating volume	62 983m^3
Full supply level	240 254m^3
Up-stream and down-stream wall slopes	1:3 (vertical:horizontal)
Dam basin liner	HDPE liner
Input streams	TSF water decant
	Pit dewatering
Operational storage capacity operation	5 days' worth

2.5.3 SMELTER COMPLEX AND CHEMICAL VAPOUR METAL RECOVERY (CVMR) PLANT

The metal concentrate produced at the concentrator plant will be pumped to smelter slurry receiving tanks at the smelter complex for further processing (Figure 2-17). The subject concentrate will then be filtered and stored in a concentrator storage shed. The stored concentrate will be dried (flash dryer) before being subjected to any further stages of processing, which will entail the consecutive steps, as follows (Figure 2-18):

1. Roasting of sulphide bearing concentrates, so as to oxidise and liberate the sulphur contained therein (to achieve sulphur concentrations below 1% in the concentrate) before smelting;
2. Smelting of the roasted concentrate in a 5MW DC furnace (capacity to smelt approximately 40 000tons/year) to produce a PGM alloy product (The proponent plans to install a second 5MW furnace s part of production ramp up a couple of years into operational mining); and
3. Atomization of the alloy product and transfer thereof to the CVMR Plant for further refinement.

Roasting

Roasting is a metallurgical process involving a 'gas–solid' reaction at elevated temperatures (below the melting point of the metal concentrate – up to approximately 600°c), with the goal of purifying the metal components (i.e. removal of sulphides from the metal concentrate in this instance). Roasting, in the context of the Volspruit project, will be effected through the application of 'hot' air to the sulphide containing concentrate, in a fluid bed roaster. The roasting process acts to oxidise the sulphide impurities in the metal concentrate to gaseous sulphur dioxide (SO_2). The 'roasted' metal concentrate will then be cooled to approximately 200°C and transferred pneumatically to the furnace feed bins for smelting (Figure 2-18).

The roasting process results in the generation of potentially significant volumes of sulphur dioxide (SO_2). The roaster off-gas (SO_2 containing) will initially be filtered through a cyclone and high temperature bag-house system, in order to reduce the dust and particulate concentration thereof to below 30mg/Nm^3. The dust and particulates captured in this system will be will be re-circulated to the roaster product bin, with the off-gas being directed through a thermal energy recovery heat exchanger before being subjected to further abatement at a sulphur fixation plant (Figure 2-18).

The sulphur fixation plant is required to ensure that the emissions to atmosphere of SO_2 from the roasting process are ultimately within regulated limits put forward under the National Environmental Management: Air Quality Act, 2004 (Act. No. 39 of 2004)[NEM:AQA]; where SO_2 is a criteria pollutant under NEM:AQA. There are several options available to industry including the production of Gypsum, Sulphuric Acid or liquid Sulphur dioxide all of which capture 99% of the sulphur in the discharge. These alternatives are discussed later in this report. (Section 2.9.5, '*Technology Alternatives*' has reference).

DC furnace

In the production of the PGM alloy product (i.e. step 2 above), three types of raw materials, i) mineral concentrate, ii) reductants and iii) fluxes are smelted. The PGM alloy is produced through the carbothermic reduction of the roasted PGM metal concentrate in a furnace (i.e. oxygen is stripped from the concentrate in a reducing atmosphere produced by carbon rich reductants, and high temperatures). The raw materials are fed to the furnaces in predetermined ratios. Energy (in the form of electricity) is introduced into the furnaces by way of a liquid paste electrode, resulting in the melting of the raw material mix in the furnace (at approximately 1650 to 1800 °C).

The proponent proposes to use anthracite as the primary furnace reductant, with a covered storage shed being provided for such in the development layout. A limestone flux is to be added to the smelting process in the furnace for the purposes of removing impurities from the molten metal, and for rendering the slag more liquid. The fluxes most commonly used are limestone and dolomite, which are added to provide particular chemical properties, smelting temperature and viscosity to slag, in order to ensure good furnace operation and PGM alloy yields. The reductants and fluxes will be delivered to the site in bags, stored in sheds onsite and transported *via* forklift to furnace batching bins as required.

The PGM alloy (i.e. the metal fraction of the melted mix) collects at the bottom of the furnace, from where it is tapped. Slag (i.e. remaining, non-metallic, impurities from the concentrate) and metals, which separate in the furnace due to different relative densities, are tapped either simultaneously from the same tap-hole, or separately from different tap-holes (Figure 2-18). The smelter will ultimately utilise two, 5 MW furnaces, the second to be installed a few years after project commencement in line with production ramp up (not assessed as part of this EIA scope).

Table 2-12: 5MW DC Furnace Key Statistics (approximations)	
Installed power	5 KW
Power consumption	829(kWh/t concentrate)
Rate of roasted concentrate feed	4.2 tons/hour
Max. rate of anthracite consumption	200kg / hour
Max rate of limestone consumption	200kg / hour
PGM alloy production	600kg/hour
Slag production rate (average)	3.9 tons/hour
Off-gas volumes produced	539 Nm^3/h
Fugitive dust generated / captured	700kg/hour

The proponent proposes to establish a slag dump (disposal facility) on the eastern section of the smelter complex. Slag waste generated though the proposed smelting activities will be disposed of to this dedicated facility, which will have an installed pollution containment barrier (liner) specification appropriate to the risk posed by the slag to the groundwater environment when disposed of (i.e. the liner specifications for the slag dump will need to be appropriate to the nature of the contaminants contained in the slag, as well as the degree to which those contaminants are mobilised/leached from the slag when disposed of). The slag dump will occupy an area of approximately 0.15ha in extent.

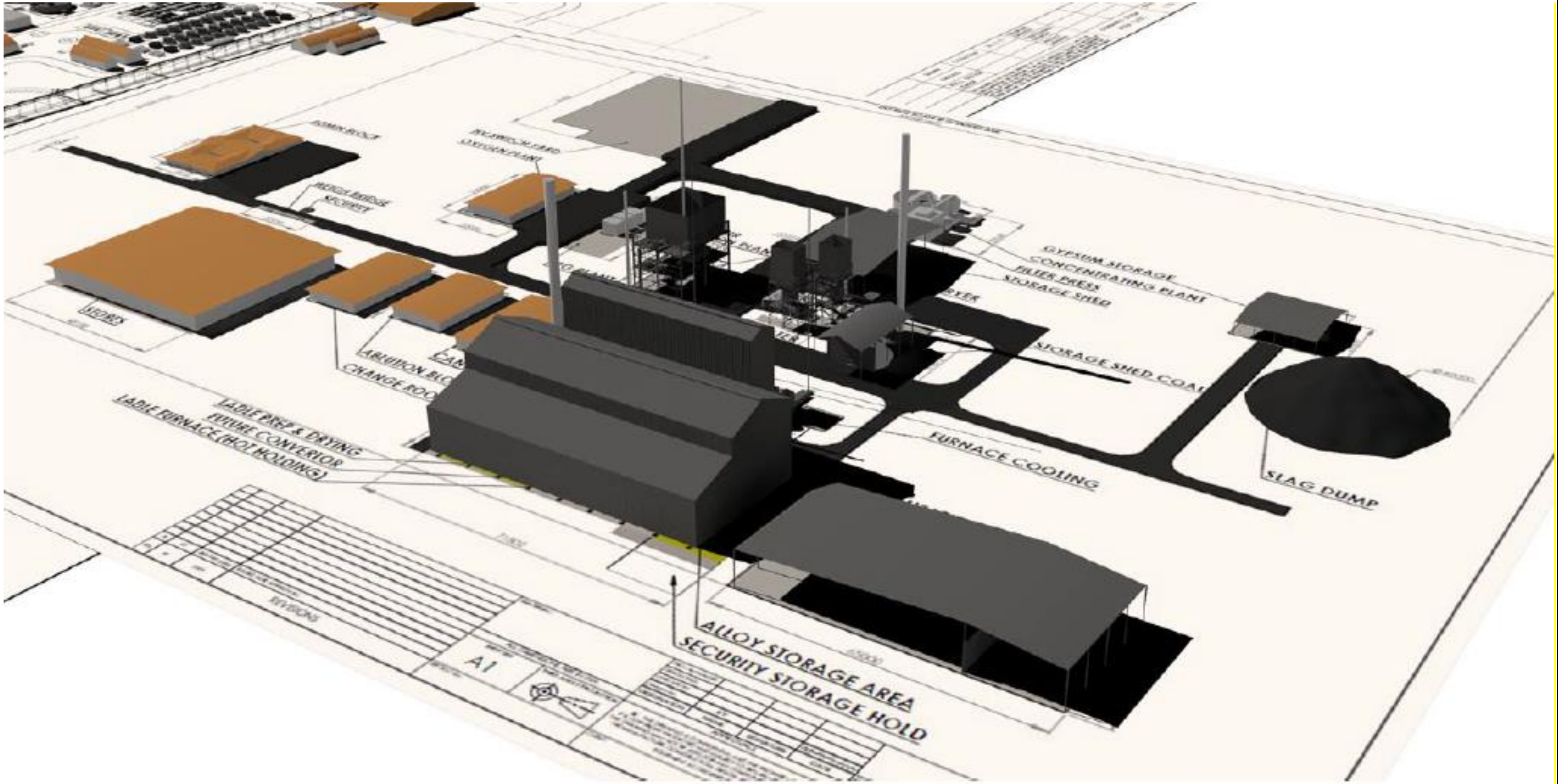


Figure 2-17: Proposed Layout of the Volspruit Smelter Complex and CVMR Plant

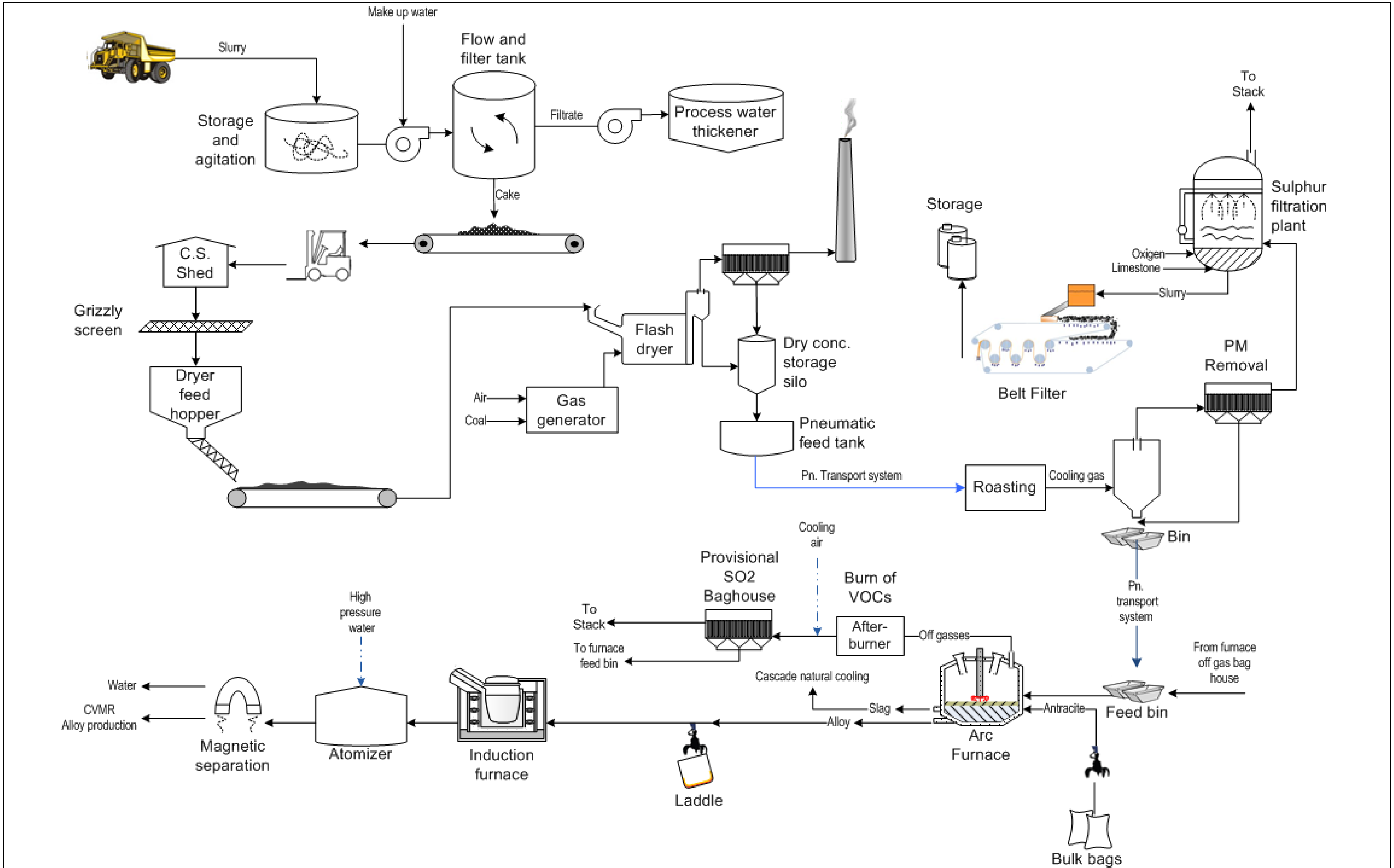


Figure 2-18: Process overview of the smelting plant

2.6 SUPPORTING STRUCTURES AND INFRASTRUCTURE

Further to the surface structures and infrastructure already detailed in the preceding sections, the proposed mine will require the establishment of a host of additional surface structures and infrastructure in support if the proposed mining activities on the site.

The following is a list of proposed supporting structures and infrastructure for the Volspruit Mine (Figure 2-19), some of which are described in further detail in the sections that follow:

- Access road (The 'Singlewood Road' will be used as the point of access to mine sections located both east and west thereof;
- Diversion of the Singlewood Road westward around the South Pit;
- Plant roads;
- Mining haul roads;
- Storm water management structures and infrastructure;
- Pollution control dam (300Ml capacity);
- Sewage reticulations;
- Sewage treatment works;
- Potable and process water reticulations;
- Water treatment works;
- Water holding tanks and reservoirs;
- Flood barrier between Nyl River and "North pit";
- Plant offices;
- Mine administration offices;
- High Voltage switching yard and other internal electrical distribution infrastructure;
- Medical clinic;
- Change houses and ablution facilities;
- Canteen;
- Workshops (electrical, mechanical, boiler maker etc.);
- Lay-down yards;
- Salvage yards;
- Storage areas;
- Waste storage and handling areas (general and hazardous);
- Metallurgical laboratory;
- Main gatehouse;
- Weighbridges;
- Topsoil and overburden stockpiles;
- Conveyors/railveyors;
- Product stockpiles;
- Return water dams;
- Car park areas; and
- Truck load-out facilities.

2.6.1 SEWAGE TREATMENT PLANT

Labour estimates were taken directly from the information provided by the proponent. This was based on the assumption that the plants will operate continuously on a 24 h/d basis, having four shifts in total (three operating and one off). Sizing of the sewage plant is based on an estimated 150 litres per person per day to meet the operational and mining labour requirements, with the plant thus requiring a minimum installed through flow capacity in the order of 26 000m^3 per annum (i.e. for 476 employees on the mine).

A modular series of containerised 150 man bio-filtration units (i.e. three such units) is recommended to meet the requirements for sewage treatment. There are two discards/outputs from this unit, namely –

1. Sewage sludge; and
2. Treated effluent.

Sewage sludge will be stored temporarily onsite for subsequent removal offsite to an appropriately licenced waste disposal facility, or waste management facility that could make environmentally sound use of the sludge through reuse, recycling or recovery thereof (e.g. composting).

The treated effluent would be re-circulated through the process water circuit, *via* the proposed return water dam, for reuse in the processing plant, or it is proposed for use in irrigating mine lawns (subject to licencing for such a water use by the Department of Water Affairs).

2.6.2 WATER TREATMENT PLANT

A water treatment plant is required on the mine for the treatment of potable water only, of which there is a requirement of 21 m^3/h. Depending on the quality of water provided, treatment of the water would be *via* a sand-filter, softening (if required) and an ultra violet unit, to make it safe for human consumption.

2.6.3 GENERAL AND HAZARDOUS WASTE MANAGEMENT

General and Domestic Waste/s

General (office and plant) waste will be generated through normal operational and maintenance activities associated with the proposed mining activities. This waste will include, *inter alia*, the following streams (Table 2-13):

Table 2-13: General Waste Generation through Project Implementation

Waste Type	**Sources**
Paper and cardboard	Waste paper and product packaging
Plastic	Food / beverage and product packaging
'Clean' scrap metal	Beverage and product packaging, as well as maintenance activities
Rubber waste	Mine work areas / conveyers / workshops
Glass	Beverage and product packaging, as well as maintenance activities
Wood waste	Product packaging and maintenance activities
Food wastes	Offices and canteen/s
Garden clippings/cuttings	Garden maintenance
Waste tyres	Vehicle workshops
Miscellaneous	Redundant PPE, tyres, etc.

The above mentioned general waste streams will require the provision of suitable temporary storage at their respective points of generation, prior to being disposed of offsite at an appropriately licenced landfill site (i.e. where such waste cannot feasibly / practically be recycled, reused or recovered).

Hazardous Waste/s

Numerous hazardous waste streams will be generated through normal operational activities associated with the proposed mining activities. This waste will include, *inter alia*, the following streams (Table 2-14):

Table 2-14: Hazardous Waste Generation through Project Implementation

Waste Type	Sources
Used oil/lubricants	Plant, equipment and vehicle maintenance/repair
Oily/contaminated rags	Plant, equipment and vehicle maintenance/repair
Fuel and oil filters	Plant, equipment and vehicle maintenance/repair
Contaminated metal scrap	Plant, equipment and vehicle maintenance/repair
Empty chemical / reagent containers, bags and drums	Offices, plant and shaft areas
Medical Waste	Clinic
WEEE waste	Offices
Printer cartridges	Offices
Contaminated soil	Anywhere where spillages of hazardous chemicals and substances to bare soil surfaces has occurred.
Contaminated absorbents	Anywhere where spillages of hazardous chemicals and substances to hard surfaces and bare soil surfaces has occurred.
Fluorescent tubes/bulbs	Offices, plant and shaft areas
Contaminated PPE	Workshops, change-houses
Slag?	Smelter

The above mentioned hazardous waste streams will require the provision of suitable temporary storage at their respective points of generation, prior to being collected regularly by an appropriately licensed waste management contractor for disposal at an appropriately permitted hazardous waste landfill (i.e. where such waste cannot feasibly/practically be recycled, reused or recovered).

Such temporary storage would need to ensure:

- The prevention of potential storm water, soil and/or groundwater contamination;
- The containment of the waste to prevent wind-blown losses; and
- That neither human health, nor safety, is compromised.

Provision will be made at the respective plant complexes for hazardous waste skips. These skips will be used to temporarily contain hazardous materials such as oiled rags, contaminated soils, oil filters, empty chemical containers and similar such hydrocarbon contaminated waste, prior to the collection thereof by a suitably licensed waste disposal contractor for disposal.

All waste items that can potentially be reused, or recycled, in an environmentally acceptable manner will be temporarily stored on an impermeable base within the proposed salvage yard at the plant complex. Waste oil, for example, will be stored in a temporary holding tank contained within an appropriately bunded area, for regular collection by a waste oil recycler. The ingress of ‘clean’ storm water into the salvage yard will be minimised through the appropriate establishment of either cut-off trenches / diversion berms on the up-slope of the yard. Rain water falling on the yard surface itself will be diverted to a ‘dirty’ storm water dam for reuse in site processes. Manifests will be maintained by the mine for all wastes leaving the mine site, irrespective of the ultimate end use thereof.

Salvage yard

In reality, even though they fall within the definition of 'waste', as provided for in the Waste Act (NEM:WA), many of the aforementioned general and hazardous waste streams have remaining/salvageable 'resource' value. A salvage yard is thus proposed at the plant complex to cater to sorting and storage requirements for such items. Concrete platforms, coupled with appropriate storm water management and separation controls, will be established to cater to the temporary storage of salvageable and recyclable waste items generated through activities associated with the project. It is anticipated that the cumulative requirements for the temporary storage of general- and hazardous wastes will exceed 100m^3 and 80 m^3 respectively. Items to be stored could vary from *inter alia* redundant plant, vehicles or equipment, to waste oils and rubber conveyers.

2.6.4 CONSTRUCTION CAMP/S

The construction phase of the project will require the establishment of contractor's yards / construction camps. These areas will only be established within the development footprint of proposed structures and infrastructure, once topsoil and vegetation stripping has taken place. Each yard will be fenced and may include, *inter alia*, the following main activities and infrastructure:

- Temporary administrative offices;
- Temporary ablution / toilet facilities (no French-drains or septic tanks);
- Material storage areas;
- Fuel storage tanks;
- Waste storage skips / containers (separate skips / containers for hazardous, general and recoverable/recyclable waste streams) and waste bins;
- Concrete batching yard;
- Temporary sleeping quarters for contracted security staff; and
- Vehicle workshop and wash bays / sheds.

Appointed contractors will be required to develop and submit method statements relating to the environmentally sound management of all of the above aspects of the camp/s. These method statements will need to be reviewed and signed off by the site environmental officer and appointed environmental control officer (ECO) before camp establishment. Method statements will essentially provide a plan of implementation as to how the contractors plan to achieve compliance with the management conditions contained in the attached environmental management programme report (EMPR).

2.7 ATMOSPHERIC EMISSIONS

The proposed mining and smelting activities will result in the generation of atmospheric emissions/pollutants regulated in terms of the National Environmental Management: Air Quality Act, 2004 (Act No 39 of 2004)[NEM:AQA].

A number of sources within the greater project proposal would, to a greater or lesser extent, result in emissions to air, including *inter alia*:

- Fugitive emissions from raw material, product and waste storage areas;
- Dust from roads and associated vehicular movement, as well as conveyers;
- Fugitive emissions from the smelter works areas; and
- Point source emissions from the smelter complex /emission abatement equipment stacks.

Specific emissions would potentially include:

- Particulate emissions (dust);
- Volatile Organic Compounds (VOC);
- Poly-Aromatic Hydrocarbons (PAH);
- Oxides of nitrogen (NO_x);
- Sulphur Dioxide (SO_2); and
- Carbon Dioxide (CO_2).

Organic emissions from the proposed smelter are not anticipated to be significant, due to the high temperatures at which the plant is operated. Appropriate emission abatement will be required to reduce the levels of the remaining pollutants to within acceptable limits. Emissions to the atmosphere are considered to be an aspect of potential significance due to the potential impact on ambient air quality and consequently health of any receptors outside the boundary of the proposed mine complex. Emissions to atmosphere will be treated and controlled through a combination of emission abatement techniques and technologies. The technologies will be applied as appropriate to the source and nature of the emission.

2.8 SERVICE PROVISION

2.8.1 WATER

The project's process water demand is estimated in the order of 2.2Ml/day. This demand is predominantly driven by the requirements for the operation of the processing plant, with limited make-up water required for the furnace cooling circuits. This demand is proposed to be met through water dewatered form the opencast pits (conservatively estimated at 4.1Ml/day), as well as return water from the TSF.

Domestic water needs at the mine will be sourced from boreholes onsite (i.e. groundwater); where the estimated potable water demand is in the order of 0.07Ml/day. This assumes that each of the anticipated 476 site employees uses approximately 150litres of water per day to meet their domestic requirements. No provision of water from a licenced water services provider is anticipated.

2.8.2 ELECTRICAL SUPPLY

The mine will need to secure its electrical supply from Eskom. The total mine electrical / power demand is estimated in the order of 50MVA (approximately 50MW). Sylvania has made application to Eskom for this power, as Volspruit currently has no network, and Eskom will need to provide (subject to a separate EIA) power for this facility.

Eskom would need to install a 132 kV transmission line and substation for this purpose Eskom would transform the 132 to 11kV via 2 x 40MVA transformers. These will be connected to the Volspruit 11kV substation, which will be an indoor arrangement. The furnaces will be fed directly at 11kV and the auxiliary loads are fed at 11kV, 525 and 400Volt respectfully via a host of step down transformers. The proponent has thus allowed for a single new 11kV substation equipped with standard Vacuum circuit breakers and a single busbar. The substation is of the cell type with 33kV isolators and vacuum circuit breakers and is of a double busbar configuration. The building will be extended to allow for the additional bays required and the double busbars will also be extended.

Figure 2-19: Site Plan for the Proposed Volspruit Mine (For an enlarged version kindly refer to Appendix 3)

2.9 ALTERNATIVES

Alternatives were introduced into South Africa's 'environmental' legislation to encourage developers, 'industry' and 'mining' to consider different ways of doing things that would have different environmental impacts, whilst still achieving the development goal. Going through the process of identifying and comparing alternatives, will likely yield improvements to the original draft proposal. The ultimate goal of the consideration of alternatives is to both reduce negative environmental impacts and to increase or introduce positive environmental impacts.

2.9.1 MINERALS AND PETROLEUM RESOURCES DEVELOPMENT ACT (MPRDA) REGULATIONS (GN. R.527 OF 2004)

The MPRDA Regulations (GN. R.527 of 2004), for example, refer to alternatives as follows:

For scoping reports in s49(1)(d): *"identify and describe reasonable land use or development alternatives to the proposed operation, alternative means of carrying out the proposed operation and the consequences of not proceeding with the proposed operation;"*

and for EIA reports in s50(d*): "a comparative assessment of the identified land use and development alternatives and their potential environmental, social and cultural impacts;"*.

Typical factors assessed for each alternative include:

- financial feasibility;
- environmental impact;
- socio-economic impact;
- land use planning;
- future expansion of the operations; and
- logistical constraints – power, water, raw materials, labour, market, etc.

Alternatives can take the form of relatively small adjustments to an operation, in which case they blur into mitigation, or totally different activities, depending on how widely the development goal has been stated. Generally, whatever the scale of the alternative, they are grouped into various types, including the following main groups (after DEAT, 2004):

- activity or process alternatives;
- location or routing alternatives;
- layout, design or scale alternatives;
- operational or scheduling alternatives; and
- the 'no-go' alternative.

The role of assessing alternatives in the EIA process is to reach the most desirable outcome for all parties involved in and affected by the proposed project. Having alternatives allows the comparison and selection of the best option, considering the pros, cons and costs of each of those alternatives (where relevant). Ultimately, the alternative that minimises negative impacts and maximises benefits should be the chosen one (provided that the chosen alternative is economically feasible). The EIA process must contain a range of alternatives developed to fulfil the purpose and goal(s) of the proposed project. All feasible alternatives should be carried through from the scoping phase and subjected to a process of impact analysis during the EIA phase of the project.

2.9.2 NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998)[NEMA] - ALTERNATIVES

The consideration of alternatives is also described in the National Environmental Management Act, 1998 (Act No. 107 of 1998)[NEMA].

Section 24 -"Implementation" of NEMA, states the following:

Implementation — (1) "*In order to give effect to the general objectives of integrated environmental management laid down in this Chapter, the potential impact on —*

the environment;
socio-economic conditions; and
the cultural heritage…

…of activities that require authorisation or permission by law and which may significantly affect the environment, must be considered, investigated and assessed prior to their implementation and reported to the organ of state charged by law with authorising, permitting, or otherwise allowing the implementation of an activity…

…(7)Procedures for the investigation, assessment and communication of the potential impact of activities must, as a minimum, ensure the following:

(a) Investigation of the environment likely to be significantly affected by the proposed activity and alternatives thereto; and
(b) Investigation of the potential impact, including cumulative effects, of the activity and its alternatives on the environment, socioeconomic conditions and cultural heritage, and assessment of the significance of that potential impact".

The sub-sections that follow are aimed at providing an overview of the various alternatives that were given consideration in the EIA process. The actual analysis thereof, with relevance to impact significance, is detailed in Section 8 of the EIA Report; where the preferred alternatives are described.

2.9.3 SITE ALTERNATIVES

"*Site alternatives can be either i) for the entire proposal; where the activity is proposed on a totally different site, or ii) or for the relocation of components of the project proposal to different sites*" (Aucamp, 2010). The identification and assessment of site alternatives for proposed mining projects is, however, difficult and largely redundant in the EIA process.

The difficulty lies predominantly in the fact that the position of underground ore bodies constrains open cast mining activities to a very specific area. The position of the ore bodies underground will not change, and so the position of the open cast pits that will be established to access the target ore bodies will fall more-or-less over these areas. Site alternatives have thus not been assessed as part of the EIA process.

Without a smelter and refinery at the mine, the project is not deemed financially viable according to the proponent. Whilst it is true the smelter complex could be positioned at distance from the mine, the fact that the smelter complex has a very limited impact (emissions, noise etc.) makes this option unpractical and/or unfeasible.

2.9.4 LAYOUT / SURFACE INFRASTRUCTURE PLACEMENT ALTERNATIVES

"*Site layout alternatives refer to different spatial configurations of components of the project on a specific site*" (Aucamp, 2010). Layout alternatives are typically derived to give due consideration to, *inter alia* –

- The specific ecological sensitivities of the site in question (e.g. site biodiversity, proximity to water resources, presence/absence of elements of cultural or historic significance and/or the presence/absence of high agricultural potential soils);
- The placement of noisy project elements in relation to potentially sensitive noise receptors; and
- The placement of visually intrusive project elements so as to minimise their impact.

The consideration of layout alternatives must also, however, ensure that such alternatives are also indeed reasonable and feasible in respect of the logistical, engineering and financial constraints applicable to the project. With this in mind, layout alternatives were considered for the placement of what were deemed to be the major surface structures and infrastructure associated with the project; where the greatest opportunity to minimise environmental impacts was identified. These project elements are as follows, and detailed in the sub-sections to follow:

- Waste Rock Dump(s);
- Tailings Storage Facility; and
- The greater Plant Complex, encompassing the proposed processing plant, smelter and CVMR Plant.

Waste Rock Dump(s)

The proponent's original proposal was to establish two waste rock dumps for the mine (Alternative 1, Figure 2-20). This proposal was based largely on a logistical requirement to place the dumps as close to the north pit as possible; where the majority of the waste rock to be placed on the subject dump(s) would come from mining the north pit in years 1 to 8 of the mining campaign. This proposal was refined to instead allow for a single, consolidated, waste rock dump to the north east of the north pit, as well as to modify the footprint thereof to ensure that it remained outside of the sensitive Hills Woodland habitat associated with the 'koppie' to the west thereof (Alternative 2, Figure 2-20).

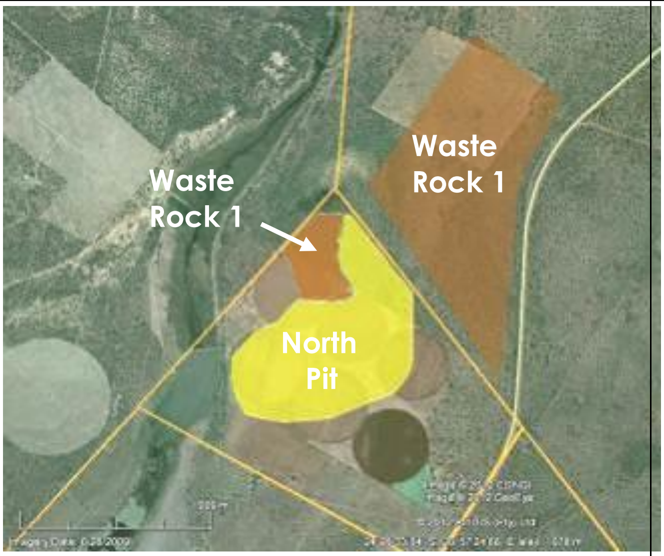
Further consideration was then given to the placement of the waste rock dump in relation to –

- The proximity thereof to the Nyl River in relation to the pollution generating potential of the dump (however low that risk may be);
- The extent to which the placement thereof fragments soils with high agricultural potential;
- The extent to which the placement of the mine residue deposits can be consolidated with respect to i) the potential, collective, visual intrusion thereof on the landscape, as well as ii) the collective pollution generating potential thereof.

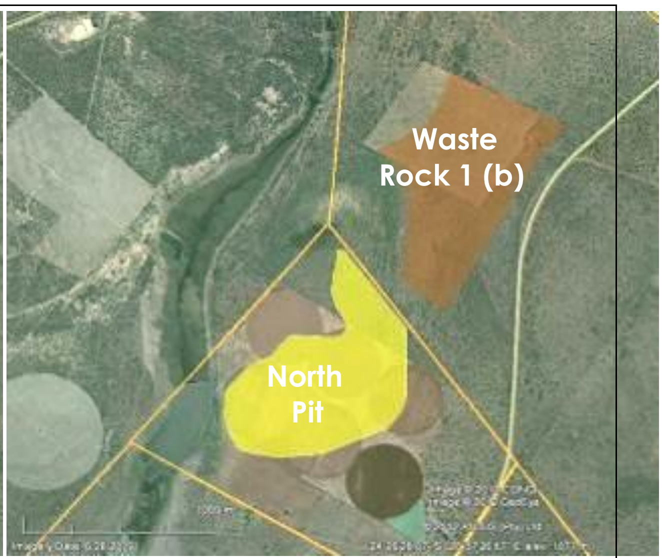
In light of the above considerations, a refined (preferred) layout alternative was developed under advisement of the EAP (Alternative 2, Figure 2-20). This alternative sees the waste rock dump moved east of the Singlewood Road and placed almost immediately North West of the preferred position of the TSF. This essentially frees up a large tract of consolidated land with high agricultural potential adjacent of the Nyl River, and aims furthermore to reduce the collective visual intrusion of the mine residue deposits (i.e.

waste rock dump and tailings storage facility) on the landscape. This is deemed the preferred alternative, with alternative 1(b) being a secondary alternative available to the proponent, subject to the Provincial Roads Authority's acceptance/refusal of waste rock transport across the Singlewood Road; where alternative 1 (b) is not deemed fatally flawed from any, *inter alia*, biophysical, social or heritage aspects, but is however deemed less optimal than alternative 2 on those same criteria.

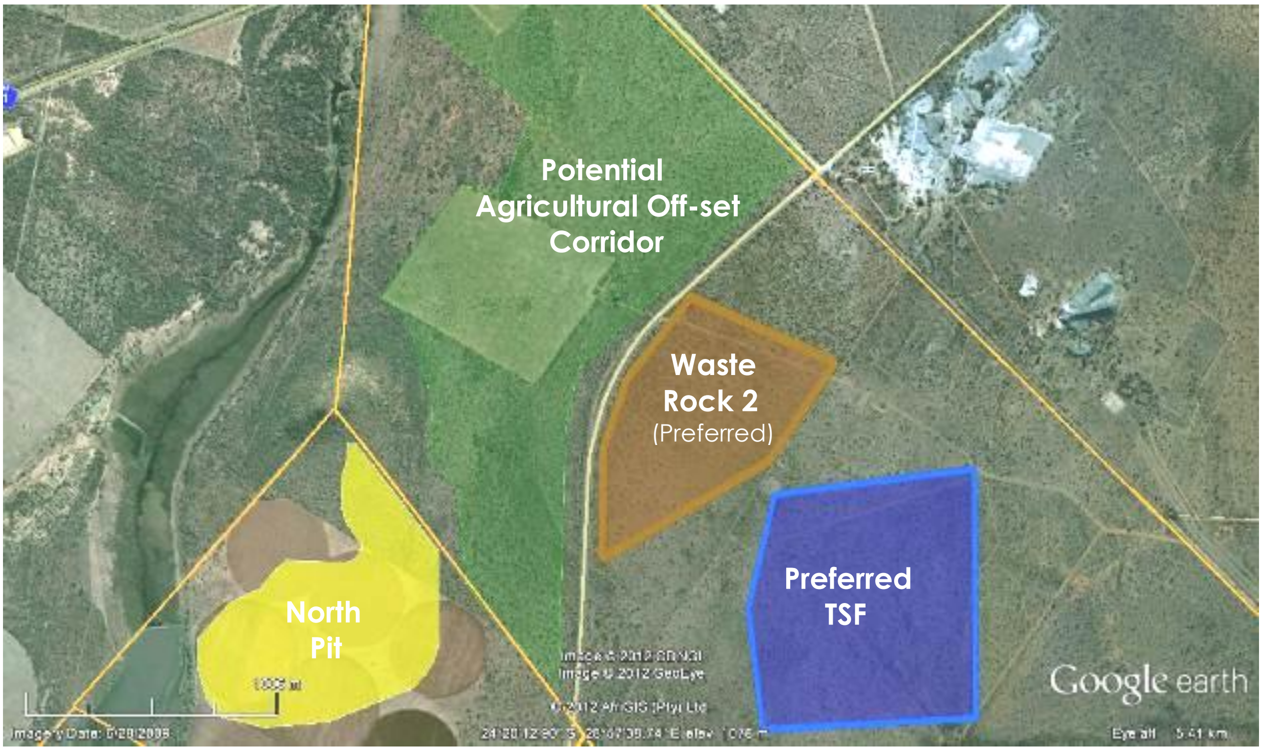
The potential impact significance of both alternatives is detailed in Chapter 8 to follow. All options are dependent on mineral prospecting outcomes on Zoetveld where it is known to have Chrome and PGM mineralisation.



Alternative 1: Initial proponent Proposal



Alternative 1: First Refinement



Alternative 2: Preferred Alternative (Final Refinement)

Figure 2-20: Waste Rock Dump(s) Layout Alternatives

Tailings Storage Facility (TSF)

Three broad locations were initially considered in respect of the surface placement of the proposed tailings storage facility (Figure 2-21). SRK Consulting were commissioned to the EIA project team to, *inter alia*, conduct a TSF site selection process to inform the EIA process (refer to Appendix 5.16: Volspruit Tailings Storage Facility Assessment Report for a copy of the detailed assessment).

In determining the most suitable position for the TSF, the site selection study took cognisance of –

- The distance to, and elevation of, the processing plant relative to the identified alternatives;
- The proximity of the alternative sites to communities, villages and existing infrastructure;
- The current and uses of the alternative sites;
- The proximity of the sites to sensitive environmental features;
- Local Topography; and
- Mineralisation.

Following desktop surveys and site visits by SRK, a site ranking matrix was developed that aimed to broadly rank the suitability of the respective alternatives according to –

- Environmental risks -
    - Interference with potential land use;
    - Loss of previously undisturbed land;
    - Risk of groundwater contamination;
    - Impacts on surface water catchment regimes;
    - Visual Impact;
    - Potential for airborne release;
    - Proximity to residential / developed areas (dust); and
    - Road safety
- Public acceptance criteria -
    - Displacement of local inhabitants;
    - Visibility of the site;
    - Wind direction relative to receptors; and
    - Distance to nearest residential area.
- Economic and Engineering criteria –
    - Seepage potential;
    - Distance from plant;
    - Impact of possible flow failures;
    - Undermining;
    - Slurry delivery line;
    - Capital costs;
    - Operating costs; and
    - Rehabilitation costs.

During the ranking process (a largely qualitative assessment), the sites were evaluated as unique situations in the current receiving environment of the site. Each site was considered and ranked according to the same set of criteria (detailed above) and local prevailing conditions. The ranking of each site, determined from the ranking criteria, for a specific site was multiplied by a weighting factor to obtain a weighted ranking for each site; where a weighting factor was applied to give more emphasis to the consideration of environmental aspects, over the financial constraints of each site.

The assessment concluded that site 2 was most favourable from a purely environmental risk perspective. In terms of public acceptance criteria, the alternatives all scored similarly. In terms of economic and engineering risk criteria alone, site 1 was ranked as the most favourable site. The combined, weighted ranking, of the alternatives sites (i.e. considering all assessment criteria) showed site 1 to ultimately be the most favourable site. Further refinements to the footprint of the site 1 alternative were also then considered; with the aim of keeping the TSF footprint outside of, and north of, a section of identified 'Hills Woodland' that extends from east to west through alternative 'TSF 1'. This led to the development of alternative 'TSF 1 B' (Figure 2-21), which is deemed to afford a greater degree of protection of onsite sensitive ecological features, as well as a greater degree of continuity between the above mentioned Hills Woodland and that which extends eastward from the south pit. The 'Hills Woodland' on the site was identified as having a greater ecological sensitivity than that of the surrounding vegetation units.

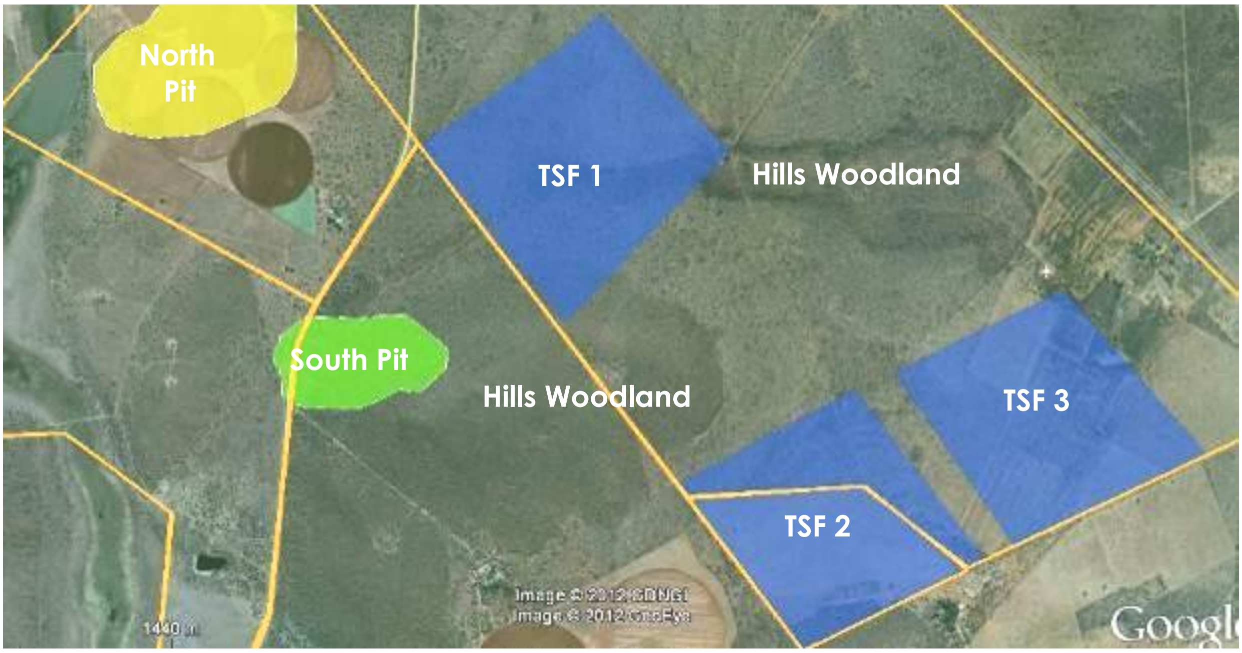
The potential impact significance of Alternative 'TSF 1 B' is evaluated in Chapter 8 hereto as the 'preferred' alternative, with alternatives 'TSF 2' and 'TSF 3' having been eliminated for further assessment by virtue of the site selection process detailed in this section.

Plant Site Alternatives

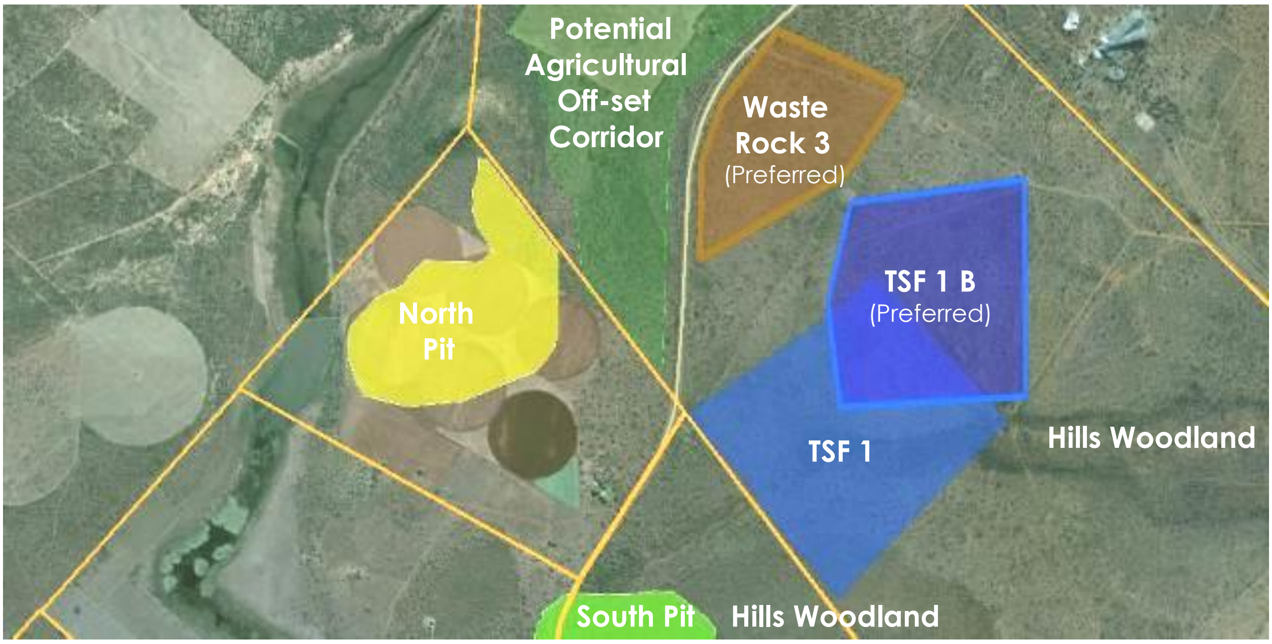
Two (2) areas were identified during the Scoping phase as potentially feasible alternatives for the placement of the processing plant, smelter and CVMR Plant (collectively called the 'plant site'). These areas were (Figure 2-22):

1. East of the Singlewood Road, in the northern corner of Portion 2 of the Farm Volspruit; and
2. West of the Singlewood road, on Portion 1 of the Farm Volspruit.

These two areas have been preliminarily identified due to their proximity to the north and south pits, which makes the transport of ore economical. The potential impact significance of both these alternatives is discussed and evaluated in Chapter 8 to follow, with alternative 1 being the preferred alternative.



Initial alternatives considered for placement of the TSF



Preferred TSF placement (TSF 1), as well as final refinement thereof (i.e. TSF 1 B preferred)

Figure 2-21: Tailings Storage Facility (TSF) Layout Alternatives

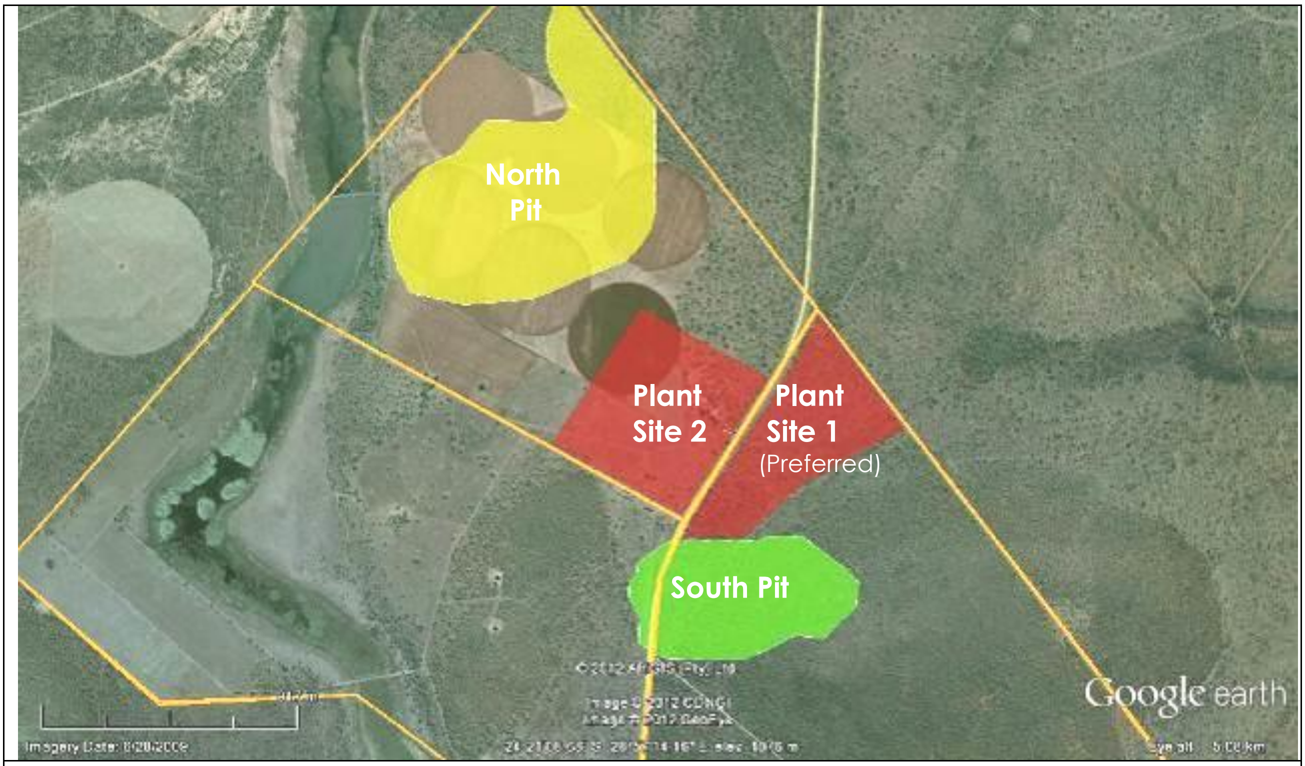


Figure 2-22: Plant Site Layout Alternatives

2.9.5 TECHNOLOGY ALTERNATIVES FOR SULPHUR FIXATION (ROASTER OFF-GAS)

More than 95% of the sulphur contained in the smelter feed concentrate will report in the roaster off-gas as sulphur dioxide (SO_2). Environmental legislation [i.e. the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)[NEM:AQA)] requires that the sulphur dioxide emissions must be reduced to less than 1,200 mg/Nm^3 (or as otherwise may be directed by any atmospheric emission licence (AEL) issued to the proponent) before the roaster off-gas can be discharged to the atmosphere.

Different gas cleaning technologies have been investigated for sulphur dioxide abatement from the roaster off-gas in this regard, and these include:

- Lime scrubbing/gypsum production;
- Sulphuric acid production; and
- Sulphur Dioxide production.

Capital and operational costs will typically be the determining factors for selecting a specific gas cleaning technology over another, provided that the technologies being considered are all capable of achieving the 'allowable' emission limits for any related 'scheduled' activities. The Operational costs will mainly be influenced by the marketability of any end product from gas cleaning, and/or the disposal requirements for any abatement residues/wastes generated through gas cleaning. It is further important to consider the availability of resources and reagents used in these respective processes.

Lime scrubbing / gypsum production

The form of sulphur fixation plant would typically be a limestone scrubbing plant, which will produce a gypsum waste that will be temporarily stored onsite prior to removal for disposal to a licenced landfill site (approximately 13m^3/hour would be generated from the proposed project, with 50% wt. $CaSO_4$ content).

Almost all commercial SO_2 scrubbing processes are based on the fact that SO_2 is acidic in nature, and remove the SO_2 from flue gases by reaction with a suitable alkaline substance. The most commonly used alkaline materials are limestone (calcium carbonate), quicklime (calcium oxide, CaO) and hydrated lime (calcium hydroxide).

Limestone is an abundant and therefore relatively cheap material and both quicklime and hydrated lime are produced from limestone by heating. The reaction taking place in wet scrubbing using a $CaCO_3$ (limestone) slurry, for example, produces variable volumes of $CaSO_3$ (calcium sulfite) and gypsum ($CaSO_4$), and can be expressed as:

$$CaCO_3 \text{ (solid)} + SO_2 \text{ (gas)} \rightarrow \underline{CaSO_3 \text{ (solid waste)}} + CO_2 \text{ (gas)}$$

Oxygen can be blown into the scrubber to aid the conversion of calcium sulphite ($CaSO_3$) to calcium sulphate ($CaSO_4$), or gypsum. The advantages and disadvantages of this type of system include (Table 2-15):

Advantages:

- Proven technology with numerous references worldwide;
- High SO_2 removal efficiencies (99%);
- Low capital costs relative to other technologies;
- High reliability; and
- Easy to operate and maintain.

Disadvantages:

- Disposal requirements for gypsum waste (cost? airspace availability?); and
- Energy intensive technology with resultant increase operational costs in an economy where electricity process are predicted to increase and where availability is unstable.

Sulphuric Acid Production Plant

The technology considered by the proponent is a catalytic process which recovers sulphur dioxide gases and other sulphur-containing gases to ultimately produce a concentrated sulphuric acid of commercial grade without addition of chemicals, or adsorbents, and without formation of any other incidental waste products.

Feed gas conditioning includes heating and mixing with recycled hot gas to prevent condensation in the blower. The SO_2 is oxidized to SO_3 in an exothermal reaction during three catalytic conversion stages. The heat of reaction is used for pre-heating of the feed gas. The SO_3 containing gas is then cooled in a heat exchanger followed by condensation in a condenser during which the SO_3 is hydrated and sulphuric acid is formed. The advantages and disadvantages of this type of system include (Table 2-15):

Advantages:

- More than 99% of the total sulphur content is recovered as commercial grade, saleable, sulphuric acid;
- Low electricity consumption relative to other technologies;
- Low cooling water consumption relative to other technologies;
- Lower operating costs than other technologies;
- Simple and flexible process with a high turn down ratio;
- Small plant footprint;
- References for the technology in various industries; and
- Steam production which can be used elsewhere in the plant as a heat source for further energy savings.

Disadvantages:

- Higher capital costs than other technologies; and
- Spent catalyst needs replacement every 8-10 years.

Sulphur Dioxide Production Plant

The technology considered uses an aqueous amine solution to achieve highly selective absorption of sulphur dioxide from a gas stream through scrubbing. The end product of which is a water saturated SO_2 gas. The subject technology broadly includes i) an SO_2 Absorber, ii) an SO_2 Stripper Tower and ii) an Amine Purification Unit (APU).

The roaster off-gas must first be quenched (water saturated), and then solids and strong acids must be removed. Quenching to saturation ensures proper SO_2 absorption and prevents excessive water evaporation from the amine solution in the SO_2 Absorber Tower.

The advantages and disadvantages of the system, relative to the other technologies under consideration, are as follows (Table 2-15):

Advantages:

- Elimination of high cost consumable reagents and associated transportation costs;
- Reduced capital costs due to its high capacity and selectivity; and
- Minimal waste/effluents from the process relative to lime scrubbing technologies.

Disadvantages:

- The technology is relatively new/novel;
- Sodium sulphate waste effluent is generated that requires environmentally sound management (cost?);
- Operating costs are higher than those of the sulphuric acid production technology; and

- Reagents and steam required to drive the process.

Summary

As a result of the high limestone consumption, subsequent gypsum disposal costs and electrical power costs, the Limestone Scrubbing technology is only feasible if a short-term approach to on-going operational expenditure is taken and the Capex 'benefit' of R 18 – 48 million taken as the basis for a decision to implement limestone scrubbing. For the longer term, as well as the benefit of potential revenue, and provided the product can be sold, from Sulphuric Acid production or Liquid Sulphur Dioxide production provides the most cost effective solution for sulphur fixation (Table 2-15).

Table 2-15: Tabular Summary of Selection Criteria for Sulphur Fixation Technologies

Item	Description	Lime Scrubbing / Gypsum Production	Sulphuric Acid Production	Sulphur Dioxide Production
1	Capital Expenditure	R174 million	R222 million	R192 million
2	Potential Revenue (R/ton of concentrate processed)	-	R157 / t concentrate (H_2SO_4)	R26 – R100 / t concentrate (SO_2)
3	Operational Costs (R/ton of concentrate processed)	R1, 003 / t concentrate	R496 / t concentrate	R611 / t concentrate
4	Effluent Generated	Gypsum Filter Cake (25t/h)	Spent catalyst (replacement every 8 to 10 years)	Na_2SO_4 effluent (1.4m3/h) Weak acid from quench
5	Reagents Consumed	Limestone (8t/h)	-	• Amine (2t/yr) • NaOH (5kg/h) • Steam (3.5t/h)
6	Water Consumption	16 m^3/h	4 m^3/h	32 m^3/h
7	Power Consumption	1, 650kW	330kW	550kW
8	Sulphur Capture Efficiency	99%	99%	99%

The proponent's implementation of a 'sulphuric acid production' or 'liquid sulphur dioxide' sulphur-fixation plant would ultimately need to ensure that the regulatory emission limits set for the roaster off-gas stream, in respect of the stack emissions for subcategory 4.16 of Section 21 to the NEM:AQA, are met (refer Section 3.4.2 for actual limits and applicable processes); where Sub-category 4.16 refers, and relates to the "smelting and converting of sulphide ores" (i.e. processes in which sulphide ores are smelted, roasted, calcined or converted).

The air dispersion modelling undertaken by ESA as part of the air quality impact assessment for the proposed project used the aforementioned emission limits to set the maximum tolerable contaminant output from the subject stacks (i.e. the modelling exercise assumes the proponent's compliance with all such regulated stack emission limits for any scheduled activities applicable to the proponent's activities – Section 3.4.2 refers). The said modelling showed there to be no reasonable cause for concern around the project resulting in exceedences of ambient air quality limits. The modelling was, however, undertaken with the assumption that a limestone scrubber would be installed to abate SO_2 concentrations in the roaster off-gas to below 1, 200mg/Nm^3 before being released to the atmosphere.

For the validity of the existing air quality modelling results (which show there to be no exceedences of ambient air quality limits, provided that the relevant stack emission limits are met) to hold true to the preferred installation of a sulphuric acid production- or liquids sulphur dioxide plant (in favour of the lime scrubber that was modelled), the proponent and technology supplier would need to be able to meet the following technical specifications (i.e. as was modelled for the lime scrubber) –

- Roaster off-gas stack exit temperature of ≥ 80° c;
- Stack height of 45m; and
- Stack gas exit velocity either greater, or equal to, that modelled for the lime scrubber.

Important to note is that although the '*primary production of acids*' is specifically listed under sub-category 7.2 of Section 21 to the NEM:AQA as a scheduled process, with its own set of emission limits for related criteria pollutants, that the listing specifically excludes those activities '*producing sulphuric acid as part of the recovery of metals from* ore' (which is the case in the context of the proponent establishing a sulphuric acid plant to abate SO_2 emissions in the roaster off-gas).

The installation of a sulphuric acid production plant is deemed as the EAP's preferred alternative for sulphur fixation relevant to the roaster off-gas generated from the smelter complex, for the reasons stated previously, and highlighted in Table 2-15. The EIA process would typically aim to provide the proponent with flexibility around the implementation of abatement technologies, provided that it can be demonstrated that the said technology(ies) can achieve the relevant stack emission limits for the related scheduled process. If the abatement technology, however, results in the generation of significant waste residues (by volume, or hazardousness) and effluents that can potentially result in significant indirect impacts on the environment, one needs to look beyond the pure emission abatement capabilities thereof.

It is for this reason that the sulphuric acid production plant is deemed as the EAP's preferred alternative for sulphur fixation, and is evaluated against the lime scrubbing alternative, in terms of their relative impact significance, in Section 8 to follow.

2.9.6 END LAND-USE ALTERNATIVES

The objectives and alternatives for end land-use following opencast mining are somewhat limited when compared, for example, to strip mining (Fugle and Rabie, 2010). The nature of opencast pit mining does not typically allow for the back-fill of the mine pits, such that any alternative terrestrial land-uses are not normally available for consideration.

The end land-use proposed by the proponent for the Volspruit mine site, is thus to have the pits fill with water once mined, and to establish/continue a combination of conservation, agricultural and limited recreational uses around the 'lakes' to be created. There are not deemed to be any reasonable, or feasible, alternatives to the proponent's proposal. This is largely due the reasons mentioned previously, as well as the relative location of the site in its present day rural/agricultural setting. No residential or commercial land-uses are considered feasible by virtue of the removed location of the site relative to Mokopane and the bulk service infrastructure already in place in the town (i.e. limitations of 'urban sprawl').

The proponent's preferred land-use is deemed most fitting in respect of the land-use character of the 'unaffected' portions of the farms Volspruit and Zoetveld, as well as the surrounding farms. The farming of the irrigated croplands to be established during the life of the mine (Figure 2-21) would continue, with the remaining green-fields areas and areas to be rehabilitated on the site, to be used for a combination of game farming / cattle grazing.

2.9.7 NO-GO ALTERNATIVE

The no-go option refers to the alternative of the proposed mine not going ahead at all. This alternative will avoid potentially positive and negative impacts on the environment and the *status quo* of the area would remain intact. The implications of the no-go option are evaluated intrinsically as part of the EIA, focussing on comparing potential impacts from the proposed project with the *status quo* and will be particularly relevant should it be found that detrimental impacts cannot be managed to an acceptable level.

3. LEGAL REQUIREMENTS

3.1 EIA AND ENVIRONMENTAL AUTHORISATION

3.1.1 NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT 107 OF 1998)[NEMA]

NEMA is South Africa's overarching environmental legislation, and contains a comprehensive legal framework to give effect to the environmental rights contained in section 24 of The Constitution. Section 2 of NEMA contains environmental principles that form the legal foundation for sustainable environmental management in South Africa. NEMA introduces the principle of integrated environmental management that is achieved through the environmental assessment process in section 24, which stipulates that certain identified activities may not commence without an Environmental Authorisation from the competent authority, in this case LEDET and DEA. Section 24(1) of NEMA requires applicants to consider, investigate, assess and report the potential environmental impact of these activities. The requirements for the investigation, assessment and communication of potential environmental impacts are contained in the so-called 2010 amendment EIA Regulations (GN R.543, R.544, R.545 and R.546; 18 June 2010).

Based on the potential significance of impacts, the Regulations identify specific activities that are either subject to a Basic Assessment process, or more comprehensive scoping and EIA process. The proposed Volspruit mine project includes several activities that require a scoping and EIA, but some others only require a Basic Assessment. All activities are however included in the scoping and EIA assessment (i.e. a single application procedure).

The activities that would be (or are likely to be) associated with the proposed Volspruit mine are listed below. It should be noted that the two lists below are comprehensive, but some of the activities may eventually not proceed.

Table 3-1: Listed activities applied for in terms of the NEMA 2010 EIA Regulations

Listing	Activity number	Description of each listed activity
GN R.544 of 18 June 2010 - Listing Notice 1	9	The construction of facilities or infrastructure exceeding 1 000 metres in length for the bulk transportation of water, sewage or storm water - (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more, excluding where: a) such facilities or infrastructure are for bulk transportation of water, sewage or storm water or storm water drainage inside a road reserve; or b) where such construction will occur within urban areas but further than 32 metres from a watercourse, measured from the edge of the watercourse. <u>REASON</u>: TSF Return water piping to processing plant. Storm water trenches from site structures (e.g. Waste Rock Dump) draining to an affected storm water dam.
GN R.544 of 18 June 2010 - Listing	10	The construction of facilities or infrastructure for the transmission and distribution of electricity -

Table 3-1: Listed activities applied for in terms of the NEMA 2010 EIA Regulations		
Listing	**Activity number**	**Description of each listed activity**
Notice 1		(i) outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts; or (ii) inside urban areas or industrial complexes with a capacity of 275 kilovolts or more. <u>REASON</u>: Electricity of between 33 and 275 KV will be transmitted within the mining area and is applied for.
GN R.544 of 18 June 2010 - Listing Notice 1	11	The construction of: (i) canals; (ii) channels; (iii) bridges; (iv) dams; (v) weirs; (vi) bulk storm water outlet structures; (vii) marinas; (viii) jetties exceeding 50 square metres in size; (ix) slipways exceeding 50 square metres in size; (x) buildings exceeding 50 square metres in size; or (xi) <u>infrastructure or structures covering 50 square metres or more</u> where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line. <u>REASON:</u> The mining of the north pit necessitates the construction of a flood diversion berm and pit access road on the outer edge thereof adjacent to, and within 32m of, the Nyl River.
GN R.544 of 18 June 2010 - Listing Notice 1	12	The construction of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50 000 cubic metres or more, unless such storage falls within the ambit of activity 19 of Notice 545 of 2010; <u>REASON:</u> The development and operation of the proposed mine will require the construction of *inter alia* return water-, pollution control- and potable water storage dams, as well as reservoirs, in excess of the 50 000cubic metre threshold.
GN R.544 of 18 June 2010 - Listing Notice 1	13	The construction of facilities or infrastructure for the storage, or for the storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of 80 but not exceeding 500 cubic metres.

Table 3-1: Listed activities applied for in terms of the NEMA 2010 EIA Regulations		
Listing	**Activity number**	**Description of each listed activity**
		REASON: The combined requirements for the storage of hazardous goods on the mine (during the operational phase) will exceed the 80 cubic metre threshold ([.e. diesel, oil, oxygen, reagents, and possibly sulphuric acid (to potentially be produced through roaster off-gas sulphur fixation)].
GN R.544 of 18 June 2010 - Listing Notice 1	20	Any activity requiring a mining permit in terms of section 27 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) or renewal thereof. REASON: A mining license application has been lodged by the proponent with the Department of Mineral Resources (DMR) for the proposed mining activities. This specific listed activity has, however, not yet been enacted under the NEMA EIA Regulations.
GN R.544 of 18 June 2010 - Listing Notice 1	22	The construction of a road, outside urban areas, (i) with a reserve wider than 13,5 metres or, (ii) where no reserve exists where the road is wider than 8 metres, or (iii) for which an environmental authorization was obtained for the route determination in terms of activity 5 in Government Notice 387 of 2006 or activity 18 in Notice 545 of 2010. REASON: Although existing roads will be used to the greatest extent practical/feasible, the development and subsequent operation of the mine requires the establishment of new pit access and other haul roads. These roads will need to be wider than 8m in width to accommodate passing heavy motor vehicles associated with the mining activities.
GN R.544 of 18 June 2010 - Listing Notice 1	23	The transformation of undeveloped, vacant or derelict land to – (i) residential, retail, commercial, recreational, industrial or institutional use, inside an urban area, and where the total area to be transformed is 5 hectares or more, but less than 20 hectares, or (ii) residential, retail, commercial, recreational, industrial or institutional use, outside an urban area and where the total area to be transformed is bigger than 1 hectare but less than 20 hectares; - except where such transformation takes place, (i) for linear activities; or (ii) for the purposes of agriculture or afforestation, in which case Activity 16 of Notice No. R 545 applies.

Table 3-1: Listed activities applied for in terms of the NEMA 2010 EIA Regulations		
Listing	**Activity number**	**Description of each listed activity**
		REASON: The mine will cause transformation of undeveloped land, to full-scale mining operations of greater than 20 Ha in extent.
GN R.544 of 18 June 2010 - Listing Notice 1	24	The transformation of land bigger than 1 000 square metres in size, to residential, retail, commercial, industrial or institutional use, where, at the time of the coming into effect of this Schedule such land was zoned open space, conservation or had an equivalent zoning. REASON: The site in question is listed as being a 'private nature reserve'.
GN R.544 of 18 June 2010 - Listing Notice 1	47	The widening of a road by more than 6 metres, or the lengthening of a road by more than 1 kilometre - (i) where the existing reserve is wider than 13,5 metres; or (ii) where no reserve exists, where the existing road is wider than 8 metres, excluding widening or lengthening occurring inside urban areas. REASON: Existing farm roads will be utilised by the proponent to the greatest extent practical/feasible, but will require widening in such instances to accommodate passing heavy motor vehicles associated with the proposed mining activities.
GN R.545 of 18 June 2010. Listing Notice 2.	3	The construction of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of more than 500 cubic metres. REASON: Potential sulphuric acid storage in excess of the threshold.
GN R.545 of 18 June 2010. Listing Notice 2.	5	The construction of facilities or infrastructure for any process or activity which requires a permit or license in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent and which is not identified in Notice No. 544 of 2010 or included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case that Act will apply. REASON: Part of the proposed project entails the establishment of a smelter (including a roaster) and CVMR Plant, both of which are scheduled process under the NEM:AQA and require an atmospheric emission licence (AEL). Return water dam and pollution control dam will require a water use licence, in terms of Section

Table 3-1: Listed activities applied for in terms of the NEMA 2010 EIA Regulations		
Listing	**Activity number**	**Description of each listed activity**
		21 (g) of the Water Act.
GN R.545 of 18 June 2010. Listing Notice 2.	15	Physical alteration of undeveloped, vacant or derelict land for residential, retail, commercial, recreational, industrial or institutional use where the total area to be transformed is 20 hectares or more; except where such physical alteration takes place for: (i) linear development activities; or (ii) agriculture or afforestation where activity 16 in this Schedule will apply. REASON: The proposed establishment of the mine and associated beneficiation activities will physically alter in excess of 20ha of undeveloped (green-fields) land.
GN R.545 of 18 June 2010. Listing Notice 2.	19	The construction of a dam, where the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, is 5 metres or higher or where the high-water mark of the dam covers an area of 10 hectares or more. REASON: The mine requires the establishment of a return water dam, as well as a pollution control dam, with a dam wall height exceeding the 5m threshold and a footprint in excess of 15ha.
GN R.545 of 18 June 2010. Listing Notice 2.	20	Any activity which requires a mining right or renewal thereof as contemplated in sections 22 and 24 respectively of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002). REASON: A mining license application has been lodged by the proponent with the Department of Mineral Resources (DMR) for the proposed mining activities. This specific listed activity has, however, not yet been enacted under the NEMA EIA Regulations.
GN R.545 of 18 June 2010. Listing Notice 2	26	Commencing of an activity, which requires an atmospheric emission licence in terms of section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), except where Activity 28 in Notice No. R. 544 of 2010 applies. REASON: Part of the proposed project entails the establishment of a smelter (including a roaster) and CVMR Plant, both of which are scheduled process under the NEM:AQA and require an atmospheric emission licence (AEL).

The process of applying for Environmental Authorisation includes a requirement to conduct an initial scoping phase, followed by a detailed EIA as part of the application process. The assessment process (Figure 3-1) is comprehensive and detailed where appropriate, aimed at identifying potential positive and negative impacts on the environment (biophysical, socio-economic and cultural), in order to:

- Examine alternatives/management measures to minimise negative and optimise positive consequences;
- Prevent substantial detrimental impact to the environment;
- Improve the environmental design of the proposal;
- Ensure that resources are used efficiently; and
- Identify appropriate management measures for mitigation and the monitoring thereof.

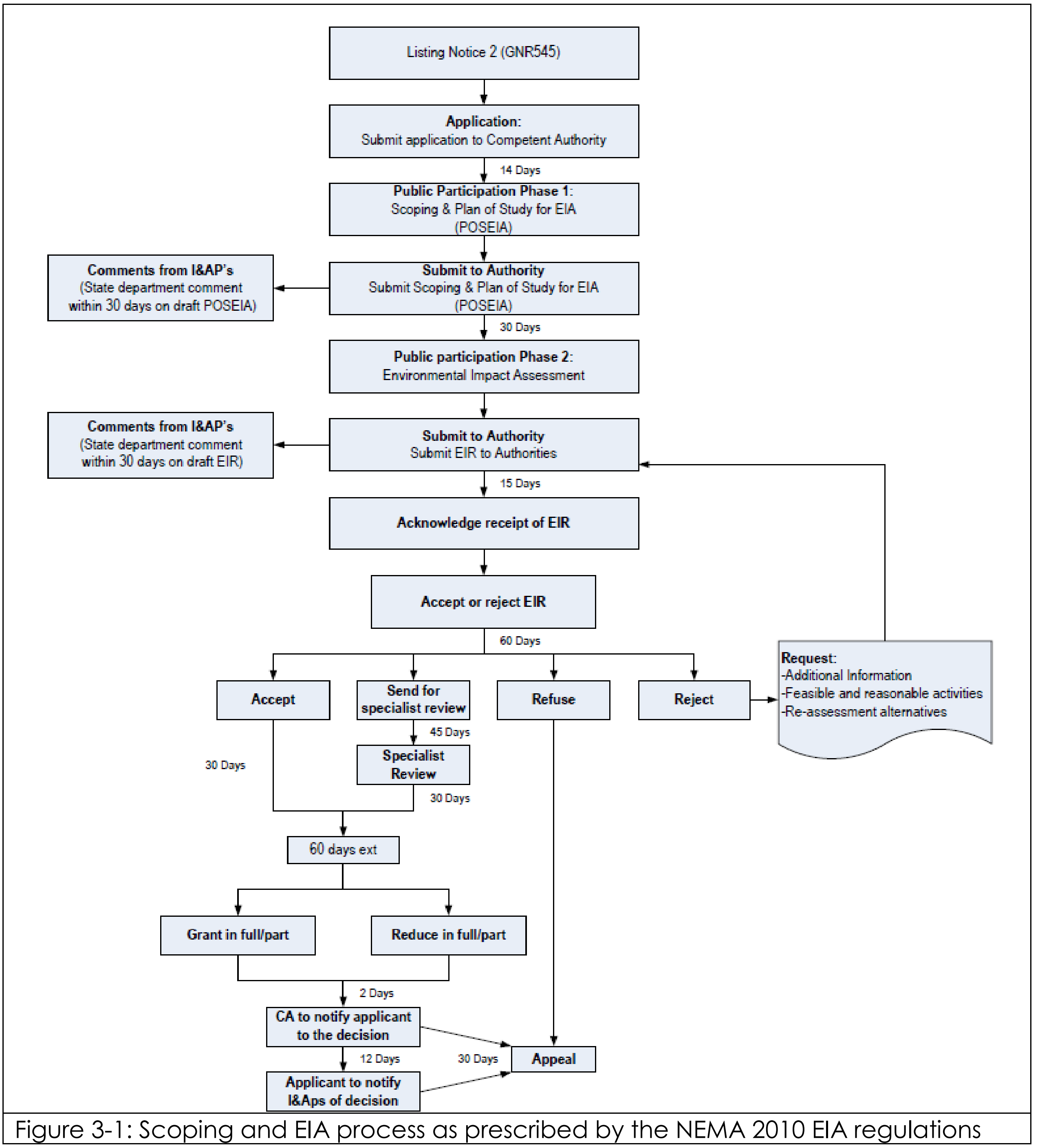


Figure 3-1: Scoping and EIA process as prescribed by the NEMA 2010 EIA regulations

3.1.2 DUTY OF CARE – SECTION 28 OF NEMA

The National Environmental Management Act, Act 107 of 1998, (NEMA) places a duty to care on all persons who may cause significant pollution or degradation of the environment. Specifically, section 28 of the Act states:

"28 (1) Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

(2) Without limiting the generality of the duty in subsection (1), the persons on whom subsection (1) imposes an obligation to take reasonable measures, include an owner of land or premises, a person in control of land or premises or a person who has a right to use the land or premises on which or in which-

- *(a) any activity or process is or was performed or undertaken; or*
- *(b) any other situation exists, which causes, has caused or is likely to cause significant pollution or degradation of the environment.*

(3) The measures required in terms of subsection (1) may include measures to-

- *(a) investigate, assess and evaluate the impact on the environment;*
- *(b) inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;*
- *(c) cease, modify or control any act, activity or process causing the pollution or degradation;*
- *(d) contain or prevent the movement of pollutants or the causant of degradation;*
- *(e) eliminate any source of the pollution or degradation; or*
- *(f) remedy the effects of the pollution or degradation."*

In the context of a mining operation (including Volspruit mine), it is generally expected that there is the potential for negative impacts on ground- and surface water resources. The significance of such impacts is dependent on:

- the nature, duration, extent and frequency of the source and its physical and chemical characteristics;
- the topographical and climatological nature of the area in which the impact is situated; and
- the sensitivity of the receiving environment.

Consequently, in the context of this assessment, the owner/operator of the mine must take "reasonable steps" to prevent pollution or degradation of the environment which may result from the proposed mining and related activity. These reasonable steps include the investigation and evaluation of the potential impact and identification of means to prevent an unacceptable impact on the environment and to contain or minimise potential impacts where they cannot be eliminated.

3.1.3 LIMPOPO ENVIRONMENTAL MANAGEMENT ACT (ACT 7 OF 2004)[LEMA]

The aim of the Limpopo Environmental Management Act, 2004 (Act No. 7 of 2004)[LEMA] is to: "*consolidate and amend the environmental management legislation of or assigned to the Province; and provide for matters incidental thereto*". Although NEMA still remains the overarching legislation governing environmental management in South Africa, there are certain provisions in LEMA which have been taken into consideration during the compilation of the EIA.

The LEMA does not, however, define any specific issues that would potentially emerge as a result of the proposed mine development. The proposed mine will be more stringently regulated under national legislation (i.e. NEMA and the associated NEMA EIA Regulations).

3.1.4 MINERALS AND PETROLEUM RESOURCES DEVELOPMENT ACT (MPRDA)

The MPRDA of 2002 replaced the Minerals Act and raises the bar on the management of finite resources in the context of a country with gross imbalances in skills, wealth and access to mineral resources. The most important concept in the MPRDA is that the mineral resources of the country belong to the people of South Africa and that the state aims to regulate all aspects of mining with that concept in mind.

The main aims and principles of the MPRDA include:

- recognition of the finite nature of mineral and petroleum resources;
- ownership of mineral and petroleum resources is by the nation;
- the government is the custodian of the mineral and petroleum resources;
- promotion of sustainable development and protection of the environment;
- social upliftment through Social Development and Labour Plans (SDLP);
- promotion of black economic empowerment (BEE);
- guaranteeing security of tenure, to enable long term planning and investment; and
- creation of an internationally competitive and efficient regulatory system.

Section 38 of the MPRDA outlines the following integrated environmental management (IEM) requirements:

- comply with the IEM requirements of NEMA, namely s23-24 dealing with EIA;
- integrate environmental management into day- to-day mine operations;
- comply with the polluter pays principle and take responsibility for any environmental damage or pollution; and
- rehabilitate impacted areas to natural or agreed standards, in line with sustainable development principles.

According to section 39 of the MPRDA, every applicant for a mining right must conduct an EIA that results in the submission of an environmental management programme (EMPR). This approval process requires an EIA process leading toward the compilation of a detailed EMPR. The Mineral and Petroleum Resources Development Regulations (GNR527) of 2004 outline further details of the EIA and EMPR:

- s49: contents of scoping reports;
- s50: contents of EIA reports;
- s51: EMPR;
- s52: EMP;
- s53: methods for calculating financial provision;
- s54: quantum of financial provision;
- s55: monitoring and performance of EMPs and EMPRs;
- s56: principles for mine closure;
- s57: application for closure certificate;
- s58: application to transfer environmental liabilities to competent person;
- s59: qualifications of person regarding transfer of environmental liabilities and responsibilities;
- s60: environmental risk report;

- s61: closure objectives; and
- s62: contents of closure plan.

The MPRDA and NEMA processes for application the submission of reports and authority review timeframes are slightly different, and as such the two process need to be streamlined in order to not let one process fall behind the other. The interrelationship between the two processes is very important and the flow diagram in Figure 3-2 indicates this relationship and the links in the process.

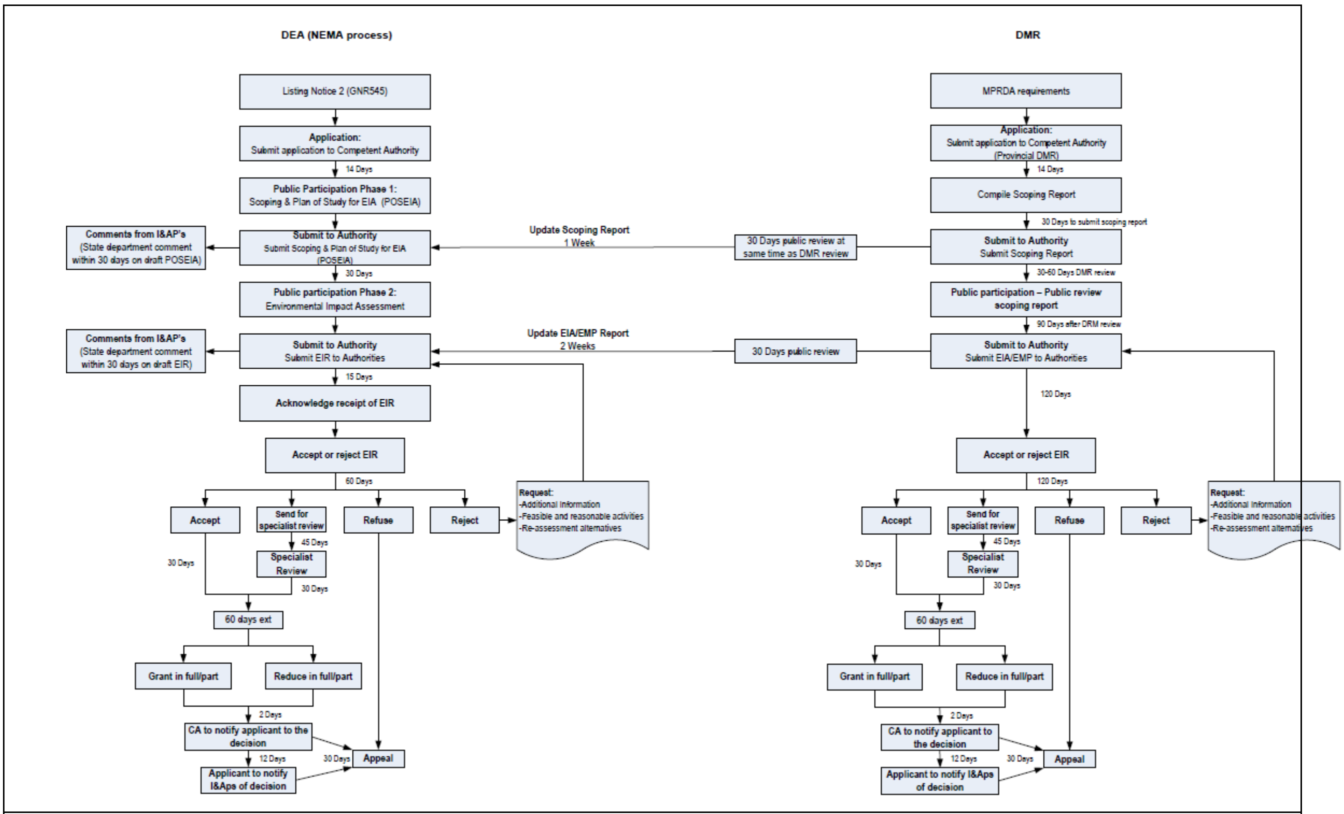


Figure 3-2: Relationship between the NEMA and MPRDA authorization process

3.1.5 MPRDA REQUIREMENTS FOR AN EMPR

The key requirements of an EMPR, according to provisions in the Act and the Regulations, are:

- baseline information for the affected environment;
- the environmental objectives, both for operation and closure;
- a quantification of environmental impacts;
- an implementation programme that includes:
  - technological options;
  - management systems;
  - action plans with time schedules;
  - emergency response plans;
  - monitoring and evaluation;
  - an environmental awareness plan aimed at informing employees; and
  - pollution/waste prevention, reduction and remediation.

The compilation of a detailed EMPR would be required to at least fulfil the above requirements. The EIA process required to inform the development of the EMPR, in terms of the MPRDA, can be undertaken in parallel with the EIA process required for the Volspruit mine project in terms of NEMA (application for authorisation to the Limpopo Department of Economic Development, Environment and Tourism, as well as the application for a waste management licence to the Department of Environmental Affairs). The parallel process does, however, need to fulfil the requirements of both Acts.

Financial Provision

The MPRDA has the following to say regarding financial provisions for mine closure:

- an applicant submitting an EMP/EMPR must make the prescribed financial provision prior to approval of the EMP/EMPR;
- the Minister may use the financial provision to undertake rehabilitation or management on behalf of the holder of an EMP/EMPR, should they fail to do so adequately themselves;
- the financial provision must be assessed and adjusted appropriately annually; and
- should urgent action be required, or the financial provision be inadequate, the Minister may recover costs.

The mine's closure/rehabilitation liability has been assessed accordingly (whether at the end of life of the mine or premature/unforeseen mine closure). This estimate of the quantum has been included in the EMPr attached hereto.

The financial provision may take the form of one of the following:

- a trust fund;
- a financial guarantee from a registered South African bank; and
- a deposit into an account specified by the DME.

The value of the financial provision must be based on the commitments made in the EMP(R) and be valid for:

- early closure of the mine;
- rehabilitation of the mine surface area to as close to pre-mining conditions;
- prevention and management of air pollution;
- prevention and management of soil, water and groundwater pollution;
- prevention of migration of water and minerals from underground to the surface;
- decommissioning and final closure; and
- Post-closure management of residual and latent environmental impacts.

3.1.6 WATERBERG DISTRICT MUNICIPALITY ENVIRONMENTAL MANAGEMENT FRAMEWORK (EMF)

In 2010, DEA, LEDET and the Waterberg District Municipality (WDM) commissioned the compilation of an EMF for the WDM. The report was compiled by NRM Consulting, with inputs from various other consultancies.

As sourced from the EMF document, it describes the following:

*"The Environmental Management Framework (EMF) is an initiative of the national Department of Environmental Affairs (DEA) in partnership with the Limpopo Department of Economic Development, Environment and Tourism (LEDET), and the Waterberg District Municipality (WDM). The EMF will support decision-making in the Waterberg District Municipality area in order to facilitate appropriate and sustainable development. The EMF integrates policies and frameworks and aligns government mandates to streamline decision-making and to improve cooperative governance. (*Waterberg EMF, 2010*)".*

The overall compilation of an EMF involves three (3) reports, namely, a *status quo* report (which described the current *status quo* for the WDM), a desired state report (which outlines what the "desired" state of the WDM should be), and then the main report, the EMF, which essentially outlines and describes how to get from the "*status quo*" to the "desired state".

After the collation of all information, the EMF in effect described eleven (11) Environmental Management Zones (EMZ) – which are detailed in Figure 3-3 to follow. Initially the EMZ's for the Waterberg District EMF were determined through the careful evaluation of the *status quo* inputs and especially the environmental sensitivity and other priority needs in the area as described in the previous section of the report *(*Waterberg EMF, 2010*)*.

There is a section of the main EMF document which provides a short description of each EMZ, a description of the desired state of each EMZ (taken from the Desired State Report) as well as an indication of preferred activities, compatible activities and undesired activities (as required in the EMF Regulations, 2010).

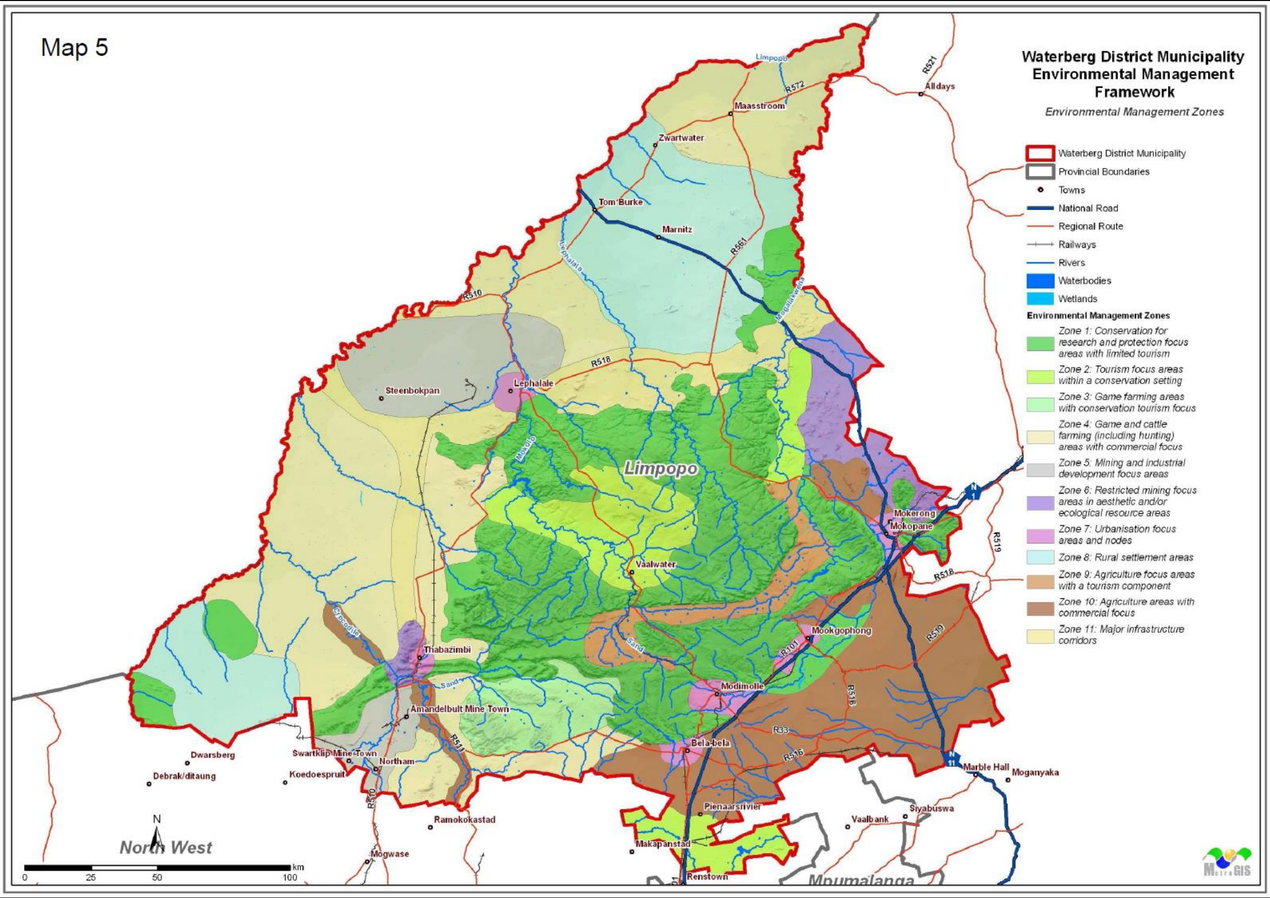


Figure 3-3: WDM Environmental Management Zones (Metro GIS, 2010)

The farms on which the proposed Volspruit Mine fall (i.e. the Farms Volspruit and Zoetveld) are located in Zones one 1 and 10. The EMF describes Zone 1 as an area where "*Protection of natural vegetation, scenic landscape and rock painting areas, with limited appropriate tourism"* should exist, and Zone 10 as: "*Agriculture areas with commercial focus*".

The EMF goes further to list "undesirable activities" for each zone, as described above, where mining is listed as an "undesirable activity" in both Zone 1 and Zone 10. However, the EMF does describe the following, when discussing undesirable activities: "*It does not* *however mean that undesired activities for example will not be allowed under any circumstances but rather that such activities will have to meet very high standards and be considered very carefully by the relevant competent authorities before they are allowed*" (Chapter 5, page 75 of the EMF, 2010).

The listing of certain activities as "undesirable activities" in a specific zone does not necessarily exclude those activities in totality. It is however a signal to both proponent as well as competent authorities that rigorous EIA and specialist studies will be required to confirm the initial screening assessment of the EMF as being "undesirable". Furthermore, where such a proposed mine to proceed the EMF again is therefore important that this proposed mine will need to meet "very high standards" and will have to be considered carefully by the relevant competent authority. In this respect, the EIA will aim to define and properly determine what these high standards would be and make management and mitigation suggestions accordingly. The aforementioned was confirmed in correspondence between the Minister of Water and Environmental Affairs and the proponent (Appendix 1: Authority Correspondence and Comments).

The EAP has engaged constructively with the LEDET on this very aspect and it was the advice of LEDET decisions were made to continue with the EIA in order to allow information to be provided so as to allow informed and defensible decisions based on the scientific studies undertaken. It was indicated by LEDET that:

- The outcome or decision of a particular process cannot be decided on one tool alone (EMF being one).
- The EMF is a guideline for decision-making and the EIA will take into account this guideline to ensure that the authority is presented with the appropriate information to evaluate the proposed Volspruit mine development.

Further to the Environmental Management Zones as described above, the Waterberg Biosphere Reserve also needs to be considered. As can be seen in Figure 3-4 below, the EMZs have been overlain with the Biosphere Reserve Zones. The farms Volspruit and Zoetveld fall within "Transition Zone 2" of the Biosphere Reserve Zones.

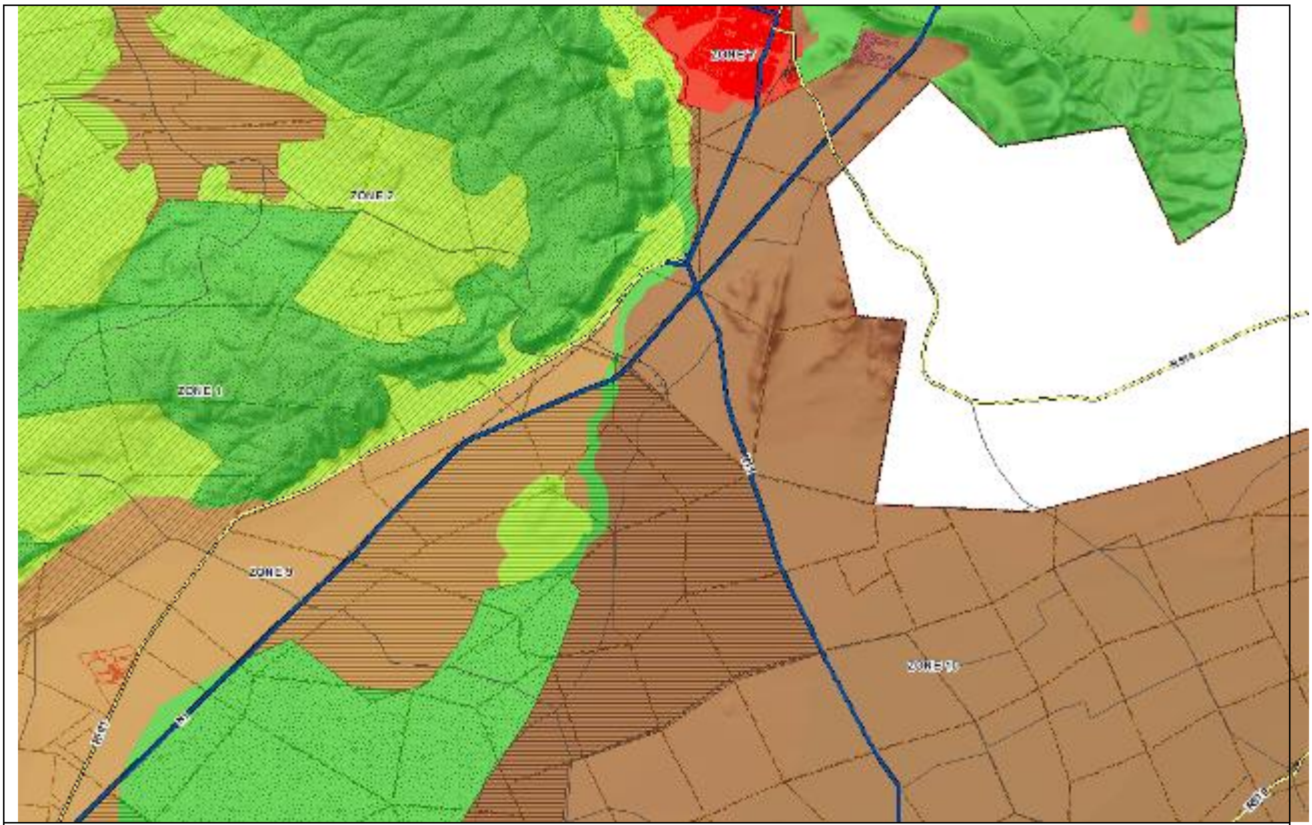


Figure 3-4: Environmental Management Zones overlain with Biosphere Reserve Zones (Adapted from MetroGIS, 2010).

Biosphere reserves are organised into three interrelated zones, namely: the core area; the buffer zone and the transition area. According to UNESCO, only the core area requires legal protection, meaning that these areas usually correspond to existing protected areas such as nature reserves or national parks.

It must be further noted that the EMF mapping software (adapted from MetroGIS) also indicated "potential mining areas" (Figure 3-5). These areas that have been identified as "potential mining areas" are identified in maps only and are not discussed or addressed in the EMF document.

- These areas that have been identified as "potential mining areas" are identified in maps only and are not discussed or addressed in the EMF document.
- The lack of discussion on the "potential mining areas" in the EMF text does not assist EAP and administrators (viz LEDET) in assessing the environmental, economic and social aspects of a proposed activity that is considered to be "undesirable".

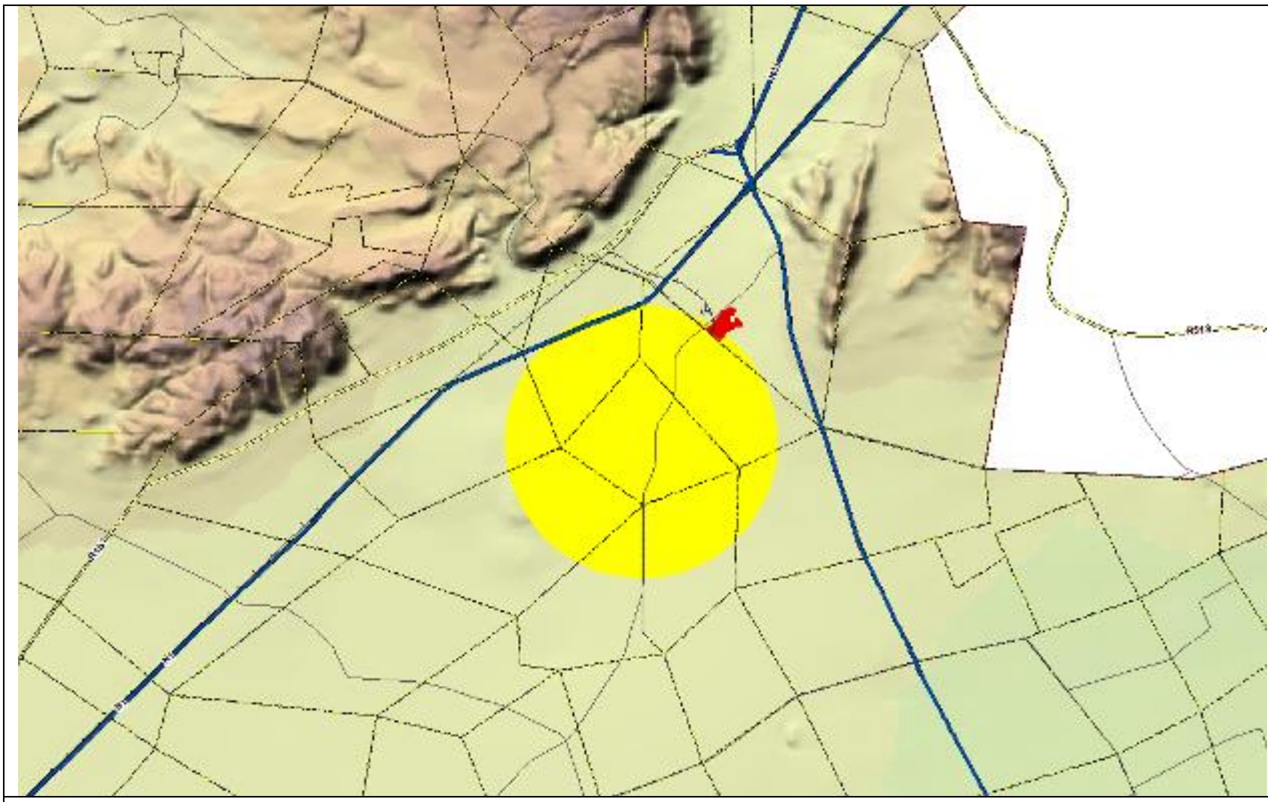


Figure 3-5: Potential mining areas as shown in a GIS layer provided by the EMF. (Adapted from MetroGIS, 2010)

3.2 PROTECTED AREAS

3.2.1 NATIONAL ENVIRONMENTAL MANAGEMENT: PROTECTED AREAS ACT (ACT 57 OF 2003)[NEM:PAA]

The following section has been adapted from personal email and verbal communications with Mr Riaan Visagie of LEDET and from the actual text of the NEM:PAA. Nature Reserves under the current legislation refers to any area which qualifies under the Act (NEM:PAA) irrespective of the type of ownership.

Section 23(2) of NEM:PAA specifies the basic qualification criteria for an area to be declared a Nature Reserves:

23. (1) The Minister or the MEC may by notice in the Gazette-
(a) declare an area specified in the notice-
(i) as a nature reserve; or
(ii) part of an existing nature reserve; and
(b) assign a name to the nature reserve.

(2) A declaration under subsection (l) (a) may only be issued-
… (b) to protect the area if the area-
(i) has significant natural features or biodiversity;
(ii) is of scientific, cultural, historical or archaeological interest; or
(iii) is in need of long-term protection for the maintenance of its biodiversity or for the provision of environmental goods and services;
(c) to provide for a sustainable flow of natural products and services to meet the needs of a local community;
(d) to enable the continuation of such traditional consumptive uses as are sustainable; or

(e) to provide for nature-based recreation and tourism opportunities…

The following requirements also apply to areas being declared as Nature Reserves under NEM:PAA, which was not a requirement prior to NEM:PAA of 2003.

- The owner or owners of the area must sign an agreement with the MEC or Minister when the area is proclaimed (Contract);
- The reserve must hand in a management plan not later than one year after proclamation; and
- The property declared gets an attachment to the deed of the specific property to indicate it is a Nature Reserve.

Even though the current legislation recognises that "Nature Reserves" proclaimed pre-NEM:PAA as still being Nature Reserves, it is however clear that pre-NEMP:AA "Private Nature Reserves" do not comply with the requirements as mentioned above, even though the act recognizes them. These non-compliances are:

- No agreement with Minister or MEC;
- No management plans; and
- No attachment to the deed

It is understood that mining activities prior to NEM:PAA of 2003 were not prohibited in Nature Reserves as the previous legislation is silent on the matter, and the fact that the Grass Valley Chrome mine falls inside the Nyl Valley Private Nature Reserve indicates that this was acceptable. However, further to this, it is understood that all newly declared areas under the NEM:PAA will be protected against mining activities as mentioned in section 48 of the NEMPAA.

<u>Prospecting and mining activities in protected area</u>

48. (1) Despite other legislation, no person may conduct commercial prospecting or mining activities-

(a) in a special nature reserve or nature reserve;

(b) in a protected environment without the written permission of the Minister and the Cabinet member responsible for mineral and energy affairs; or

(c) in a protected area referred to in section 9(b) or (d).

(2) The Minister, after consultation with the Cabinet member responsible for mineral and energy affairs, must review all mining activities which were lawfully conducted in areas indicated in subsection (l) (a), (b) and (c) immediately before this section took effect.

(3) The Minister, after consultation with the Cabinet member responsible for mineral and energy affairs, may, in relation to the activities contemplated in subsection (2), as well as in relation to mining activities conducted in areas contemplated in that subsection which were declared as such after the commencement of this section, prescribe conditions under which those activities may continue in order to reduce or eliminate the impact of those activities on the environment or for the environmental protection of the area concerned.

(4) When applying this section, the Minister must take into account the interests of local communities and the environmental principles referred to in section 2 of the National Environmental Management Act, 1998.

Private Nature Reserves proclaimed up to 2003

As explained in the pre-2003 section of this document it is clear that these reserves are Nature Reserves under the previous provincial legislation.

The actual status of the "Nyl Valley Private Nature Reserve" still needs to be legally clarified and declared as such under NEMPAA, have an agreement with the Minister and MEC, as well as a formal management plan as stipulated in NEM:PAA.

One can conclude that the Nyl Valley Private Nature Reserve is indeed a Nature Reserve, on paper, which was officially promulgated in 1960. However, it needs to be determined if it can still be considered a nature reserve under NEM:PAA, due to mining and agricultural activities which have been allowed to take place within this area and due to the fact that the status is not supported by the new requirements of NEM:PAA of 2003.

The National DEA is currently making recommendations to Provincial Departments (such as LEDET) as to what steps need to be followed to align these Private Nature Reserves to the NEM:PAA requirements.

LEDET is undertaking the following steps in order to formalize the alignment of these Private Nature Reserves:

1. Collecting of the proclamation notices of all Private Nature Reserves for the province (This was finalized in 2010);
2. Digitizing of the diagrams into the GIS system (in progress, and target end date is July 2011);
3. Visits by the Provincial Department to each Private Nature Reserve for assessment and interaction with land owners (There are in the region of 300 Private Nature Reserves to be visited in Limpopo Province alone); and
4. Determination of the future of each private reserve and the alignment with the objectives of NEM:PAA.

As such, the formal promulgation of these Private Nature Reserves to align with the objectives of NEM:PAA is on-going, and creates some degree of uncertainty around the implications thereof to the planned mine.

3.2.2 PROCLAMATION OF ZOETVELD AS A PRIVATE NATURE RESERVE

On 27 January 1960, the remainder of the Farm Zoetveld (and other portions of the neighbouring Grass valley farm) were gazetted as a "Private Nature Reserve". This nature reserve was proclaimed as the 'Nyl Valley Private Nature Reserve'.

The details of this registration of this private nature reserve were received from stakeholders at a meeting in Mokopane on 19 April 2011. The extent of this nature reserve is outlined in Figure 3-6 below.

It is noted that the Farm Zoetveld may indeed be a Private Nature Reserve, promulgated in 1960. Very little is known about its current status under the new National Environmental Management: Protected Areas Act (Act 57 of 2003).

A report by Mr. Visagie, (2011) states that: "*The Nyl Valley Private Nature Reserve overlaps the current proposed Volspruit Mine. This is specific for the remainder extend of the farm Zoetveld 294 KR. This property is protected under the National Environmental Management: Protected Areas Act (NEM:PAA) (Act 57 of 2003) and specifically under section 48 of the Act*".

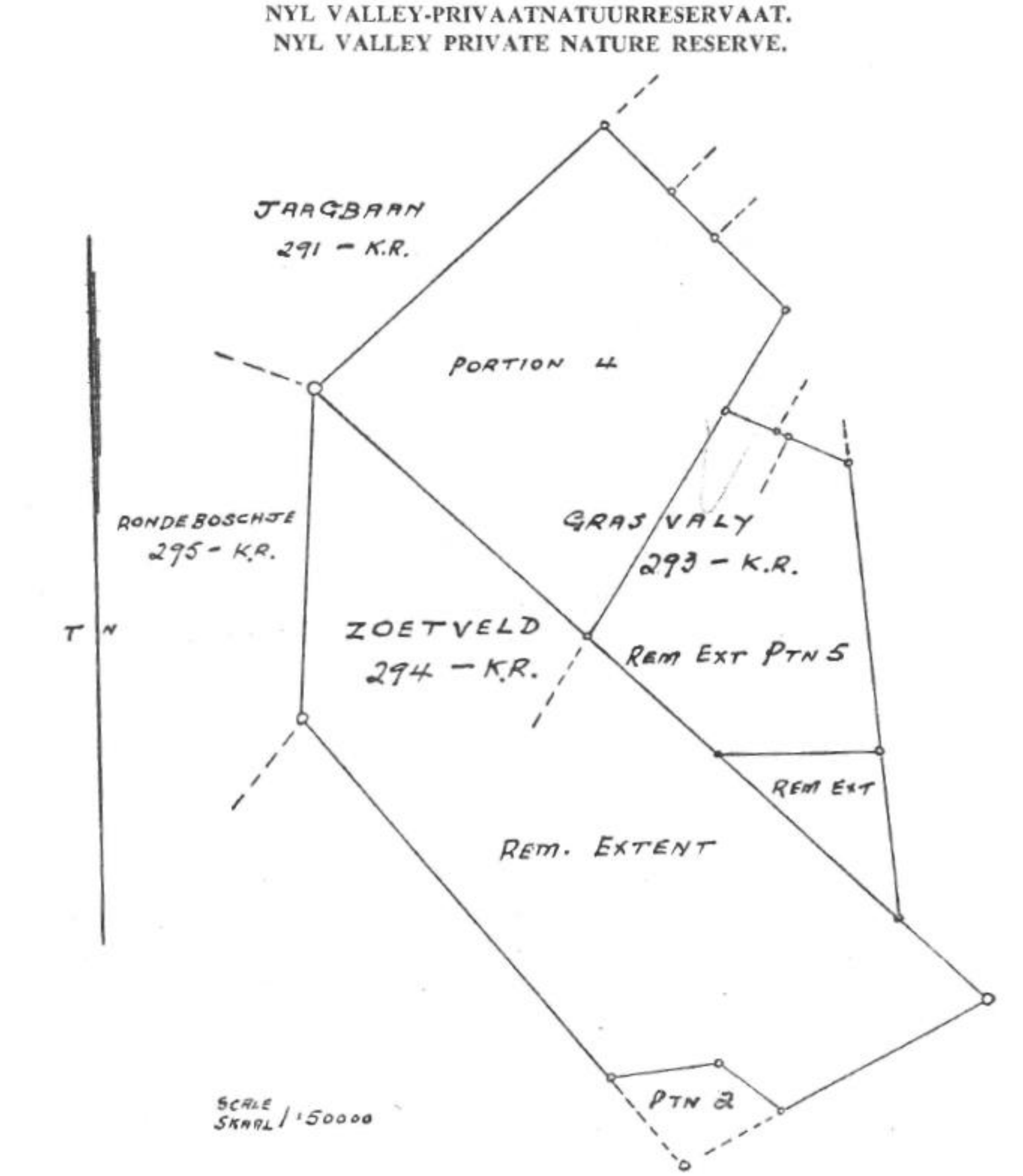


Figure 3-6: Extent of the Nyl Valley Private Nature Reserve proclamation (27 January 1960)

Furthermore, it must be noted that the now defunct Grass valley Chrome mine was operational until the 1980s on the Remainder of Portion 5 of the Farm Grass valley (inside this private nature reserve).

Notably, the Farm Zoetveld is not proposed to be mined for any mineral at this time, as the prospecting right is held exclusively on Volspruit and a small portion of Zoetveld. Zoetveld has, however, been identified as the location for the preferred alternatives in respect of the placing the mine's tailings storage facility and waste rock dump.

All Nature Reserves prior to the NEM:PAA of 2003 had been proclaimed under numerous Provincial Legislation from 1950 up to 2003. In the "old Transvaal" reserves were declared under the ordinance of the Province.

When an area was proclaimed under that legislation the following applied:

- The owner of the property had to write a letter to the Director of Nature Conservation to motivate the proclamation of the specific farm or farms;
- Applications were then approved or denied from the director's office on his/her discretion;
- The only basic requirement was that the area had to be conservation orientated; and
- The owner had the right also to name his reserve as he pleased and then the area was gazetted and proclaimed under that name.

Nature conservation officials visited these reserves yearly for inspection purposes. When perusing the legislation in place in the mentioned period (1950-2003) it will be noted that there are no references to the word Private Nature Reserve. It was discovered that legally all areas declared were classified as Nature Reserves. However, a trend developed in the naming of reserves to indicate the type of ownership. Owners of properties adopted the use of the word Private Nature Reserve, which was not stipulated by legislation.

Thus, a Private Nature Reserve prior to NEM:PAA of 2003 and a State Owned Nature Reserve had the same status in terms of the law, as both are Nature Reserves. The Nyl Valley Private Nature Reserve came to existence through the process described above. The main reason for including the farm Zoetveld as a Nature Reserve may have been to obtain long standing permits for specific species on the property. At the moment, however, there seems to be no evidence that the use of the farm Zoetveld is in fact conservation orientated.

Deproclamation of Zoetveld as a private nature reserve

Allowance is made for the deproclamation of private nature reserves and there is indeed an official process that have been formalised by LEDET for deproclamation of private nature reserves.

To this extent Sylvania has requested and received guidelines and forms from LEDET and the applicant is considering the de-proclamation of relevant portions of land held which request can only be submitted once the Applicant's subsidiary, who has been purchased the land, becomes the registered owner thereof.

3.3 BIODIVERSITY

3.3.1 NATIONAL FORESTS ACT (ACT NO. 84 OF 1998)[NFA]

There are a number of tree species that are protected according to Government Notice no. 1012 under section 12(l) (d) of the National Forests Act, 1998 (Act No. 84 of 1998). In terms of section1 5(1) of the National Forests Act, 1998 "*no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell donate or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree, except under a license granted by the Minister to an (applicant and subject to such period and conditions as may be stipulated)*".

A number of species which have a geographic distribution that includes the study area appear on this list, including the following: *Acacia erioloba, Boscia albitrunca, Combretum imberbe, Curtisia dentata, Elaedendron transvaalensis, Pittosporum viridiflorum, Prunus africana, Sclerocarya birrea subsp. caffra* and *Securidaca longependunculata*. Protected tree species recorded in the study area were *Acacia erioloba, Sclerocarya birrea subsp. caffra* and *Boscia albitrunca*.

An application for a licence granted by the minister for the removal and/or relocation of these trees which may be disturbed or affected by the proposed Volspruit mine will be made with the Department of Agriculture, Forestry and Fisheries. However, these tree species will be identified, marked and their coordinates transferred to a location map. The applicant will aim to avoid the unnecessary destruction of protected species during the detail design phase of the project. Where such avoidance may be impractical, the Applicant will apply for the necessary permits to remove.

3.3.2 WATERBERG BIOSPHERE RESERVE

Although not a formal protected area the Waterberg Biosphere Reserve need to be afforded consideration. Waterberg Biosphere Reserve (WBR) is essentially a not-for-profit NGO that is only concerned about the Waterberg area made up of a number of stakeholder groups and work in partnership with government, corporate and civil society.

Typically biosphere reserves are organised into 3 interrelated zones, namely: the core area; the buffer zone and the transition area. According to UNESCO only the core area requires legal protection, meaning that these areas usually correspond to existing protected areas such as nature reserves or national parks.

A WBR management plan (WBR Management Plan 2011 -currently in draft form) has been developed, it is desired that the WBR will form an important part of the South African conservation effort and network of conservation initiatives and will therefore contribute towards the sustainable preservation of biodiversity. The WBR includes priority conservation areas and is therefore desired that it be recognised for its significant contribution towards international, national, regional and local conservation efforts.

The WBR Management Strategies have been set as follows (WBR 2011):

- Planning Instruments & Resource Protection Strategies, whereby the natural resource base is protected and enhanced
- Strategic Environmental Assessment for WBR and surrounds, including, in preparation of the periodic review,
- an assessment of possible reserve boundary changes
- existing core, buffer and transition zones, and
- any possible changes needed to ensure that their environmental and developmental integrity is optimised

The WBR has been zoned into different zones and in Figure 3-4 below, the Waterberg EMF EMZs which have been overlain with the Biosphere Reserve Zones. The farms Volspruit and Zoetveld fall within “Transition Zone 2” of the Biosphere Reserve Zones.

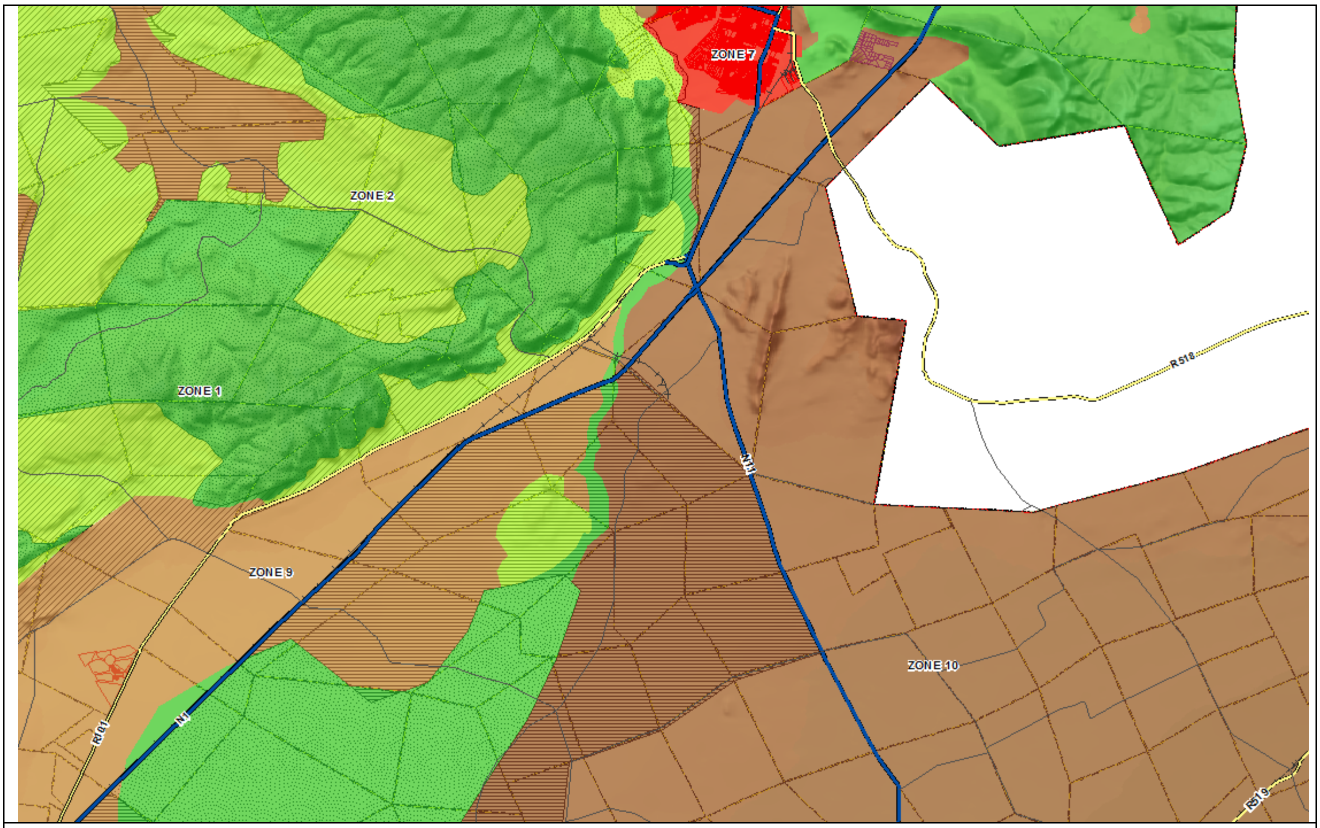


Figure 3-7: Environmental Management Zones overlain with Biosphere Reserve Zones (Adapted from MetroGIS, 2010).

As part of the various strategies set out to achieve the desired levels of conservation (desired state) have been proposed to include the promulgation of Provincial regulations for the WBR in terms of Chapter 11 of the Limpopo Environmental Management Act 7 of 2003 (which provides for the declaration of limited development areas and could be utilised to declare the WBR as a limited development area.

Incorporation of regulations into District and Local Municipality land use management tools – The development of guidelines, regulations and applicable acts that will be included in the Provincial regulations for the WBR should be incorporated in the District and Local municipal SDFs and land use management schemes.

The desired state for the WBR is defined as follows (WBR 2011):

- That the spatial planning tools of government will recognise and support the pivotal role that the WBR will play in conservation and eco-tourism;
- That the eco-tourism value of individual landowners' properties are underpinned and enhanced through the protection of the area's natural attributes, while enabling a broad enough range of tourism product types across the distinctive biosphere zones;
- That the environmental heritage, conservation areas, biodiversity hotspots and ecologically sensitive areas be actively protected and managed through appropriate spatial development tools to ensure that its natural integrity is retained and that these areas are not adversely affected by other activities

Table 3-2: Notable Guidelines for the WBR Zones for Transition Zones (WBR 2011)

LANDUSE	TRANSITIONAL ZONE 1	TRANSITIONAL ZONE 2
CONSERVATION	▪ Not a priority land use	▪ Not a priority land use

	▪ Conservation of natural habitat focused on forming buffer areas around mining and industrial developments ▪ Ancillary management, environmental education, research & tourism-related infrastructure ▪ Breeding of rare and valuable game ▪ species provided it conforms to the environment applicable	▪ Conservation an important principle ▪ to minimise the impact on the ▪ surrounding environment
INDUSTRY/ COMMERCIAL/ BUSINESS	▪ Industry & commercial not permitted (limited to existing facilities and no ▪ further expansion permitted) ▪ Business permitted for tourist orientated facilities only: ▪ Curio shops, restaurants, kiosks, research centres, arts and crafts.	▪ Agri-industries and commercial land use activities allowed – to serve Biosphere communities only ▪ Business uses entail mainly shopping centres, filling stations and general dealers – to serve Biosphere communities

3.3.3 CONSERVATION OF AGRICULTURAL RESOURCES ACT (ACT 43 OF 1983)[CARA]

As defined by the Conservation of Agricultural Resources Act (CARA) (Act 43 of 1983), 'Conservation' is defined as: "*in relation to the natural agricultural resources, includes the protection, recovery and reclamation of those resources*;"

The objectives of the CARA, as stated in section 2 of the Act, entitled "Objects of Act", are:

"*The objects of this Act are to provide for the conservation of the natural agricultural resources of the Republic by the maintenance of the production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources, and by the protection of the vegetation and the combating of weeds and invader plants*."

The objectives of CARA are noted and the proposed Volspruit mine will strive to meet these objectives as far as practicably possible. Mitigation and management measures relating specifically to the conservation of high agricultural potential soils that occur on the farm Volspruit will be outlined and discussed in the EIA phase and in the compilation of the EMPR.

The area where the mine is proposed to be placed (more specifically where the North Pit is to be located) is under intensive centre pivot irrigation agriculture, with high crop yields year round. From this and other tools used (including the Waterberg EMF) it can be determined that the soils in the area where the North Pit is proposed to be located has a high agricultural potential and needs to be managed accordingly.

Furthermore, Regulation 5 of CARA entitled: "Prohibition of spreading weeds", states:
No person shall-

(a) sell, agree to sell or offer, advertise, keep, exhibit, transmit, send, convey or deliver for sale, or exchange for anything or dispose of to any person in any manner for a consideration, any weed; or

(b) in any other manner whatsoever disperse or cause or permit the dispersal of any weed from any place in the Republic to any other place in the Republic.

Regulation 5 is noted and the Volspruit mine will strive to meet this requirement of CARA. The management and mitigation measure to achieve this will be defined in the EIA and EMPR.

Furthermore, Government Notice Regulation (GNR) 1048 of 25 May 1984 contains the regulations which have been promulgated under the Conservation of Agricultural Resources Act (CARA). Amongst others, GNR 1048 defines the following key aspects:

Flood area: *in relation to a water course, means the area which in the opinion of the executive officer is flooded by the flood water of that water course during a 1-in-10 years flood.*

Utilisation and protection of vlei, marshes, water sponges and water courses

7.(1) Subject to the provisions of the Water Act, 1956 (Act 54 of 1956), and sub-regulation (2) of this regulation, no land user shall utilise the vegetation in a vlei, marsh or water sponge or within the flood area of a water course or within 10 metres horizontally outside flood area in a manner that causes or may cause the deterioration of or damage to the natural agricultural resources.

(2) Every land user shall remove the vegetation in a water course on his farm unit to such an extent that it will not constitute an obstruction during a flood that could cause excessive soil loss as a result of erosion through the action of water.

(3) Except on authority of a written permission by the executive officer, no land user shall-

(a) drain or cultivate any vlei, marsh or water sponge or a portion thereof on his farm unit; or

(b) cultivate any land on his farm unit within the flood area of a water course or within 10 metres horizontally outside the flood area of a water course.

(4) The prohibition contained in sub-regulation (3) shall not apply in respect of-

(a) a vlei, marsh or water sponge or a portion thereof that has already been drained or is under cultivation on the date of commencement of these regulations provided it is not done at the expense of the conservation of the natural agricultural resources; and

(b) land within the flood area of a water course or within 10 metres horizontally outside the flood area of a water course that is under cultivation on the date of commencement of these regulations, provided it is already protected effectively in terms of regulation 4 against excessive soil loss due to erosion through the action of water.

(5) The provisions of regulation 2(2), (3) and (4) shall apply mutatis mutandis with regard to an application for a permission referred to in sub-regulation (3).

These regulations will be adhered to as far as possible and addressed accordingly in the EIA phase, where impacts and mitigation measures are tabled and discussed. The management of high potential agricultural soils (such as those currently under intensive centre pivot irrigation) will be discussed during the EIA phase.

3.3.4 NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT (ACT 10 OF 2004)[NEMBA]

The National Environmental Management: Biodiversity Act (Act 10 Of 2004)[NEMBA] is the primary legislation governing biodiversity management in South Africa.

Section 2: "Objectives of the Act", states the following:

Objectives of Act:
2. The objectives of this Act are-
a) within the framework of the National Environmental Management Act, to provide for-
(i) the management and conservation of biological diversity within the Republic and of the components of such biological diversity.
(ii) the use of indigenous biological resources in a sustainable manner; and
(iii) the fair and equitable sharing among stakeholders of benefits arising from bio-prospecting involving indigenous biological resources;
b) to give effect to ratified international agreements relating to biodiversity which are binding on the Republic;
c) to provide for co-operative governance in biodiversity management and conservation; and
d) to provide for a South African National Biodiversity Institute to assist in achieving the objectives of this Act.

The objectives of this Act will be upheld and promoted during the development of the EIR and EMP. The specialist who will be undertaking the biodiversity assessment will include this legislation in the development of their management and monitoring recommendations.

Requirements for biodiversity assessments

It is acknowledged that there are no national guidelines for biodiversity assessments, however, in November 2009, the Department of Agriculture and Rural Development: Directorate of Nature Conservation published the "GDARD requirements for biodiversity assessments" (Version 2). Although these guidelines are specific for Gauteng Province, the essence of reporting on biodiversity issues and the minimum requirements for biodiversity studies can be adapted and used in any situation.

These guidelines will act as reference documentation for the reporting of biodiversity aspects on the Volspruit Project.

3.4 AIR QUALITY

3.4.1 NATIONAL ENVIRONMENTAL AIR QUALITY ACT (ACT 39 OF 2004)[NEM:AQA]

Air Quality Management in South Africa has undergone significant changes with regard to amendments in Air Quality legislation. With the introduction of the NEM:AQA, there has been a shift in Air Quality Management from a sourced based and best practicable means (BPM) approach under the Air Pollution Prevention Act, 1965 (Act No. 45 of 1965)[APPA] to an ambient air quality management approach whereby responsibilities for air quality management (AQM) have been devolved down from the national level to the local authority level (including district and metropolitan municipalities). NEM:AQA was brought into full force on 1 April 2010 and has superseded APPA.

Section 21 of the NEM:AQA provides for the listing of activities resulting in atmospheric emissions. Specifically, the Minister must publish, by notice in the Government Gazette, a list of activities, which result in atmospheric emissions and which the Minister reasonably believes have or may have a significant detrimental effect on the environment.

Furthermore, such a notice must establish minimum emission standards for substances resulting from a listed activity, including the permissible amount or concentration of substances being emitted, as well as the manner in which measurements of such emissions must be carried out. The notice may also contain transitional and other special arrangements in respect of activities which are carried out at the time of their listing. The DEA has given effect to new emissions regulations under Section 21 through the Listed Activities and Minimum Emission Standards (22 November 2013 GN. R.893), which include air emission standards applicable to the proposed smelter and CVMR Plant at the proposed Volspruit Mine, and would accordingly require an Air Emission Licence (AEL).

The NEM:AQA has repealed APPA in totality (in terms of section 60 of NEM:AQA). However, at this point in time, due to the nature of the framework of the Act and that many local authorities are not adequately prepared for implementation of the legislation, it has only been partially devolved to the municipal and provincial administration level.

Further to the "duty of care" previously discussed in terms of NEMA, NEM:AQA defines air pollution in the following terms:

""air pollution" means any change in the composition of the air caused by smoke, soot, dust (including fly ash), cinders, solid particles of any kind, gases, fumes, aerosols and odorous substances;"

This definition is particularly applicable to the generation or entrainment particulate matter (commonly referred to as dust), and gives context to the duty to prevent pollution in terms of atmospheric emissions. NEM:AQA is effects-based legislation, with the result that activities that result in atmospheric emissions are to be managed through the setting of health-based ambient air quality standards. Each new development proposal with potential impacts on air quality must be assessed not only in terms of its individual contribution, but in terms of its additive contribution to baseline ambient air quality (i.e. cumulative effects must be considered).

3.4.2 NEM:AQA SECTION 21 EMISSIONS LIMITS FOR THE SMELTER COMPLEX

The NEM:AQA requires all persons undertaking listed/scheduled processes to obtain an Atmospheric Emissions Licence (AEL). These listed processes were gazetted on 22 November 2013 under GN. R.893. The activities of the proposed mine (specifically the proposed smelter complex) do fall into these listings, as detailed below.

Table 3-3: Emission standards for smelting and converting of sulphide ores: NEM:AQA 4.16		
Description	Processes in which sulphide ores are melted, roasted, calcined or converted.	
Application	All installations	
Substances or mixtures of substances	Plant status	mg/Nm³ under normal conditions of

Common name	Chemical symbol		273 Kelvin and 101.3kPa
Particulate Matter	N/A	New	50
		Existing	100
Oxides of Nitrogen	NO_x expressed as NO_2	New	350
		Existing	2000
Sulphur Dioxide (feed SO2 < 5% SO2)	SO_2	New	1200
		Existing	3500
Sulphur Dioxide (feed SO2 > 5% SO2)	SO_2	New	1200
		Existing	2500

Table 3-4: Emission standards for precious metal production and refining: NEM:AQA 4.17			
Description	The production or processing of precious and associated base metals		
Application	All installations		
Substances or mixtures of substances		Plant status	mg/Nm³ under normal conditions of 273 Kelvin and 101.3kPa
Common name	Chemical symbol		
Particulate Matter	N/A	New	50
		Existing	100
Chlorine	Cl_2	New	50
		Existing	50
Sulphur Dioxide	SO_2	New	400
		Existing	400
Hydrogen Chloride	HCl	New	30
		Existing	30
Hydrogen fluoride	HF	New	30
		Existing	30
Ammonia	NH_3	New	100
		Existing	100
Oxides of Nitrogen	No_x expressed as NO_2	New	300
		Existing	500

Table 3-5: Emission standards for drying and calcining of mineral solids including ore: NEM:AQA 4.1			
Description	Drying and calcining of mineral solids including ore		
Application	Facilities with a capacity of more than 100 tons/month product.		
Substances or mixtures of substances		Plant status	mg/Nm³ under normal conditions of 273 Kelvin and 101.3kPa
Common name	Chemical symbol		
Particulate Matter	N/A	New	50
		Existing	100
Oxides of Nitrogen	NO_x expressed as NO_2	New	500
		Existing	1200
Sulphur Dioxide	SO_2	New	1000
		Existing	1000

Further to this, Figure 3-8: Interrelationship between the EIA and AEL processes shows how the EI and AEL application processes interrelationship between the AEL and EIA application processes. As the smelter complex will require an AEL application, this interrelationship needs to be catered for and an AEL application submitted before the EIA authorisation is issued.

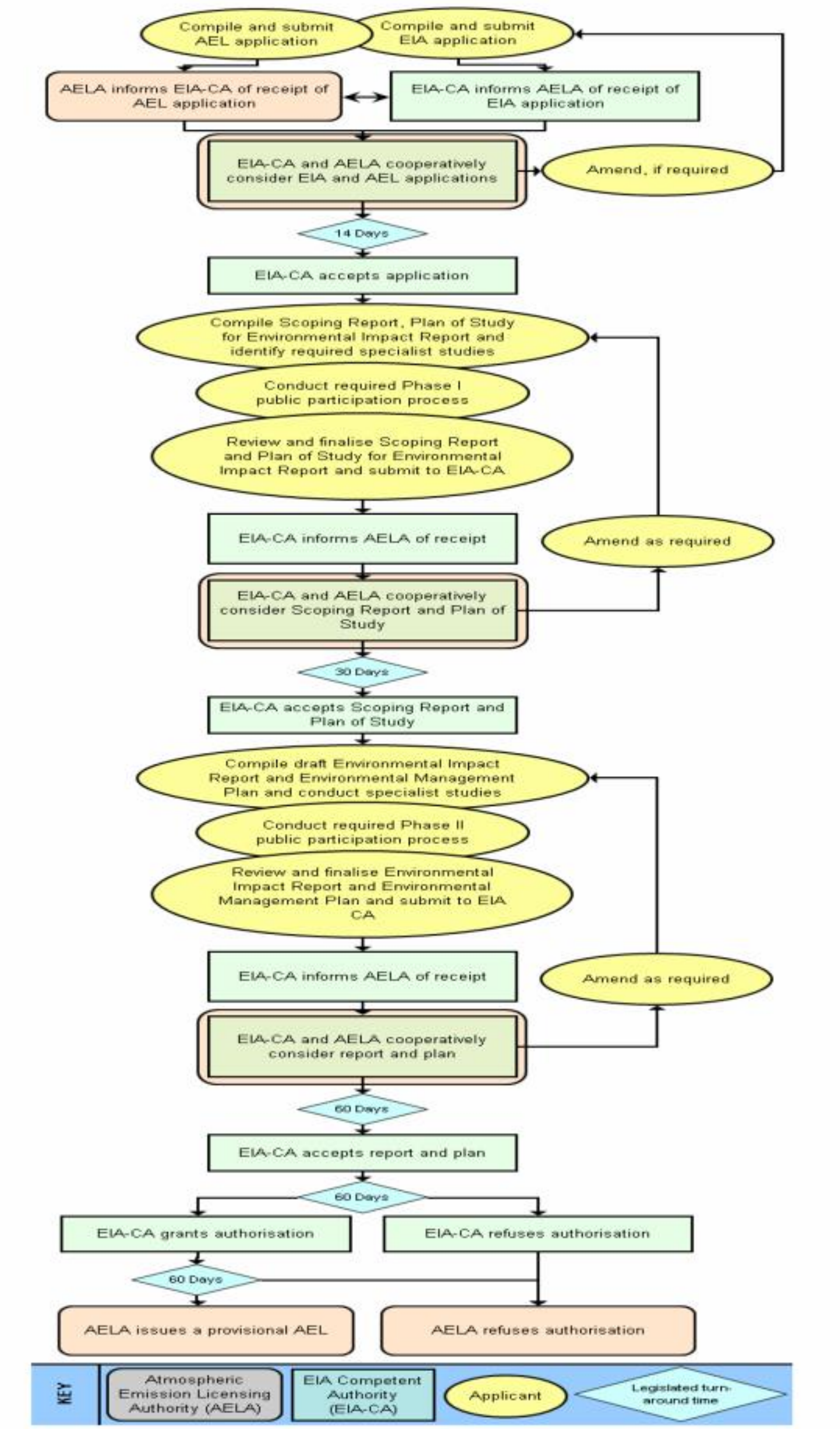


Figure 3-8: Interrelationship between the EIA and AEL processes

3.4.3 AMBIENT AIR QUALITY STANDARDS

NEM:AQA also makes provision for the establishment of national standards for ambient concentrations of specified substances or mixtures of substances in ambient air, which through ambient concentrations, bio-accumulation, deposition or in any other way, present a threat to health, well-being or the environment or which are reasonably believed to present such a threat. In December 2009 the Minister of Water and Environmental Affairs published national ambient air quality standards referring to various pollutants (Table 3-6). In addition, criteria and limits for dust deposition have also been drafted (Table 3-7).

Table 3-6: National Ambient Air Quality Standards (24 December 2009)

Substance	10-minute maximum	1-hour maximum	8-hour maximum	24-hour maximum	Annual average
Sulphur Dioxide ((SO_2)	500 µg/m^3	350 µg/ m^3		125 µg/ m^3	50 µg/ m^3
Nitrogen Dioxide(NO_2)		200 µg/ m^3			40 µg/m3
Carbon Monoxide (CO)		30 mg/ m^3	10 mg/ m^3		
Particulate Matter (PM10)				75 µg/ m^3	40 µg/ m^3
Ozone (O_3)			120 µg/ m^3		
Lead(Pb)					0.5 µg/ m^3
Benzene(C_6H_6)					5 µg/ m^3

3.4.4 NATIONAL DUST CONTROL REGULATIONS

Section 32 of NEM:AQA states that the Minister or MEC may prescribe measures relating to dust control. These regulations were gazetted on 1 November 2013 under GN. R.827.

The purpose of the regulation is to prescribe general measures for the control of dust in all areas. A dustfall standard is set out in the regulations and shown in Table 3-7 below.

Table 3-7: Acceptable dust fall rates

No.	***Description***	***Dustfall rate, D (mg/m²/day , 30 day average)***	***Permitted frequency of exceeding dust fall rate***
1	Residential	D ≤ 600	Two within a year, not sequential months
2	Non-Residential	600 < D ≤ 1 200	Two within a year, not sequential months

The regulations also indicate that the air quality officer may require that a person undertakes a dustfall monitoring program and states regulations to be met for the monitoring and reporting of dustfall. The regulations include dust control measures required to be implemented by a person who exceeds the dustfall standards.

3.5 WASTE MANAGEMENT

3.5.1 NATIONAL ENVIRONMENTAL MANAGEMENT: WASTE ACT (ACT 59 OF 2008)[NEM:WA]

In the past, waste management activities were regulated under the Environment Conservation Act (ECA), 1989 (Act 73 of 1989), specifically section 20(1), which states that "*no person shall establish, provide or operate any disposal site without a permit issued by the Minister of Water Affairs*". Based on strict interpretation applied by authorities, any waste handling facility, including waste storage and treatment, also required permitting (or at least exemption) in terms of section 20(1). These requirements have, however, been replaced by the National Environmental Management: Waste Act (Act 59 of 2008) [NEM:WA], which was enacted on 10 March 2009 and came into force on 01 July 2009.

The NEM:WA defines 'waste' as "*any substance, whether or not that substance can be reduced, re-used, recycled and recovered -*
(a) that is surplus, unwanted, rejected, discarded, abandoned or disposed of;
(b) which the generator has no further use of, for the purposes of production;
(c) that must be treated or disposed of; or
(d) that is identified as a waste by the Minister by notice in the Gazette, and includes waste generated by the mining, medical or other sector, but- (i) a by-product is not considered waste; and (ii) any portion of waste, once re-used, recycled and recovered, ceases to be waste".

Other key definitions in NEM:WA are:

- Hazardous waste: "*Any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment*";
- General waste: "*Waste that does not pose an immediate hazard or threat to health or to the environment, and includes (a) domestic waste; (b) building and demolition waste; (c) business waste; and (d) inert waste*"; and
- Inert waste: "*Waste that (a) does not undergo any significant physical, chemical or biological transformation after disposal; (b) does not burn, react physically or chemically biodegrade or otherwise adversely affect any other matter or environment with which it may come into contact; and (c) does not impact negatively on the environment, because of its pollutant content and because the toxicity of its leachate is insignificant*".

While the waste streams resultant directly from the Volspruit mine and processing/ beneficiation plant will indeed fall within the definition of what is a 'waste', as provided for in the NEM:WA, the Waste Act is very clear in terms of the application thereof; where the Act does not apply to *inter alia* "*Residue deposits and residue stockpiles that are regulated under the Mineral and Petroleum Resources Development Act 2002 (Act No. 28 of 2002) [MPRDA]*".

'*Residue deposits and residue stockpiles*' are defined in the MPRDA as follows:

- Residue deposit, "*means any residue stockpile remaining at the termination, cancellation or expiry of a prospecting right, mining right, mining permit, exploration right or production right*"; and
- Residue stockpile, means "*any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, beneficiation plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or*

accumulated for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or production right".

The Volspruit mine and processing plant/beneficiation plant wastes/tailings are deemed to be mineral residue deposits that will remain on site at the end of life of mine. The above definition of residue deposits is thus deemed to be triggered, thereby placing these waste streams outside the scope of application of the NEM:WA, their management is prescribed in terms of the MPRDA Regulation 73

According to section 19(1) and 19(3) of the NEM:WA, the Minister may publish a list of waste management activities that have, or are likely to have, a detrimental effect on the environment and must specify whether a waste management licence is required to conduct these activities. Under these provisions, a list of 'Category A', 'Category B' and 'Category C' waste management activities were published via General Notice No: 921 on 29 November 2013 as Schedule 1 to NEM:WA. Category A and B activities require a Waste Management Licence in terms of section 20(b) of NEM:WA, whereas Category C activities require that the person conducting these activities complies with the relevant requirements or standards as listed in GN. R.921.

In terms of this notice, a person who wishes to commence, undertake or conduct any of these listed activities must, as part of the Waste Management Licence application, conduct either a Basic Assessment process (for Category A activities), or a scoping and EIA (for Category B) as stipulated in the EIA Regulations (GN R.543). Activities listed under category C do not require a Basic Assessment or Scoping and EIA. The licensing process for waste management activities and the supporting information required is therefore the same as for activities listed in GN R.544, R.545 and R.546 that require an Environmental Authorisation. In order to avoid duplication by requiring two approvals for the same activity, waste activities listed in the EIA Regulations were removed by means of General Notice No: 719 on 3 July 2009, which means that currently, waste activities only require a Licence in terms of NEM:WA and not an Environmental Authorisation in terms of NEMA too.

The implications of the preceding paragraphs are that the waste management activities to be undertaken on the site, which would at face value require a waste license from the competent authority in terms of section 20 of the NEM:WA to proceed, actually do not. This does not, however, exempt the mine from having to ensure that these waste streams are managed in a manner that is environmentally and socio-economically acceptable to IAPs and all relevant spheres of Government; irrespective of whether the waste management activities to be undertaken require a waste license from the competent authority, or not.

Further to the above, it should be taken into consideration that salvage yards and sewage plants, for example, or storage of general and hazardous wastes (other than mining related residue stockpiles) will still require waste licensing if the applicable thresholds for such in GN. R.921 of 29 November 2013 are exceeded. It is expected that these thresholds will be exceeded and a waste licence has been submitted to National DEA to cater to these licensing requirements, for the activities detailed in Table 3-8 to follow.

Table 3-8: Table of Waste Management Activities Applicable to the Project (GN. R.921 of 29 November 2013)
Category B
Activity 4 (1): The storage of hazardous waste in lagoons excluding storage of effluent, wastewater or sewage. <u>REASON</u>: If the definition of a 'lagoon' is applied in the strictest sense, then excavated holding tanks required for the proposed oil/water separators to be constructed at wash bays and workshops will be regarded as lagoons.
Activity 4 (7): The disposal of any quantity of hazardous waste to land. <u>REASON</u>: Possible Slag waste residue disposal to landfill on site.
Activity 4 (10): The construction of facilities for activities listed in Category B of this Schedule. <u>REASON:</u> Construction of waste management related structures and infrastructure for the aforementioned activities.
Category C
Activity 5 (1): The storage of general waste at a facility that has the capacity to store in excess of 100m^3 of general waste at any one time, excluding the storage of waste in lagoons or temporary storage of such waste. <u>REASON:</u> Scrap/salvage yard, as well as temporary waste storage areas within the Processing- and Smelter Complexes.
Activity 5 (2): The storage of hazardous waste at a facility that has the capacity to store in excess of 80m^3 of hazardous waste at any one time, excluding the storage of hazardous waste in lagoons or temporary storage of such waste. <u>REASON:</u> Potentially contaminated steel scrap, sewage screenings/sludge, waste oil, temporary storage of hazardous waste in skips within Plant areas, as well as potential gypsum and slag waste storage.
Activities previously listed under GN. R.718 (now replaced by GN. R.921) at time of application and no longer listed under GN. R.921
Category B Activity 4 (7): The Treatment of effluent, wastewater or sewage with an annual throughput capacity of 15 000 cubic meters or more. REASON: Sewage Treatment Plant, Water Treatment Plant.

3.5.2 MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT 2002

Definition of residue deposit and residue stockpile

While the waste streams resultant directly from the Volspruit mine and processing/ beneficiation plant will indeed fall within the definition of what is 'waste', as provided for in the NEMWA, the Waste Act is very clear in terms of the application thereof; where the Act does not apply to *inter alia* '*Residue deposits and residue stockpiles that are regulated under the Mineral and Petroleum Resources Development Act 2002 (Act No. 28 of 2002) [MPRDA]*'.

'Residue deposits and residue stockpiles' are defined in the MPRDA as follows:

- Residue deposit, means any residue stockpile remaining at the termination, cancellation or expiry of a prospecting right, mining right, mining permit, exploration right or production right; and
- Residue stockpile, means any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, beneficiation plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or production right.

The Volspruit mine and processing plant/beneficiation plant wastes/tailings are deemed to be derived from or incidental to a mining operation and are stored for potential re-use by the mine on the mine property. The above definition is thus deemed to be triggered, thereby placing these waste streams outside the scope of application of the Waste Act.
Further to the above waste management and licensing activities, there are a number of considerations to be taken into account with regards to mining waste residues (waste and discard rock, as well as tailings from the processing plant).

The following regulations and guidelines are taken from the DEA National Waste Management Strategy (NWMS), specifically section 4.4, which deals with mining waste:

4.4(1) - "General, hazardous and industrial wastes from the mining industry fall within the scope of the Waste Act, and therefore are addressed by the NWMS. Section 4(1)(b) of the Waste Act specifically excludes residue deposits and stockpiles from the scope of the Act, in as much as these are regulated in terms of the Mineral and Petroleum Resources Development Act, 2002, (MPRDA) – which falls under the aegis of the Minister of Mineral and Energy Affairs".

4.4(2)- "Residue stockpiles are defined in the MPRDA as:

… any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, beneficiation plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or production right;"

4.4(3) - "A residue deposit is any residue stockpile that remains at the termination of a mining or prospecting activity".

4.4(4) – "The MPRDA requires prospecting and mining operations to be conducted in accordance with the environmental principles set out in section 2 of NEMA, 1998 and provides further definition to this by establishing:

- *Liability for environmental damage and the responsibility to rehabilitate the environment is assigned to permit holders, and the need for applicants for permits to make financial provision for environmental liability; and*
- *Permit holders are required to receive environmental authorisation in terms of NEMA, which includes the requirement to submit an Environmental Management Programme that contains a waste management plan, and to comply with any prescribed waste standards".*

4.4(5)- "The 2008 Amendment to NEMA further defines the requirements for an Environmental Management Programme (EMPR). It further empowers the Minister of Mineral Resources to perform environmental functions in terms of NEMA that relate to mining activities (including prospecting, exploration and production). In respect to these activities, the Minister of Mineral Resources is empowered to:

- *Stipulate mining activities that require EIAs and EMPRs;*
- *Evaluate EIAs and EMPRs; and*
- *Issue Environmental Authorisations*".

4.4(6)- "These parts of the amendment are scheduled to come into force 18 months after the proclamation of the NEMA amendment. Before they come into effect DEA will consult with DMR to determine whether the necessary capacity and administrative arrangements exist on the part of the DMR to fulfil the environmental functions that will be transferred".

4.4(7)- "In relation to mining waste, the strategic focus in terms of the waste hierarchy is on ensuring the treatment and safe disposal of mining waste. However, opportunities for reuse of mining waste need to be fully exploited".

4.4(8) – "It is in the interests of industry and good governance that norms and standards that apply to acceptable uses are developed for the storage, transport, disposal, re-use, treatment and processing of residue stockpiles and deposits. In relation to ash, for instance, it is necessary for standards for toxicity to be developed to ensure that potential re-use in brick-making or as cement extender does not pose a risk to health".

4.4(9) - "Residue stockpiles" constitute a heterogeneous category of actual or potential waste substances. DEA will engage with DMR to determine if a memorandum of understanding is possible to classify residue stockpiles with the framework of the WCMS".

4.4(10) – "Appropriate waste management options for mining waste which falls outside of the Waste Act should be identified in an Industrial Waste Management Plan (IndWMP) for the mining sector. The central purpose of the plan will be to establish waste management guidelines and targets for the mining sector with which EMPRs must be aligned. In terms of the framework for IndWMPs described in section 3.4 of this strategy, the waste management plan in an EMPR corresponds to a site-level IndWMP".

4.4(11) – "Institutional responsibility for the drafting of the mining sector plan will lie with the Chamber of Mines, who will be required to undertake a public consultation process in drawing up the plan. In approving or amending the Mining Sector IndWMP, the Minister for Environment Affairs will consult with the Minister of Mineral Resources".

3.5.3 WASTE CLASSIFICATION

Waste must be classified, in order to determine the risk associated with its handling and disposal, such that these may be appropriately managed. In terms of NEMWA:

- Hazardous Waste: is any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment;
- General Waste: is waste that does not pose an immediate hazard or threat to health or to the environment, and includes (a) domestic waste; (b) building and demolition waste; (c) business waste; and (d) inert waste; and
- Inert Waste: Waste that (a) does not undergo any significant physical, chemical or biological transformation after disposal; (b) does not burn, react physically or chemically biodegrade or otherwise adversely affect any other matter or environment with which it may come into contact; and (c) does not impact negatively on the environment, because of its pollutant content and because the toxicity of its leachate is insignificant.

In order to determine whether waste is hazardous, general or inert waste it must be classified.

The NEMWA Waste Classification and Management Regulations GN 634:2013 were promulgated on 23 August 2013 promulgated on 23 August 2013. The regulations:

- Regulate the classification and management of waste
- Prescribe requirements for the disposal of waste to land
- Prescribe requirements and timeframes for the management of certain wastes
- Prescribe general duties of waste generators, transporters, and managers.
- Establish a mechanism and procedure for the listing of waste management activities that do not require a Waste Management Licence

Regulation 4 (2) requires that waste be classified according to the provisions of SANS 10234 (GHS – Globally Harmonised System for the Classification and Labelling of chemicals) within 180 days of the generation thereof. This excludes pre-classified wastes specified under Annexure 1 thereto. Regulation 4(4) requires that waste be reclassified every 5 years, or within 30 days of a significant change to the processes or raw materials used to generate the waste.

SANS 10234 sets out a comprehensive classification system to determine whether a waste is hazardous based on the nature of its physical, health and environmental hazardous properties.

The SANS 10234 standard covers the harmonized criteria for the classification of hazardous substances and mixtures, including waste, for their safe transport, use at the workplace or in the home, according to their health, environmental and physical hazards. It also stipulates the harmonized communication elements for labelling and Safety Data Sheets (SDS). The standard accordingly provides detail on classification criteria (including tests methods, often with reference to SANS 10228, labelling, hazard identification symbols (pictograms), packaging and the minimum information required for a Safety Data Sheet (SDS).

Classification in terms of SANS 10234 means establishing whether a waste is hazardous based on the nature of its intrinsic physical, health and environmental hazardous properties (Hazard Classes; Table 3-9), as well as Hazard Categories, which are sub-divisions within each hazard class with specific criteria that determine the degree or severity of the hazard.

Table 3-9: Hazard Classes of the SANS 10234 (GHS) Classification System.		
Physical Hazards	**Health Hazards**	**Hazards to the Aquatic Environment**
▪ Explosives ▪ Flammable gases ▪ Flammable aerosols ▪ Oxidizing gases ▪ Gases under pressure ▪ Flammable liquids ▪ Flammable solids ▪ Self-reactive substances / mixtures ▪ Pyrophoric substances ▪ Self-heating substances / mixtures ▪ Substances / mixtures that on contact with water, emit flammable gases ▪ Oxidizing substances / mixtures ▪ Organic peroxides ▪ Corrosive to metals	▪ Acute toxicity ▪ Skin corrosion & skin irritation ▪ Serious eye damage & eye irritation ` ▪ Respiratory sensitization & skin sensitization ▪ Germ cell mutagenicity ▪ Carcinogenicity ▪ Reproductive toxicity ▪ Specific target organ toxicity: single exposure ▪ Specific target organ toxicity: repeated exposure ▪ Aspiration hazards	▪ Acute aquatic toxicity ▪ Chronic aquatic toxicity

Importantly, the classification of a waste has no bearing on the disposal / management requirements thereof, but is used predominantly to inform:

i) appropriate handling and storage of hazardous waste; as well as,
ii) the development of an associated Safety Data Sheet (SDS) for hazardous waste in terms of SANS10234, as required in terms of Regulation 5 (1).

The proponent will be required to classify waste produced in order ensure that appropriate measures are put in place for handling and management thereof. Most notably the smelter slag will need to be classified and landfill disposal designs developed accordingly.

3.6 WATER

3.6.1 NATIONAL WATER ACT (ACT 36 OF 1998)[NWA]

The National Water Act 1998 (Act No. 36 of 1998)[NWA], aims to manage national water resources in order to achieve sustainable use of water for the benefit of all water users. This requires that the quality of water resources is protected and integrated management of water resources takes place.

In terms of the National Water Act, Act No. 36 of 1998 (NWA) a water use licence is required for:

(a) taking water from a water resource;
(b) storing water;
(c) impeding or diverting the flow of water in a watercourse;

(d) engaging in a stream flow reduction activity contemplated in section 36;
(e) engaging in a controlled activity identified as such in section 37 (1) or declared under section 38 (1);
(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
(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;
(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; and
(k) using water for recreational purposes.

Other provisions of the NWA have been taken into account, specifically relating to Part 4 (section 19), which deals with pollution prevention, in particular situations where pollution of a water resource occurs or might occur as a result of activities on land. A person who owns controls, occupies or uses the land in question is responsible for taking measures to prevent pollution of water resources. If these measures are not taken, the catchment management agency concerned may itself do whatever is necessary to prevent the pollution or to remedy its effects and to recover all reasonable costs from the persons responsible for the pollution.

The proposed mine will require water use licencing for the following aspects thereof:

- The dewatering of water from the proposed opencast pits, as is necessary for the efficient continuation of mining activities in those pits or for the safety of people working in those pits (also required in relation to the potential alteration of the characteristics of the Nyl River and associated flood plain through pit dewatering);
- The abstraction of groundwater from site boreholes to meet the potable/domestic water needs of mine employees;
- The disposal of tailings and waste rock 'to land' (i.e. tailings storage facility and waste rock dump);
- The disposal of slag and gypsum waste 'to land';
- Construction of a flood protection berm on the western extent of the proposed north pit; and
- The containment of potentially contaminated water in impoundments/dams (e.g. TSF return water dam, polluted storm water containment dam).

3.6.2 INTEGRATED WATER AND WASTE MANAGEMENT PLAN

An Integrated Water and Waste Management Plan (IWWMP) is compiled in order to promote the environmentally sustainable and equitable use of water in relation to the proposed mining operations. The IWWMP is intended to be a simple, feasible, implementable plan for the Mine based on site specific programmes, also taking into account the National Water Resource Strategy (NWRS), relevant Catchment Management Strategy (CS), Resource Quality Objectives (RQO) and the sensitivity of the receiving water resources and down-stream water users in the vicinity of the mine (Figure 3-4).

This plan would consolidate a number of so-called 'sectorial' water and waste management programmes, relating to specific mine water and waste management aspects, into a single stand-alone document for ease of implementation by the mandated parties at the mine (Figure 3 – 4). The 'sectorial' programmes referred to above cover, inter alia, the following aspects:

- Pollution prevention;
- Water re-use and reclamation;
- Water treatment;
- Storm water management; and
- Water balances.

The consolidation of the above has been done taking cognisance of the resource quality objectives of the National Water Resource Strategy, as well as the relevant Catchment Management Strategy. The formulation of the IWWMP is, furthermore, based on an understanding of the above objectives in conjunction with an impact assessment for all those on site activities that have the potential to impact upon receiving water resources and users in the vicinity of the mine.

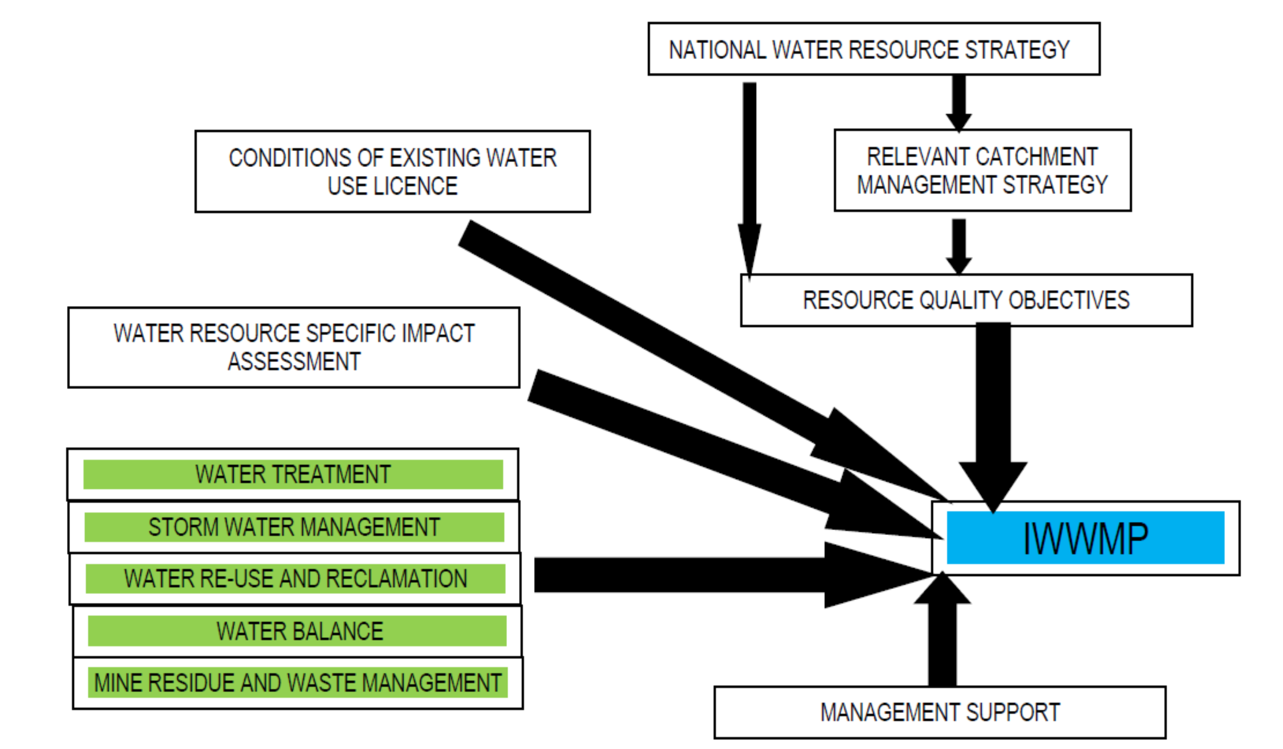


Figure 3-9 Approach to Integrated Waste and Water Management Planning (Adapted from DWAF IWWMP Operational Guidelines, 2008).

The objective of an IWWMP is not to merely compile all existing site knowledge from prior EIA processes or EMPRs into a single unmanageable document (DWA, 2008). It rather, however, applies the principles of the hierarchy for Water Quality Management (WQM) to focus mine management's attention on dealing expressly with those site activities that impact either directly, or indirectly, on water resources and sets clear action plans for the control of water (containing waste) and waste as sources of pollution (Figure 3-5). The hierarchy makes use of precautionary principles and sets an order of priority for mine water and waste management decisions and actions.

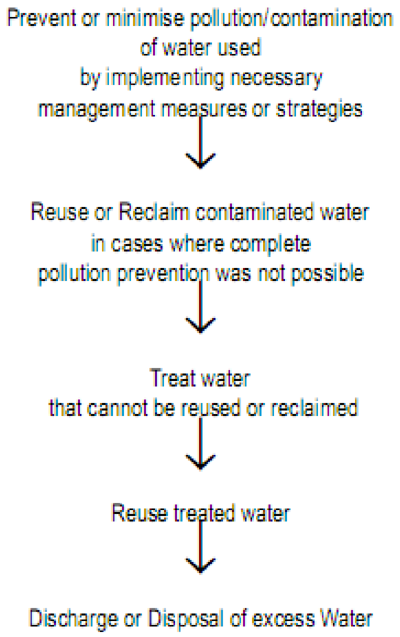


Figure 3-10: Hierarchy of Water Quality Management (DWAF, 2006).

This plan also considers, to the greatest extent possible, the waste and water management actions required for implementation through the entire Life of Mine (including the post closure and rehabilitation phase), whilst remaining dynamic enough to respond to changes in the receiving environment and available Best Practise Environmental Technology alternatives.

The National Water Resource Strategy describes the central objective of managing water resources as follows (DWAF, 2004):

"...to ensure that water is used to support equitable and sustainable social and economic transformation and development."

Strategic Water Resource Management requires the party mandated to manage water and waste at the mine to have an informed understanding of the existing development pressures and water resource quality and quantity issues within the greater catchment. The potential impacts of the mine's activities can then be managed to minimise not only the local/direct impacts of the mine's operations on localised water resources, but also to ensure that the mine's activities do not further exacerbate any existing catchment management issues through indirect and cumulative impacts.

3.6.3 OPERATIONAL GUIDELINES FOR IWWMP

In February 2010, the Department of Water Affairs (DWA) produced an "Operational Guideline: Integrated Water and Waste Management Plan", which was compiled to assist mines and industries who apply for a licence in terms of section 40 (1) of the National Water Act (Act 36 of 1998). The aim of the guidelines document is to assist in compiling water quality management technical documents in accordance with an established approach acceptable to all stakeholders concerned and to assist in the motivation of the application as well as to assist the decision makers with the consideration of the application (DWA, 2010).

This guideline advocates that the IWWMP is a living document that needs to be updated and "kept alive" as new information becomes available to provide on-going and updated guidance to the water user on their water and waste management (DWA, 2010). This IWWMP guideline document was considered to during the compilation of the IWWMP for the Volspruit Project.

3.6.4 WATER USE FOR MINING ACTIVITIES (GN 704)

Mining and associated infrastructure development is guided by the provisos in the Government Notice Regulation 704 of 4 June 1999. GN 704 stipulates the "*Regulations on the use of water for mining and related activities aimed at the protection of water resources*".

Regulations 4, 6 and 7 of GN 704 place restrictions on locality of mines, capacity requirements of clean and dirty water systems and protection of water resources respectively. These three sections are critical to this particular project as the area is sensitive and protection of water resources in the area is highest priority.

Regulation 4 of GN704 states amongst others, the following:

"No person in control of a mine or activity may -

a. *locate or place any reside deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100m from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked;*
b. *except in relation to a matter contemplated in regulation 10, carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood line or within a horizontal distance of 100 meter from any watercourse or estuary, whichever is the greatest.*
c. *Place or dispose of any reside or substance which causes or is likely to cause pollution of a water resource, in the workings of any underground or opencast mine excavation, prospecting diggings, pit or any other excavation; or*
d. *Use any area or locate any sanitary convenience, fuel depots, reservoirs or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood line of any watercourse or estuary.*"

The North Pit of the proposed Volspruit Mine falls within the current 1:100 and 1:50 year flood lines of the Nyl River. The proponent proposes the establishment of a 6m high flood protection berm to essentially alter the flood lines of the river around the western extent of the north pit, thereby making mining possible. The flood berm will not only alter the flood lines, but would protect the open cast pit from flooding.

Due to the proposed altering of the flood lines by means of a flood berm, an application for exemption to mine within the flood line may not be required. The north pit will still, however, fall within 100m of the edge of the delineated Nyl River floodplain, and will accordingly require Water Affairs' exemption from the provisions of GN 714 if it is to proceed to within 100m of the wetland. A water use licence will also be required for the flood berm, and should not be overlooked by the proponent. All other structures, including dams and tailing storage facilities will be well outside of the 1:100 year flood line and more than 100 metres away from the flood plain and wetland.

3.7 HERITAGE RESOURCES

Aspects concerning the conservation of cultural resources are dealt with mainly in two acts. These are the National Heritage Resources Act (Act 25 of 1999)[NHRA], and to a lesser extent the National Environmental Management Act (Act 107 of 1998)[NEMA].

3.7.1 NATIONAL HERITAGE RESOURCES ACT (ACT 25 OF 1999)[NHRA]

According to the NHRA the following are afforded 'protected' as cultural heritage resources in South Africa:

a. Archaeological artefacts, structures and sites older than 100 years;
b. Ethnographic art objects (e.g. prehistoric rock art) and ethnography;
c. Objects of decorative and visual arts;
d. Military objects, structures and sites older than 75 years;
e. Historical objects, structures and sites older than 60 years;
f. Proclaimed heritage sites;
g. Grave yards and graves older than 60 years;
h. Meteorites and fossils; and
i. Objects, structures and sites or scientific or technological value.

A Heritage Impact Assessment (HIA) is the process to be followed in order to determine whether any heritage resources are located within the area to be developed as well as the possible impact of the proposed development thereon. An Archaeological Impact Assessment (AIA) only looks at archaeological resources. An HIA must be done under the following circumstances:

i. *"The construction of a linear development (road, wall, power line, canal etc.) exceeding 300m in length;*
ii. *The construction of a bridge or similar structure exceeding 50m in length;*
iii. *Any development or other activity that will change the character of a site and exceed 5 000m^2 or involve three or more existing erven or subdivisions thereof;*
iv. *Re-zoning of a site exceeding 10 000 m^2; and*
v. *Any other category provided for in the regulations of South African Heritage Resources Agency (SAHRA) or a provincial heritage authority*".

The proposed mining and supporting activities indeed trigger the aforementioned listings, and an HIA is thus required.

<u>Structures</u>

Section 34 (1) of the NHRA states that, "*no person may demolish any structure or part thereof which is older than 60 years without a permit issued by the relevant provincial heritage resources authority*"; where 'a structure' means, "*any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith*" and 'alter' means, "*any action affecting the structure, appearance or physical properties of a place or object, whether by way of structural or other works, by painting, plastering or the decoration or any other means*".

<u>Archaeology, palaeontology and meteorites</u>

Section 35(4) of this NHRA deals with archaeology, palaeontology and meteorites. The Act states that, "*no person may, without a permit issued by the responsible heritage resources authority (national or provincial):*

a) *destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or paleontological site or any meteorite;*
b) *destroy, damage, excavate, remove from its original position, collect or own any archaeological or paleontological material or object or any meteorite;*
c) *trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or paleontological material or object, or any meteorite; or*
d) *bring onto or use at an archaeological or paleontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and paleontological material or objects, or use such equipment for the recovery of meteorites; and*
e) *alter or demolish any structure or part of a structure which is older than 60 years as protected".*

The above-mentioned may only be disturbed or moved by an archaeologist, after receiving a permit from the South African Heritage Resources Agency (SAHRA). In order to demolish such a site or structure, a destruction permit from SAHRA is needed.

Human remains

Graves and burial grounds are divided, in terms of the NHRA, into the following:

A. ancestral graves;
B. royal graves and graves of traditional leaders;
C. graves of victims of conflict;
D. graves designated by the Minister;
E. historical graves and cemeteries; and
F. human remains.

In terms of section 36(3) of the NHRA, "*no person may, without a permit issued by the relevant heritage resources authority:*

a) *destroy, damage, alter, exhume or remove from its original position of otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;*
b) *destroy, damage, alter, exhume or remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or*
c) *bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) any excavation, or any equipment which assists in the detection or recovery of metals*".

Human remains that are less than 60 years old are subject to provisions of the Human Tissue Act (Act 65 of 1983) and to local regulations. Exhumation of graves must conform to the standards set out in the Ordinance on Excavations (Ordinance No. 12 of 1980) (replacing the old Transvaal Ordinance No. 7 of 1925).

Permission must also be gained from the descendants (where known), the National Department of Health, Provincial Department of Health, Premier of the Province and local police. Furthermore, permission must also be gained from the various landowners (i.e. where the graves are located and where they are to be relocated) before exhumation can take place.

Human remains can only be handled by a registered undertaker or an institution declared under the Human Tissues Act (Act 65 of 1983 as amended). Unidentified/unknown graves are also handled as older than 60 until proven otherwise.

Following the completion of the AIA and HIA the coordinates of any such finds were plotted and overlaid on the development proposal to ascertain the extent to which such elements would be impacted upon by the proposed project. The proponent has aimed to minimise the impact on any identified entities throughout the detail design phase and prior to finalising permits for destruction and/or exhumation, which will only be considered in circumstances when mitigation is impossible.

3.8 MAJOR HAZARD INSTALLATIONS

The EIA process assesses impacts on the environment and does not specifically focus on issues of internal health and safety, as these are regulated by other legislation such as the Occupational Health and Safety Amendment Act (Act No. 181 of 1993)[OHSA]. However there are instances in which the application of health and safety regulation is relevant within the domain of impact on the environment. The OHSA regulations include Regulation 1179 (Hazardous Chemical Substances) and Regulation 7122 (Major Hazard Installations). A "hazardous chemical substance" is defined in Government Notice R.1179 Hazardous Chemical Substances Regulations (1995) as any toxic, harmful, corrosive, irritant or asphyxiant substance, or a mixture of such substances for which (a) an occupational exposure limit is prescribed, or (b) an occupational exposure limit is not prescribed; but which creates a hazard to health.

Certain emissions from the proposed Volspruit mine may be seen as potentially creating a hazard to health. In terms of section 8(2d) of the OHSA, 1993 the employers have to establish, as far as is reasonably practicable, what hazards to the health or safety of persons are attached to any work which is performed, any article or substance which is produced, processed, used, handled, stored or transported and any plant or machinery which is used in his business. He shall, as far as is reasonably practicable, further establish what precautionary measures should be taken with respect to such work, article, substance, plant or machinery in order to protect the health and safety of persons. The employer shall, furthermore, provide the necessary means to apply such precautionary measures.

A Major Hazardous Installation (MHI) is defined in terms of the OHSA as an installation:

- "*where more than the prescribed quantity of any substance is or may be kept, whether permanently or temporarily*; or
- *where any substance is produced, used, handled or stored in such a form and quantity that it has the potential to cause a major incident*".

A major incident as referred to above is defined as "*an occurrence of catastrophic proportions, resulting from the use of plant or machinery, or from activities at a workplace*". It is impossible to put a specific value to "catastrophic" because it will always differ from person to person and from place to place. However, when the outcome of a risk assessment indicates that there is a possibility that the public will be involved in an incident, then the incident can be seen as catastrophic [Dept. of Labour 2005]. Certain substances listed in Schedule A of the General Machinery Regulations may possibly be used or stored in quantities exceeding the stated thresholds. Previous expert opinion for existing plants similar to that envisaged, however, stated that the proposed installation has no potential to cause a catastrophe, and no further involvement with the MHI Regulations should be required.

3.9 NOISE

3.9.1 NOISE CONTROL REGULATIONS (R 154 GG 13717 OF 10 JANUARY 1992)

The Noise Control Regulations (R 154 GG 13717 of 10 January 1992) promulgated in terms of ECA, defines:

- Nuisance noise, as "*any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person*"; and
- Disturbing noise, as "*any noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more*".

Regulation 4 states, "*No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof*". In addition, section 28 of NEMA imposes a 'duty of care' on every person who may cause significant pollution to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

The SANS 10103 of 2008 has also laid down recommended sound pressure levels for specific districts and has provided the following continuous noise levels per district, as provide for in Table 3-10 that follows.

Table 3-10: Recommended continuous noise rating levels (SANS 10103 of 2008)

1	2	3	4	5	6	7
	Equivalent continuous rating level ($L_{Req.T}$) for ambient noise - dBA					
	Outdoors			Indoors, with open windows		
Type of district	Day-night L_{Rdn}	Daytime $L_{Req.d}$	Night-time $L_{Req.n}$	Day-night $L_{R.dn}$	Daytime $L_{Req.d}$	Night-time $L_{Req.n}$
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with some workshops, with business premises and with main roads	60	60	50	50	50	40
e) Central business district	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

3.10 VISUAL IMPACT AND SENSE OF PLACE

3.10.1 WESTERN CAPE DEPARTMENT OF AND DEVELOPMENT PLANNING: GUIDELINE FOR INVOLVING VISUAL AND AESTHETIC SPECIALISTS IN EIA PROCESSES

A guideline document was developed by the Provincial Government of the Western Cape: Department of Environmental Affairs and Development Planning (WCDEADP), which is titled: "Guideline for Involving Visual and Aesthetic Specialists in EIA Processes".

This guideline document, which deals with specialist visual input into the EIA process, has been organised into a sequence of sections, following a logical order covering the following:'

- the background and context for specialist visual input;
- the triggers and issues that determine the need for visual input;
- the type of skills and scope of visual inputs required in the EIA process;
- the methodology, information and steps required for visual input;
- finally, the review or evaluation of the visual assessment process.

The following key principles and concepts will be considered during visual input into the EIA process (WCDEADP, 2005):

- An awareness that 'visual' implies the full range of visual, aesthetic, cultural and spiritual aspects of the environment that contribute to the area's sense of place.
- The consideration of both the natural and the cultural landscape and their inter-relatedness.
- The identification of all scenic resources, protected areas and sites of special interest, together with their relative importance in the region.
- An understanding of the landscape processes, including geological, vegetation and settlement patterns, which give the landscape its particular character or scenic attributes.
- The need to include both quantitative criteria, such as 'visibility' and qualitative criteria, such as landscape or townscape 'character'.
- The need to include visual input as an integral part of the project planning and design process, so that the findings and recommended mitigation measures can inform the final design and hopefully the quality of the project.

3.11 GUIDELINES APPLICABLE TO EIA PROCESS

3.11.1 GUIDELINES ON THE INVOLVEMENT OF SPECIALISTS IN THE EIA PROCESS

The Western Cape Department of Environmental Affairs and Development Planning (WC DEADP) has developed policy guidelines around specialist involvement in EIA processes. The guidelines aim to improve the quality of specialist input and facilitate informed decision-making. The guidelines clarify the roles and responsibilities of all role players with regard to specialist input in the EIA process.

These guidelines have been derived to help practitioners draft appropriate terms of reference for specialist input and assist role-players to evaluate the appropriateness of specialist inputs in individual cases. Although these guidelines have been developed by the Western Cape, they can be adopted for use anywhere in the country.

Guidelines that have been considered in terms of the Scoping, Plan of Study for EIA and Preliminary EIA include:

- Guideline for Determining the Scope of Specialist involvement in EIA processes (June 2005)
- Guideline for the Review of Specialist input in EIA processes (June 2005)
- Guideline for involving Biodiversity specialists in EIA processes (June 2005)
- Guideline for involving Hydrogeologists in EIA processes (June 2005)
- Guideline for involving Heritage specialists in EIA processes (June 2005)
- Guideline for involving Visual and Aesthetic specialists in EIA processes (June 2005)
- Guideline for involving Economists in EIA processes (June 2005)
- Guideline for Environmental Management Plans
- Guideline for Involving Social Assessment Specialists in EIA Processes

The full versions of these reports can be downloaded from: http://www.capegateway.gov.za/eng/pubs/guides/G/103381

3.11.2 GUIDELINES APPLICABLE TO PARTICIPATION PROCESSES

Guidelines that have been considered in terms of the Scoping, Plan of Study for EIA and Preliminary EIA include:

- DEA Guideline 4: Public Participation
- DMR Guideline for the compilation of a scoping report with due regard to consultation with communities and interested and affected parties as required in terms of S 10(1)(b), 22(4)(b), and 30 of the MPRDA 2002
- DMR Guideline for consultation with communities and interested and affected parties as required in terms of S 10(1)(b), 16(4)(b), 27(5)(b) as well as S 39of the MPRDA 2002

4. LOCAL SDFS AND IDPS RELEVANT TO THE VOLSPRUIT PROJECT AREA

4.1 MOGALAKWENA LOCAL MUNICIPALITY SPATIAL DEVELOPMENT FRAMEWORK (SDF)

A Spatial Development Framework (SDF) is regarded as an integral part of the Integrated Development Plan (IDP) as required by section 26 of the Municipal Systems Act of 2000 (Act 32 of 2000). In terms of the act, a SDF "*…must include the provision of basic guidelines for a land use management system for the municipality*." However, a SDF is not a one-dimensional map or plan. It seeks to arrange development activities, land uses and the built form - in such a manner that they can accommodate the ideas and desires of people - without compromising the natural environment and how services are delivered (Mogalakwena SDF, 2009).

Further to the statement above, the Waterberg District Municipality SDF, 2009 states that: "*While mining is recognised as a pillar of the local economic base and key job provider, the long term impact thereof should be carefully considered. Current indications are that with the exception of one or two protected areas there is no direct conflict between mining and prospective mining activities and the major tourism and conservation areas in the municipality*."

The above statement clearly indicates that mining is recognised in the SDF as an economic pillar, however, the impact thereof should be carefully considered. The EIA process seeks to better understand and quantify these potential impacts.

The Mogalakwena SDF (2009) states that: "*The increasingly important role of mining in the local economy is recognised by the Council. However, mining is driven by international commodity prices and economic conditions. The Council will therefore support the mining sector in terms of land and services availability but in such a way that it does not take on responsibilities in terms of business risks of the mines*".

The Mogalakwena SDF contains various sections on water; Land use; biospheres etc… and one of the sections in the SDF described "Environmental Features". These features are described as follows: "*The environmental features of the municipal area are dominated by the river and specifically the river buffer along it…. River buffers are ecologically important for the protection of ecosystems and should therefore be avoided and not disturbed through development. In this respect, river buffers should be protected from urban, rural, mining and crop farming activities as far as practically possible.*"

This important statement that river buffers are ecologically important and should be avoided as far as practically possible is noted. It is agreed that river buffers are important, and this is a key aspect evaluated as part of this EIA process, where biodiversity and wetland specialists' reports have guided the impact assessment round these sensitive environmental attributes, looking at the site specific characteristics. It must be considered that if feasible and defensible mitigation measures are implemented, (specifically pertaining the management of the buffer area) that these be considered.

Furthermore, as stated in the section above pertaining to the Waterberg EMF, this SDF is a decision-making tool, which, along with other tools (such as the EMF and EIA) will guide decision-makers in reaching a defensible and realistic decision. These tools together have been used to evaluate the proposed Volspruit mine development.

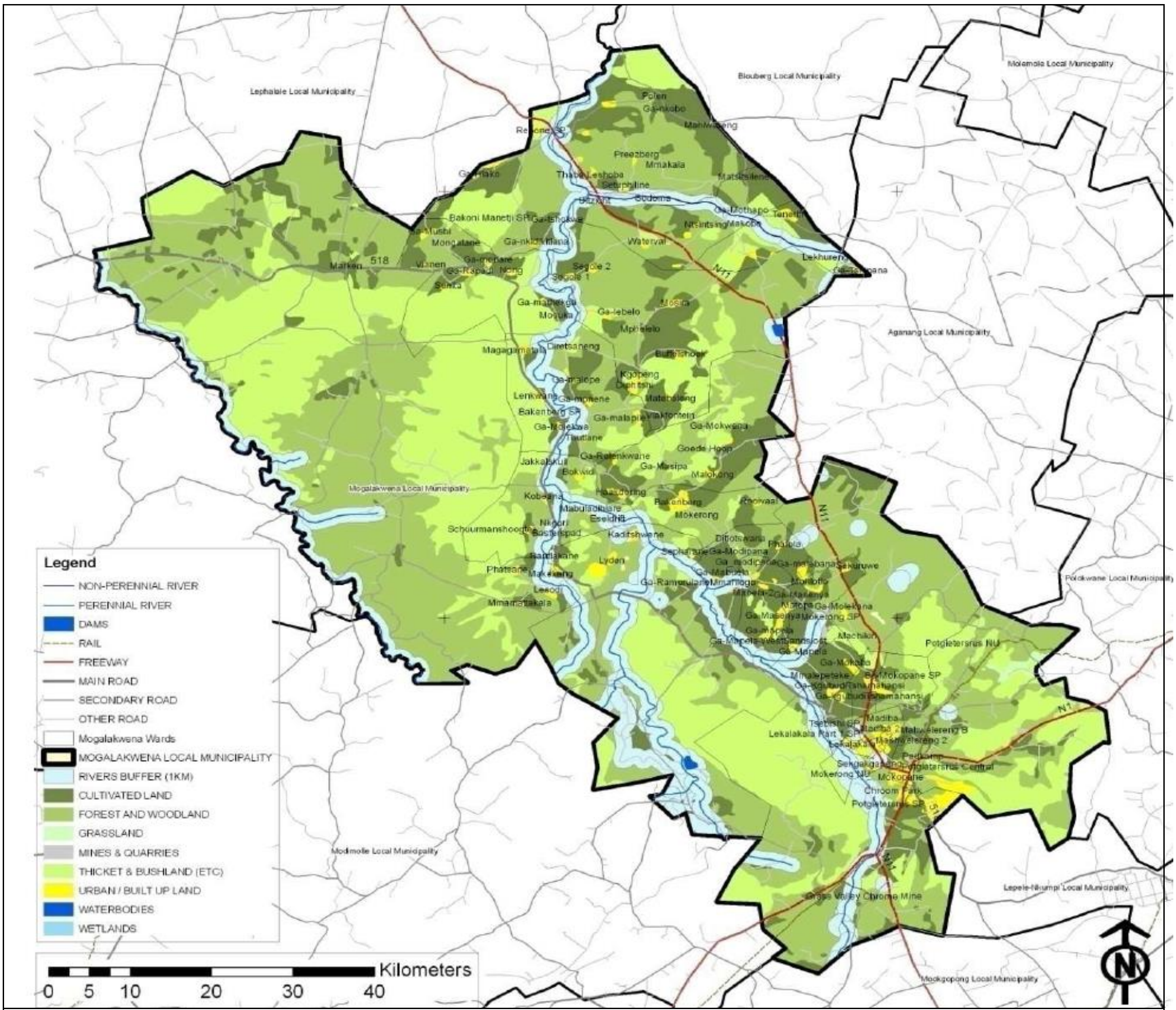


Figure 4-1: Environmental features (Mogalakwena SDF, 2009)

4.2 INTEGRATED DEVELOPMENT PLAN (IDP)

An Integrated Development Plan (IDP) is a management tool for assisting municipalities in achieving their developmental mandates. Every municipality is required by law to develop and adopt its IDP through the legal framework provided (Mogalakwena IDP, 2009).

The Mogalakwena IDP further described the following: "*Minerals can be considered a finite resource. In addition, mineral deposits are also fixed in space (i.e. their geographic location). As such, mineral deposits influence and determine the macro spatial patterns in terms of the location of mining activities and mineral processing activities. It is therefore important to locate and describe those mineral occurrences that can be considered significant in terms of the type of mineral, the degree of the deposit, the current and possible future demand and price levels. The significant mineral deposits can be considered mineral/mining zones that impact and determine land uses. Some of these zones have been, or are being, exploited at present. In cases where no exploitation has taken place as yet, it is important to highlight the location of these particular zones in order to prevent or minimize their sterilization with other land-uses (e.g. urban* *development). The Waterberg District has significant mineral zones with the most important being the Platreef, the Mogalakwena Area and the Mogalakwena tin fields*."

The Mogalakwena IDP also identified this proposed Volspruit mining project, by indicating that: "*The establishment of another Mine (Pan Palladium in joint venture with Impala Platinum) is currently being investigated on the farm Volspruit 326 KP, approximately 20km south of Mokopane. Consultants have been appointed to investigate the environmental and social aspects of the feasibility study. It is envisaged that mineralised ore containing platinum group metals, base metals (nickel and copper) and gold will be extracted*."

As has been determined from the scoping phase of the EIA, water resources on the farm Volspruit and surrounding areas are a key concern and consideration in the entire EIA process. This is further reiterated by the statement in the IDP that: "*Underground water is another key environmental issue that has to be protected*."

In conclusion the IDP identifies the following strategic guidelines that emanate from relevant legislation and need to be taken into consideration:

- avoid pollution and degradation of the environment;
- avoid waste, promote responsible waste management;
- minimize negative impacts on the environment;
- consider consequences of exploitation of non-renewable natural resources;
- avoid placing ecosystems at risk;
- protect vulnerable ecosystems;
- protect biological diversity; and
- protect cultural heritage sites.

The municipality has adopted the following principles in respect of environmental conservation:

- Efficient waste management services;
- Public education programmes;
- Promotion of recycling initiatives/drives;
- Preventative and curative programmes for air and ground pollution;
- Environmental education programmes.

The above guidelines have been considered toward the undertaking of the EIA and development of the draft EMPr for the proposed mine. Environmental protection and minimization of pollution and waste generation are addressed in detail in the EIA phase of the process.

5. PUBLIC PARTICIPATION

5.1 INTRODUCTION

Public participation provides the opportunity for Interested and Affected Parties (IAPs) to participate on an informed basis, and to ensure that their needs and concerns are considered during the impact assessment process. IAPs represent various interests and sectors of society and the relevant organs of state. The Public Participation Process is aimed at achieving the following:

- Provide opportunities for IAPs and the authorities to obtain clear, accurate and understandable information about the expected environmental and socio-economic impacts of the proposed development;
- Establish a formal platform for the public with the opportunity to voice their concerns and to raise questions regarding the project. These issues should be accurately recorded and considered and/or addressed;
- Utilise the opportunity to formulate ways for reducing or mitigating any negative impacts of the project, and for enhancing its benefits;
- Enable project proponent to consider the needs, preferences and values of IAPs in their decisions;
- Clear up any misunderstandings about technical issues, resolving disputes and reconciling conflicting interests;
- Provide a proactive indication of issues which may inhibit project progress resulting in delays, or which may result in enhanced and shared benefits; and
- Ensure transparency and accountability in decision-making;
- Provide local knowledge on the public area;
- Influence project decisions.

Through informed and transparent public participation, effective social and environmental management/mitigation measures can be established and implemented should the project by authorised.

The public participation process to date is discussed below. Refer to Appendix 4: Public Participation Report for further details of -

- The distribution of a project Background Information Document (BID) to a wide range of potentially interested and affected parties (IAPs) and stakeholders;
- The placement of press advertisements and site notices;
- Proof of re-advertisement (press and site notices) and distribution of project scope amendment notifications;
- List of registered IAPs;
- Copies of communications to IAPs and key stakeholders;
- Copies of meeting presentations and associated minutes of meetings; and
- Comments and Responses Report (C&RR);

5.2 IAP NOTIFICATION & CONSULTATION

The first step in the public participation process was to advertise the project as required by the 2010 EIA Regulations, in order to inform potential IAPs of the proposed project and EIA process. This was done by means of the following (Appendix 4: Public Participation Report):

- A Background Information Document (BID) was compiled giving detail on the applicant, the Environmental Assessment Practitioner (EAP), the scope and locality of the proposed project, the EIA process, purpose and process of public participation, and included an invitation to register as IAP and provide comment, as well as an open invitation to the first public meeting;

- Pre-identification of interested and affected parties (IAPs), including adjacent landowners, using existing databases, and distributing the BID to these stakeholders. The BID was also sent to any other IAPs who responded to site or press notifications;
- Advertising the proposed project and associated EIA process in "The Business Day" on Wednesday 6 April 2011, as well as the "The Daily Sun" newspaper on Wednesday 6 April 2011 and "Die Bosvelder" on Thursday 7 April 2011. The advertisements indicated where written comments may be directed to and were placed in English, Afrikaans and North-Sotho.
- Further to the above, a re-advertisement notification was placed in "The Business Day" and "Die Beeld" on Thursday 12 May 2011, as well as in "Die Bosvelder" on Friday 13 May 2011. This re-advertisement notification was done to include the additional smelter complex and air quality legislation relating to the smelter complex;
- A2-size site notices were erected on the site, as well as at selected shops in the town of Mokopane in all 3 languages as stated above.
- An English advertisement was placed in "The Star" on January 6th 2014, advertising public meetings occurring in January 2014. Additionally, both English and Afrikaans advertisements were placed in "The Northern News" on 10th January 2014 for the same public meetings.
- A radio advertisement is scheduled for the 14th January 2014 and the 16th January 2014 on Capricorn Radio (in English) to further announce the public meetings occurring in the following week.

Proof of these advertisements, sending of the BID, proof of site notices, communications with IAPs and others are contained in the public participation report attached as Appendix 4: Public Participation Report to this report.

5.3 COMMENTS AND ISSUES RAISED BY IAPS

The scoping and EIA phases of the project yielded many comments from various IAPs. These comments were collated from submissions to the EAP, as well as questions asked at meetings attended. An EIA phase Comments and Responses Report (C&RR) is contained in the public participation report, which is included in Appendix 4: Public Participation Report hereto.

To date there are in excess of 300 registered IAPs for the project, ranging from *inter alia* direct/adjacent landowners, civil society, farmers, non-governmental organisations (NGO), Local/Provincial and National Government Institutions, community based organisation (CBO), business forums/owners, political organisations, various unions (farmers, mining and otherwise), academics and environmental conservation groups.

The comments received from IAPs to date are extensive and highly varied in nature. Concerns around the project's potential impacts on surface- and groundwater quality, as well as, the continued availability to down-stream users, has emerged as a dominant theme amongst the comments/concerns received. Further extensive concern has been raised by IAPs to date, around the potential impacts that the project may have on the biodiversity and ecosystem functioning of the Nyl river, its associated floodplain wetland and the Nylsvley Nature Reserve (a Ramsar site 40km up-stream of the project site). These concerns were raised in relation to the potential indirect impact of potential pit dewatering and possible groundwater pollution arising from the proposed mining activities. The overwhelming majority of comments and representations received from IAPs to date express opposition to, and concerns around, the proposed mining activities.

A preliminary comments and response report included as part of the EIA report (which covers comments and responses from the previous public comment period as well as for the period 13th January up to 28th January 2014. The final comments and responses report will then be submitted to the DMR on or by the 22nd February 2014 and to LEDET on or by the 21st March 2014.

5.4 PUBLIC PARTICIPATION – MEETINGS HELD TO DATE

During the months from March 2011 to April 2012, various public participation process (PPP) meetings were held with conservation NGOs, stakeholders, farmers, landowners and the general public as part of NEMA EIA application LEDET EIA Ref No: 12/1/9/2-W11 and prior MPRDA Application DMR Ref No LP30/5/1/2/2/10016MR (note that this application was withdrawn as the required specialist studies could not be completed within time and application was resubmitted in terms of MPRDA).

Additional public participation meeting were held by EScience Associates between 2013 and early 2014 as part of NEMA EIA application LEDET EIA Ref No: 12/1/9/2-W11 and prior MPRDA Application DMR Ref No LP30/5/1/2/2/10068MR.

For detailed record of public participation meetings held please refer to Appendix 4: Public Participation Report. A summary of meetings held are set out below:

1. On 31 March 2011, a Key Stakeholder meeting was held at the South African National Biodiversity Institute (SANBI) in Pretoria, where key non-governmental stakeholders were invited to attend. Attendees included SANBI, Friends of Nylsvley, Endangered Wildlife Trust (EWT) and the International Mire Conservation Group. Birdlife South Africa was also invited, but could not attend. Minutes and Notes made at this meeting are contained in the Stakeholder & Public Participation Report in Appendix 4 to this report.
2. EScience Associates and Sylvania were invited by the Limpopo Wetland Forum to give a presentation on the Volspruit Mine project to the Limpopo Wetland Forum meeting at Potlake Nature Reserve in Limpopo Province on 12 April 2011. The questions posed at that meeting are contained in the comments and responses report, which is included in Appendix 4: Stakeholder & Public Participation Report.
3. On 19 April 2011, EScience Associates were invited to give a presentation of the project to the Mokopane Farmers. This meeting was not a formal public participation meeting, but a meeting arranged by the Mokopane Farmers, to which EScience was invited to present. The questions which came out of this meeting, after the presentation was given, are included in Appendix 4: Stakeholder & Public Participation Report.
4. On 27 July 2011, EScience Associates held a focus group meeting, specifically for Volspruit and Zoetveld property owners and directly affected farmers surrounding the two farms. The meeting was held at Kanniedood Guest House close to the farm Zoetveld. The minutes of the meeting and presentation given are included in the Stakeholder & Public Participation Report (Appendix 4).
5. On 28 July 2011, EScience Associates held a Public Meeting at Protea Hotel: The Park, in Mokopane. This meeting was open to any member of the public interested in the proposed project. The minutes of the meeting and presentation given are included the Stakeholder & Public Participation Report (Appendix 4).
6. On 31 August 2011, Mr Brian Gardner held a meeting with Dr Piet Prinsloo, who represented a number of concerned Mookgopong stakeholders especially with regards to groundwater related issues. The minutes/notes taken at this meeting are presented the Stakeholder & Public Participation Report (Appendix 4).
7. On 24 April 2012 ESA held a focus group meeting was convened with affected farmer and landowners at the Kanniedood Guesthouse close to the farm Zoetveld. The meeting was intended to provide an update to the invitees around the specialist investigations being undertaken for the EIA. The minutes of the meeting and presentation given are included the Stakeholder & Public Participation Report (Appendix 4).

8. On the 7th October 2013 ESA held a focus group meeting with affected farmers and landowners at the Kanniedood Guesthouse close to the farm Zoetveld. The meeting was intended to provide an update to the invitees around the specialist investigations being undertaken for the EIA. The minutes of the meeting and presentation given are included in the Stakeholder & Public Participation Report (Appendix 4). These minuets were revised to direct comments made concerning this meeting
9. On the 29th October 2013 ESA held a focus group meeting with affected farmers and landowners, as well as, conservation group, at the Kanniedood Guesthouse close to the farm Zoetveld. The meeting was intended to provide an update to the invitees around the specialist investigations being undertaken for the EIA. The minutes of the meeting and presentation given are included in the Public Participation Report (Appendix 4). These minutes were revised to the direct complaints made concerning this meetings minutes.
10. On 20 January ESA held a conservation focus group meeting at The Pretoria Botanical Gardens. The meeting was open to the invitees to give presentations of the outcomes of the further specialist studies undertaken and to give a summary of the conclusions come to by the EAP as well as the way forward regarding the EIA process. Focus was given to conservation relevant topics such as avifauna and wetland impacts. The minutes of the meeting and presentation given are included in Appendix 4: Stakeholder & Public Participation Report.
11. On 21 January ESA held a Farmers/ Landowners focus group meeting at the Kanniedood Guesthouse close to the farm Zoetveld. The meeting was open to the invitees to give presentations of the outcomes of the further specialist studies undertaken and to give a summary of the conclusions come to by the EAP as well as the way forward regarding the EIA process. The focus was broad due to the concerns of the landowners being broad, but groundwater impact was given the most focus. The minutes of the meeting and presentation given are included in Appendix 4: Stakeholder & Public Participation Report.
12. On 22 January ESA held a Grassroots Community focus group meeting at Protea Hotel: The Park, in Mokopane. The meeting was aimed at grassroots community and focus was given to the social and labour plan intended to be implemented by Sylvania should the project be approved. The conclusions of the EIA were explained. The minutes of the meeting and presentation given are included in Appendix 4: Stakeholder & Public Participation Report.
13. On 23 January ESA held a public meeting at Protea Hotel: The Park, in Mokopane. This meeting was open to any member of the public interest in the proposed project. The meeting was open to the invitees to give presentations of the outcomes of the further specialist studies undertaken and to give a summary of the conclusions come to by the EAP as well as the way forward regarding the EIA process. The minutes of the meeting and presentation given are included in Appendix 4: Stakeholder & Public Participation Report.
14. On 24 January ESA held a public meeting at De Beer conference venue in Mookgopong. This meeting was open to any member of the public interest in the proposed project. The meeting was open to the invitees to give presentations of the outcomes of the further specialist studies undertaken and to give a summary of the conclusions come to by the EAP as well as the way forward regarding the EIA process. The minutes of the meeting and presentation given are included i in Appendix 4: Stakeholder & Public Participation Report.

5.5 MEETINGS HELD WITH COMPETENT AUTHORITIES AND GOVERNMENT DEPARTMENTS

To date six (6) meetings have been held with the leading competent authority for the EIA process, which is LEDET.

1. The initial meeting on 10 March 2011 was to outline the project to LEDET and submit the EIA application forms.
2. The second authority meeting held at LEDET on 2 June 2011 was aimed at clarifying various aspects around environmental legislation, guidelines and policies, and how these are to be dealt with during the compilation of the scoping report and in context of the entire EIA process.
3. A site visit undertaken by ESA with LEDET officials on the 8th of May 2012. This site visit was convened at LEDT's request.
4. A meeting with the Limpopo Department of Agriculture was also held on 22 August 2011 to discuss the direct issues that this department has with the proposed Volspruit mine project, with specific reference to the impact on Agricultural land and agricultural practices in the area.
5. A meeting was also held with the Mogalakwena Municipality on 27 July 2011 at 10:00. This meeting was primarily to discuss the project directly with the municipality.
6. A further meeting on 30 September 2011 was held in Polokwane with the Department of Water Affairs.
7. An additional Authorities meeting was held on the 3rd December 2014. This meeting was called by EScience Associates on the request of Dr Shaker (affiliated to Mokopane Municipality).
8. A further Authorities meeting is planned in mid-February to assist authorities to comment on the EIA document

The minutes of these meetings as discussed above (and the presentation given at the first meeting) are provided in section 2.5.7 of the Appendix 4: Stakeholder & Public Participation Report.

5.6 EIA PHASE ENGAGEMENTS

An initial draft environmental impact assessment report (EIR) and draft environmental management programme report (EMPR) were made available to stakeholders for comment from 30 November 2012 to 15 January 2013. The referenced workshops and public meeting were held on 6 and 7 December 2012 respectively, so as to allow for an initial stakeholder review of the draft EIR and EMPR prior to convening these meetings / workshops.

The draft EIR and EMPR were also made available to LEDET and the DEA, and other state departments with jurisdiction (key commenting authorities) in line with the requirements of the 2010 NEMA EIA Regulations. As a result of the complexity of additional work required, and the lack of a flood event occurring within the constraints of the MPRDA EIA timeframes, the EIA process could not be concluded to the extent that an informed and defensible decision could be recommended by the EAP and specialists in terms of the MPRDA Application Ref No LP30/5/1/2/2/10016MR within timeframes required by the DMR.

Although both the proponent and EAP sought to obtain extension in terms of MPRDA application ref no LP30/5/1/2/2/10016MR, as a result of the restrictive provisions of the MPRDA EIA Regulations the DMR could only allow extension to the 4th of May 2013, as a result of the lack of a flood materialising in this restricted period as and the complex nature of the additional work that had to be undertaken, the work required to be able to make an informed decision, could not be completed within the timeframes as stipulated by the MPRDA.

The proponent thus had to reapply in terms of the MPRDA Regulations and a new updated Scoping report was issued in terms of DMR Ref No LP30/5/1/2/2/10068 MR and additional specialist work undertaken. The Scoping report was released in to the public domain on the 6th September 2013. The scoping period was available for comment from Friday 6 September 2013 to Sunday 6the October 2013.

The DMR stipulations require the EAP to conduct the EIA and finalise the EMP, on or before, the 28th January 2014. The comment period for this draft EIA report runs from 13 January 2014 to the 13 February 2014. By the 22 February 2014 the draft EIA report will be resubmitted to the DMR to include any additional comments made between the 28th January 2014 and the 13th February 2014.

EIA & EMPR ↓	Draft EIA and EMP report issued to IAP's for comment	14 January 2014
	Public meetings	23-24 January 2014
	EIA report issued to the DMR	28 January 2014
	EIA and EMPR comments period closed for submission to the DMR	13 February 2014
	Comments and response report updated and submitted to the DMR	22 February 2014
	EIA and EMP comment period closed for submission to LEDET	13 March 2014
Final EIA and EMPR ↓	Comments and responses report updated and submitted to LEDET	21 March 2014
	Authority decision-making	April, May, June 2014
Decision and appeals	Appeal period (Chapter 7 – 2010 NEMA EIA Regulations)	July / August 2014

5.7 DECISION MAKING PHASE

Once the relevant authorities have made a decision about the proposed project, IAPs will be notified of this decision.

6. DESCRIPTION OF THE RECEIVING ENVIRONMENT

6.1 CURRENT ONSITE ACTIVITIES

Commercial agricultural activities are undertaken on the farms directly affected by the proposed mining activities (i.e. the farms Volspruit and Zoetveld), as well as on the majority of the adjoining farms in the study area. The commercial farming activities are the main income for the majority of the farmers that reside in the region. The main agricultural activities include crops, citrus, cattle, pigs and game farming.

Crop farming on the subject farms includes the production of maize for seeds, sugar beans, butter beans, bake beans, wheat, and sunflower. Lucerne, corn, sugar grace, and goroh are also grown for cattle and game feed. The use of irrigation in the area is quite extensive; importantly it allows farmers to grow crops during both winter and summer months. Crop production is based on a system of seasonal rotation.

There are approximately 105ha of irrigated cropland on Ptn. 1 of the farm Volspruit 326 KR, of which approximately 3ha is year round lucerne. There is also approximately 105ha of irrigated cropland on Ptn. 2 of the farm Volspruit 326 KR, of which about 33ha is year round Lucerne. Cattle and game farming are also undertaken on the subject farm portions, with game farming being more pronounced on Ptn. 2 thereof.

There are homesteads located on each of the affected farm portions. There are also workshops, stores, staff quarters and other structures and infrastructure (e.g. concrete reservoirs, water pumps, sheds) supportive of the commercial agricultural activities on each of the subject properties.

6.2 LAND-USE AND LAND-COVER OF THE STUDY AREA

The general land cover of the study area indicates that a significant portion of the farm Volspruit 326 KR consists of cultivated land under irrigation, and the remainder of natural vegetation and low ‘koppies’. The Nyl River flows through the property from south to north, with roughly two-thirds of the farm located east from this river. The farm Zoetveld on the other hand is characterized chiefly by indigenous bushveld vegetation, with localized areas to the south east and northwest thereof having been disturbed by previous agricultural activities (Figure 6-1, Figure 2-1).

The regional use of land on the surrounding properties is predominantly crop agriculture, cattle grazing and game farming. The abandoned Grass Valley Chrome mine is located on the north-eastern border of the farm Zoetveld 294 KR.

The main agricultural activities include crops, citrus, cattle, and game farming. Each farming activity is summarised below:

Game farming: Half of the farms in the surrounding the proposed mine site area undertake game farming, although most of the farms in the area tend to combine game farming activities with other agricultural activities, such as cattle farming or crop production. Only three farms in the area appear to derive their primary income from game farming. One of which derives their income primarily from breeding with rare game species and the other two from game hunting. The rest of the farms that have game either hunt it privately or have day hunters accompanied by Professional Hunters (PH) but do not rely on these activities as their main income sources. The majority of the farmers in the area have buck species (i.e. kudu, gemsbok, rooibok, blouwildbees, etc.). From information obtained, only

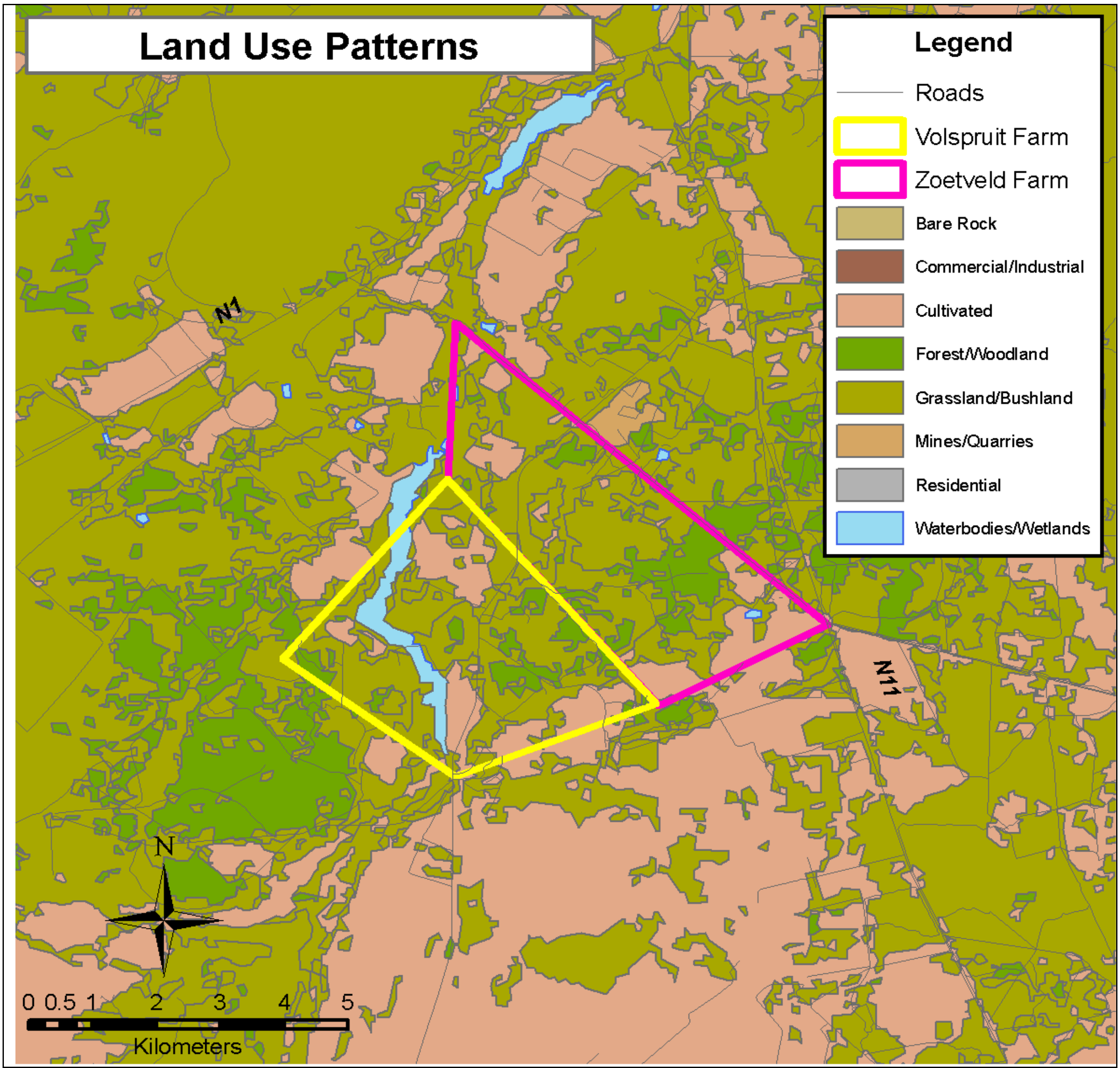


Figure 6-1: Land-use patterns on the farms Volspruit and Zoetveld, as well as surrounding areas.

one farm in the area has selected Big Five species. A number of farmers have built camping facilities on the edge of the Nyl River for tourist to camp and to enjoy the natural environment and to supplement their other income sources.

Cattle and pig farming: Cattle farming is taking place on about half of the farms surrounding the proposed mine site. The majority of the cattle are used for the production of red meat, or as stud bulls. There are no dairy farmers on the surrounding farms. Farms that undertake cattle farming that border with the Nyl River use water from the river to water their cattle. Cattle farmers also make use of the irrigated crop production to feed their cattle in winter months. A couple of farms in the area have pig farms and one of the farms also has an abattoir established on its premises.

Crop farming and vegetable farming: Crops are being produced by about half of the farms surrounding the proposed mine site. Crop production in the region includes maize for seeds, sugar beans, butter beans, bake beans, wheat, and sunflower. Lucerne, corn, sugar grace, and goroh are also grown for cattle and game feed. Some farms also grow vegetables such as tomatoes, cabbage and butternut. The majority of the farmers make use of irrigation (from the Nyl River and boreholes) and only a small number of farmers rely on the rain. The use of irrigation in the area is quite extensive; importantly it allows farmers to grow crops during both winter and summer months.

Citrus farming: Only one of the farms surrounding the proposed mine site produces citrus. Citrus includes predominantly oranges that are being exported to the local markets, as well as Europe. It must be noted that there are very strict regulations that citrus farmers have to comply with if they want to export their products to Europe.

Other farming: A few farms in the area are business establishing olive groves and pecan nut groves. Revenues from these activities will though be reached only a few years time once the trees in the groves reach fruit-bearing stage.

6.3 REGIONAL CLIMATE

The proposed site is located in the summer rainfall region of Southern Africa with precipitation usually occurring in the form of convectional thunderstorms. Rainfall is during the summer months and averages 95mm per month. The mean annual rainfall is 625mm per annum.

The Waterberg experiences warm mean annual temperatures of around 19 ˚C. Hot summers (November to February) occur with maximum temperatures reaching the low thirties (30 ˚C) and minimums in the high teens (˚C). Mean summer temperatures are in the low twenties (Figure 6-2).

The coolest temperatures occur in winter months between May and August. Maximum temperatures reach low twenties (˚C) and minimum temperatures drop to single digits, occasionally dropping below 0 ˚C. Mean winter temperatures are in the low teens (Figure 6-2).

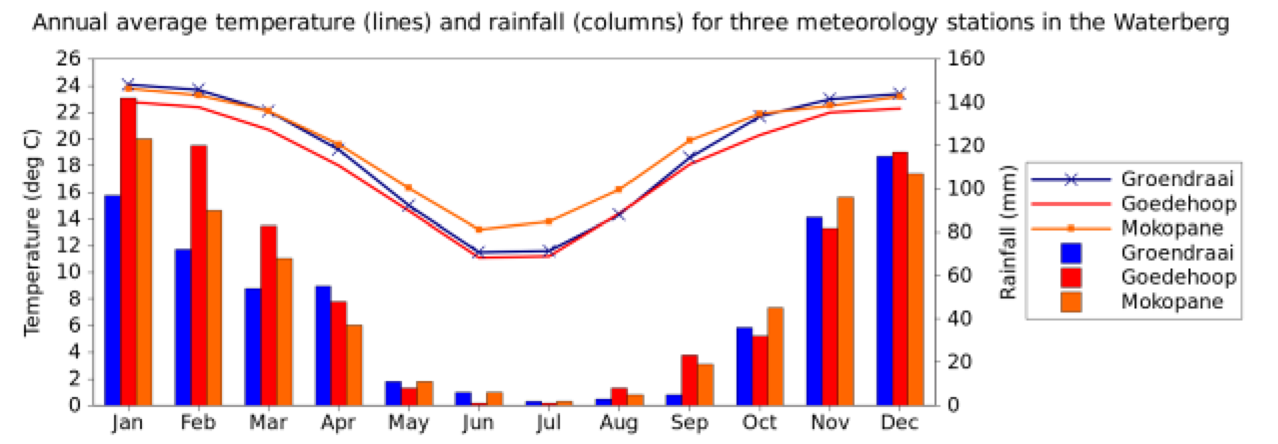


Figure 6-2: Climatological monthly means of temperature and rainfall for three meteorological stations near the proposed site.

6.3.1 LOCAL WIND PATTERNS

Overall, the Limpopo province experiences the lowest mean annual wind speeds in South Africa (Kruger, 2011). Winds are mostly light, between 7 and 14 km/h (2-4 m/s). Strong gusts of 40 km/h (12 m/s) do occur, but mostly in conjunction with thunderstorms and are short lived (Kruger, 2010). The wind direction at the proposed site is influenced by the topography of the hills and valleys associated therewith (Figure 6-4, Figure 6-5). Mokopane is situated in a North-South Valley and northerly flow is typically channelled down this valley toward the south (Figure 6-3).

The proposed Volspruit mine site is situated south of the abovementioned valley, which has a left-hand 'kink' in it, causing winds over the subject site to be North-Easterly (Figure 6-3). The CALMET modelling package was used to more appropriately simulate the prevailing wind direction and strength over the Volspruit mine site (Figure 6-3).

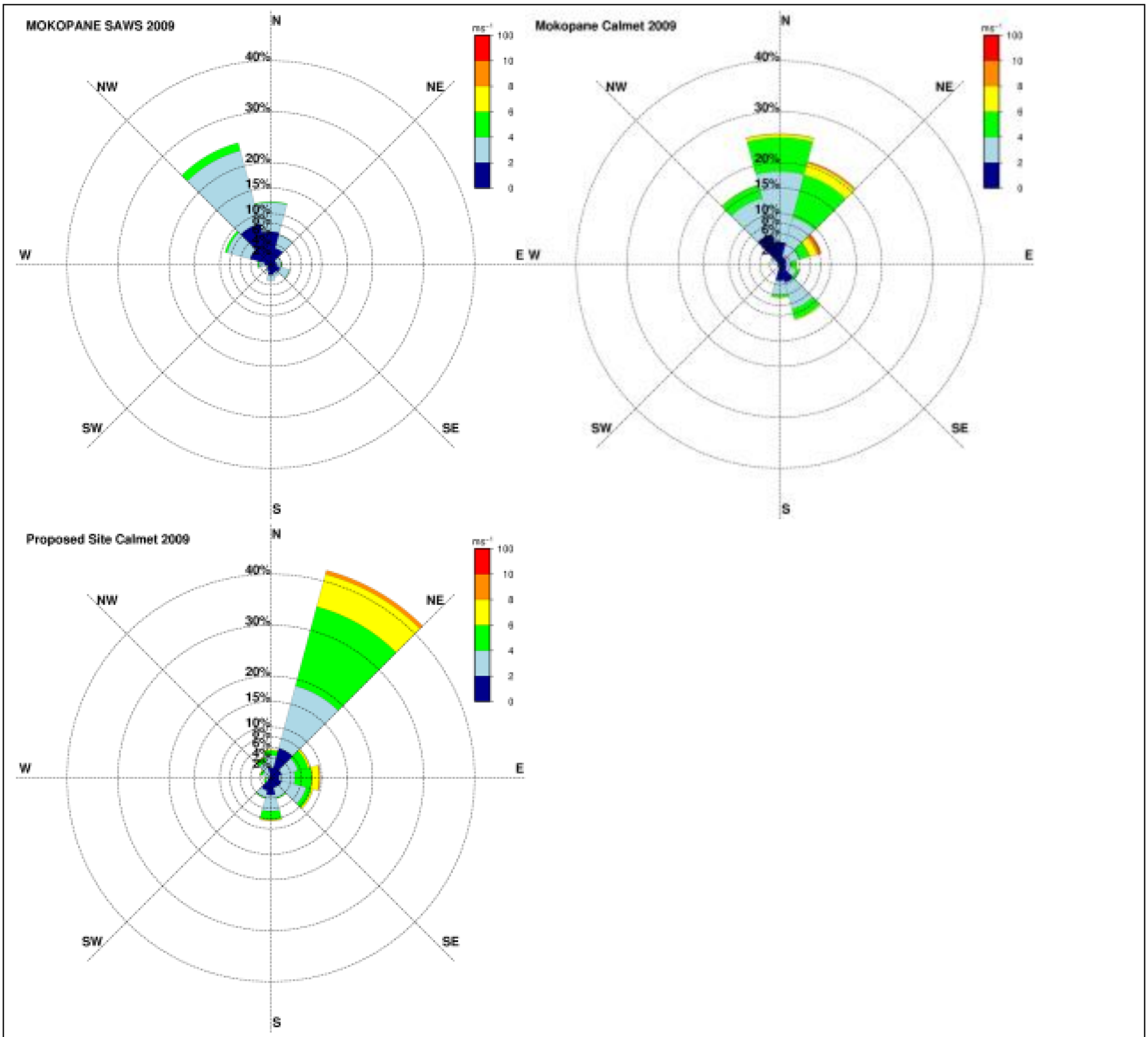


Figure 6-3 : Annual wind rose plots for Mokopane produced from (top left) observed 2008 SAWS data (top right) CALMET modelled data (2009), and for the proposed site (bottom left) from CALMET 2009.

6.4 TOPOGRAPHY

The study area lies on the flats to the east of the Nyl River. The terrain is very gently sloping towards the river in the west. There is also a small 'koppie' in the north-eastern corner on the boundary of the site, as well as a larger koppie in the middle of the site. The elevation ranges from 1061 to 1 113 mamsl across the study site.

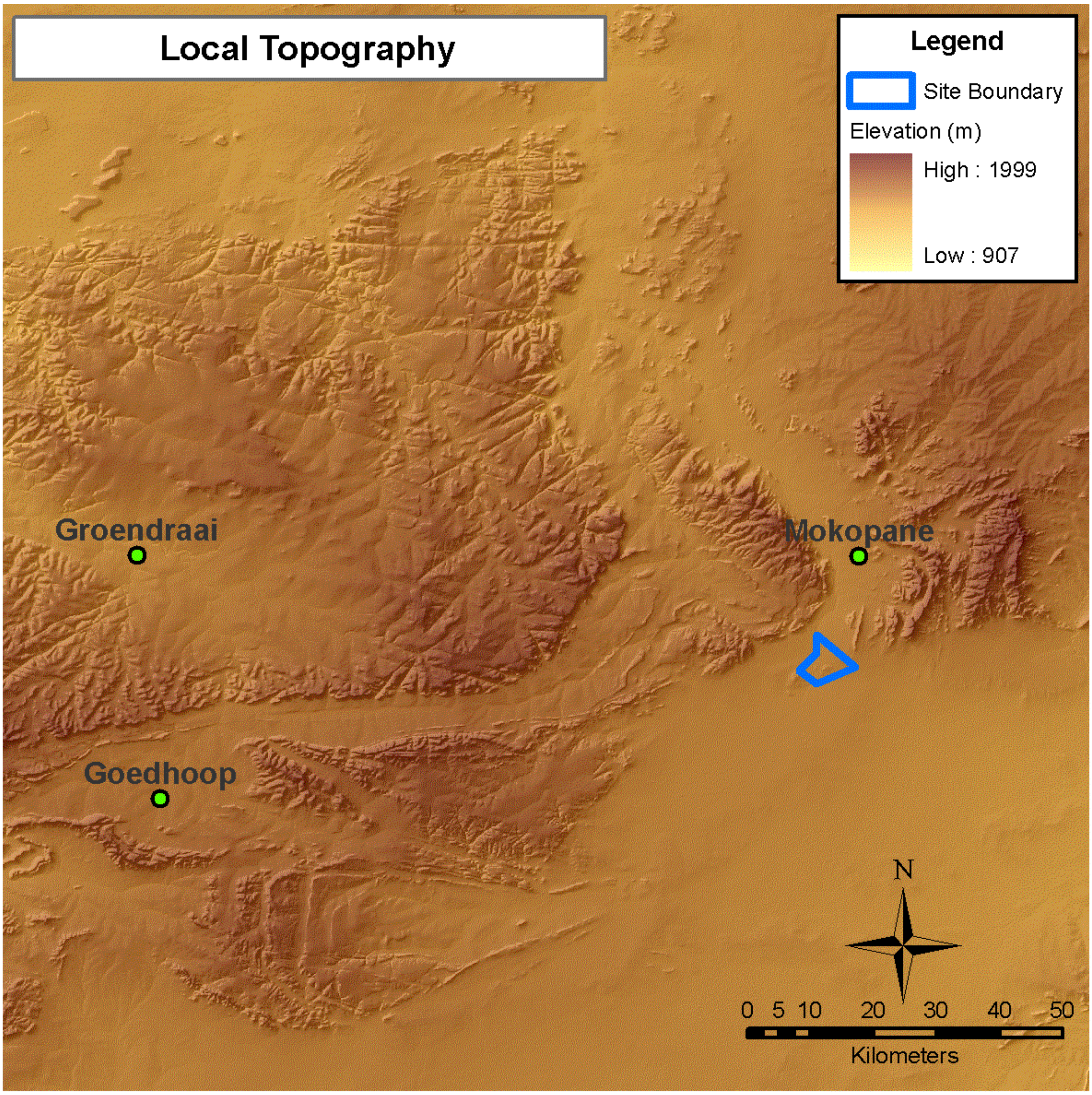


Figure 6-4: Digital Elevation data (USGS) at 30 second Arc spacing (1km resolution) over the proposed location of the Sylvania mine

6.1 GEOLOGY

6.1.1 REGIONAL GEOLOGY

The Bushveld complex consists of the eastern, western, northern and southern limbs as well as satellite outcrops at Nietverdiend (far west) and Villa Nora (far north). According to dating of the rocks, they fall partly into the Vaalian Erathem and partly in the Mokolian Erathem. The main Bushveld igneous complex intruded into rocks of the Transvaal

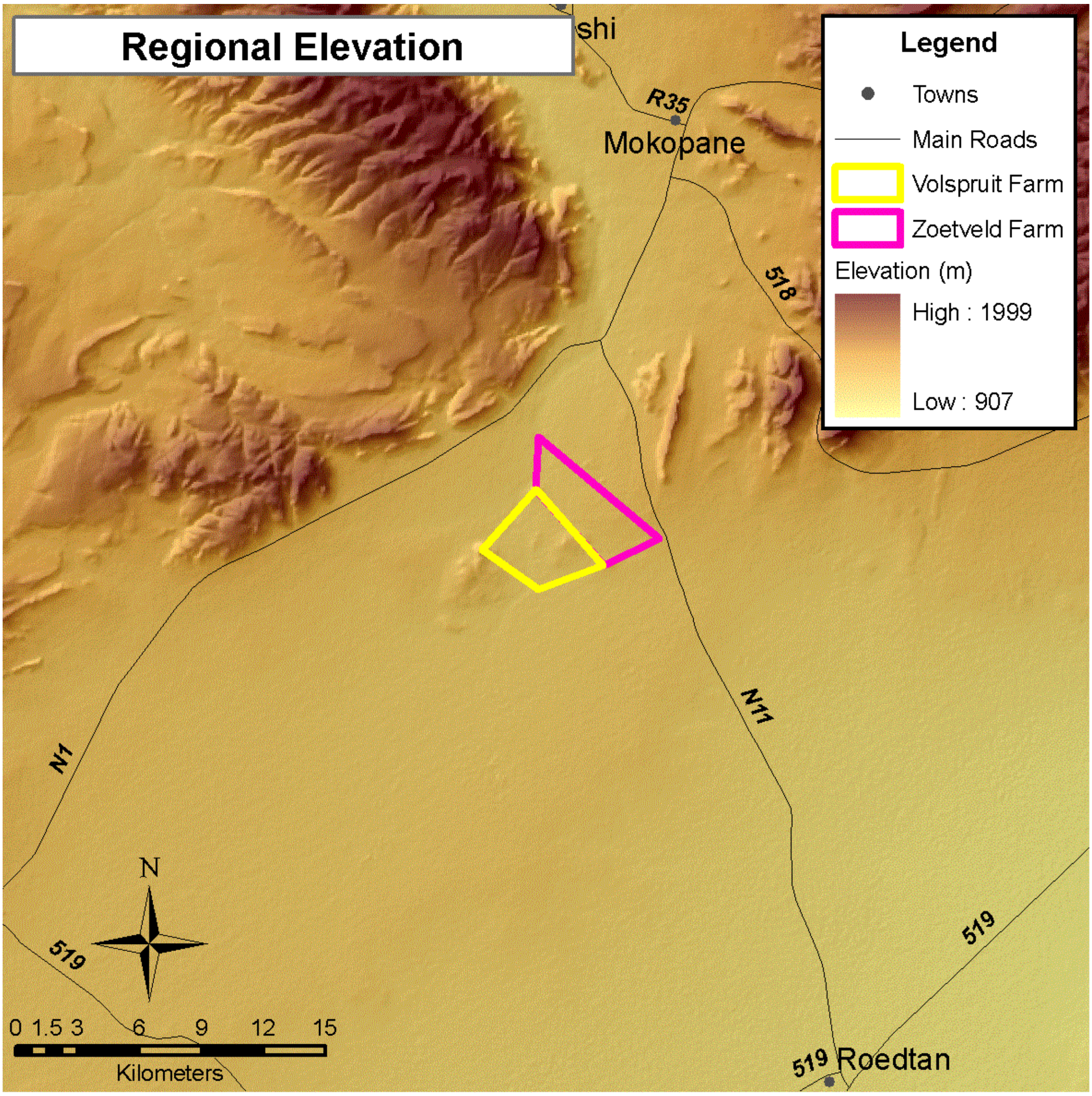


Figure 6-5: Digital Elevation data (USGS) at 30 second Arc spacing (1km resolution) over the proposed location of the Sylvania mine

Supergroup, largely along an unconformity between the Magaliesberg quartzite of the Pretoria Group and the overlying Rooiberg felsites. The total extent of the Bushveld complex is approximately 66 000km2, just over half of which is covered by younger formations (IGS, 2010).

The Volspruit Project is situated on the northern limb, where the mafic rocks have a different sequence to those of the eastern and western limbs. Furthermore, the Bushveld rocks transgress the Transvaal Supergroup from the Smelterskop and Magaliesberg formations in the south to the ironstones of the Penge formation further north, the dolomites of the Malmani Subgroup and eventually resting on the Archaean Turfloop granite in the extreme north (IGS 2010).

The mafic rocks of the Bushveld complex host layers rich in Platinum Group Elements (PGEs), chromium and vanadium, and constitute the world's largest known resource of these metals. In addition, nickel and copper are generally associated with the deposits and are significant by-products. The mafic rocks of the eastern and western limbs (collectively termed the Rustenburg Layered Suite) have been divided into five zones known as the Marginal, Lower, Critical, Main and Upper Zones, from the base upwards.

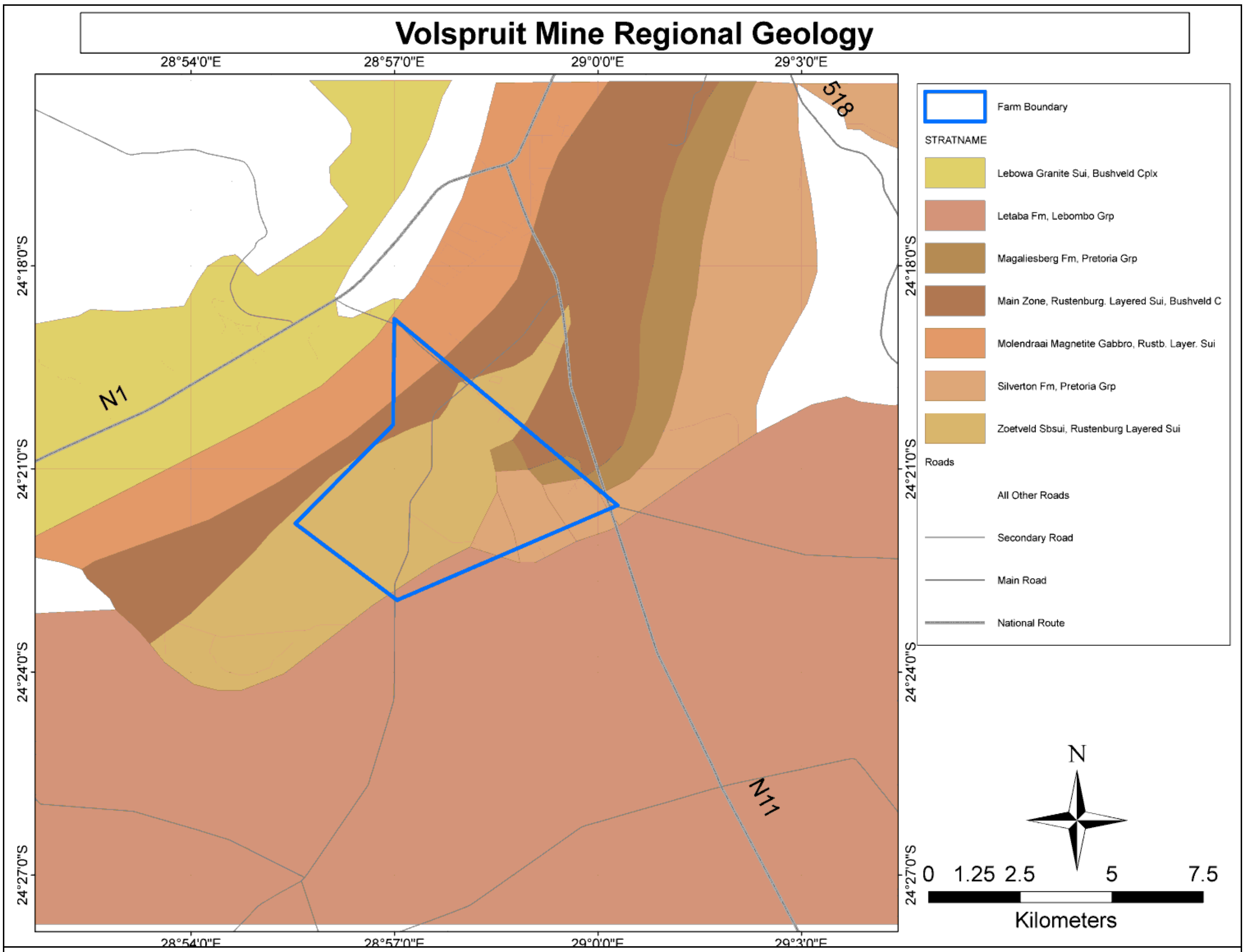


Figure 6-6: Regional geology of the Volspruit area (adapted from MetroGIS, 2010)

6.1.2 SITE GEOLOGY

The rocks underlying the Volspruit Project comprise cumulates of the Lower Zone of the Rustenburg Layered Suite of the Bushveld complex and its immediate floor rocks consisting of the Transvaal Supergroup. The succession is dominated by ultramafic cumulates which range in composition from dunites and harzburgites to orthopyroxenites (IGS, 2010).

The zone of PGE and base metal sulphide mineralisation which has been targeted by the Volspruit exploration (informally referred to as the Volspruit PGE-Ni Reef) is hosted in pyroxenites (orthopyroxenites cumulates) in the lower portion of the upper Volspruit subzone. This zone usually occurs several tens of metres above an approximately 100m thick zone of harzburgites (olivine cumulates), which is the only significant sequence of harzburgites in the Volspruit subzone (IGSM 2010).

The current distribution of the various Lower Zone units is controlled by several major episodes of post and possibly syn-Bushveld faulting. Outcrop is extremely poor in the Volspruit area and structure is best revealed by the aeromagnetic data acquired by IGS. Faulting most likely occurred in three phases: an initial, block faulting episode (reverse-faulting) resulted in horsts of Lower Zone being emplaced into the upper portions of the Rustenburg Layered Suite and into higher sediments. The second generation of faulting, along a WNW-ESE trend, was also reverse faulting, resulting in a stepped arrangement in the Rustenburg Layered Suite. The third phase of faulting along a south-westerly trend resulted in the uplift of wedges of Transvaal sediments into the Rustenburg Layered Suite (IGS 2010).

Contamination of the sequence by partly digested country rock xenoliths and by melts of floor rock litho-types is more common in the footwall harzburgite than in the pyroxenitic sequence. Often a coarse-grained to pegmatoidal feldspathic pyroxenite/norite is encountered that may contain coarse nuggets of sulphide (IGS, 2010).

The ore body has a fairly flat lying disposition: the ore zone is shallowest in the north-east, but down-faulted to the south and west to a depth of approximately 70 to 90 metres at the south-western extent of the body. The eastern and southern margins of the body are fault-bounded; exploration of the western edge is constrained by the floodplain of the Nyl River; the property boundary defines the northern limit of the body (IGS, 2010).

6.2 SOILS

The dominant soil types in the area are Hutton (Hu) and Glenrosa (Gs) (Figure 6-7). The area is mainly Hutton form soils with variable depth, with small Katspruit areas near the river, while Mispah and Glenrosa form soils are generally found in the elevated areas.

There are three land types on the site. The land type that covers most of the site is the Ae land type (Land Type Survey Staff, 1987). There are also two smaller areas of the Ca land type and the Bd land type. Ae land type refers to yellow and red soils without water tables belonging to one or more of the following soil forms: Inanda, Kranskop, Magwa, Hutton, Griffin, Clovelly. The Ae land type consists of red, high base status, > 300mm deep soils (MacVicar *et al*. 1974).

The main geology that influences the soil types present in the area is quartzite, which gave rise to the sandy soil in the study area. Most of the soils in the area are very sandy, while in other areas the soil texture changes to mostly sandy loam soil. The higher clay contents are probably due to the surrounding geology that is more basic.

A specialist soil scientist was commissioned to the EIA team to undertake, *inter alia*, a delineation of the different soil forms present over the study area, as well as to provide specialist inputs around the agricultural potential thereof. The study delineated seven primary soil forms over the study area (Figure 6-7); where the Hutton soil form width depths greater than 50cm is deemed to have high agricultural potential. The full 'Soil Survey and Land Capability Assessment Report' is attached hereto in Appendix 5.8.

6.3 BIODIVERSITY

The services of an integrated team of terrestrial-, avifaunal-, aquatic and wetland ecologists were commissioned to the greater EIA project team to assist in determining an ecological/biodiversity *status quo* for the study site, as well as to assist in identifying potential impacts thereon due to the project proposal. Copies of the specialist Avifaunal- (bird) and Biodiversity Assessment Reports are attached hereto under Appendix 5.12 and Appendix 5.7 respectively. This specialist report details, *inter alia:*

- Plant and animal life either known, or anticipated, to occur over the subject site;
- Sensitive vegetation types/habitats and ecosystems occurring on the site; and

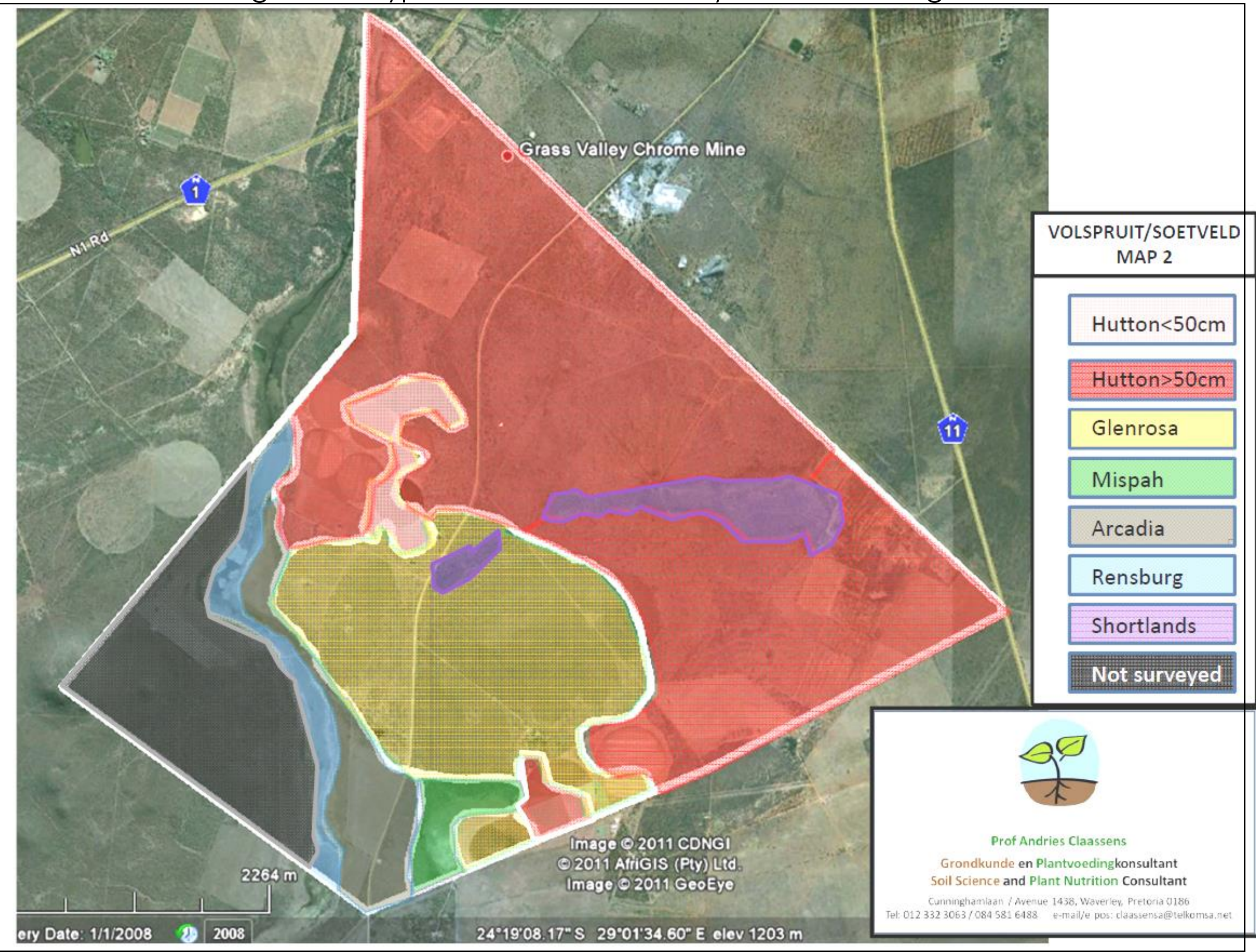


Figure 6-7: Delineation of Site Soils

- The present ecological state, as well as the ecological importance and sensitivity of wetlands and aquatic environments identified on the site.

6.3.1 VEGETATION TYPE(S)

The study area falls within the Savannah Biome (Rutherford & Westfall 1986, Mucina & Rutherford 2006). The most recent and detailed description of the vegetation of this region is part of a national map (Mucina, Rutherford & Powrie, 2005; Mucina *et al*. 2006). This national map shows three vegetation types occurring in the study area, all of which occur within the study site, namely i) Central Sandy Bushveld, ii) Subtropical Freshwater Wetlands and iii) Springbokvlakte Thornveld (Figure 6-8).

Springbokvlakte Thornveld is classified as an Endangered vegetation type in the original publication where it is described (Rutherford et al. 2006) and is listed in the Draft National List of Threatened Ecosystems (GN 1477 of 2009, published under the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)) as Vulnerable. The listing criteria in the Act are more rigorous than in the scientific publication. The natural vegetation on site is therefore considered to potentially have high conservation status.

The area of Springbokvlakte Thornveld on site is, however, restricted to a small part of the southern part of the site where there is existing disturbance. This vegetation type is therefore considered to not occur on site in any natural undisturbed form.

Central Sandy Bushveld

This vegetation type occurs in low undulating areas, sometimes between mountains and sandy plains and catenas. The vegetation is a tall, deciduous *Terminalia sericea* and *Burkea africana* woodland on deep sandy soils and low, broad-leaved Combretum woodland on shallow rocky or gravelly soils. The understory is a grass-dominated herbaceous layer with relatively low basal cover. There are two known Central Bushveld endemics in this vegetation (Mucina *et al*. 2006), the grass *Mosdenia leptostachys* and the herb *Oxygonum dregeanum* subsp. *canescens* var. *dissectum*. At a national scale this vegetation type has been transformed approximately 24% and only 2% is conserved of a target of 19%; it is therefore considered to be a vulnerable vegetation type (Mucina *et al*. 2006).

Springbokvlakte Thornveld

This is an open-to-dense, low thorn savannah dominated by Acacia species or shrubby grassland with a very low shrub layer karroid shrubland occurring on flat to slightly undulating plains. Dominant species include the small trees, *Acacia karroo, Acacia luederitzii, Acacia nilotica, Acacia mellifera and Ziziphus mucronata*, the tall shrubs, *Rhus engleri* and *Euclea undulata*, the low shrubs, *Acacia tenuispina* and *Ptycholobium plicatum*, and the grasses, *Aristida bipartita, Dichanthium annulatum, Ischaemum afrum* and *Setaria incrassata*. There is one known Central Bushveld endemic in this vegetation (Mucina *et al*. 2006), the grass *Mosdenia leptostachys*. At a national scale this vegetation type has been transformed almost 50%, and only 1% is conserved of a target of 19%. This vegetation type is therefore considered to be Endangered (Figure 6-8, Driver *et al*. 2005, Mucina *et al*. 2006).

Sub-tropical Freshwater wetlands

This vegetation consists of low beds of reeds, sedges and rushes and waterlogged meadows dominated by grasses found in areas of flat topography in waterlogged clay soil. It is found typically along edges of seasonal pools in aeolian depressions as well as fringing alluvial backwater pans or artificial dams. At a national scale this vegetation type has only been transformed to a small extent and is well-conserved. This vegetation type is therefore considered to be least threatened. Wetlands do, however, constitute important habitats for various species of restricted distribution and represent important hydrological processes in the landscape. In general, wetland vegetation is protected under the National Water Act.

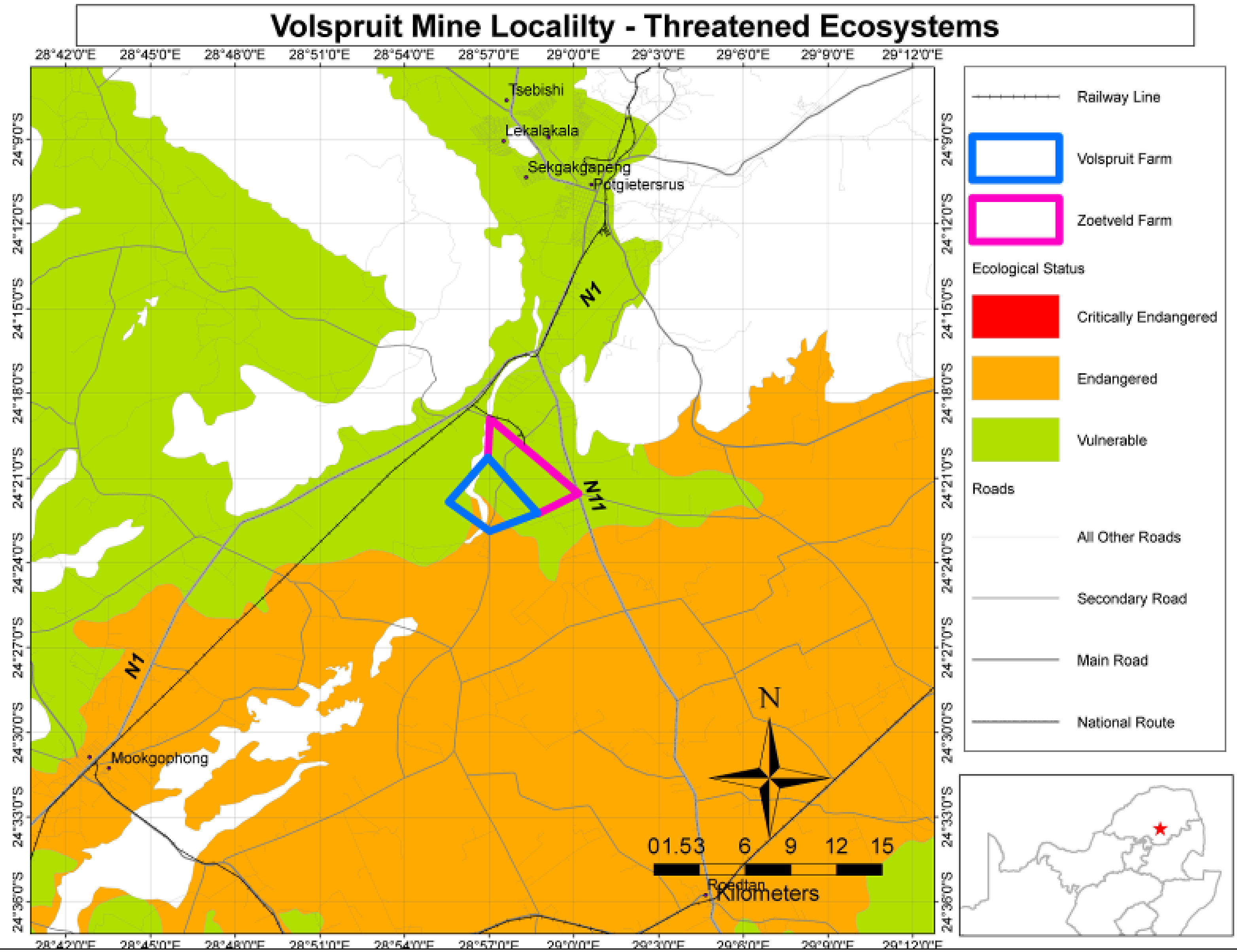


Figure 6-8: Threatened ecosystems on the Volspruit farm (Green = Central Sandy Bushveld, Orange = Springbokvlakte thornveld, White strip through site = freshwater wetland) – GIS layer taken from SANBI national database information

6.3.2 PROTECTED TREES

There are eight protected tree species that are believed to occur in the area, and it has been evaluated that at least six of them have a possibility of occurring on site. It was confirmed during the field survey that three of these species occur in or around the site, namely *Acacia erioloba*, *Boscia albitrunca* and *Sclerocarya birrea* subsp. *Caffra (*Table 6-1). If any individuals of these trees are affected by proposed infrastructure, a permit will be required (Appendix II of Appendix 5.7: Biodiversity Impact Assessment Report has reference).

Table 6-1: Protected tree species with confirmed occurrence on site	
Scientific name	**Common name**
Acacia erioloba	Camel Thorn
Boscia albitrunca	Shepherd's Tree
Sclerocarya birrea subsp. *caffra*	Marula

6.3.3 RED DATA LISTED PLANTS

Of the species that are considered, or known, to occur within the geographical area (i.e. by virtue of habitat suitability over the subject site) under consideration, there are five species recorded in the quarter degree grids that are listed on the IUCN Red List. Three of these could occur in habitats that are available in the study area (Table 6-2).

Table 6-2: 'Red List' plants likely/confirmed to occur on site	
Scientific name	**Common name**
Oryza longistaminata	Longstamen rice, Red rice, Wild rice
Callilepis leptophylla	Wild daisy
Hypoxis hemerocallidea	African star grass, African potato

According to IUCN Ver. 3.1 (IUCN, 2001) one of these species, *Oryza longistaminata*, is listed as 'Vulnerable' and the other two as 'Declining'. The 'Vulnerable' species, *Oryza longistaminata*, was evaluated as having a high probability of occurring on site - it occurs in wetlands and seasonally flooded areas, and was recorded on site in this habitat. Both species classified as 'Declining' have a high probability of occurring on site.

6.3.4 WETLAND VEGETATION DYNAMICS

Within the Nylsvley Ramsar site roughly 600 plant species have been recorded, though this includes wetland species, as well as adjacent woodland species (WRC Report TT 441/09). Of special significance is the wetland plant *Oryza longistaminata* (wild rice), with stands of wild rice on the Nyl river floodplain representing the southernmost extent of this species' range, and it occurs at no other locality in South Africa. This species was recorded within the study area. No Red Data wetland plant species are, however, expected to occur within the wetland habitat on site.

The vegetation of the Nyl river floodplain shows clear zonation related to the depth and duration of inundation. This zonation is evident in the southern reach of the floodplain that border the study site; where the central, most frequently inundated section of the floodplain is dominated by a variety of sedges (*Eleocharis* and *Schoenoplectus spp*.) and other mostly obligate wetland species (e.g. *Panicum schinzii*), while the sides and perimeter of the floodplain are grass dominated and charaterised by various facultative wetland species such as *Dichanthium annulatum, Digitaria eriantha, Dinebra retroflexa,* *Eragrostis superba, Fingerhuthia Africana, Ischaemum fasciculatum, Panicum maximum, Setaria sphacelata, Setaria incrassata, Sorghum bicolor* and *Cenchrus ciliarus.*

Vegetation zonation within the greater floodplain occurs not only laterally (i.e. whenone moves away from the channel), but also vertically above the channel and downstream along the channel, with the extent and duration of inundation decreasing along all three directions (Higgins et al., 1996). The location of the study area towards the extreme lower end of the floodplain would thus appear to indicate that the floodplain on the farm Volspruit is charaterised by less frequent flooding and flooding of shorter duration than the upper Nyl floodplain around the Nylsvley Nature Reserve, with resultant differences in vegetation between these areas. This is reflected in the vegetation, with *Oryza longistaminata* being observed only in small isolated stands on the Volspruit sections of the floodplain.

In terms of the 'vertical axis', studies undertaken by Coetzee and Rogers (cited in Havenga et al., 2007) indicate that a statistically significant change in vegetation species composition can be detected for a mere 90mm change in elevation. Activities that alter the flooding regime of the floodplain by as little as 90mm (increase or decrease) could thus be expected to have a significant impact on vegetation composition. In addition, specific species have specific depth and duration of flooding requirements. *Oryza longistaminata,* for example, grows best in water depths of 100-500mm and requires a minimum of 25 days of flooding (Marneweck 1988, as cited in Havenga, et al., 2007). Greater flooding depths reduce flowering of the wild rice, while too short or no flooding increases stress on the wild rice and over several years can reduce the viability of the plant due to a loss in reserves. The importance of the hydrological regime that drives the floodplain ecosystem, in terms of determining the vegetation of the floodplain, is thus clearly illustrated.

Higgins *et al*. (1996) recognise three different flood events based on the frequency, spatial extent and duration of the flood. These flood events coincide with the vegetation zonation observed in the Nylsvley Nature Reserve:

- Channel zone flood – Occurs in 7 out of 10 years. Only the channel is inundated for a period of about 3-4 months. Provides habitat for the truly aquatic species on the floodplain;
- Floodplain zone flood – Occurs in 4 out of 10 years. Such a flood would roughly coincide with the sedge dominated area of the floodplain. Also has a duration of approximately 50 days; and
- Hydromorphic zone flood – Occurs approximately 3 out of 10 years, with flooding lasting for a period sufficient for the breeding of water birds (more than 50 days). Such a flood would inundate the entire (or at least most of the) delineated wetland area on the farm Volspruit

Very rare flood events (such as the 1:100 year flood events), which need to be considered as part of the environmental and mining application processes, and which are depicted by the 1:100 year floodlines, flood an area in excess of the delineated floodplain area (hydromorphic area) and extend well into the surrounding terrestrial Bushveld vegetation.)

6.3.5 FAUNA

The study area encompasses a number of different habitat types, including wetlands, savannah and woodlands, and transformed/cultivated areas, and as such, is expected to support a range of faunal species associated with these differing habitats. The Nyl River makes up the western site boundary, and the river and the surrounding wetlands provide a spectrum of habitats, from open water within the channel of the watercourse, dense reed beds along and within the channel, and moist tall and short grassland within both the inundated wetlands and floodplain areas. The wetlands provide an important forage and water resource which attracts a large variety of species, particularly aquatic and avifaunal (bird) species.

Based on a literature review of faunal species distribution ranges in southern Africa, it is estimated that approximately 270 bird, 101 mammal, 72 reptile and 28 amphibian species could potentially occur within the study area, and of these 471 faunal species potentially occurring, a number of Red Data List species were identified.

Within the study area, all areas of natural vegetation should be considered important from a biodiversity maintenance standpoint, as they potentially support a large diversity of fauna, including several Red Data List species, while wetland and riparian habitats are particularly important and sensitive due to their additional role in facilitating faunal movement and migration between areas of suitable habitat and geographically separate populations.

Mammals

Of the 27 Red List mammals potentially occurring, 14 have been previously recorded in the Nylsvley Nature Reserve, approximately 40km south-west of the study area (http://www.environment.gov.za/Enviro-Info/sote/nsoer/resource/wetland/ ylsvley_ris.htm, accessed 7 June 2010). No Red Data List species were, however, observed during the site surveys. Serval (*L. serval*) have, however, previously been spotted by a farm owner in the area.

Avifauna

The two farm portions identified for mining, as well as supporting activities, comprise a total area of 2 632ha [5.2% of the greater Nyl river floodplain Important Bird Area (IBA) - Figure 6-9]. The greater Nyl river floodplain is believed to support approximately 61% of the breeding population of inland waterbirds south of the Zambesi and Cunene Rivers, and 92% of the Southern African waterbird species have been recorded in the said flood plain at some time or another (Tarboton, 1991). Flood events attract over 80 000 birds to the floodplain (Batchelor & Tarboton, 1981); 102 aquatic bird species have been recorded at Nylsvlei and 57 of these have been proven to breed on the floodplain (Tarboton, 1987). Twenty-three species on the South African Red Data Book-Birds list have been recorded on the floodplain, (Higgins & Rogers, 1993). Eight of these species breed on the floodplain, some breeding nowhere else in Southern Africa. On a sub-continental scale the Nyl River floodplain, when in flood, provides a waterbird breeding habitat rivalled only by the Pongola River floodplain in KwaZulu-Natal Province, South Africa and the Okavango delta of Botswana (Higgins et al, 1996).

The Nyl river floodplain is regarded as a global important bird area (IBA) by birdlife international based on meeting the below criteria:

> *"A4. Congregations*
> *Criteria: A site may qualify on any one or more of the four criteria listed below:*
>
> *i). Site known or thought to hold, on a regular basis, 1% of a biogeographic population of a congregatory waterbird species…; and*
> *iii). Site known or thought to hold, on a regular basis, 20,000 waterbirds or 10,000 pairs of seabirds of one or more species".*

According to the IBA site account, 426 bird species have been recorded in the area (46% of the species found in southern Africa). The Nyl river floodplain has been recognized as a critical area for the Bittern *Botaurus stellaris*, which is disappearing rapidly in South Africa. Although it is now less common at Nylsvley than previously, this area still holds one of the largest and most stable breeding populations in South Africa. In high rainfall years, Dwarf Bittern *Ixobrychus sturmii*, Little Bittern *Ixobrychus minutus*, Lesser Gallinule *Porphyrio alleni* and Lesser Moorhen *Gallinula angulata* are common.

Other rare and/or endangered species like the Slaty Egret *Egretta vinaceigula*, Rufousbellied Heron *Butorides rufiventris*, Streakybreasted Flufftail *Sarothrura boehmi* and Baillon's Crake *Porzana pusilla*, breed erratically, whenever conditions are suitable. A relatively large wintering Corncrake *Crex crex* population are known to occur in the area. Striped Crake *Aenigmatolimnas marginalis* and Spotted Crake *Porzana porzana* are occasional summer visitors.

The wetland also occasionally in years of good flooding supports extremely large numbers of Great White Egret *Egretta alba*, Little Egret *Egretta garzetta*, Yellowbilled Egret *Egretta intermedia*, Squacco Heron *Ardeola ralloides*, Blackcrowned Night Heron *Nycticorax nycticorax*, African Spoonbill *Platalea alba* and Southern Pochard *Netta erythrophthalma*. Marabou Stork *Leptoptilos crumeniferus* and Black Stork *Ciconia nigra* occur rarely at Nylsvley. Yellowbilled Stork *Mycteria ibis* and Grass Owl *Tyto capensis* are fairly common in the flooded grasslands and Blackwinged Pratincole *Glareola nordmanni* occasionally occur in large numbers in the drier grassland surrounding the floodplain. Almost every species of South African duck is found here from time to time, some in very large numbers.

The surrounding woodland is known to hold Secretarybird *Sagittarius serpentarius*, Bat Hawk *Macheiramphus alcinus* and Whitebacked Vulture *Gyps africanus* in small numbers. Cape Vulture *Gyps coprotheres* and Martial Eagles *Polemaetus bellicosus* are scarce visitors. Other woodland specials include Redcrested Korhaan *Eupodotis ruficrista*, Pied Babbler *Turdoides bicolor*, Whitethroated Robin *Cossypha humeralis*, Kalahari Robin *Erythropygia paena*, Burntnecked Eremomela *Eremomela usticollis*, Barred Warbler *Camaroptera fasciolata*, Marico Flycatcher *Melaenornis mariquensis*, Crimsonbreasted Shrike *Laniarius atrococcineus*, Whitecrowned Shrike *Eurocephalus anguitimens*, Burchell's Starling *Lamprotornis australis*, Whitebellied Sunbird *Nectarinia talatala*, Scalyfeathered Finch *Sporopipes squamifrons*, Violeteared Waxbill *Uraeginthus granatinus*, Blackcheeked Waxbill *Estrilda erythronotos* and Shafttailed Whydah *Vidua regia*.

The proposed mining site is located at the northern end of the greater floodplain, but still falls entirely within the boundaries of the IBA (Figure 6-9). The Moorddrift dam is located just to the north west of the IBA in the Nyl river and is situated almost immediately downstream from the proposed mining site (Figure 6-9). Co-ordinated Waterbird Counts (CWAC) have been conducted at irregular intervals at the site and have also confirmed its relevance as an avifaunal habitat in the area, with 66 waterbird species having been recorded there. It is expected that the dam could be used as a stop-over or staging area as birds move to and from the main Nyl River floodplain, as water levels recede there and the dam still holds water.

Figure 6-9: Satellite image of the study area farm portions, which are indicated with an orange border. The Nyl River Floodplain Important Bird Area (IBA) is indicated in green and the Moorddrift dam Co-ordinated Waterbird Count (CWAC) site to the north of the IBA is also indicated.

Reptiles

A Southern African python (P. natalensis), which is listed by NEMBA (2004) as a protected species and as vulnerable by the South African red data book (Branch, 1988), was sighted immediately to the north of the study area.

Amphibians

Although 28 amphibian species (all belonging to the order Anura) potentially occur within the Quarter Degree Square (QDS), only one is considered a red data species – the "Near-threatened" Giant bullfrog (*Pyxicephalus adspersus*). This species has a rather specialised habitat, requiring seasonal vleis, pans or other water-filled depressions as well as surrounding grassland to meet its life history requirements.

6.3.6 AQUATIC ECOLOGY

The overall habitat integrity of the Nyl River on site was deemed by the specialist to be good to excellent. However, larger impacts that were evident at individual sites are summarised below:

- Farm dams and road crossings were associated with the following impacts:
    - Reduced flows, which result in loss of habitat diversity and availability;
    - Migration barriers, which limit natural dispersal of fish and prevent recolonisation after unfavourable conditions (such as droughts);
    - Inundation of aquatic habitats;
    - sedimentation and bed modification (affecting benthic habitats); and
    - modification of channel and bed characteristics downstream of the dam wall.
- Agricultural activities (livestock grazing and cultivated fields) were associated with:
    - Slightly reduced water quality (trampling and urination/defecation by cattle;
    - Surface runoff from cultivated fields);
    - Sedimentation of substrates (bed modification) (resulting from erosion of cultivated fields, roads or grazed banks); and
    - Presence of alien fish species (Common carp disturb bottom substrates, compete for food and habitat and create turbid waters).

<u>Water Quality</u>

The purpose of this section is not to describe the baseline water quality of the Nyl River on site. The purpose of this section is merely to interpret measured on-site variables in terms of the ecological requirements of the biota living therein.

Electrical conductivity (EC) levels were very low ranging from 15.7 mS/m (Nyl 1) to 38.0 mS/m (Nyl 5) (Table 6-3, Figure 6-10). These levels reflect good water quality in terms of dissolved salts, with a slight increase at the downstream sites (4-6), probably as a result of the concentrating effect of evaporation and evapo-transpiration from standing water bodies. The decrease observed in the EC level at the most downstream site (Nyl 7) is thought to be related to dilution from lateral seepage and tributaries.

The pH of the study sites ranged between 7.8 and 8.9, and should not be limiting to the aquatic biota. These levels fell within the target for fish health of between 6.5 and 9.0 as it is expected that most species will tolerate and reproduce successfully within this pH range (DWAF, 1996). Oxygen levels were also high at all the sites. The abundance of wetland vegetation present means that oxygen, as well as pH levels, can be expected to vary greatly over a 24 hour period due to photosynthesis. The clarity of the water was mostly clear, with increases in turbidity apparently associated with dams and trampling by livestock. Water temperatures ranged between 21.5°C and 29.1°C at the time of sampling.

Figure 6-10: Aquatic biodiversity sampling sites

Table 6-3: In situ water quality variables measurements (January 2011)

Monitoring site	Conductivity (mS/m)	pH	Oxygen saturation (%)	Dissolved oxygen (mg/l)	Water Temp. (ºC)	Clarity (visual)
Nyl 1	15.7	7.8	80	6.5	21.5	Clear
Nyl 2	20.3	7.8	76	5.6	24.0	Clear
Nyl 3	28.5	7.8	70	5.5	26.7	Turbid
Nyl 4	32.4	7.8	79	6.2	26.3	Turbid
Nyl 5	38.0	8.2	80	6.5	28.1	Clear
Nyl 6	37.0	8.2	75	5.8	28.0	Slightly turbid
Nyl 7	19.7	8.9	102	7.5	29.1	Clear

Macro-invertebrates

Very little aquatic macro invertebrate information was available for the Nyl River but rivers sampled in the vicinity (e.g. within A42 and B51E) indicate moderate South African Scoring System (SASS5) scores, with Average Score Per Taxon (ASPT) ranging from 5 to 6.5, suggesting a moderate to high representation by sensitive taxa and Largely Natural to Moderately Modified conditions for invertebrates (Rivers Database, River Health Programme) (WCS, 2010).

Fish

The dominant velocity-depth category (habitat) available for fish at most sites (Figure 6-10) was slow (<0.3m/s)-shallow (<0.5m) and slow-deep. Fish species with a preference or requirement for slow (lentic) habitats can therefore be expected to occur at these sites. The primary cover feature available to fish was provided in the form of macrophytes and overhanging vegetation (also typical valley bottom wetland habitats). The absence of substrates in the form of cobbles and boulders that could serve as cover for fish in the area is expected to be reflective of natural conditions, and the presence of this cover feature at sites Nyl 3 and Nyl 4 is the result of farm dam construction.

During a January 2011 baseline aquatic fauna study performed in the study area, seven indigenous fish species were sampled (Table 6-4). These included the Johnston's topminnow (*Aplocheilichthys johnstoni*), Hyphen barb (*Barbus bifrenatus*), Straightfin barb (*Barbus paludinosus*), Sharptooth catfish (*Clarias gariepinus*), Mozambique tilapia (*Oreochromis mossambicus*), Southern mouthbrooder (*Pseudocrenilabrus philander*) and Banded tilapia (*Tilapia sparrmanii*). *Barbus paludinosus* was by far the most abundant and most widespread indigenous fish species in the study area. The relative abundance of *Pseudocrenilabrus philander* was moderate while the rest of the species had a generally low abundance. One alien fish species, namely the Common carp (*Cyprinus carpio*) was also sampled within the study area at Site Nyl 6.

Table 6-4: Fish species (No. of individuals) Sampled on site in January 2011

SPECIES		Fish Sampling Sites						
ABBREVIATION	ENGLISH COMMON NAME	Nyl 1	Nyl 2	Nyl 3	Nyl 4	Nyl 5	Nyl 6	Nyl 7
AJOH	JOHNSTON'S TOPMINNOW	4	2		1	12	7	
BBIF	HYPHEN BARB	1						
BPAU	STRAIGHTFIN BARB	12	100+	500+	500+	150+	300+	200+
CGAR	SHARPTOOTH CATFISH			2	2			
OMOS	MOZAMBIQUE TILAPIA			30	5		2	
PPHI	SOUTHERN MOUTHBROODER	8	12	20	7	12	30	50
TSPA	BANDED TILAPIA	2				3	7	
CCAR*	COMMON CARP						1	
Sampling time (minutes electrofishing)		20	15	30	25	20	20	23

The fish species within the study area differ in their tolerance of environmental disturbance Overall, the fish assemblage expected or observed within the Volspruit Mine study area was classified as being *tolerant to moderately tolerant* to environmental change. The most sensitive of all species is the Johnston's topminnow, which is described as being *intolerant* to habitat alterations and water quality deterioration. This species could be considered an important indicator of change. The Threespot barb is also moderately intolerant to changes in trophic structure, but this species was not sampled during the current survey, and it is assumed that it is not abundant in this river reach.

The Mozambique tilapia (Oreochromis mossambicus) is considered 'Near Threatened' (IUCN 2010). Although this species is widespread and common, it is threatened by hybridization with the rapidly spreading alien Nile tilapia (Oreochromis niloticus). Johnston's topminnow is considered 'Least Concern', while the other fish species within the study area are widespread and common

Most of the fish species expected or observed in the study area are classified as '*truly migratory'*, or potadromous. Most of the *Barbus* species, *C. gariepinus* and *T. sparrmanii* all require movement between reaches, while *P. philander* and *A. johnstoni* primarily migrate within a single reach. It is therefore essential that flows are maintained to meet the needs of migratory species. For this reason, the geohydrology of the landscape should be carefully considered, abstraction and road crossings should be limited and no new in-stream dams or should be constructed as part of any proposed developments or mining activities.

6.3.7 SENSITIVITY OF NATURAL HABITATS ON SITE

During the biodiversity assessment undertaken by Wetland Consulting Services in 2011, a map was created using satellite imagery and information obtained from a number of site visits. This was done to determine areas on the Farms Volspruit and Zoetveld that are more or less sensitive, depending on current on-site conditions and the status of the bushveld and agricultural lands in terms of their sensitivity to development.

Areas containing untransformed natural vegetation, high diversity or habitat complexity, Red List organisms or systems vital to sustaining ecological functions are considered sensitive. In contrast, any transformed area that has no importance for the functioning of ecosystems is considered to have low sensitivity. The information provided in the preceding sections was used by the specialist's to compile a map of remaining natural habitats and areas important for maintaining ecological processes in the study area (Figure 6-11). Broad scale mapping, based on aerial imagery, was used to provide information on the location of sensitive features.

There are a number of features that need to be taken into account in order to evaluate sensitivity in the study area. These include the following:

- <u>Perennial and non-perennial rivers and streams</u>: this represents a number of ecological processes, including groundwater dynamics, hydrological processes, nutrient cycling and wildlife dispersal. The main hydrological system in the study area is the Nyl River. Wetlands are protected according to the National Water Act and the National Environmental Management Act. One Red List plant species was recorded in these areas in the study area. This wetland system is considered to represent key ecological goods and services in this region. All areas associated with the Nyl River system are considered to have HIGH or VERY HIGH sensitivity;
- <u>Vegetation considered to have high conservation value at a national scale (classified as critically endangered or vulnerable)</u>: Central Sandy Bushveld and Springbokvlakte Thornveld are both listed in a conservation category in scientific

literature, although only Springbokvlakte Thornveld is protected according to the National Environmental Management: Biodiversity Act. Low hills in the study area are considered to contain moderately high intrinsic biodiversity;

- Occurrence of populations of Red List plants that have been evaluated as having a high chance of occurring within remaining natural habitats within the study area: One Vulnerable plant species was recorded on the floodplain of the Nyl River. The river system is therefore considered to be important habitat for this species in the study area;
- Occurrence of protected trees that are known to occur on site: Protected tree species recorded in the study area were *Acacia erioloba, Sclerocarya birrea subsp. caffra* and *Boscia albitrunca*. These were found in "hills woodland" and "plains thornveld".

These factors have been taken into account in evaluating sensitivity within the study area. Any natural area remaining on site could potentially be classified as sensitive. However, the undisturbed terrestrial vegetation is not of high species richness and is relatively uniform within distinct habitats. No species of conservation concern were found within terrestrial plains woodland. It is, therefore, classified as having medium sensitivity on site. Wetland vegetation is considered to have high sensitivity due to the important ecological processes that these areas support, the fact that wetlands are linear systems in which upstream impacts can severely affect downstream areas and the fact that a vulnerable plant species, *Oryza longistaminata*, occurs within this habitat on site.

Figure 6-11 that follows, read in combination with Table 6-5, provides a specialist's summary of the nature and extent of the sensitive habitats present over the farms Volspruit and Zoetveld. It can be seen that the north pit is predominantly located across an area with low sensitivity; where current agricultural practices have largely modified the applicable section of the farm Volspruit. The south pit footprint is located predominantly in an area with medium-high sensitivity; where the sensitivity is associated with 'Hills woodland' present at that location.

The majority of the remaining surface structures and infrastructure proposed as part of the mine will be located on areas with medium and low-medium sensitivity, with the exception of a nominal section of the proposed plant area, which will extend into the medium-high sensitivity area indicated immediately north of the south pit.

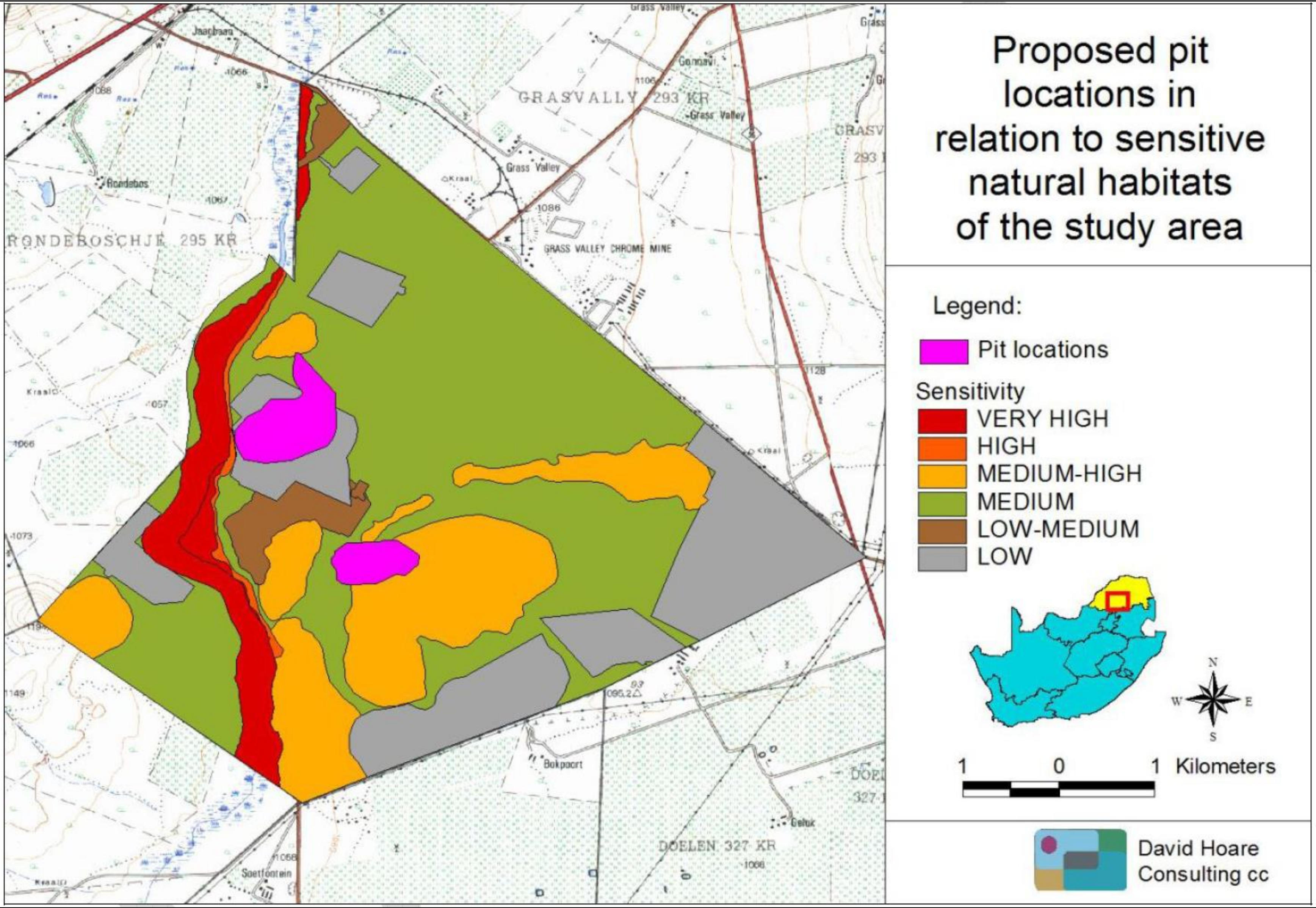


Figure 6-11: Proposed pit location in relation to sensitive natural habitats of Volspruit and Zoetveld (David Hoare Consulting, 2011)

Table 6-5: Explanation of Sensitivity Ratings (with reference to Figure 6-11)

Sensitivity	Factors contributing to sensitivity
VERY HIGH	Indigenous natural areas that are highly positive for the following: • High intrinsic biodiversity value (high species richness and/or turnover, presence of species of concern, unique ecosystems). • Low ability to respond to disturbance (low resilience, dominant species very old). • High conservation status (low proportion remaining intact, highly fragmented, habitat for species that are at risk). • High value ecological goods & services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value) • Protected habitats (areas protected according to national / provincial legislation, e.g. National Forests Act, Draft Ecosystem List of NEM:BA, Integrated Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act)
HIGH	Indigenous natural areas that are moderately positive for the following: • Moderate intrinsic biodiversity value (moderate species richness and/or turnover, presence of species of concern). • Moderate ability to respond to disturbance (moderate resilience, dominant species of intermediate age). • Moderate conservation status (low proportion remaining intact, moderately fragmented, habitat for species that are at risk). • Moderate value ecological goods & services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value). And may also be positive for the following: • Protected habitats (areas protected according to national / provincial legislation, e.g. National Forests Act, Draft Ecosystem List of NEM:BA, Integrated Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act)
MEDIUM-HIGH	Indigenous natural areas that are positive for two or less of the factors listed above.
MEDIUM	Other indigenous natural areas in which factors listed above are of no particular concern. May also include natural buffers around ecologically sensitive areas and natural links or corridors in which natural habitat is still ecologically functional.
MEDIUM-LOW	Degraded or disturbed indigenous natural vegetation.
LOW	No natural habitat remaining.

6.4 SURFACE WATER

The services of Africa Environment Development (AED) were commissioned to the greater EIA team to undertake a surface water impact/hydrological assessment for the proposed mining activities (i.e. in support of the EIA process). Surface water aspects, as pertains to the aquatic/riverine ecology of the Nyl River and its associated wetland, are also dealt with in the specialist biodiversity assessment undertaken by Wetland Consulting Services (WCS) for the EIA, detailed specialist reports compiled as part of these assessments are attached hereto in Appendix 5.3.

The only surface water resource traversing the study area is the Nyl River (incl. its associated floodplain wetland). The Nyl River flows roughly south to north through the farm Volspruit (west of the proposed mine) and on through the northern extent of the farm Zoetveld. The Nyl River floodplain is located within the Limpopo River Catchment (Primary Catchment A), with the Nyl River, which becomes the Mogalakwena River downstream of Mokopane, being a direct tributary of the Limpopo River. The Nyl floodplain itself stretches across four quaternary catchments, with the proposed mining area being located in catchment A61E (WCS, 2010)(Figure 6-13).

The Nyl River floodplain is located roughly between the towns of Modimolle in the south and Mokopane in the north. In its entirety, the floodplain measures approximately 70km in length and stretches from the farm Middelfontein to the farm Moorddrift. The floodplain alone covers approximately 24 250 hectares, while the greater catchment thereof is roughly 2 300km^2 in size and covers the south-eastern fringe of the Waterberg plateau (WCS, 2010)(Figure 6-12). The 'Nylsvley' Ramsar Site, which constitutes the Nylsvley Nature Reserve, is located within the upper reaches of the floodplain, approximately 40km upstream of the proposed mining area (straight line distance). The reserve protects over 500ha of the floodplain (based on the figures quoted, this represents just more than 2 % of the floodplain).

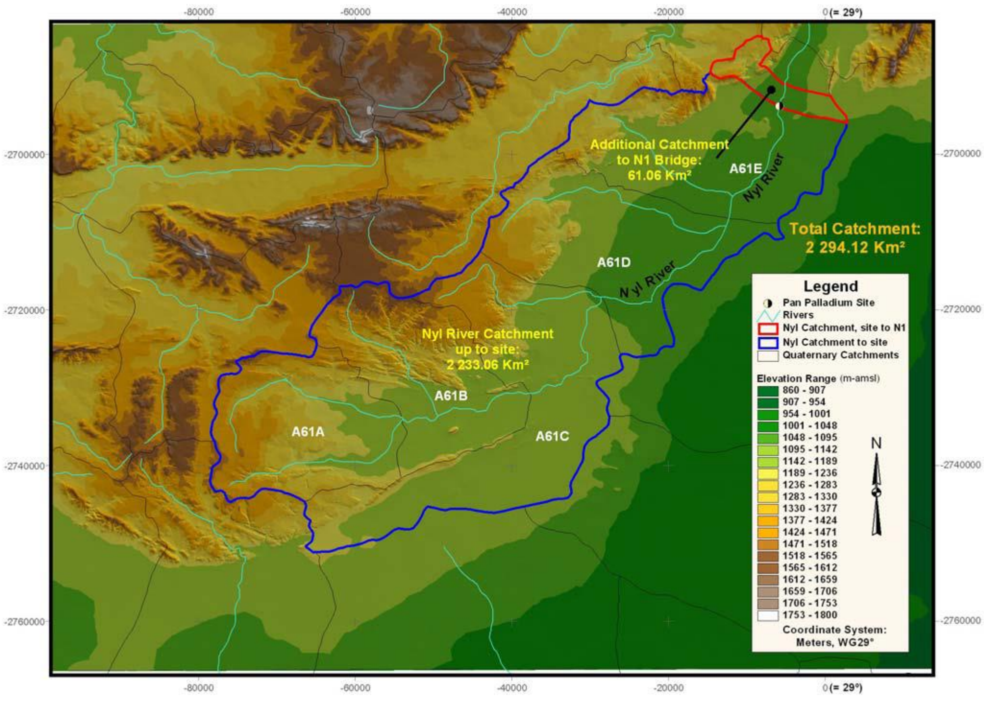


Figure 6-12: The catchment and quaternary catchments of the Nyl River (of AED, 2010)

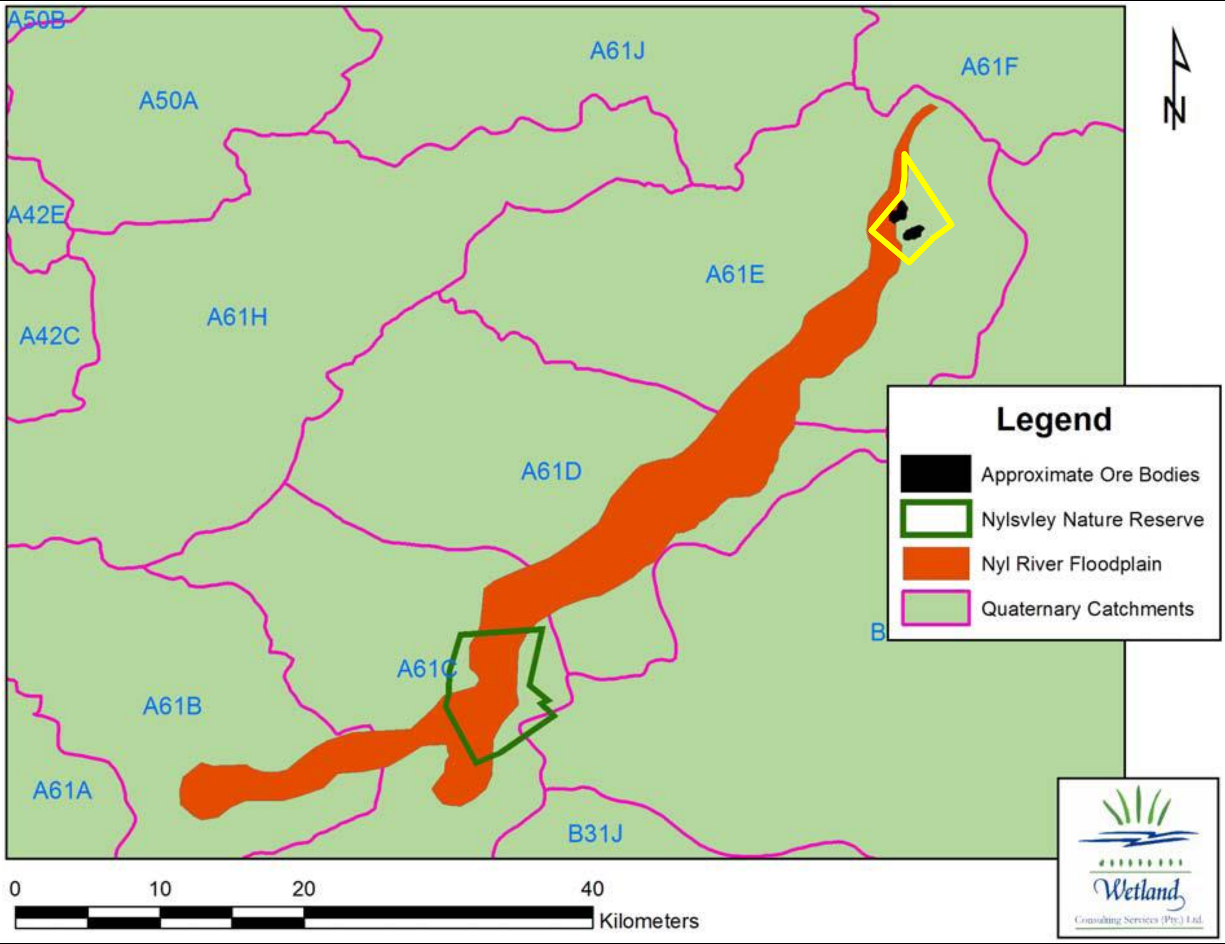


Figure 6-13: Map showing the Nyl River floodplain in relation to the quaternary catchments. The Yellow outline represents the farm boundaries of Volspruit and Zoetveld. Wetland Consulting Services (2010). Directional of flow is from south west to north east.

6.4.1 WATER USE AND ABSTRACTION

Water use in this system appears to be limited to an abstraction for Modimolle from Donkerpooort Dam, alien vegetation, farm dams and groundwater abstraction for irrigation and town water supply. Principal uses of water in the Nyl River system are crop irrigation and residential use. An estimated 11 million m^3 per annum are required to irrigate 1 525 ha of crop lands in the Nyl catchment (Theron et al., 1992), along with other abstraction. It is reported that there are approximately 2 000 boreholes and in excess of 300 dams in the Nyl River system (Nylsvley Ramsar Information Sheet 1997).

Water abstraction for town water supply provides Modimolle, Mookgopong as well as Mokopane. Whereas Modimolle receives almost all of its water from the Roodeplaat dam (100 km south, Pretoria) the report of Royal Haskoning DHV indicates the DWA All Towns Study indicates the additional abstraction for Modimolle of an estimated at 0.93 million m^3/a. Mookgopong uses approximately 0.75 million m^3 per annum from boreholes on the Nyl River floodplain and surrounding areas.

Ground and surface water abstraction

Groundwater abstraction data for the larger A61E was sourced from DWA Groundwater Resource Assessment II (GRAII) for the upstream catchments outside the study area, and was obtained by hydrocensus and crop water modelling in the study area. Abstraction for irrigation and other uses was estimated at 6 Mm³/a (as set out below in Table 6-6: Summary of Groundwater Abstraction in Groundwater Model Domain).

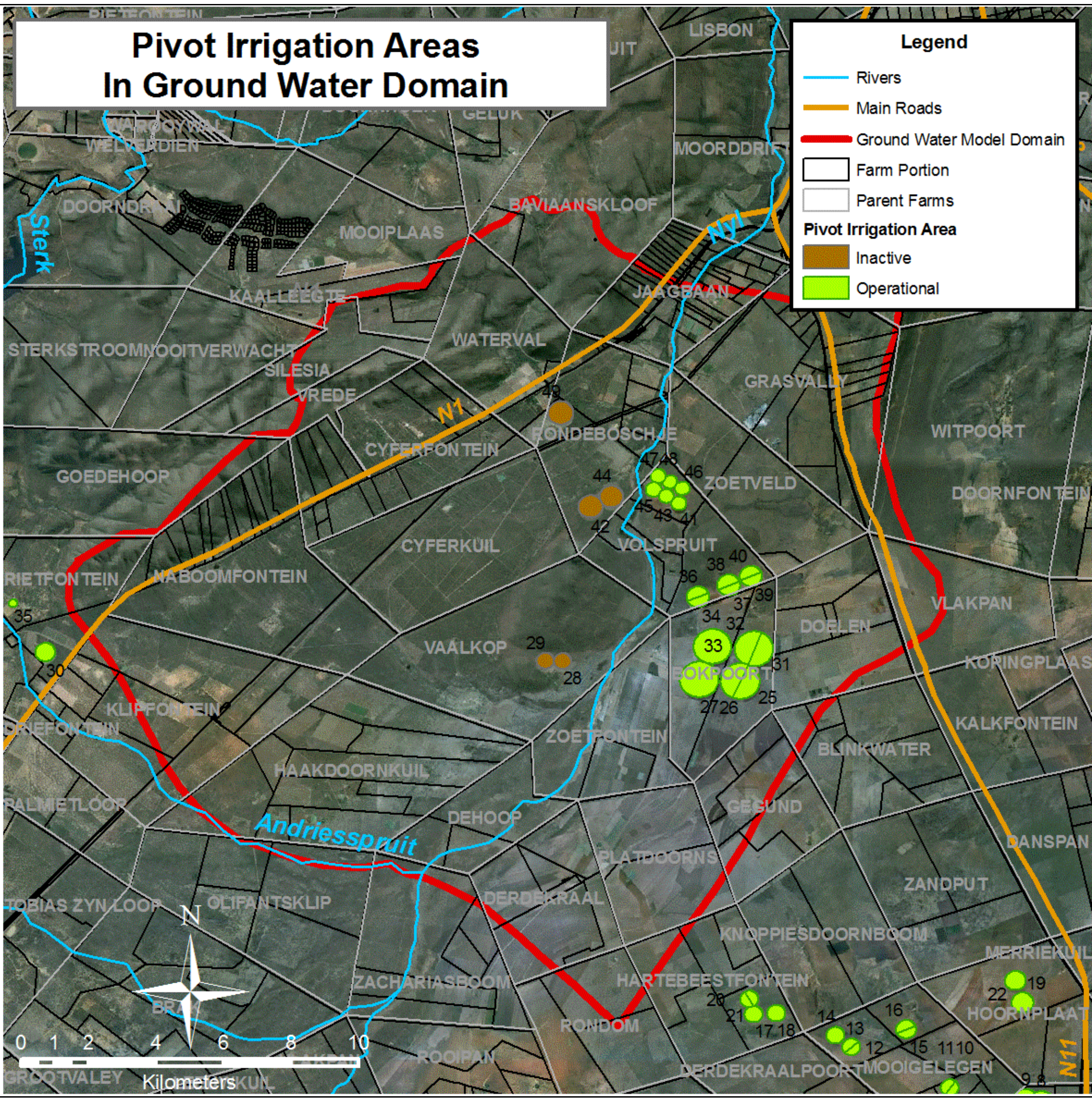


Figure 6-14: Groundwater abstraction for crop irrigation within groundwater modelling domain

Volumes of water used for irrigation has proved to be a sensitive issue and data pertaining to water use could not be sourced from crop producers, it has been indicated that these data would be made available through a Water Forum; however this is yet to be established. Since it is impossible to establish the exact water volumes used to irrigate crops without access to measurements (e.g. water meter data), crop water use and irrigation requirements were estimated with the help of a simulation model.

Soil Water Balance (SWB) model simulations were carried out for areas under irrigation. The SWB model is a daily time step, generic crop, irrigation scheduling model that simulates the soil water balance and crop growth from specific crop growth parameters (refer Appendix 5.4: Agricultural Irrigation Assessment). The areas under pivot irrigation were identified from Landsat satellite imagery, and water demand for the production of maize, beans, and wheat (typical rotation crops grown in area) was undertaken at first for all areas that have been cropped under pivot, an audit review of area under irrigation revealed a number of areas to have been decommissioned/ to be inactive over the modelling period and was excluded (refer Figure 6-14).

A number of assumptions were made in order to be able to quantify effective water use and are as follows:

- Pivot area effectively utilised is 66% (not under irrigation 100% of time)
- Excess irrigation/ Groundwater recharge (some 25% is over irrigated)
- DWA Registered use approximates actual use for smaller users

Excess irrigation reports back to groundwater as recharge. Calculated volumes required for irrigation (effective water use as opposed to abstraction) is approximately 25% less than what is indicated on the DWA Register of groundwater abstraction for the catchment A61E (refer Table 6-6). Volumes calculated to be extracted and irrigated (including 25% excess irrigation) is approximately 50% of what is registered (refer Table 6-6).

Table 6-6: Summary of Groundwater Abstraction in Groundwater Model Domain

	Farm	Fraction pivot area utilised	Av plant use requirement Calculated	Excess irrigation/ Groundwater recharge	Av abstracted and irrigated Calculated	DWA Water Use registration
			Total m3	%	Total m3	Total m3
P de Klerk	**FARM VOSLPRUIT 326 KR Portion 1**					
	m3/day	Pivot area 66%	1 952	25%	2 440	1 242.47
D de Beer	**FARM VOSLPRUIT 326 KR Portion 2**					
	m3/day	Pivot area 66%	2 227	25%	2 784	2 270.95
B De Klerk	**FARM BOKPOORT 328 KR Portion 0&1**					
	m3/day	Pivot area 66%	4 436	25%	5 545	3 555.23
M De Klerk	**FARM BOKPOORT 328 KR Portion 2**					
	m3/day	Pivot area 66%	4 224	25%	5 281	2 270.95
All other users registered on DWA database						
			5 265		5 265	5 264.70
Total estimate	**m3/day**		**18 104.19**		**21 314.06**	**14 604.28**
Total annual use m3/a			**6 608 029**		**7 779 633**	**5 330 562**
Total annual use Mm3/a			**6.6**		**7.78**	**5.33**
Hydrological model input (rounded)			**6.5**			
Assumptions	1 Pivot area		66%			
	2 Excess irrigation/ Groundwater recharge		25%			
	3 DWA Registered use approximates actual use for smaller users					

Under current conditions within the larger Nyl catchment and specifically the area covered by the modelling domain significant groundwater abstraction occurs in pursuit of crop irrigation, and the hydrological balance reflects significant reduction in groundwater evapotranspiration. Accordingly the wetland system has already been impacted by these activities (refer to Table 6-7 below).

Table 6-7: Water balance for groundwater modelling domain		
Water balance for groundwater modelling domain	**Virgin/ Natural state**	**Current abstraction 6.5 Mm3/a**
Mean Annual Precipitation mm	588.12	588.12
Mean Annual Runnoff mm	16.06	13.35
Abstraction (Mm3/a)	0	6.5
Abstraction (mm/a)	0	19.37
Aquifer Recharge mm/a	19.64	19.76
Baseflow mm/a	2.36	1.98
Groundwater Baseflow mm/a	0.16	0
Interflow mm/a	2.21	2.21
Transmission losses (mm)	1.23	2.97
Groundwater Evapotranspiration mm/a	20.5	4.12
Groundwater outflow mm/a	0.23	-1.28
Aquifer storage change mm	-1.46	-0.87

Table 6-8: DWA registered Groundwater Abstraction for Groundwater Model Domain

Register	Register	Customer Name	WMA	WU Status	Drainage	WU Sector	Resource	Outside GW	Inactive	Registered	Property Name	In Ground
27057657	CLOSED	A S G BOERDERY	O	CLOSED	A61E	RE:	BOREHOLE			15 750.00	DOELEN KR 327/4(A61E)	yes A61E2
27057657	CLOSED	A S G BOERDERY	O	CLOSED	A61E	RE:	BOREHOLE					yes A61E2
27057684	CLOSED	AF LOUWRENS	O	CLOSED	A61E	RE:	BOREHOLE			43 680.00	22(A61E)	yes A61E2
27095063	ACTIVE	WESTHUIZEN	O	D	A61E	RE:	BOREHOLE			43 680.00	22(A61E)	yes A61E2
27095063	ACTIVE	WESTHUIZEN	O	D	A61E	RE:	BOREHOLE				(A61E)	yes A61E2
27056257	ACTIVE	AKT TRUST	O	D	A61E	RE:	BOREHOLE		388 800.00		2(A61E)	yes A61E2
27092805	ACTIVE	ALICENTE 109	O	D	A61E	RE:	BOREHOLE	115 470.00			PALMIETLOOP KR 337 POR 0	
27092805	ACTIVE	ALICENTE 109	O	D	A61E	RE:	BOREHOLE				PALMIETLOOP KR 337 POR 0	
27041656	CLOSED	AM VENTER	O	CLOSED	A61E	RE:	BOREHOLE	25 000.00			7(A61E)	
27041683	ACTIVE	ESTERHUIZEN	O	D	A61E	RE:	BOREHOLE	5 400.00			RIETFONTEIN KR 318 GED 9	
27056587	CLOSED	ASG BOERDERY	O	CLOSED	A61E	RE:	BOREHOLE			15 750.00	DOELEN KR 327/1(A61E)	yes A61E2
27056569	CLOSED	ASG BOERDERY	O	CLOSED	A61E	RE:	BOREHOLE			15 750.00	DOELEN KR 327/2(A61E)	yes A61E2
27056532	CLOSED	ASG BOERDERY	O	CLOSED	A61E	RE:	BOREHOLE			3 000.00	DOELEN KR 327/3(A61E)	yes A61E2
27056532	CLOSED	ASG BOERDERY	O	CLOSED	A61E	RE:	BOREHOLE					
27056587	CLOSED	ASG BOERDERY	O	CLOSED	A61E	RE:	BOREHOLE					
27056569	CLOSED	ASG BOERDERY	O	CLOSED	A61E	RE:	BOREHOLE					
27041638	ACTIVE	CHB WHITE	O	D	A61E	RE:	BOREHOLE	48 000.00			RIETFONTEIN KR 318 PTN 3	
27056934	ACTIVE	CM GENIS	O	D	A61E	RE:	BOREHOLE			6 810.00	GRASVALLY KR 293 PTN 16	yes A61E2
27041353	ACTIVE	CMJ BOTHA	O	D	A61E	RE:	BOREHOLE			7 884.00	KLIPFONTEIN KR 322 GED 14	yes A61E2
27070829	ACTIVE	CORHANDI	O	D	A61E	1	BOREHOLE	4 015.00			10(A61E)	yes A61E2
27041530	ACTIVE	CP HARRIS	O	D	A61E	RE:	BOREHOLE			5 400.00	KLIPFONTEIN KR 322/9(A61E)	yes A61E2
27079857	ACTIVE	WALT	O	D	A61E	RE:	BOREHOLE			70 200.00	4(A61E)	yes A61E2
27056293	ACTIVE	CS LE ROUX	O	D	A61E	RE:	BOREHOLE			9 125.00	2(A61E)	yes A61E2
27057274	ACTIVE	DALRIKA TRUST	O	D	A61E	RE:	BOREHOLE			60 000.00	1	yes A61E2
27041594	ACTIVE	DK STRATFORD	O	D	A61E	1	BOREHOLE	1 460.00			RIETBOKSPRUIT KR 302/7	
27041567	ACTIVE	DR ERASMUS	O	D	A61E	1	BOREHOLE	3 200.00			RIETBOKSPRUIT KR 302 GED 2	
27057746	ACTIVE	E DE BEER	O	D	A61E	RE:	BOREHOLE			123 341.00	(A61E)	yes A61E2
27057746	ACTIVE	E DE BEER	O	D	A61E	RE:	BOREHOLE			705 554.00		yes A61E2
27057746	ACTIVE	E DE BEER	O	D	A61E	RE:	BOREHOLE					
27089230	COMPLETE	E DE BEER	O	E	A61E	RE:	BOREHOLE					
27040853	ACTIVE	INV	O	D	A61E	RE:	BOREHOLE			72 000.00	KLIPFONTEIN KR 322 GED 5	yes A61E2
27040853	ACTIVE	INV	O	D	A61E	RE:	BOREHOLE					
27040853	ACTIVE	INV	O	D	A61E	RE:	BOREHOLE					
27040853	ACTIVE	INV	O	D	A61E	RE:	BOREHOLE					
27057489	ACTIVE	PROPERTIES NO	O	D	A61E	RE:	BOREHOLE			453 500.00	VOLSPRUIT KR 326/1(A61E)	yes A61E2
27057489	ACTIVE	PROPERTIES NO	O	D	A61E	RE:	BOREHOLE					yes A61E2
27057489	ACTIVE	PROPERTIES NO	O	D	A61E	RE:	BOREHOLE					yes A61E2
27056275	CLOSED	TRUST	O	CLOSED	A61E	RE:	BOREHOLE			50 400.00	VOLSPRUIT KR 326/5(A61E)	yes A61E2
27057951	ACTIVE	GF MALHERBE	O	D	A61E	RE:	BOREHOLE	26 064.00			GEGUND KR 332/0(A61E)	
27057951	ACTIVE	GF MALHERBE	O	CLOSED	A61E	RE:	BOREHOLE	10 000.00			GEGUND KR 332/0(A61E)	yes A61E2
27041120	CLOSED	GG DE VILLIERS	O	CLOSED	A61E	RE:	BOREHOLE	115 470.00			0(A61E)	
27081586	CLOSED	GP VAN STADEN	O	CLOSED	A61E	RE:	BOREHOLE	20 916.00			13(A61E)	
27047981	ACTIVE	HN GROBLER	O	E	A61E	SUPPLY	BOREHOLE			3 200.00	320/7(A61E)	yes A61E2
27047981	ACTIVE	HN GROBLER	O	D	A61E	RE:	BOREHOLE			8 185.00	320/7(A61E)	yes A61E2
27047981	ACTIVE	HN GROBLER	O	D	A61E	RE:	BOREHOLE					yes A61E2
27057283	ACTIVE	JA VELTHUYSEN	O	D	A61E	RE:	BOREHOLE			4 927.00	10	yes A61E2
27041148	ACTIVE	JA VELTHUYSEN	O	D	A61E	RE:	BOREHOLE			4 927.00	7(A61E)	yes A61E2
27057639	ACTIVE	WALT	O	D	A61E	RE:	BOREHOLE			75 000.00	DERDEKRAAL KR 352 PTN 2	yes A61E2
27057639	ACTIVE	WALT	O	D	A61E	RE:	BOREHOLE			18 250.00	DERDEKRAAL KR 352 PTN 2	yes A61E2
27083183	ACTIVE	JLP BOTHA	O	D	A61E	RE:	BOREHOLE	25 000.00			RIETFONTEIN KR 318/7(A61E)	
27040880	ACTIVE	JP BOTHA	O	D	A61E	RE:	BOREHOLE	60 000.00			RIETFONTEIN KR 318/5(A61E)	
27040880	ACTIVE	JP BOTHA	O	D	A61E	RE:	BOREHOLE	20 000.00				
27041610	ACTIVE	K CARGNELUTTI	O	D	A61E	RE:	BOREHOLE	36 135.00			RIETFONTEIN KR 318 PTN 2	
27041674	ACTIVE	L DE VILLIERS	O	D	A61E	RE:	BOREHOLE	362 880.00			RIETFONTEIN KR 318 GED 8	
27041674	ACTIVE	L DE VILLIERS	O	D	A61E	RE:	BOREHOLE					
27070277	ACTIVE	LP STEENKAMP	O	D	A61E	RE:	BOREHOLE		210 000.00		VAALKOP KR 325/0(A61E)	yes A61E2
27086956	ACTIVE	MC FOURIE	O	D	A61E	RE:	BOREHOLE	24 300.00			DRIEFONTEIN KR 317/16(A61E)	
27086956	ACTIVE	MC FOURIE	O	D	A61E	RE:	BOREHOLE					
27086956	ACTIVE	MC FOURIE	O	D	A61E	RE:	BOREHOLE					
27056328	ACTIVE	ME DE BEER	O	D	A61E	RE:	BOREHOLE			20 821.00	JAAGBAAN KR 291 PTN 21(A61E)	yes A61E2
27056328	ACTIVE	ME DE BEER	O	D	A61E	RE:	BOREHOLE			102 621.00		yes A61E2
27056408	ACTIVE	MJ DE KLERK	O	D	A61E	RE:	BOREHOLE			324 000.00	BOKPOORT KR 328/1(A61E)	yes A61E2
27056408	ACTIVE	MJ DE KLERK	O	D	A61E	RE:	BOREHOLE			973 658.00		yes A61E2
27057540	ACTIVE	PROPERTIES 390	O	D	A61E	RE:	BOREHOLE		120 000.00		3(A61E)	yes A61E2
27058647	ACTIVE	MYBI TRUST	O	D	A61E	RE:	BOREHOLE			9 765.00	16	yes A61E2
27056248	ACTIVE	OLER MALHERBE	O	D	A61E	RE:	BOREHOLE			98 550.00	DOELEN KR 327 PTN 0	yes A61E2
27090594	CLOSED	PF KIESLING	O	CLOSED	A61E	RE:	BOREHOLE	115 470.00			PALMIETLOOP KR 337 POR 0	
27056391	ACTIVE	PJ DE KLERK	O	D	A61E	RE:	BOREHOLE			324 000.00	BOKPOORT KR 328/0A61E)	yes A61E2
27056391	ACTIVE	PJ DE KLERK	O	D	A61E	RE:	BOREHOLE			960 608.00		yes A61E2
27082086	ACTIVE	PJ MALAN	O	D	A61E	RE:	BOREHOLE			36 900.00	JAAGBAAN KR 291 GED 5(A61E)	yes A61E2
27080060	ACTIVE	BOERDERY	O	D	A61E	RE:	BOREHOLE			86 000.00	3(A61E)	yes A61E2
27057773	ACTIVE	BOERDERY	O	D	A61E	RE:	BOREHOLE			72 000.00	1(A61E)	yes A61E2
27057265	ACTIVE	PW PRINSLOO	O	D	A61E	RE:	BOREHOLE			45 000.00	2	yes A61E2
27057256	ACTIVE	PW PRINSLOO	O	D	A61E	RE:	BOREHOLE			36 500.00	7	yes A61E2
27057256	ACTIVE	PW PRINSLOO	O	D	A61E	RE:	BOREHOLE			36 500.00	7	yes A61E2
27056756	ACTIVE	PW PRINSLOO	O	D	A61E	RE:	BOREHOLE			225 000.00	9	yes A61E2
27075138	ACTIVE	MANGANESE	O	D	A61E	RE:	BOREHOLE		58 548.00		4(A61E)	yes A61E2
27085172	ACTIVE	SJ BIRKHOLTZ	O	D	A61E	RE:	BOREHOLE			40 000.00	323/4(A61E)	yes A61E2
27085181	ACTIVE	SJ BIRKHOLTZ	O	D	A61E	RE:	BOREHOLE			40 000.00	JAAGBAAN KR 291/8(A61E)	yes A61E2
27085172	ACTIVE	SJ BIRKHOLTZ	O	D	A61E	RE:	BOREHOLE					
27085172	ACTIVE	SJ BIRKHOLTZ	O	D	A61E	RE:	BOREHOLE					
27085172	ACTIVE	SJ BIRKHOLTZ	O	D	A61E	RE:	BOREHOLE					
27058451	ACTIVE	INTERNATIONAL	O	D	A61E	RE:	BOREHOLE	10 360.00			5(A61E)	
27040817	ACTIVE	T WESSELS	O	D	A61E	RE:	BOREHOLE	76 980.00			DRIEFONTEIN KR 317 GED 17	
27040791	ACTIVE	T WESSELS	O	D	A61E	RE:	BOREHOLE	103 620.00			RIETFONTEIN KR 318 GED 6	
27040791	ACTIVE	T WESSELS	O	D	A61E	RE:	BOREHOLE					
27059637	ACTIVE	NOMINEES	O	D	A61E	MINING	BOREHOLE		39 015.00		18(A61E)	yes A61E2
27056621	ACTIVE	1039	O	D	A61E	RE:	BOREHOLE			70 000.00	JAAGBAAN KR 291 PTN 13(A61E)	yes A61E2
27056621	ACTIVE	1039	O	D	A61E	RE:	BOREHOLE					yes A61E2
27056649	ACTIVE	BOERDERY	O	D	A61E	RE:	BOREHOLE			48 600.00	ZOETFONTEIN KR 330/0(A61E)	yes A61E2
27056649	ACTIVE	BOERDERY	O	D	A61E	RE:	BOREHOLE					yes A61E2
27057577	ACTIVE	BOERDERY	O	D	A61E	RE:	BOREHOLE			108 640.00	PLATDOORNS KR 333 PTN 0	yes A61E2
27056364	ACTIVE	TRUST	O	D	A61E	RE:	BOREHOLE			47 680.00	1(A61E)	yes A61E2
27056364	ACTIVE	TRUST	O	D	A61E	RE:	BOREHOLE			263 119.00		yes A61E2
Total								**1 209 740.00**	**816 363.00**	**5 786 275.00**	**15 852.81**	**Ml/day**
Large irrigators										**3 864 661.00**	**10 588.11**	**Ml/day**
Other users										**1 921 614.00**	**5 264.70**	**Ml/day**

6.4.2 WETLANDS

The National Water Act, 1998 (Act No. 36 of 1998)[NWA], defines wetlands as follows:

"*Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*."

A single large floodplain wetland associated with the Nyl River was delineated on site, traversing the study area from south to north along the western boundary of the site. The following figures show the delineated wetland area (Figure 6-15) and the position of the North and South open cast pits in relation to the delineated wetland (Figure 6-16).

Two dams were also identified within the floodplain – the southern dam, the larger of the dams, is built across the entire floodplain width, while the northern dam is built within the floodplain but off the main channel where a minor, poorly defined and un-named tributary joins the floodplain. Numerous shallow earthen ponds were observed within this tributary. The floodplain covers approximately 110.7 ha of the study area, with the dams covering an additional 10.6 ha. The wetland thus makes up 19.5 % of the study area. Within the context of the greater Nyl River floodplain, the section of floodplain on site represents approximately 0.5% of the entire Nyl floodplain. The north pit will be located outside of, but almost immediately adjacent to, the delineated wetland edge.

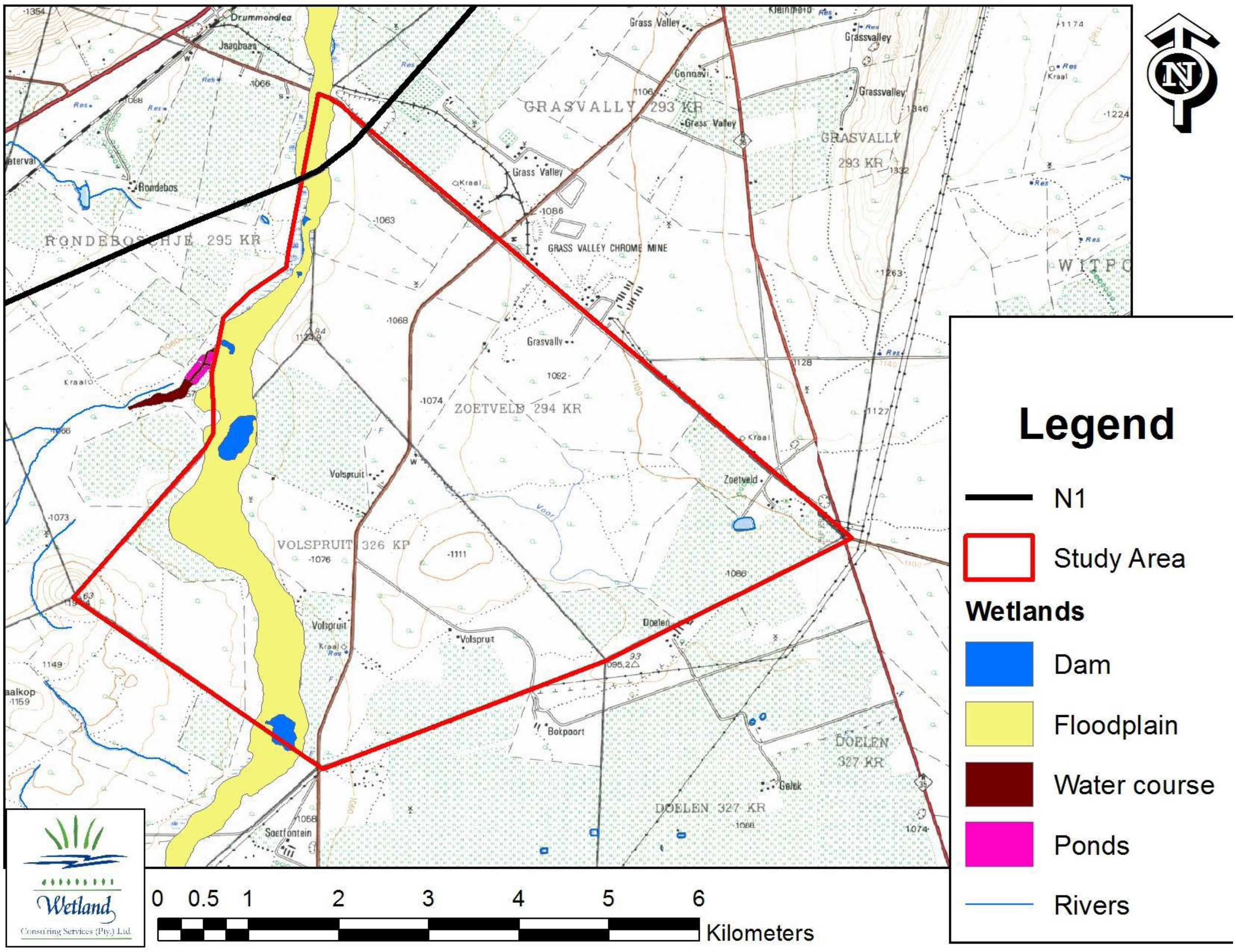


Figure 6-15: Wetlands on the proposed Volspruit mining site. Delineated wetland indicated by the white area (WCS delineation, 2011). Farm boundary of Volspruit and Zoetveld indicated by red line.

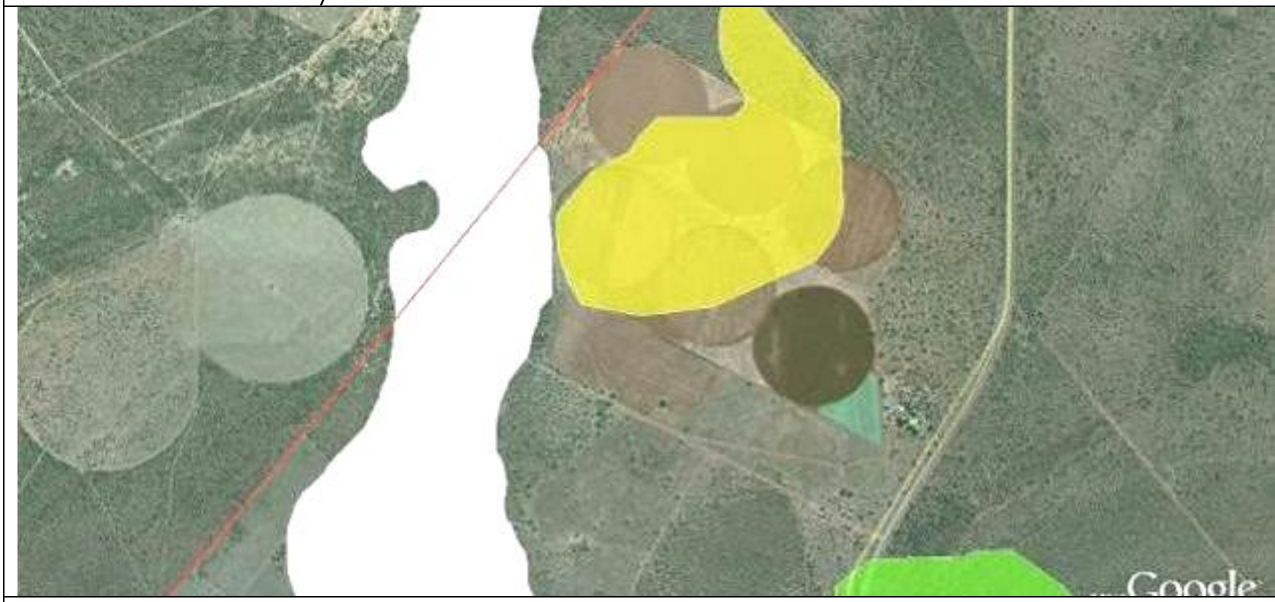


Figure 6-16: Position of North (yellow) and South (green) open cast pits in relation to the delineated wetland areas onsite. (WCS wetland delineation, 2011)

Within the study area, the southern reaches of the floodplain are characterised by a broad, flat, grassed wetland approximately 380m across. No defined channel was observed in these areas, as is the case with large portions of the greater Nyl Floodplain to the south of the site. Zonation of the vegetation on site does, however, indicate that the central region of the floodplain is inundated more frequently and that most surface flows will be confined to this section.

The Convention on Wetlands (Ramsar, Iran, 1971) -- called the "Ramsar Convention" -- is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories. Portions of the Nyl river floodplain (i.e. the Nylsvley Nature Reserve) have been recognised as a RAMSAR Wetland of International importance (Figure 6-12).

Functional Importance

Numerous functions are typically attributed to wetlands based on the location, size and type of wetland in question. A floodplain wetland, such as that located on the western extent of the study area, is typically expected to be of importance in terms of:

- Flood attenuation;
- Flow regulation;
- Sediment trapping;
- Water quality enhancement;
- Biodiversity support; and
- Direct use benefits such as tourism and grazing.

In terms of the functions of the floodplain on site, it is impossible to separate the functionality from the functions performed by the entire Nyl floodplain, of which the section on site forms part of the lower reaches. The discussion below is thus applicable to the entire Nyl floodplain, but also to the relevant section of the floodplain on site.

In terms of the Nyl floodplain, studies undertaken by Kleynhans et al (2007) indicate that despite the size of the Nyl floodplain, the value of the flood attenuation function of the floodplain is small. This is due to the impact of downstream tributaries that negate the flood attenuation impact of upstream wetlands, the shape of the river valley downstream of the floodplain that limits the extent of the flooded area, and the lack of significant infrastructure or high productive land within the area downstream of the floodplain that would be flooded in the absence of the flood attenuation function of the wetland.

The same study by Kleynhans *et al.* also found that the Nyl floodplain performs a limited function in terms of baseflow maintenance (surface flows) and regulation due to the large losses of water from the wetland through evaporation and potentially groundwater recharge. This was already referred to above where it was indicated that the lower reaches of the floodplain flood less often and less frequently than the upper reaches. For some flood events, no water leaves the floodplain with all water lost on the floodplain. While the study did not consider groundwater recharge effects, previous studies have concluded that the aquifer below the floodplain surface is generally separated from the floodplain by clay lenses and that very little recharge occurs (Porszasz and Bredenkamp, 1973; Scott and Wijers, 1992; Morgan, 1996 cited in Kleynhans *et al.,* 2007).

The Nyl floodplain however definitely plays a significant role in trapping sediments entering the system from upstream reaches. Flows entering the floodplain slow down significantly and spread out over large areas, encouraging the deposition of sediments. In addition, the extended retention time and contact with wetland sediments and vegetation will allow the floodplain to play a role in water quality enhancement through the trapping of nutrients and pollutants. The significance of this function is, however, reduced during low flood years when little or no water is discharged from the floodplain to lower reaches.

Present Ecological State

The present ecological state (PES) of the floodplain wetland on the farm Volspruit 326 KP is described by WCS as being 'moderately modified, but with some loss of natural habitats'.

This due to the increased water usage experienced within the catchment of the Nyl River floodplain and the resultant decreased flows within the Nyl River, which further act to diminish the extent, depth and duration of flooding. Given the sensitivity of the vegetation on the floodplain to changes in the depth and duration of inundation, the changes in flows have undoubtedly led to changes in the vegetation composition of the floodplain on site.

Further changes to the vegetation have been brought about by livestock grazing, burning, cultivation within the wetland and disturbances due to roads constructed through the wetland. Changes in vegetation typically also affected other aspects of biodiversity associated with the floodplain through changes in the habitat utilised by these species, making the habitat potentially less suitable for occupation by the species.

The dams on site have also markedly altered the vegetation of the floodplain on site through increasing the depth and duration of flooding at a local level immediately upstream and downstream of the dams. This is clearly evident on site through the presence of *Typha capensis* and *Phragmites australis* which is only associated with those areas affected by the dams.

Ecological Importance and Sensitivity

Ecological Importance and Sensitivity (IES) is a concept used to evaluate a wetland in terms of:

- Ecological Importance;
- Hydrological Functions; and
- Direct Human Benefits.

The scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et. al. (2008) on the assessment of wetland ecological goods and services (the WET-EcoServices tool). Based on this methodology, an EIS assessment was undertaken by WCS for the delineated wetland on site, with the result discussed and illustrated below.

"In terms of ecological importance, given the biodiversity supported by the Nyl floodplain (especially in terms of avifauna), the floodplain on site is considered to be of very high ecological importance. The hydrological functions supported by the floodplain have been found to be somewhat more limited than would generally be expected from a floodplain of the size of the Nyl floodplain. However, some sediment trapping and water quality enhancement is likely to occur. In addition, should significant infrastructure be constructed downstream of the Nyl floodplain in close proximity to the Mogalakwena River, the flood attenuation value of the floodplain

could increase. Direct human benefits include the provision of grazing and the tourism value of the floodplain".

Given all of this, the Nyl floodplain on site is considered by WCS "*to be of Very High ecological importance and sensitivity, and should be placed in an ecological management class of A*". This refers to floodplains that are ecologically important and sensitive on a national or international level, which is also recognized by the Ramsar wetland status afforded the Nylsvley Nature Reserve.

Table 6-9: Scoring system used for wetland EIS Assessments

Ecological Importance and Sensitivity categories	Range of Median	Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

6.4.3 THE ORIGIN AND GEOMORPHOLOGY OF THE NYL RIVER FLOODPLAIN WETLAND

The Nyl river has as its source the Groot Nyl- and Klein Nyl rivers that originate in the Waterberg Mountains in the extreme southwest of the catchment. These two rivers converge just to the east of the town of Modimolle to form the Nyl river, which then flows in a north-easterly direction and supports the large Nylsvley wetland. A number of significant tributaries join the Nyl river from the western side of its catchment, draining out of the Waterberg Mountains (e.g. Olifantspruit, Bad-se-Loop, Tobiasspruit, and Andriesspruit). It is striking that no significant tributaries enter the Nyl river from the Springbok Flats on the eastern side of the catchment. The Springbok Flats are an extensive area of low-relief and low-gradient with no defined drainage systems, and the watershed/catchment boundary of the Nyl river is very poorly defined in this area (WCS, 2012).

Further to the north, across the Zebediela Fault which forms the northern limit of the Springbok Flats, the Maribashoek and Buffelshoek Mountains lie to the east of the Nyl river. These mountains are the source of a number of steep tributaries that enter the Nyl river, including thebRooisloot, Dorpspruit and Pholotsi rivers. In contrast, no major tributaries join the Nyl river from the west in this reach, until the confluence with the Sterkspruit further north (WCS, 2012).

It has been proposed by McCarthy *et al*. (2011) that "*progradation of coarse-grained tributary fans across the narrow river valley*" in these northern reaches of the Nyl River resulted in the partial impoundment of the Nyl River and created the accommodation space for sedimentation in the upper reaches thereof. The steep eastern tributaries, specifically the Rooisloot, Dorpspruit and Pholotsi, are the source of these alluvial fans. The reduction in upstream gradient resulting from the obstruction of river flow by these alluvial fans across the river valley allowed sediments transported into the upper Nyl from its western tributaries in the south to accumulate in the river valley, over time filling up the floodplain basin to its current level. Sediment accumulation is still active on the floodplain, and sediments have attained a depth of roughly 35m (McCarthy *et al*., 2011)(Figure 6-17).

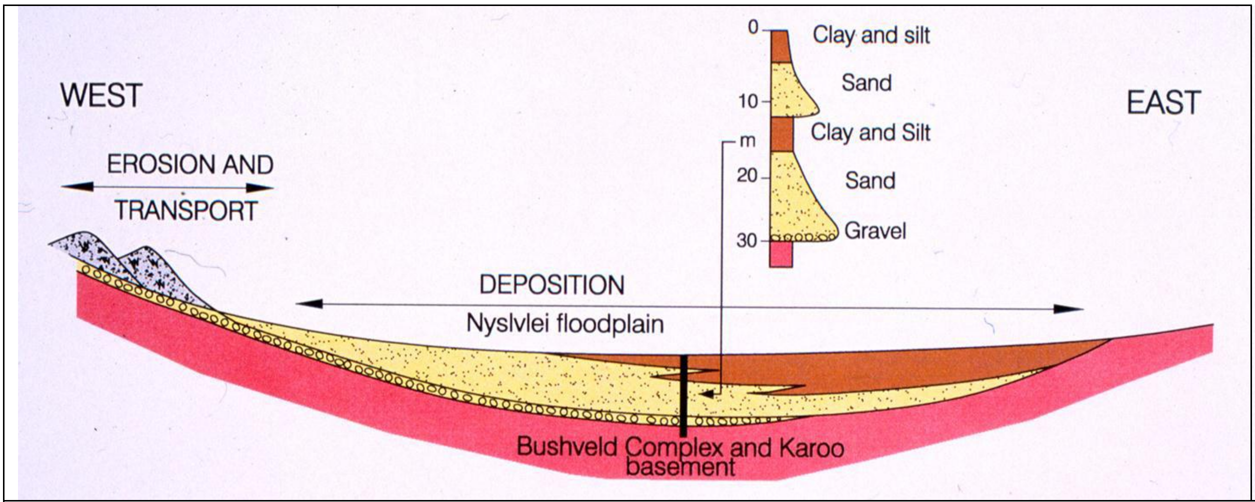


Figure 6-17: Schematic cross-section through the Nylsvlei (McCarthy, 2012)

The main source of sediments to the Nylsvley wetland is the tributaries draining from the Waterberg Mountains to the west in the southern and middle reaches of the wetland. Figure 6-17 above, reproduced with permission of Prof. Terence McCarthy (Presentation: Geohydrology of the Nylsvlei floodplain, presented 12/11/2012, McCarthy), shows a cross section through the sediments in the wetland basin and adjacent areas. As sediment rich flows from the west reach the lower gradients east of the mountains, sediment loads are deposited. Initially the heavier coarse grained material (gravel) is deposited, followed by finer sand and eventually clay particles (WCS, 2012).

Over time, as the basin filled and gradients became lower, the area of clay deposition slowly progressed westwards, closer to the mountains. This has resulted in the wetland under current conditions being characterised by a thick clay layer across the full width of the floodplain. Underlying this clay layer is a series of interleaved clay and sand layers, with greater depths dominated by sandy deposits and eventually coarser gravel overlying the bedrock (WCS, 2012).

6.4.4 WETLAND CLAY LAYER

In order to gain a better understanding of the links between the groundwater and surface water (or lack thereof) during a flood event it was required to further investigate the river bed in detail to determine the presence of the clay layer on the farm Volspruit, the thickness of the clay layer along the river and the extent of the clay layer towards the edges of the riverbed. This investigation was carried out by Soil

Science and Plant Nutrition Consultant, Prof Andries Claassens. The full report is attached hereto under Appendix 5.2 A Grouting Strategy and Packer testing

An extensive survey of the area that is expected to be undercut by the mine dewatering drawdown cones was carried out so as to determine the lateral and vertical extent as well as permeability of the clay layer associated with the Nyl River. It was found that the permeability of the clay soil is low and that very little water would be lost from the river bed over time due to the thick clay layer.

Measurements and soil sample analyses were conducted along numerous transects of the river bed. Figure 6-18 below shows two cross sections of the river bed indicating the extent and thickness of the clay layer.

6.4.5 HYDROLOGY AND FLOODING

Flow within the tributaries feeding the Nyl River is strongly seasonal, with peak flows during the wet summer months. Rainfall in the catchment however varies considerably in time, space and intensity, with average rainfall ranging from 740mm in the west to 600mm in the east. The 69-year mean annual rainfall at Nylsvley Nature Reserve is 623 mm with an annual coefficient of variation of 24% (Frost, 1987). Given this variability in rainfall and water inputs to the wetland, the seasonality of the system is easy to understand, with flooding of the Nylsvley occurring on average only 3 out of 5 years (WCS, 2012).

Analysis of satellite imagery (McCarthy *et al.*, 2011) indicates that the Nyl wetland receives most of its surface water from the Groot and Klein Nyl rivers in the south, as well as from several of its western tributaries, with virtually no water inputs from the east. Work undertaken by McCarthy *et al.* (2012) indicates that up to a 100% of annual flow within the western tributaries of the Nyl river infiltrates into the sandy sediments along the western edge of the Nylsvley wetland prior to reaching the floodplain. This view is based on the decreasing channel sizes and eventual disappearance of the channels, and the loss of water that this represents, of the western tributaries as they approach the floodplain. Thus in order for flooding of the Nylsvley floodplain to occur, 110% or more of the average annual rainfall is required (McCarthy, 2012) so that surface runoff generated within the Waterberg mountains reaches the Nylsvley wetland and is not all lost to groundwater recharge (WCS, 2012).

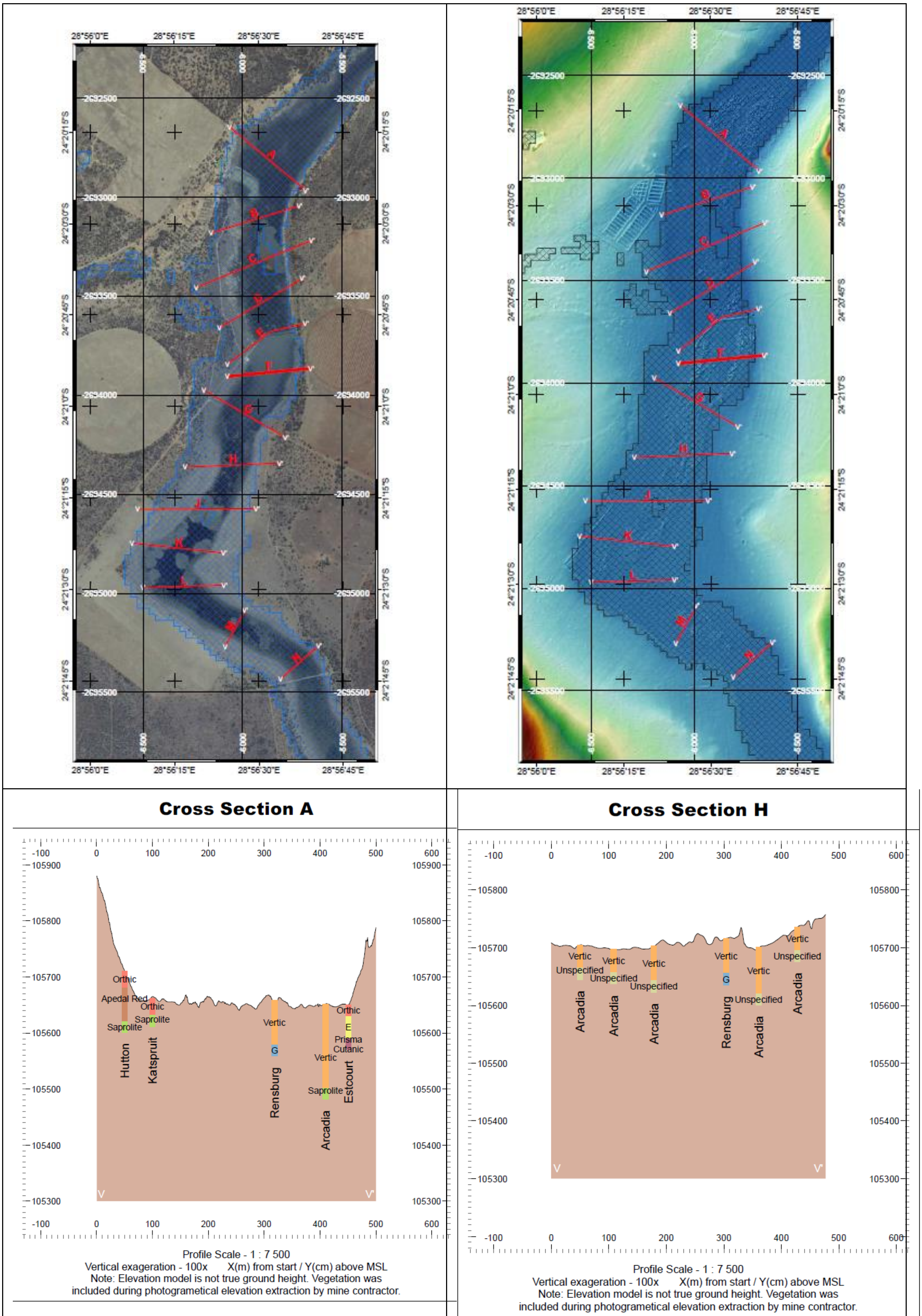


Figure 6-18: Cross sections of Nyl River bed on Volspruit farm indicating presence, thickness and extent of clay layer

Water lost to groundwater recharge by the western tributaries is expected to support a large alluvial aquifer within the sandier sediments underlying the Nylsvley floodplain. The existence of this alluvial aquifer, and its response to rainfall, can be verified through monitoring of water levels within and immediately adjacent to the wetland. In the case of the Volspruit study area, groundwater levels immediately adjacent to the wetland were found to be at around 5m below surface (Giep du Toit, 2012), and while no substantial flooding of the wetland occurred during the period these boreholes were monitored, an increase in water levels following limited, localised flooding was observed (refer to Appendix 5.1 Groundwater Impact Assessment Report prepared by GeoPollution Technologies for more detail on these piezometer boreholes)(WCS, 2012).

The general consensus of a number of researchers (Kleynhans, 2006) has been that the alluvial aquifer is separated from the surface water within the Nylsvley wetland by clay layers of low permeability (preceding section refers). In the same study, Kleynhans found that soil permeability on the floodplain was governed by the soil layer with the lowest permeability, and that several of these layers yielded permeability rates too low to measure with a Guelph Permeameter, and that recorded infiltration rates varied from 0.036 mm/hour to 0.864 mm/hour. It is thus considered unlikely that flood waters within the wetland play a significant role in recharging the alluvial aquifer underlying the wetland, though the response of water levels within the alluvial aquifer to flooding does show that the aquifer is recharged during a flood (Morgan 1996), though this likely takes place on the sandier sediments along the western side of the floodplain, rather than within the floodplain itself. Work undertaken by GPT and logging of boreholes drilled to install piezometers indicates that there is little if any alluvium present under the clay layer associated with the Nyl in the Volpsruit area. That has led to the hypothesis that the Nyl previously flowed further to the west and was pushed to the east by the advance of the alluvial fan that around which seepage has been detected by Landsat imaging of the Nyl floods (refer Figure 8-18).

6.4.6 FLOOD LINES

As part of the pre-feasibility study that was undertaken in 2010 for Sylvania Platinum and Pan Palladium, the flood lines for the property were modelled by African Environmental Development (AED). A summary of the full flood line report is contained in Appendix 5. The two figures below indicate the extent of the flood lines. In summary, the flood line modelling that was undertaken concluded that it was clear that the overriding feature having an impact on the 100-year flood lines in the study area, is the N1 bridge north of the site. What also became obvious was that approximately half of the proposed north pit (i.e. the western half thereof) is located within the present day 1:50 and 1:100 flood lines (Figure 6-19).

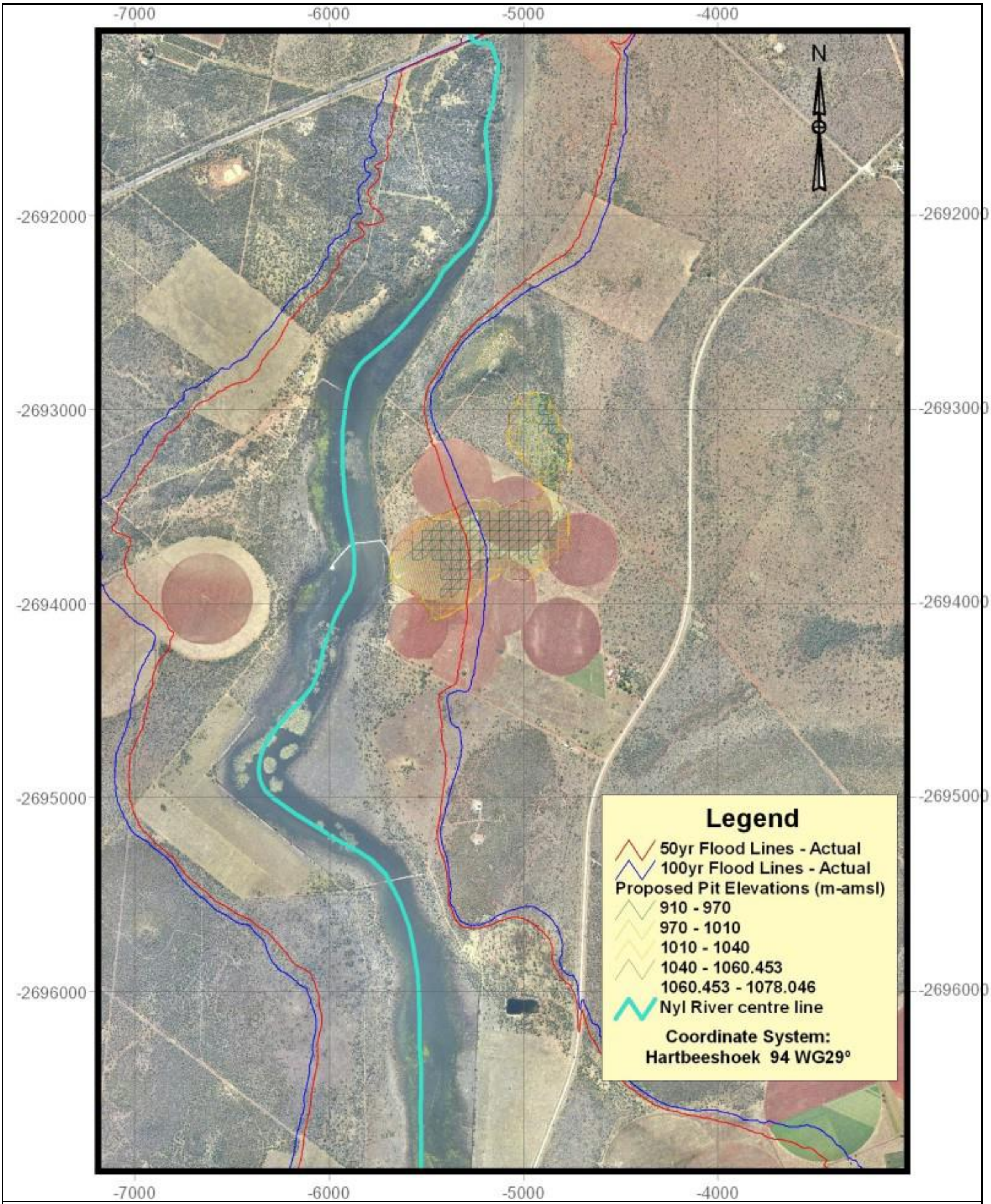


Figure 6-19: The final 50- and 100-year flood lines at Volspruit mine on a backdrop of an orthophoto produced by Southern Mapping Company (Pty) Ltd (AED, 2010)

6.4.7 SURFACE WATER QUALITY

Water samples were taken by AED at four points (Figure 6-20) along the course of the Nyl river as part of the surface water assessment for the EIA (Full report contained in Appendix 5.3: Surface Water Impact Assessment Report). These samples were then submitted to a SANAS-accredited laboratory for analysis. The sites where surface water sampling was undertaken are as follows:

1: The first sampling site was located immediately down-stream from the Nylsvley Nature Reserve, where a dirt road crosses the floodplain wetland. The site was located on the farm Vogelsfontein 527 KR. At this point, the wetland is approximately 6km wide;

2: The second sample was obtained from a quarry, or borrow pit, on the farm Volspruit 326 KR, located on the eastern bank of the Nyl river. It was located roughly 440 m from the centre of the Nyl river, placing it possibly still within the alluvial riverbed. It appears as if sand and gravel was mined at this quarry, probably for building the nearby provincial gravel road. The quarry also had a lot of calcrete exposed along its sidewalls. The wetland in the vicinity of the quarry is approximately 1.5 Km wide;

3: This sampling site was located at an existing farm dam in the Nyl river. The dam wall is actually constructed just within the Volspruit side of the boundary between the farms, Volspruit 326 KR and Rondeboschje 295 KR. The wall is constructed from rock, probably sourced from the nearby Grass Valley Chrome Mine; and

4: This sampling site marks the furthest down-stream sample of the Nyl river. The sample site is located on the farm Moorddrif 289 KR. At this site, there was, once again, water in the Nyl River from which a sample could be collected. It is about 9 km down-stream from Site 3, the dam at the proposed North Pit of Volspruit Mine and some 6km down-stream from the N1 Bridge.

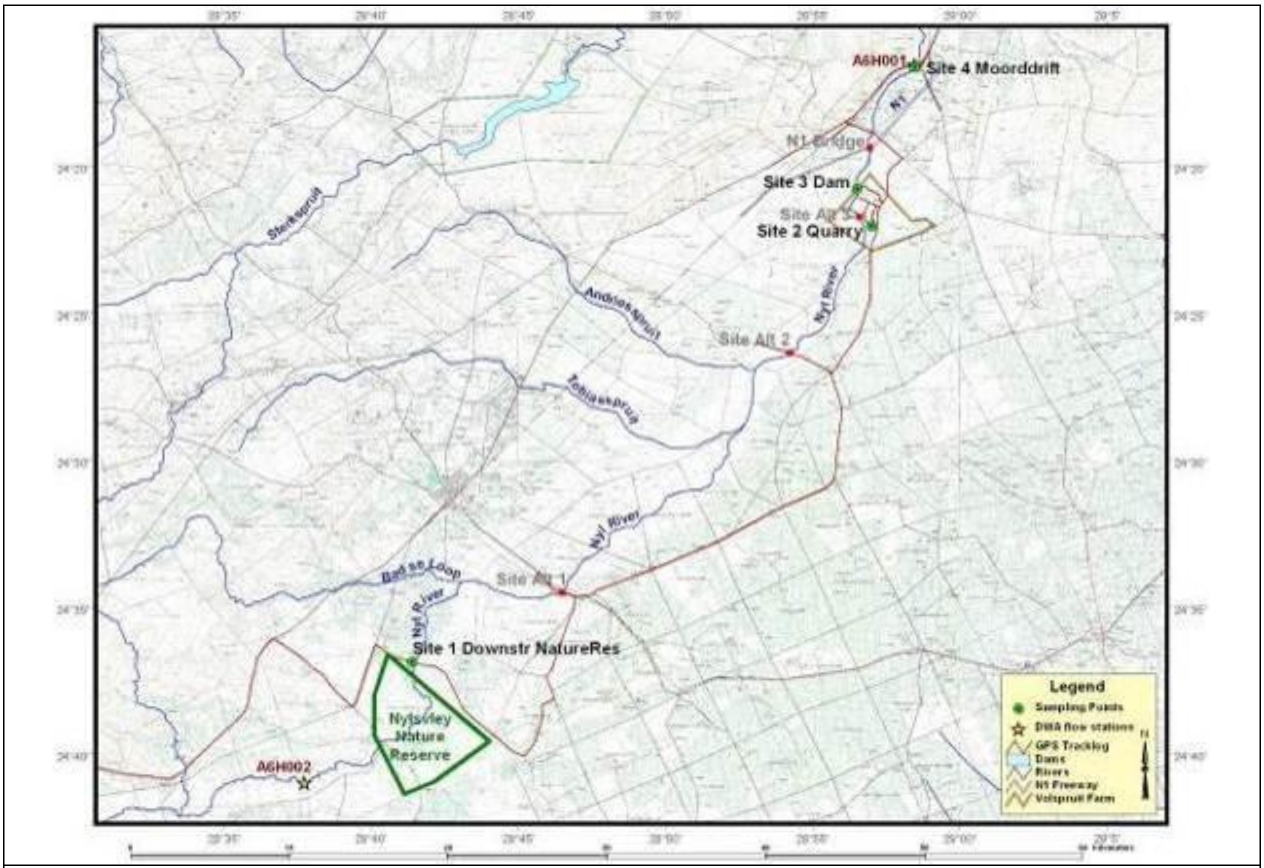


Figure 6-20: Surface water sampling points

The sample results for the four sites were compared with the South African National Standard, SANS 241:2011 – Edition 1.0 (Table 6-10). SANS 241 is the official South African drinking water standard. The 2006 version of this standard provided for two levels of quality, Recommended (Class I) and Maximum Allowable for a short period (Class II). The recently released 2011 version of the standard has simplified the standard to a certain extent by removing some of the unnecessary determinants from the standard (determinants such as calcium, magnesium and potassium that do not really pose a health hazard to humans). At the same time the standard has been brought in line with the World Health Organisation standards and the concentrations of some determinants were increased or decreased.

Table 6-10: Comparison of measured results for surface water samples against SANS 241:2006 and SANS 241:2011

Sample ID → Determinant ↓	Units	Site 1 Downstr. Nature Reserve	Site 2 Quarry	Site 3 Farm Dam	Site 4 Moorddrif	SANS 241:2006 (Edition 6.1)		SANS 241:2011 (Edition 1)
						Class I	Class II	
Physical and Macro Determinants								
pH	@25ºC	6.6	9.2	7.2	7.6	5.0-9.5	4.0-10.0	≥5 to ≤9.7
Conductivity	mS/m @25ºC	11	98	22	75	<150	150-370	≤170
Total Dissolved Solids	mg/l @180ºC	75	666	150	510	<1 000	1 000-2 400	≤1 200
Total Hardness	mg/l CaCO3	17.9	67.5	35.9	88			
Total Alkalinity	mg/l CaCO3	29	459	70	168			
Sulphate	mg/l	<50 (22)	<50 (43)	<50 (24)	<50 (12)	<400	400-600	≤250 (Aesthetic), ≤500 (Acute Health)
Nitrate	mg/l N	0.4	0.4	0.5	0.4	<10	10-20	≤11
Orthophosphate	mg/l P	0.1	0.1	0.1	0.1			
Chloride	mg/l	16	76	19	83	<200	200-600	≤300
Calcium	mg/l	4	74	9	29	<150	150-300	Not classified
Magnesium	mg/l	1.9	14	6.3	19	<70	70-100	Not classified
Sodium	mg/l	9.3	27	11	45	<200	200-400	≤200
Iron	µg/l	62	37	930.9	48.6	<200	200-2 000	≤300 (Aesthetic), ≤2 000 (Chronic Health)
Potassium	mg/l	3.9	3.5	9.8	9.9	<50	50-100	Not classified
Metals by ICP Mass Spectroscopy								
Aluminium	µg/l	4.87	4.40	1157.90	0.79	<300	300-500	≤300
Antimony	µg/l	0.08	0.03	0.17	0.10	<10	10-50	≤20
Arsenic	µg/l	0.30	0.25	13.60	0.60	<10	10-50	≤10
Barium	µg/l	45.80	132.90	94.70	72.70			
Beryllium	µg/l	0.02	0.01	0.05	0.01			
Bismuth	µg/l	0.01	0.03	0.02	0.03			
Caesium	µg/l	1.38	0.10	1.95	0.10			
Cadmium	µg/l	0.01	0.01	0.10	0.02	<5	5-10	≤3
Chromium Total	µg/l	0.20	1.00	5.27	0.20	<100	100-500	≤50
Chromium(VI)	µg/l	<0.03	<0.03	<0.03	<0.03			
Cobalt	µg/l	0.90	0.06	2.90	0.20	<500	500-1 000	≤500
Copper	µg/l	43.00	0.96	245.00	5.29	<1 000	1 000-2 000	≤2 000
Indium	µg/l	0.001	<0.001	0.002	0.001			
Lanthanum	µg/l	0.05	0.01	0.70	0.01			
Lead	µg/l	0.19	0.05	2.20	0.50	<20	20-50	≤10
Lithium	µg/l	0.56	3.50	2.06	1.40			
Mercury	µg/l	0.90	0.97	0.80	1.78	<1.0	1.0-5.0	≤6
Molybdenum	µg/l	0.18	0.20	0.50	0.29			
Manganese	µg/l	19.90	0.79	15.00	1.10	<100	100-1 000	≤100 (Aesthetic), ≤500 (Chronic Health)
Nickel	µg/l	7.50	1.38	59.00	1.99	<150	150-350	≤70
Platinum	µg/l	0.02	0.02	0.05	0.05			
Rubidium	µg/l	2.07	0.47	3.60	2.59			
Selenium	µg/l	0.50	0.40	3.08	0.38	<20	20-50	≤10
Tellurium	µg/l	0.01	0.01	0.03	0.08			
Thallium	µg/l	0.06	0.20	0.10	0.29			
Tin	µg/l	0.20	0.04	0.10	0.03			
Titanium	µg/l	0.29	0.20	47.80	0.06			
Tungsten	µg/l	0.10	0.18	0.30	0.50			
Vanadium	µg/l	0.25	2.78	3.90	0.10	<200	200-500	≤200
Zinc	µg/l	28.70	11.00	52.00	1.56	<5000	5 000-10 000	≤5000
Uranium	µg/l	0.40	2.49	3.89	0.70	<70	70-284	≤15

The iron, aluminium and arsenic concentrations at site 3 (farm dam) exceeded the SANS 241:2011 standard. Iron only exceeded the "aesthetic" range, but both arsenic and aluminium fell beyond the "human health" range of the standard.

In addition to these three determinants, there were other determinants at this same site that were higher than would be expected when compared to the same determinants at the other sampling sites in the Nyl river. Among others, these determinants were Copper, Nickel and Zinc. All these elements are associated with agricultural chemicals and it is inferred that the proximity of the dam from which the sample was collected to the large centre pivot irrigation systems near the dam is the reason for finding these elements in the farm dam water. Under normal circumstances, they should not have been observed in the measured concentrations.

In general and ignoring the elements discussed above (which according to the surface water specialist, was "*undoubtedly from an agricultural and not a natural origin*", the water quality of the samples associated with the Nyl river were of an exceptionally good quality. The water complied with the SANS 241:2011 drinking water standards in all respects (no microbial analysis was done). This does not come as a surprise, as water being filtered through a wetland is usually "polished". The Nyl river wetland happens to be the largest floodplain wetland in South Africa. So all three samples collected directly from the wetland were of an excellent quality (ignoring the agricultural-related chemicals in the farm dam at site 3).

The water from the quarry also complied 100% with SANS 241:2011, but had a high pH and alkalinity when compared to the other samples. It also had the highest conductivity/TDS of all the samples. It is believed that this is due to the fact that the water from the quarry is a mixture of surface- and groundwater and that this water has been mineralised to a certain extent by the minerals associated with the geology into which the quarry was made. The water in the quarry is also subjected to evaporation and subsequent concentration of chemicals. Nevertheless, in general, all the samples were of an excellent quality.

6.5 GEOHYDROLOGY

6.5.1 INTRODUCTION / REGIONAL GEOHYDROLOGY

The rock underlying the Volspruit Mine site is comprised of cumulates of the Lower Zone of the Rustenburg Layered Suite of the Bushveld Complex and floor rocks consisting of the Transvaal Supergroup. Groundwater in these rocks is usually associated with deeply weathered and fractured mafic rocks. The groundwater yield potential in the Eastern Limb of the Bushveld Complex is regarded as low as 81%, with boreholes on record having a yield less than 2l/s. However, yields around the Volspruit property exceed 6l/s, as observed from the data collected during the various hydrocensuses for the project.

In the Northern Limb, the Rustenburg Layered Suite rocks are mainly found in the valleys and flat areas with widespread groundwater resources. Borehole yields of 0.5 – 2 l/s are common, with >5 l/s found in localised areas. Potgietersrus Platinum Mines (PPL) have a permit to abstract up to 1 500 m^3/d from an abandoned chrome mine south of Mokopane in the catchment A61E (in which the Volspruit project is found). Groundwater use in the A61E catchment is at the limit of the estimated sustainable yield. A ‘present status category’ of D (80-100 % of recharge) is already used. Therefore the volume of ‘allocatable’ groundwater for use in this catchment is limited.

In general, the Bushveld Complex is generally characterised by low permeability strata, with transmissivity being dependant on the amount of fracturing. As a result abstraction boreholes in the Bushveld setting usually have poor and unsustainable yields. However, it is apparent that a larger extent of faulting and fracturing is found in certain areas of the Northern Limb than in the rest of the Bushveld Complex (as is the case at Volspruit). This occurrence is likely to increase borehole yields and sustainability in these areas.

The groundwater quality is generally classified as good, with isolated NO_3 pollution present due to agricultural activity. Mining in the area has the potential to contaminate and should be recognised. Groundwater contributes to surface water base flow throughout the catchment *via* sub-surface seepage and springs. The Waterberg and Soutpansberg Ranges are important areas for groundwater recharge and drainage base flow.

The relationship between groundwater, base flow, and river flow is reasonably well understood where hydrographs are available. However, the impact of groundwater abstraction on surface water resources is less well understood. Recharge of the groundwater system from river flow, especially during flood events, is important.

6.5.2 HYDROCENSUS RESULTS

During the hydrocensuses performed by GPT in 2010 and 2011, the following observations were made:

- Groundwater levels were measured in 48 boreholes of a total of 72 identified boreholes during hydrocensus conducted in between 2010 and 2011.
- The water levels ranged from 1.5 to 38 mbgl.
- The boreholes identified during the hydrocensus around the proposed mine show an average yield of 6.25 l/s.

Two geophysical surveys were performed on site in 2010 and 2011. For the surveys, the Geometrics "Stratagem" EH 4 CSAMT instrument and the ABEM "Lund" resistivity imaging system were used. It was also possible to map structures identified by Integrated Geological Solutions that were provided to GPT. Ten percussion boreholes were also drilled on the site between 2010 and 2011 and most of these holes were targeted on geophysical anomalies. During drilling, it was observed that:

- The newly drilled boreholes showed blow yields ranging between 0.5 and 4l/s.
- The holes may be used for monitoring purposes in the future as the depths range between 40 and 174mbgl.

Nine piezometer holes were drilled along the Nyl River to study the interaction of the river with the underlying aquifer. The depths of the multi-level piezometers ranged between 5.6 and 27.08mbgl. Pump testing was performed on the newly drilled percussion boreholes as well as additional existing boreholes. Pumping test analysis showed the following results:

- Transmissivities for the tested boreholes ranged between 1.4 and 171.6 m2/day indicating highly variable flow characteristics for the lithologies on site.
- An overall variable transmissivity and hydraulic conductivity was therefore observed in the pumping test data.

Six existing exploration core holes were identified for packer testing to determine which hydrogeological unit is the major water bearing unit on site. However, only four of the six identified core holes could be packer tested successfully. The packer test information was interpreted to indicate the following:

- Hydraulic conductivity values obtained from the packer tests, which can only be performed in competent rock, were lower than those obtained from pumping tests by approximately an order of magnitude overall.
- This indicates that the upper weathered zone is most probably the major water bearing lithological unit.

The newly drilled piezometer holes were fitted with electronic groundwater level data loggers. The data obtained from the loggers indicate that:

- Data obtained from data loggers installed in the newly drilled piezometer holes, for the monitored period, indicates that the Nyl River and the groundwater on site are unlikely to be hydraulically connected.

Short term geochemical analyses of the rock material on site, as well as long term geochemical modelling, indicate that:

- The material is unlikely to form acid rock drainage, but could possibly cause an increase in major ion concentrations in groundwater.
- According to the geochemical model, due to mineral oxidation, weathering and dissolution an increase in pH and major ions in groundwater as well as salinity over the life of mine and beyond, can be expected, however due to dilution groundwater impacts associated with oxidation of backfilling are low and plume concentrations should not impact water abstracted from neighbouring boreholes

During the two hydrocensuses performed, various water samples were collected and submitted for chemical analysis. The analysis data was interpreted as follows:

- The groundwater quality of almost all samples contained constituent concentrations that exceed the maximum allowable standard for domestic use (SANS 241).
- Constituents found in concentrations that exceed the standard, include calcium, magnesium, nitrate and chloride.
- As a result of these elevated constituents, electrical conductivity and total dissolved solids levels are thus elevated as can be seen from the results.

Therefore, the general assumption can be made that groundwater quality on the Volspruit property is poor according to the SANS drinking water standards due to the exceedances indicated. The aquifer was also classified according to the Parsons aquifer classification system. Based on this system, the deduction was made that:

- The aquifer can be classified as a sole source aquifer and should receive a high level of protection.

The potential contaminant sources at the proposed mine were identified as:

- Opencast mine
- Waste rock dumps
- Tailings dams
- Workshops and petroleum storage tanks
- Septic tanks
- General waste facilities

Pathways for contaminant movement on site were identified as:

- The weathered and unsaturated zones which serve as pathways for groundwater flow
- Faults and fracture zones which serve as pathways for groundwater flow
- Surface runoff draining to surface water bodies

Receptors to contamination were identified as:

- Groundwater users by means of borehole abstraction
- Water courses: water users, fauna and flora, also including aquatic life

6.5.3 GROUNDWATER QUALITY

Eighteen (18) groundwater samples, as well as one surface water sample from the Nyl River, were collected from selected boreholes identified during the hydrocensus in 2010 (Figure 6-21). Ten further water samples were also collected from selected for subsequent analysis from boreholes identified during the hydrocensus in September 2011. The water samples were submitted for major cation and anion analyses to an accredited laboratory.

The results of the water chemical analyses are contained in Table 6-11 and Table 6-12, and compared to the SABS Drinking Water Standards (SANS 241:2006, Ed. 6.1) as the potential receptor of concern is groundwater users. Colours of individual cells refer to the drinking water classification of the specific water sample. The groundwater quality of almost all samples contained constituent concentrations that exceed the maximum allowable standard for domestic use (SANS 241). Only the water quality in borehole 'GV1' complies with the standard.

The boreholes 'VOL1', 'ABDUL' and the sample from the Nyl River partially comply with the standard, with just elevated magnesium, iron and manganese concentrations, respectively. Constituents found in concentrations that exceed the standard include calcium, magnesium, nitrate and chloride. As a result of these elevated constituents, electrical conductivity and total dissolved solids levels are thus elevated as can be seen from the results especially borehole 'BOK8', 'M2', 'M3', 'M4', 'M5' and 'M6' which also showed elevated concentrations of calcium.

Elevated nitrate levels were detected in 'VOL17', 'VOL19', 'VOL20', 'VOL21', 'VOL22', 'M19', 'M24', 'M25', 'M5' and 'M6' and are primarily a health concern because it can be readily converted in the gastrointestinal tract to nitrite as a result of bacterial reduction.

Boreholes 'DEK1', 'BOK1', 'BOK8', 'VOLS1', 'VOLS3', 'VOLS5' were the samples with the most elevated total constituent concentrations in 2010 with Cl contributing for the most part. Other major contributing constituents identified are NO_3, Mg, Na, Ca and SO_4. Nitrate (NO_3) is found in most sampled boreholes; the most likely source is fertilizers. The NO_3 is transported vertically with infiltrating water. The elevated Cl concentrations may be attributed to induced salinity of the groundwater from irrigation practices.

Boreholes 'M19', 'M2', 'M5' and 'M19' were the samples with the most elevated total constituent concentrations in 2011, with Cl too contributing the most thereto. Other major contributing constituents identified are NO_3, Mg, Na, Ca and SO_4. Nitrate (NO_3) is found in all sampled boreholes; the most likely source is fertilizers. The NO_3 is transported vertically with infiltrating water. The elevated Cl concentrations may be attributed to induced salinity of the groundwater from irrigation practices. SO_4 values at Bokpoort are also elevated from 2010, which may indicate an increase in sulphate based fertilisers at Bokpoort farm. However, this may also be indicative of increased sulphide mineral dissolution in the underlying rock due to an increase in oxygen availability in the groundwater.

The stiff diagrams and piper diagram constructed with the 2010 sample chemistry, show that the general water type of the boreholes on the farm Volspruit is Mg-Ca/HCO_3. The water type for the boreholes south of Volspruit Portion 1 on Volspruit Portion 2 are Mg-Ca/Cl, while on the farm Bokpoort Mg-Na/Cl type water is found. The boreholes located north of Volspruit show a Mg-Ca/HCO_3 –Cl type signature. The sample taken from Nyl River plots uniquely on the piper diagram as a Na-Mg/HCO_3-Cl water type. Since the samples were taken after the rain season the water chemistry signature differs between the river and groundwater, as the river has been sourced by run-off from different areas.

The stiff diagrams and piper diagram constructed by GPT with the 2011 sample chemistry (full report attached in Appendix 5.1 :Groundwater Impact Assessment Report), show that the general water type for the boreholes south of Volspruit Portion 1 on Volspruit Portion 2 are Mg-Ca/CO_3, while on the farm Bokpoort Mg-Ca/Cl type water is found. The chemical analyses supplied within this report should serve as baseline water quality throughout the life of the proposed mining operations.

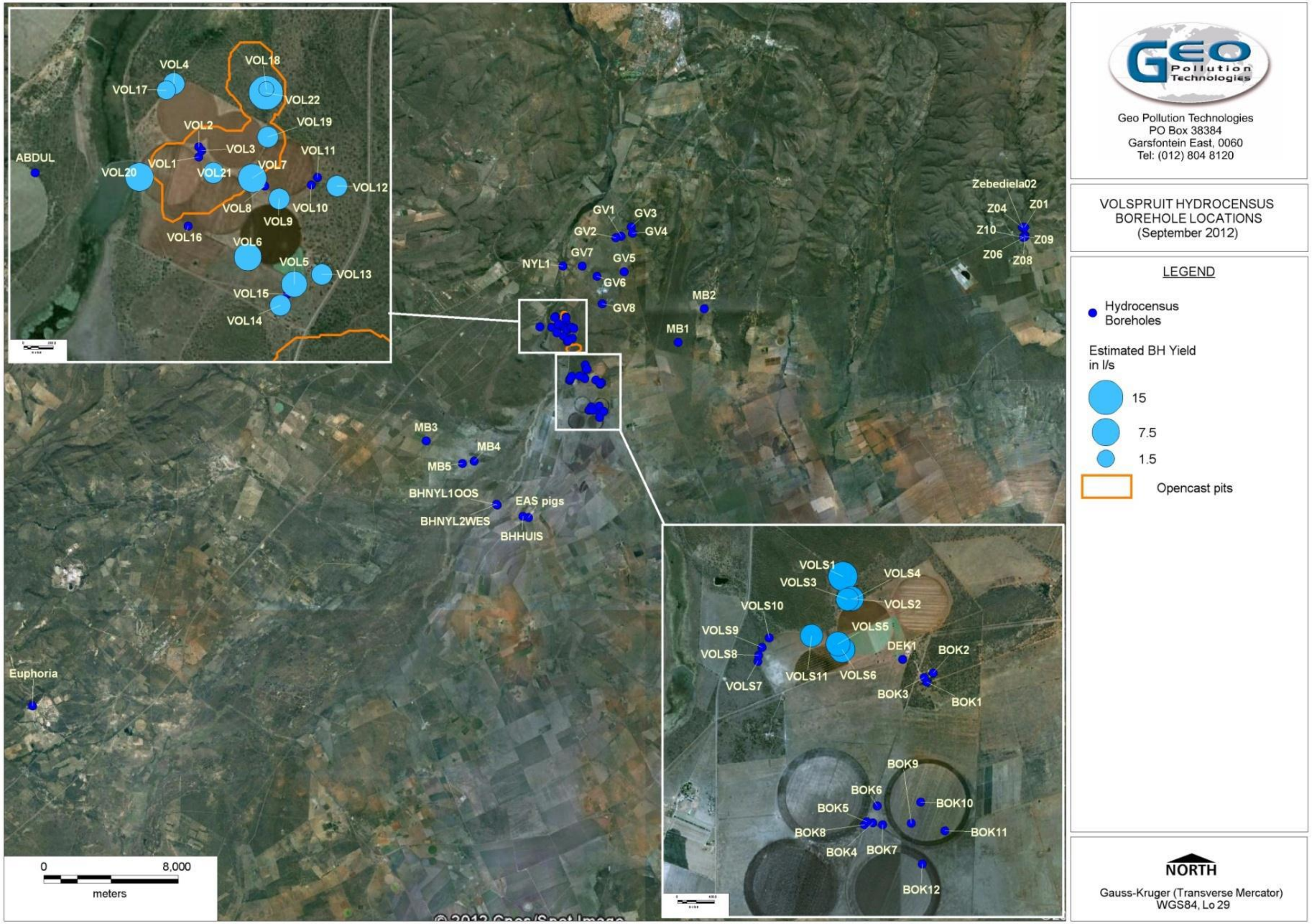


Figure 6-21: Estimated borehole yields

Table 6-11: Results of Major Cation and Anion Analyses (Groundwater)

Sample Nr.	ABDUL	BOK1	BOK8	DEK1	GV1	GV5	GV7	GV8	NYL1	VOL20	VOL21	VOL22	VOL22 (10 l/s)		Class I	Class II
Ca	46.07	185.97	341.11	129.91	24.42	78.23	78.90	10.13	5.58	52.91	32.40	53.77	47.29		150	300
Mg	73.61	152.24	188.66	145.73	63.40	122.48	83.28	121.21	4.08	141.29	101.10	151.69	132.13		70	100
Na	33.20	232.80	90.32	209.16	23.30	26.70	28.28	46.39	15.90	12.40	11.71	13.77	12.76		200	400
K	5.21	5.22	5.67	5.21	1.69	1.91	3.01	28.35	4.61	4.42	5.60	5.54	5.27		50	100
Mn	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.07	0.00	0.02	0.06	0.03	0.04		0.1	1
Fe	0.00	0.00	0.02	0.00	0.01	0.01	0.00	0.00	0.26	0.02	0.02	0.01	0.03		0.2	2
F	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.22	0.27	0.71	0.66		1	1.5
NO_3	0.75	35.37	46.37	48.75	43.49	63.87	21.66	0.00	0.00	132.18	169.05	292.04	265.09		44	88
NH_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.08	0.06	0.04	0.04		1	2
Al	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00		0.3	0.5
PO_4	0.00	0.18	0.00	0.25	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		-	-
HCO_3	463.10	346.60	139.71	387.16	309.23	283.33	340.98	349.90	50.38	586.41	309.07	349.69	346.98		-	-
Cl	51.30	886.30	1228.20	716.80	39.30	370.80	224.50	259.50	20.30	44.50	42.10	76.00	78.40		200	600
SO_4	18.46	71.90	128.26	117.07	18.42	10.42	30.69	16.17	4.32	59.22	60.98	121.11	98.75		400	600
TDS by sum	457.00	1713.00	2061.00	1526.00	333.00	766.00	622.00	665.00	80.00	634.00	445.00	660.00	607.00		1000	2400
M-Alk(CaCO3)	381.00	284.90	114.70	318.20	254.90	234.80	280.80	305.80	41.40	482.80	254.40	287.80	287.40		-	-
pH	7.59	7.47	7.22	7.45	7.77	8.06	7.69	8.84	7.39	7.67	7.64	7.63	8.04		5.0 - 9.5	4.0 - 10.0
EC	112.90	346.50	384.00	279.80	70.80	160.90	124.20	126.60	13.15	123.00	92.40	141.50	141.10		150	370
Cat/An Bal. %	2.42	-1.09	-4.86	-3.67	1.36	-3.84	-3.36	-1.84	-1.42	2.22	1.59	2.51	-1.28		-	-

Notes:
Class I
Class II
Exceeding maximum allowable standard for domestic use
na- not analysed
All concentrations are presented in mg/l, EC is presented in mS/m
0 = below detection limit of analytical technique

Table 6-12: Results of Major Cation and Anion Analyses (Groundwater) - Continued

Sample Nr.	VOLS1	VOLS3	VOLS5	M15	M19	M2	M20	M24	M25	M3	M4	M5	M6		Class I	Class II
Ca	39.48	82.01	51.38	90.00	186.00	306.00	43.40	97.10	95.00	301.00	302.00	380.00	396.00		150	300
Mg	157.32	231.53	130.25	35.40	211.00	204.00	222.00	231.00	226.00	201.00	203.00	251.00	262.00		70	100
Na	62.76	95.26	107.69	28.30	269.00	226.00	72.20	82.40	79.60	226.00	226.00	72.60	74.90		200	400
K	4.43	4.78	3.27	8.85	6.01	3.21	5.95	4.25	4.14	3.14	3.17	6.67	6.21		50	100
Mn	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1	1
Fe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.2	2
F	0.26	0.48	0.00	0.36	0.55	0.42	0.21	0.29	0.27	0.25	0.25	0.13	0.19		1	1.5
NO_3	26.62	46.18	31.52	90.10	99.10	61.50	58.10	156.00	146.00	61.10	61.20	195.00	198.00		44	88
NH_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		1	2
Al	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.3	0.5
PO_4	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.39		-	-
HCO_3	384.80	429.99	469.24	267.16	503.46	511.55	648.67	443.92	450.56	513.05	512.76	167.87	167.82		-	-
Cl	397.70	704.40	353.10	15.50	779.00	997.00	356.00	488.00	481.00	995.00	1010.00	979.00	977.00		200	600
SO_4	50.15	94.52	55.56	53.10	367.00	118.00	79.50	153.00	136.00	114.00	115.00	480.00	505.00		400	600
TDS by sum	908.00	1435.00	940.00	496.00	2200.00	2200.00	1200.00	1470.00	1430.00	2190.00	2200.00	2470.00	2530.00		1000	2400
M-Alk(CaCO3)	317.40	353.40	386.50	221.00	414.00	422.00	542.00	372.00	371.00	423.00	423.00	138.00	138.00		-	-
pH	7.82	7.45	7.71	7.98	7.53	7.83	8.31	8.37	7.68	7.79	7.83	7.48	7.52		5.0 - 9.5	4.0 - 10.0
EC	183.60	278.90	186.50	70.00	445.00	440.00	187.00	305.00	305.00	485.00	490.00	495.00	490.00		150	370
Cat/An Bal. %	-3.48	-3.93	-3.50	-4.22	-2.84	1.37	-1.02	-1.19	-0.87	0.97	0.76	-1.93	-0.67		-	-

Notes:
Class I
Class II
Exceeding maximum allowable standard for domestic use
na- not analysed
All concentrations are presented in mg/l, EC is presented in mS/m
0 = below detection limit of analytical technique

Groundwater Chemistry and health risks

From the chemical analysis of the water samples collected from the boreholes; calcium, magnesium, nitrate and chloride were the chemical substances found not to comply with SANS 241 drinking water standard. The health risks to humans were obtained from the DWAF water quality guidelines and are summarised in Table 6-13.

Table 6-13: Summary of Human Health Risks Posed by Present Day Pollutant Concentrations

Elevated element	Groundwater/surface water samples	Human Health effects at current concentrations
Nitrate	BOK1, BOK8, DEK1, GV1, GV5, VOL13, VOLS1, VOLS3, VOLS5, VOL17, VOL19, VOL20, VOL21, VOL22, M15,M19, M24, M25, M5, M6.	Concentrations above 20 mg/l cause methaemoglobinaemia in infants and mucous membrane irritation in adults.
Chloride	BOK1, BOK8, DEK1, VOLS3, M19, M2, M3,M4, M5, M6.	Water aesthetically unacceptable due to a salty taste and may cause nausea, a disturbance of electrolyte balance and dehydration especially in infants (>1200 mg/l).
Calcium	BOK8, M2, M3, M4, M5, M6	No health effects. Severe scaling problems Lathering of soap severely impaired (>80mg/L)
Magnesium	BOK1, BOK8, DEK1, GV1, GV5, GV7, GV8, NYL1, VOL20, VOL21, VOL22, VOL22, VOLS1,VOLS3, VOLS5, M15, M19, M2, M20, M24, M25, M3, M4, M5, M6.	Water aesthetically unacceptable because of bitter taste. Severe scaling problems. Diarrhoea in all new users. Health problems may occur above concentrations of 400 mg/L

6.5.4 GROUNDWATER VULNERABILITY

According to Lynch *et al*., aquifer vulnerability is defined as "*the intrinsic characteristics that determine the aquifer's sensitivity to the adverse effects resulting from the imposed pollutant*". The following factors have an effect on groundwater vulnerability:

- Depth to groundwater: Indicates the distance and time required for pollutants to move through the unsaturated zone to the aquifer;
- Recharge: The primary source of groundwater is precipitation, which aids the movement of a pollutant to the aquifer;
- Aquifer media: The rock matrices and fractures which serve as water bearing units;
- Soil media: The soil media (consisting of the upper portion of the vadose zone) affects the rate at which the pollutants migrate to groundwater;
- Topography: Indicates whether pollutants will run off, or remain on the surface, allowing for infiltration to groundwater to occur; and

- Impact of the vadose zone: The part of the geological profile beneath the earth's surface and above the first principal water-bearing aquifer. The vadose zone can retard the progress of the contaminants.

The Groundwater Decision Tool (GDT) was used by GPT to quantify the vulnerability of the aquifer underlying the site. The depth to groundwater below the site was estimated from water levels measured during the hydrocensus and borehole drilling inferred to be ~20 mbgl at the site. A groundwater recharge of 3.2%, a sandy clayey-loamy clay soil and a gradient of 1.15% were assumed and used in the estimation. The GDT calculated a vulnerability value of 45%, which is moderate, or medium. This implies that the aquifer is reasonably sensitive to contamination and care should be taken with any mining, or related activities, which could generate pollutants.

6.5.5 AQUIFER CLASSIFICATION

The main aquifers underlying the area were classified in accordance with the Aquifer System Management Classification document. The aquifers were classified by using the following definitions:

- Sole Aquifer System: An aquifer which is used to supply 50% or more of domestic water for a given area, and for which there is no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality are immaterial;
- Major Aquifer System: Highly permeable formations, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (Electrical Conductivity of less than 150 mS/m);
- Minor Aquifer System: These can be fractured or potentially fractured rocks which do not have a high primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important for local supplies and in supplying base flow for rivers; and
- Non-Aquifer System: These are formations with negligible permeability that are regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, groundwater flow through such rocks, although imperceptible, does take place, and needs to be considered when assessing the risk associated with persistent pollutants.

Based on information collected during the hydrocensus, it can be concluded that aquifer system in the study area can be regarded as a major aquifer, based on the reliance of the surrounding water users on groundwater. The aquifer can, furthermore be classified as a 'sole source aquifer system' due to the relative absence of surface water and heavy reliance on groundwater in the area. The aquifer vulnerability is deemed to be 'medium'. The cumulative implication of these attributes is that the groundwater quality management index calculated for the aquifer by GPT is shown to be 'high'.

6.6 AIR QUALITY

The farms Volspruit and Zoetveld are predominantly used for crop production in the form of planted and irrigated lands. Much of the farm land is also used for livestock farming and game farming. The only real impact that these current activities could potentially have on the ambient air quality is by the generation of dust from open agricultural lands and movement of vehicles on the farm's gravel roads, as well as the potential generation of odour from livestock farming (not anticipated).

The farms Volspruit and Zoetveld also have a public gravel road traversing roughly north-south through the site, and vehicular traffic on this road appears to have a low impact on ambient dust and PM_{10} (Particulate Matter) levels in the area, predominantly during dryer times of the year.

The abandoned Grass Valley Mine, located north of the study site, could be seen to negatively influence ambient air quality in the area, but this contribution is anticipated to be nominal and has not been quantified as part of the EIA.

6.7 NOISE

The prevailing ambient noise levels on the farms Volspruit and Zoetveld are made up predominantly of farming activity noise and the occasional passing car on the gravel section of the Singlewood Road that divides the farm Volspruit. Noise from the N1 and N11 is audible at times, both during the day- and night-time periods.

The services of a noise and vibration specialist (dB Acoustics) were commissioned to the EIA project team, such that the prevailing ambient noise levels over the site could be quantified. A total of 31 point measurements were taken in this regard, with due consideration given to the relative proximity of potentially sensitive noise receptors to the study site when choosing those points (Figure 6-22). A copy of the full Noise Impact Assessment is attached hereto under Appendix 5.10: Noise Impact Assessment Report.

The following general observations were made by the noise specialist in and around the study area, so far as concerns prevailing ambient noise levels and the sources thereof in the study area:

- "*The proposed mine is situated between the N1 and N11 Roads, and traffic noise is audible at times;*
- *Farm activity noise is audible at times, but is generally site specific;*
- *There is a constant flow of traffic along the N1 Freeway and along the N11 Road.*
- *Singlewood Road is used by vehicles on an intermittent basis. Heavy duty vehicles also make use of this road;*
- *There are trees and uneven ground conditions which will act to dampen noise as it propagates from the N1 and N11 roads; and*
- *The prevailing noise levels in and around the study area is typical of the noise levels expected within a farming community with higher*".

Table 6-15 shows the measured results for day- and night time ambient noise level monitoring undertaken for the EIA. Table 6-14 provides a basis for comparison of the measured ambient noise levels (i.e. as per Table 6-15) against noise levels generated by typical household and office sources.

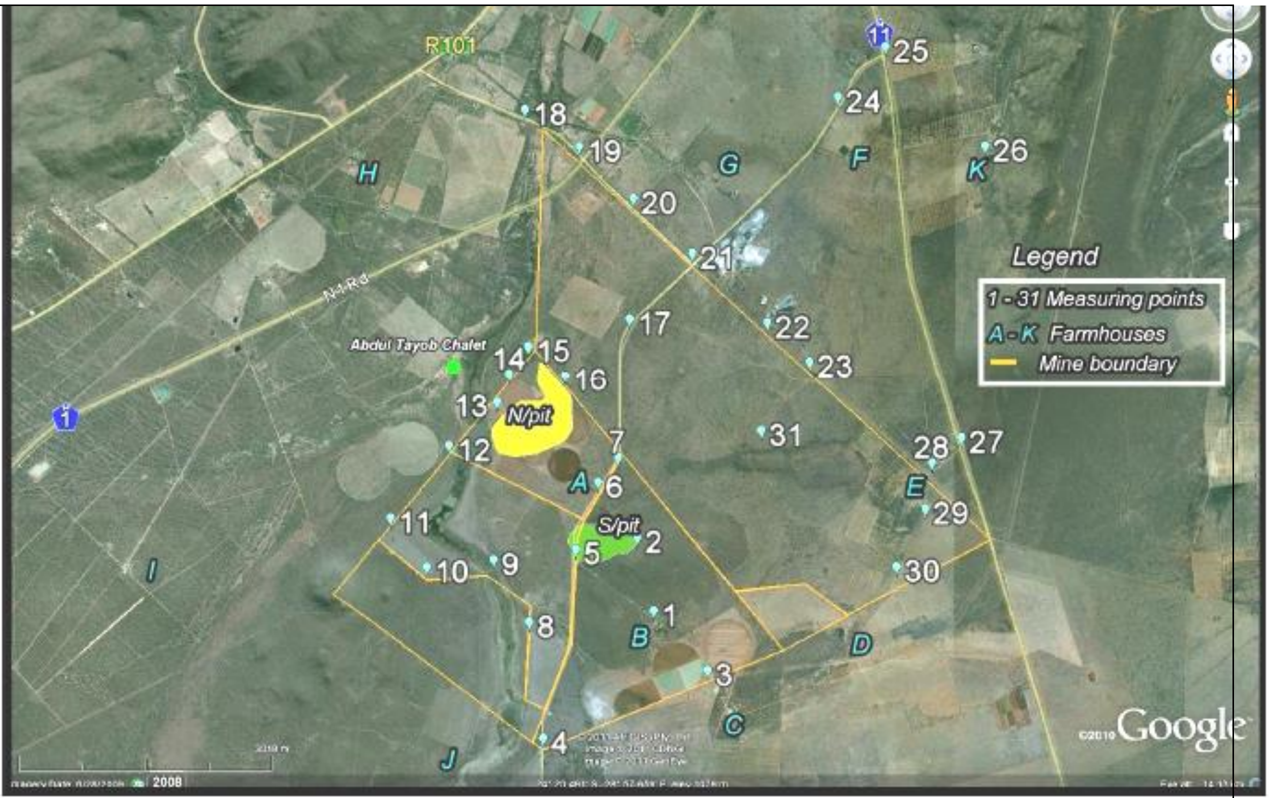


Figure 6-22: Ambient noise level measurements points and potential noise receptors

Table 6-14: Tabular summary of noise levels in and around the house and workplace to which a person may be exposed to on a daily basis

	Activity	dBA
Communication	Whisper	30
Communication	Normal Conversation	55-65
Communication	Shouted Conversation	90
Communication	Baby Crying	110
Communication	Computer	37-45
Home/Office	Refrigerator	40-43
Home/Office	Radio Playing in Background	45-50
Home/Office	Background Music	50
Home/Office	Washing Machine	50-75
Home/Office	Microwave	55-59
Home/Office	Clothes Dryer	56-58
Home/Office	Alarm Clock	60-80
Home/Office	Vacuum Cleaner	70
Home/Office	TV Audio	70
Home/Office	Flush Toilet	75-85
Industry	Industrial activities	85-95
Home/Office	Ringing Telephone	80
Home/Office	Hairdryer	80-95
Home/Office	Maximum Output of Stereo	100-110

Table 6-15: Measured ambient noise levels for the day and night time periods at the study site

Position	Day time			Night time		
	Leq -dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA	Leq - dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA
1	**44.8**	61.3	20.4			
2	**32.5**	61.4	20.7			
3	**32.8**	61.1	21.3	**28.5**	53.4	23.0
4	**39.3**	65.6	19.4	**28.3**	50.1	23.4
5	**33.7**	55.2	20.8	**32.5**	54.1	24.0
6	**37.3**	63.5	23.7	**35.4**	47.8	31.0
7	**32.8**	63.5	23.7	**35.4**	47.8	31.0
8	**32.8**	55.5	20.7	**29.7**	47.1	22.4
9	**28.6**	46.4	20.9	**29.7**	47.1	22.4
10	**31.6**	58.8	20.4			
11	**29.2**	60.3	21.2	**38.2**	50.4	30.9
12	**32.8**	59.7	23.4	**34.1**	47.1	27.7
13	**30.5**	60.4	23.9	**34.1**	47.1	27.7
14	**28.7**	47.9	22.2			
15	**27.9**	40.3	23.9			
16	**31.3**	58.6	20.0			
17	**40.3**	58.3	20.2	**38.7**	54.7	33.9
18	**50.5**	59.2	42.3	**47.4**	60.0	37.6
19	**69.0**	79.9	49.3	**64.3**	76.4	29.4
20	**37.7**	64.3	23.2	**48.7**	64.5	36.9
21	**52.2**	75.7	21.3	**41.1**	56.6	32.2
22	**34.7**	58.1	18.2	**34.9**	42.6	29.0
23	**31.7**	48.1	21.2	**34.9**	42.6	29.0
24	**49.0**	75.2	27.2	**40.7**	49.0	34.9
25	**60.1**	79.1	27.4	**35.3**	50.6	28.8
	Leq -dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA	Leq - dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA
26	**39.0**	57.7	27.0	**33.9**	54.8	24.7
27	**59.2**	79.8	22.9	**35.9**	49.8	29.7
28	**31.9**	47.9	23.7	**34.9**	42.6	29.0
29	**32.3**	53.0	24.2			
30	**29.8**	46.6	21.7	**33.9**	54.8	24.7
31	**32.6**	59.5	24.0			

6.8 VISUAL AESTHETICS

The relevant provincial and local authorities have been referred to in order to determine whether any restrictions through legislation, by-laws or policies were applicable and which would subsequently prevent or limit development. The following has been ascertained:

- *The Environmental Management Zones that the proposed area for development falls under (the farms Volspruit and Zoetveld), as per the Environmental Management Framework jointly compiled by DEA, LEDET and the Waterberg District Municipality, are listed as Zone 1 and Zone 10 (Waterberg EMF, 2010). "The EMF describes Zone 1 as an area where 'Protection of natural vegetation, scenic landscape and rock painting areas, with limited appropriate tourism' should exist; and Zone 10 as 'Agriculture areas with commercial focus'" (ESA Draft Scoping Report, 2010); and*
- *The Mogalakwena Local Municipality Spatial Development Framework recognises mining as an economic pillar for job provision in the area, but states that "The long-term impact thereof should be carefully considered". "Current indications are that…there is no direct conflict between mining and prospective mining activities and the major tourism and conservation activities in the municipality" (Mogalakwena SDF, 2009).*

Research had also been conducted insofar the following possible flaws are concerned:

- No biosphere reserves, proclaimed scenic routes, national parks, proclaimed view-shed protection areas, as provided for by the National Heritage Resources Act, have been found in relative proximity to the development; and
- No scenic routes, special areas or proclaimed heritage sites are within proximity to the proposed development.

There are no national or provincial conservation areas or viewshed protection areas within visual proximity to the proposed development. Two nature reserves (the Ethabeni Nature Reserve and Doorndraai Dam Nature Reserve) are, however, located relatively close to the proposed development site. The closest however, Doorndraai, is located some12,4km west-northwest of the proposed development, well outside visual range, with the development not en-route or visible from the study site.

As far as land cover and morphology is concerned, the area is dominated by grassland, and bushland, with interspersed patches of Woodland surrounding the proposed industrial activity, and mainly cultivated and degraded land where the open cast pits and surface structures are suggested to be developed. The development itself, as well as the majority of land directly surrounding it will be situated on plains, surrounded by lowlands and mountains, with low mountains beyond towards Mokopane. Most of the directly surrounding area is relatively unspoilt by agriculture or industrial activity, apart from the Grass valley chrome mine site that was operational until the 1980's.

Figure 6-23: Photographic examples of the varied land uses and topographical character of the study area.

The waste rock stockpiles of the Grass valley mine are still evident towards the northeast of the proposed development site. The general appearance of the area where Volspruit and Zoetveld lie is dominated by flat agricultural lands, interspersed with small koppies and larger hills.

The general sense of place of the area is that of a particular kind of openness. As the area is dominated by open farmland and bushveld areas, the visual and aesthetic feeling of the area is described as open and pleasant.

6.9 ARCHAEOLOGY, HERITAGE AND CULTURE

Based on the field survey done during September 2011 by Archaetnos cc. for the subject EIA process, as well as on information obtained from a 2002 study conducted by Matakoma Heritage Consultants (purpose of study unknown), it is clear that a number of cultural heritage (archaeological and historical) sites occur over the study area (Figure 6-24).

A short, general, background to archaeology of the general area is given in the following sections, after which the archaeology and history of the proposed Volspruit mine area is discussed. This section is taken from a report prepared by Mr. Anton Pelser of Archaetnos Cultural and Cultural Resource consultants. The full specialist report is contained in Appendix 5.5 hereto.

6.9.1 THE STONE AGE

The Stone Age is the period in human history when lithic (stone) material was mainly used to produce tools (Coertze & Coertze 1996: 293, as referenced by Pelser, 2011). In South Africa the Stone Age can be divided into three periods. It is however important to note that dates are relative and only provide a broad framework for interpretation. The division for the Stone Age according to Korsman and Meyer (1999: 93-94, as referenced by Pelser, 2011) is as follows:

- Early Stone Age (ESA) 2 million – 150 000 years ago
- Middle Stone Age (MSA) 150 000 – 30 000 years ago
- Late Stone Age (LSA) 40 000 years ago – 1850 - AD

A number of Stone Age sites (dating right from the Early to the Later Stone Age) are known in the larger geographical area, such as the famous Makapansgat and Cave of Hearths (Berg 1999: 4; 93-95), as referenced by Pelser, 2011. During a 2002 archaeological/heritage survey of the eastern portion of the farm by Matakoma Consultants, the purpose of the study being unknown, a number of Stone Age sites and finds were recorded (Pelser, 2011)(Figure 6-24) .

6.9.2 THE IRON AGE

The Iron Age is the name given to the period of human history when metal was mainly used to produce artefacts (Coertze & Coertze 1996: 346), as referenced by Pelser, 2011. In South Africa it can be divided in two separate phases according to Van der Ryst and Meyer (1999: 96-98), as referenced by Pelser, 2011, namely:

- Early Iron Age (EIA) 200 – 1000 AD
- Late Iron Age (LIA) 1000 – 1850 AD

Huffman (2007: xiii), as referenced by Pelser, 2011 however indicates that a Middle Iron Age should be included. His dates, which now seem to be widely accepted in archaeological circles, are:

- Early Iron Age (EIA) 250 – 900 AD
- Middle Iron Age (MIA) 900 – 1300 AD
- Late Iron Age (LIA) 1300 – 1840 AD

No Early Iron Age sites are known in the area (Berg 1999: 6), although a number of Later Iron Age sites are known to exist in the area around Mokopane (Berg 1999: 7). The 2002 study by Matakoma also located some stone walled features on Volspruit that could be related to the LIA (Pelser, 2011).

6.9.3 THE HISTORICAL AGE

The historical age started with the first recorded oral histories in the area. It includes the moving into the area of people that were able to read and write. The first Europeans to move into the area were early travellers, adventurers, hunters and missionaries such as the Schoon expedition of 1836 (Berg 1999: 13), as referenced by Pelser, 2011, who passed close by to where Mokopane is today, followed by the Voortrekkers (Berg 1999: 14), as referenced by Pelser, 2011.

The town of Potgietersrus (Mokopane) was established at the end of 1860, although plans to establish were already presented in 1852 by Hendrik Potgieter (the plan was to name the town Vredenburg). Nothing came of these plans. The next plan was approved by the ZAR "Volksraad" in September 1858 (for Pieterpotgietersrust), although only in December 1860 did serious work on town establishment commence. In 1870 the town was abandoned because of high incidences of death caused by "fever" (malaria), and only in 1890 people moved in again (Berg 1999: 141-142), as referenced by Pelser, 2011.

The earliest map for Volspruit dates to 1893, and is a map of the farm drawn up by a surveyor for one George W. Compton in June 1893 (http://csg.dla.gov.za). A number of recent historical sites and features were recorded during Matakoma's 2002 survey on Volspruit, including a number of graves and graveyards, as well as the remains of homesteads and old farm structures.

6.9.4 IDENTIFIED ELEMENTS OF POTENTIAL CULTURAL / HISTORIC SIGNIFICANCE ON VOLPSRUIT AND ZOETVELD

Stone Age

A total of 18 Stone Age (SA) sites have been identified across the study area. The sites are mainly scatters of stone tools, cores and flakes, found in open-air locations, dating to mainly the Middle and Later Stone Ages (MSA/LSA), although there is a possibility of some earlier ESA material as well (Figure 6-24, blue pins).

Iron Age

Two features from the Iron Age were identified in the study area during the 2002 Matakoma study (Figure 6-24, yellow pins). These consist of a circular stone packed structure, as well as a packed stone wall. It was not possible to determine whether or not these indeed represent LIA stone walling. No other evidence of the existence of Iron Age settlement was found in the area during the 2011 survey.

Historical Age

A number of recent historical sites and features were recorded during Matakoma's 2002 survey on Volspruit, including a number of possible graves and graveyards, as well as the remains of homesteads and old farm structures. Archaetnos was able to re-locate some of these during the 2011 survey, while also recording a number of other more recent historical sites.

A total of 10 sites have been recorded to date and include, *inter alia*, graves/graveyards, recent ruins, old farmsteads, old farm structures and infrastructure and an explosives magazine (Figure 6-24, green and pink pins).

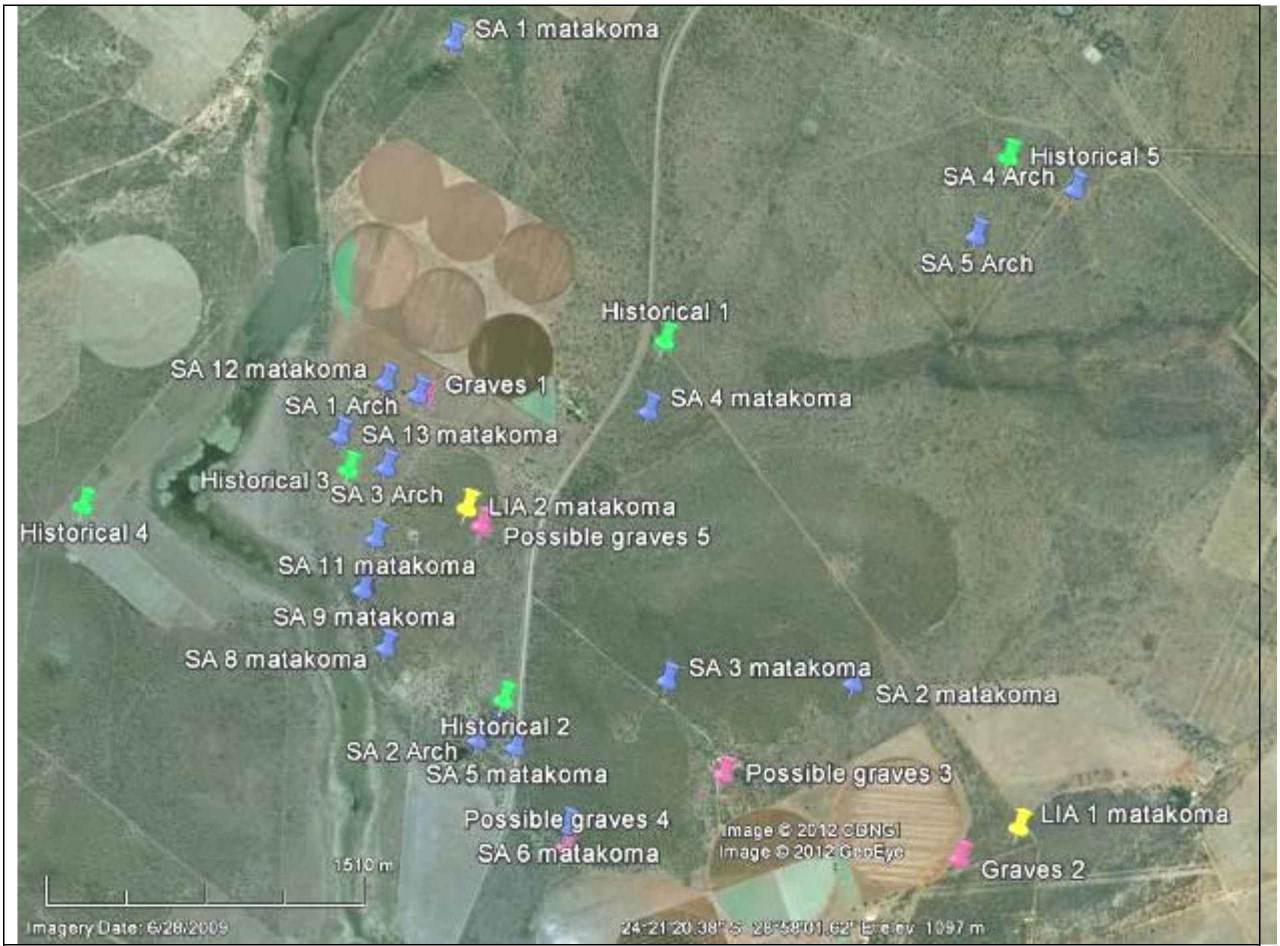


Figure 6-24: Identified elements of cultural/historic significance


Figure 6-25: Photographs of MSA and LSA flakes and tools (left) & graveyard (right) located on the study site.

6.9.5 PALAEONTOLOGY

Most of the farm Volspruit is underlain by Precambrian igneous rocks of the lower Rustenberg Layered Suite of the Bushveld Igneous Complex. To the west, a small part of the property is underlain by of the Precambrian Silverton Formation of the Pretoria Group. The extreme southern portions of the property are underlain by Jurassic volcanic rocks of the Karoo Supergroup. The floodplains of the Nyl River are covered by Quaternary alluvial
deposits.

The Bushveld Igneous Complex is an intrusive igneous body comprising a series of ultramafic-mafic layers and a suite of associated granitoid rocks, while the Silverton Formation of the Pretoria Group comprises hornfels and shale. As these rocks are Precambrian in age and most are of igneous origin, it is highly unlikely that fossils will be affected by the proposed mining development. The Jurassic Karoo rocks comprise lava which is certainly not fossil-bearing, and the Quaternary sediments on the floodplain of the Nyl River are the only sedimentary deposits where there is a possibility of fossils being preserved. As these deposits are not consolidated it is very unlikely that any fossils will be present (Paleontological Desktop Report: Prof. Bruce Rubridge: April 2011).

6.10 SOCIO-ECONOMIC ENVIRONMENT

This chapter examines key socio-economic characteristics of the study area. This is essential as it provides both qualitative and quantitative data related to the economies under observation, creating a baseline against which the potential impacts of the project can be assessed. A detailed socio-economic profile is contained in the Socio-economic Impact Assessment (SEIA), compiled by Urban-econ development economists, included hereunder in Appendix 5.11 Socio-economic Impact Assessment Report. The section that follows provides a succinct summary thereof.

The Mogalakwena Local Municipality, where the proposed activity is to take place, comprises of 342 479 people and 79 452 households, thus representing 6% of the provincial population. Over the last decade, the size of the municipality from the population perspective has been growing at about the same growth rate observed in the rest of the Province, and the country; however unlike the trend observed in the province and the rest of the country, its population growth has been increasing and not declining.

Households residing in the Mogalakwena Local Municipality have relatively the same level of income as the average household in the country and are better off than an average household in the Limpopo Province. A considerably lower percentage of households in the Mogalakwena have no income compared to that of the Limpopo Province. This is related to the fact that the unemployment rate in the Local Municipality is better than the unemployment rate in the Province. All of the above suggests that households residing in Mogolakwena have on average better access to employment opportunities than households in the rest of the Province. This could be explained by the fact that the Local Municipality has a very well developed mining sector and is strategically located between Pretoria and Polokwane.

Households living in the primary study area generally have better access to formal dwellings and electricity. Their access to water and sanitation, however, differs significantly from that observed in the country and in Gauteng. Although most of the households have access to water and sanitation in Mogalakwena, a great share of them have these services outside their dwellings. This is though indicative of the settlement pattern and dwelling structure that are observed in rural areas throughout the country.

The labour market in the primary study area comprises of 61 442 employed and 20 443 unemployed people. It has a bigger labour participation rate (39.2%) than in Limpopo but significantly lower participation rate than in South Africa. This however could be explained by the fact that a significant number of working age population is encouraged job-seekers. These people are not considered to be economically active and are not included in the calculation of the unemployment rate. Therefore, the actual unemployment rates are deceiving and do not reflect the actual need to create new employment opportunities for people in the primary study area, as well as the rest of the country.

The economy of the Municipality is relatively small (R10.7 billion of GDP-R), but since 1996 its average performance was slightly better than in other study areas under analysis, particularly Limpopo. This was attributed to the sharp increase of the mining sector in the area in the beginning of the century and supported by the growth of the transport industry.

The mining sector is the largest sector in the primary-study area's economy. It contributes 35% to the Municipality's economy in nominal prices. Such a dependency on mining, however, is not ideal as any fluctuations in commodity prices and demand for commodities would have a notable impact on the local economy. The global recession in 2009 had exactly the same effect on the economy, when the value added of the mining sector dropped by 19%.

From the employment perspective, the sectors that create the majority of jobs in the Municipality are the services sectors, such as community services and trade. Given the employment creation targets set by government in its New Growth Path and assuming that it is matched by investment, the economy of Mogalakwena could be growing at a higher rate in the future than it did over the past few years.

7. IMPACT ASSESSMENT METHODOLOGY

7.1 INTRODUCTION

Once a list of potential impacts has been developed, the second major goal of the EIA process is to rate, rank, quantify, or somehow make sense of, the many impacts, so that the significant ones are emphasised in decision-making. There are many techniques for doing this, but it must always be remembered that the technique should suit the project.

There are very few cases where all potential impacts can be precisely quantified, especially considering that the impacts cover such varying topics as employment effects and groundwater quality, but a list of impacts with no indication of their 'relative significance' would make decisions very difficult to reach and informed conclusions very hard to make. In almost all situations, impact significance is done using semi-quantitative methods. At this stage a few definitions are deemed necessary.

Significance: The concept of significance is at the core of impact identification, prediction, evaluation and decision-making and the focus of EIA always narrows down to a decision about whether the project is likely to cause significant/unacceptable adverse environmental effects. Despite this, the concept remains largely undefined and there is no international consensus on a single definition. Some examples of definitions or interpretations from various authors are provided in Table 7-7-1 that follows:

Table 7-7-1: Selected Definitions of Significance

Source	Definition or interpretation
Haug *et al.* (1984)	Determining significance is ultimately a judgement call. The significance of a particular issue is determined by a threshold of concern, a priority of that concern, and a probability that a potential environmental impact may cross the threshold of concern.
Canter and Canty (1993)	Significance can be considered on three levels: (1) significant and not mitigatible, (2) significant but mitigatible, and (3) insignificant. Significance is sometimes based on professional judgement, executive authority, the importance of the project/issue, sensitivity of the project/issue, and context, or by the controversy raised.
US Environmental Protection Agency (1993)	Determination of significance requires predicting change. These impact predictions are along with societal values, the major input to significance determination. Ideally, change should be compared against thresholds of concern, some of which may be legally mandated and others, which may be levels or states of valued components determined by the public, authorities or the EIA team.
Sadler (1996)	The evaluation of significance is subjective, contingent upon values, and dependent upon the environmental and community context. Scientific disciplinary and professional perspectives frame evaluations of significance. Scientists therefore evaluate significance differently from one another and from local communities.
Sippe (1999)	Environmental significance is an anthropocentric concept, which uses judgement and values to the same or greater extent than science-based criteria and standards. The degree of significance depends upon the nature (i.e. type, magnitude, intensity, etc.) of impacts and the importance communities place on them.

Importantly, the NEMA EIA Regulations of 2010 (GN. R.543) states:

A **"significant impact"** means an impact that by its magnitude, duration, intensity or probability of occurrence may have a notable effect on one or more aspects of the environment;

Regulation 31(2)(l) states that an Environmental Impact Report must include::
"an assessment of each identified potentially significant impact, including—
- (i) cumulative impacts;
- (ii) the nature of the impact;
- (iii) the extent and duration of the impact;
- (iv) the probability of the impact occurring;
- (v) the degree to which the impact can be reversed;
- (vi) the degree to which the impact may cause irreplaceable loss of resources; and
- (vii) the degree to which the impact can be mitigated"

Qualitative Methods/Assessment: This is done using statements, pictures or illustrations to compare the impact of an activity versus the initial state of the receiving environment. For example, a social impact assessment makes use of interviews to find out how residents in an area feel about a project proposal, whilst the visual assessment uses photomontage to show how the views in the area will change.

Qualitative methods are typically used where the variables describing an impact are not tangible and difficult to quantify. This method has the disadvantage of sometimes being vague and is inherently based on the judgment of the assessor thereof. However, these value-based opinions are an important component of any EIA process and the challenge in the EIA process is to balance value based input with scientific/technical information.

Quantitative Methods/Assessment: This is done using numerical methods where data is directly comparable. However, scientific/technical information cannot always be quantified – in many instances, ecological impacts are difficult to quantify. So, although there is a component that can be precisely quantified, the more important biological impacts will have to be semi-quantitative at best. Quantitative assessment is typically applied for noise, air and other forms of pollution, where the direct physical changes may be easily quantified and compared against regulatory limits, yet the indirect impacts thereof on humans, plants and animals is not so easily calculated. It is important to note that where quantitative models are used, they must as far as possible take into account the existing environmental loading for the environmental aspect being assessed.

Semi-quantitative Methods/Assessment: This covers a range of methods that slot in-between the two methods above. On the more qualitative side, an ordinal system can be used where impacts are assigned a significance that is relative, but not precise, such as: negligible, minor, major, severe, etc..

Baselines: Environmental impacts are measured against a baseline (i.e. the existing conditions prior to the proposed development).

Thresholds: A threshold represents that point at which potential environmental effects are considered significant. Thresholds are an analytical tool for judging significance. They can be defined as a quantitative or qualitative standard or set of criteria against which the significance of a given environmental effect may be determined. A threshold may be based on aspects relating to:

- Health-based standards, such as air pollutant emission standards, water pollutant discharge standards, noise levels etc.;
- Service capacity standards, such as transportation service, water supply capacity or waste treatment plant capacity; or
- Ecological tolerance standards such as physical carrying capacity, impacts on threatened or endangered species.

7.2 TYPE OF IMPACTS

Potential environmental impacts may either have a positive or negative effect on the environment, and can in general be categorised as follows:

a) Direct / Primary Impacts
Primary impacts are caused directly due to the activity and generally occur at the same time and at the place of the activity.

b) Indirect / Secondary Impacts
Secondary impacts induce changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken.

c) Cumulative Impacts
Cumulative impacts are those that result from the incremental impact of the proposed activity on common resources when added to the impacts of the other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time, and can include both direct and indirect impacts.

7.3 DETERMINING SIGNIFICANCE

Impact significance assessment has been quantified to the greatest extent possible throughout this EIA, with qualitative methods having been employed, together with professional/specialist judgement, to assess the less tangible of the identified impacts.

The following criteria/method has also been used to, semi-quantitatively determine the relative significance of the identified impacts, such that can at some level be ranked/compared, so that the significant impacts are emphasised.

The scores associated with each of the levels within each criterion are indicated in brackets after each description [like this].

Nature

Nature (N) considers whether the impact is:

- positive [- ¼]
- negative [+1].

Extent

Extent (E) considers whether the impact will occur:
- on site [1]
- locally: within the vicinity of the site [2]
- regionally: within the local municipality [3]
- provincially: across the province [4]
- nationally or internationally [5].

Duration

Duration (D) considers whether the impact will be:
- very short term: a matter of days or less [1]
- short term: a matter of weeks to months [2]
- medium term: up to a year or two [3]
- long term: up to 10 years [4]
- very long term, or permanent: 10 years or longer [5].

Intensity

Intensity (I) considers whether the impact will be:
- negligible: there is an impact on the environment, but it is negligible, having no discernable effect [1]
- minor: the impact alters the environment in such a way that the natural processes or functions are hardly affected; the system does however, become more sensitive to other impacts [2]
- moderate: the environment is altered, but function and process continue, albeit in a modified way; the system is stressed but manages to continue, although not with the same strength as before [3]
- major: the disturbance to the environment is enough to disrupt functions or processes, resulting in reduced diversity; the system has been damaged and is no longer what it used to be, but there are still remaining functions; the system will probably decline further without positive intervention [4]
- severe: the disturbance to the environment destroys certain aspects and damages all others; the system is totally out of balance and will collapse without major intervention or rehabilitation [5].

Probability

Probability (P) considers whether the impact will be:
- unlikely: the possibility of the impact occurring is very low, due either to the circumstances, design or experience [1]
- likely: there is a possibility that the impact will occur, to the extent that provisions must be made for it [2]
- very likely: the impact will probably occur, but it is not certain [3]
- definite: the impact will occur regardless of any prevention plans, and only mitigation can be used to manage the impact [4].

Mitigation or Enhancement

Mitigation (M) is about eliminating, minimising or compensating for negative impacts, whereas enhancement (H) magnifies project benefits. This factor considers whether –

A negative impact can be mitigated:
- unmitigated: no mitigation is possible or planned [1]
- slightly mitigated: a small reduction in the impact is likely [2]

- moderately mitigated: the impact can be substantially mitigated, but the residual impact is still noticeable or significant (relative to the original impact) [3]
- well mitigated: the impact can be mostly mitigated and the residual impact is negligible or minor [4]

A positive impact can be enhanced:
un-enhanced: no enhancement is possible or planned [1]

- slightly enhanced: a small enhancement in the benefit is possible [2]
- moderately enhanced: a noticeable enhancement is possible, which will increase the quantity or quality of the benefit in a significant way [3]
- well enhanced: the benefit can be substantially enhanced to reach a far greater number of receptors or recipients and/or be of a much higher quality than the original benefit [4].

Reversibility

Reversibility (R) considers whether an impact is:

- irreversible: no amount of time or money will allow the impact to be substantially reversed [1]
- slightly reversible: the impact is not easy to reverse and will require much effort, taken immediately after the impact, and even then, the final result will not match the original environment prior to the impact [2]
- moderately reversible: much of the impact can be reversed, but action will have to be taken within a certain time and the amount of effort will be significant in order to achieve a fair degree of rehabilitation [3]
- mostly reversible: the impact can mostly be reversed, although if the duration of the impact is too long, it may make the rehabilitation less successful, but otherwise a satisfactory degree of rehabilitation can generally be achieved quite easily [4].

7.4 CALCULATING IMPACT SIGNIFICANCE

The table below summarises the scoring for all the criteria.

Table 7-2: Scoring for Significance Criteria

CRITERION	SCORES					
	- ¼	1	2	3	4	5
N-nature	positive	negative	-	-	-	-
E-extent	-	site	local	regional	provincial	national
D-duration	-	very short	short	moderate	long	very long
I-intensity	-	negligible	minor	moderate	major	severe
P-probability	-	very unlikely	unlikely	likely	very likely	-
M-mitigation	-	none	slight	moderate	good	-
H-enhancement	-	none	slight	moderate	good	-
R-reversibility	-	none	slight	moderate	good	-

Impact significance is a net result of all the above criteria. The formula proposed to calculate impact significance (S) is:

For a negative impact: $S = N \times (E+D) \times I \times P \div \frac{1}{2}(M+R)$; and
For a positive impact: $S = N \times (E+D) \times I \times P \times (H)$.

Negative impacts score from 2 to 200. Positive impacts score from – ½ to -200.

7.5 UNDERSTANDING IMPACT SIGNIFICANCE

The following is a guide to interpreting the final scores of an impact (for negative impacts):

Table 7-3: Final Significance Scoring

Final score (S)	**Impact significance**	
0 – 10	Negligible	the impact should cause no real damage to the environment, except where it has the opportunity to contribute to cumulative impacts
10 – 20	Low	the impact will be noticeable but should be localized or occur over a limited time period and not cause permanent or unacceptable changes; it should be addressed in an EMP and managed appropriately
20 – 50	Moderate	the impact is significant and will affect the integrity of the environment; effort must be made to mitigate and reverse this impact; in addition the project benefits must be shown to outweigh the impact
50 – 100	High	the impact will affect the environment to such an extent that permanent damage is likely and recovery will be slow and difficult; the impact is unacceptable without real mitigation or reversal plans; project benefits must be proven to be very substantial; the approval of the project will be in jeopardy if this impact cannot be addressed.
100 – 200	Severe	the impact will result in large, permanent and severe impacts, such as local species extinctions, minor human migrations or local economic collapses; even projects with major benefits may not go ahead with this level of impact; project alternatives that are substantially different should be looked at, otherwise the project should not be approved

Two examples will help illustrate this system:

SCENARIO 1 – An industrial facility proposes discharging effluent containing a high salt content into a nearby stream. These salts will cause temporary problems for the ecosystem, but are washed downstream, diluted and will have no long term effects. The short term damage to the stream can be reversed fairly easily, but only if the ecosystem has not been seriously damaged by the salts over a long time. A mitigation measure is also proposed whereby during low flow periods (dry season) a pulse of clean water is discharged into the stream after the saline effluent, diluting the salts and pushing them downstream faster, so that the salts become so dilute as to have little or no effect.

From this scenario, the criteria are:

- nature = negative = 1
- extent = local = 2
- duration = medium = 3
- intensity = moderate = 3
- probability = very likely = 4
- mitigation = moderate = 3

- reversibility = moderate = 3,

and therefore impact significance is:
S = N x (E+D) x I x P ÷ ½(M+R)
  = 1 x (2+3) x 3 x 4 ÷ ½(3+3)
  = 60 ÷ 3
  = 20.

Note that the impact prior to mitigation is major, but that due to the mitigation and the fact that the ecosystem can recover easily from the effects of salt (high reversibility), the residual impact becomes minor/moderate.

<u>SCENARIO 2</u> – The above scenario applies, except that the effluent contains metals. These metals become adsorbed onto clay and organic matter in the stream bed and are accumulative toxins within the ecosystem, getting into the food chain and concentrating upwards into predator species. Fresh water flushing will only very slightly mitigate this and ecosystem recovery will not be easy or fast.

From this scenario, the criteria are:
- nature = negative = 1
- extent = local = 2
- duration = very long = 5
- intensity = moderate = 3
- probability = very likely = 4
- mitigation = slight = 2
- reversibility = slight = 2,

and therefore impact significance is:
S = N x (E+D) x I x P ÷ ½(M+R)
  = 1 x (2+5) x 3 x 4 ÷ ½(2+2)
  = 84 ÷ 2
  = 42.

Note that in this case, the original impact (of the metals) is more serious than the salt, but it is the limited mitigation and reversibility that also act on the residual score and result in this score being moderate.

8. IMPACT SIGNIFICANCE ASSESSMENT/ANALYSIS

Impact analysis is, in a sense, the core of the EIA process. It is the phase where all relevant project information that has been gathered is manipulated and distilled – it is the 'Environmental Impact Assessment'. The impact analysis has two major goals, starting with listing and describing all possible environmental impacts and then proceeding to give some perspective on the relative significance of the various impacts. The predicted effects of mitigation measures also need to be factored into the impact analysis.

Environmental impact analysis needs to take cognisance of the following issues that all fall under the definition of the 'environment':

- Physical natural environment: water, land, air;
- Biological natural environment: flora, fauna, ecosystems;
- Resources: land/space, minerals, water, rights of use;
- Economic: cost, profit, distribution of income, jobs, skills, permanence;
- Human health: occupational, environmental health, pollution, safety; and
- Human cultural: religion, tradition, aesthetics, heritage, recreation.

One needs to, however, bear in mind that the natural environment is the most threatened and irreplaceable resource upon which all the other human aspects depend. The analysis of impact significance assessment for potential project impacts furthermore needs to consider impacts that may be realised through all project phases, as follows:

- Construction/establishment;
- Operation; and
- Decommissioning, closure and rehabilitation.

Relative impact significance is semi-quantitatively assessed (Section 7.2) for relevant aspects (e.g. water, air, biodiversity, noise, visual character, heritage resources, etc.) for each respective phase of the project referred to above. Impact significance is however also, to the greatest extent possible, quantified through comparison against legislated thresholds (e.g. ambient air quality limits under NEM:AQA), or other applicable legal limits/standards.

In addition, a brief description of mitigation to be implemented in order to minimise the significance of the potential impacts is provided. The details of *inter alia* required mitigation, monitoring and reporting are put forward in the comprehensive Environmental Management Programme Report (EMPR) for the project, to which this EIA is annexed.

8.1 INDICATORS OF POTENTIAL IMPACT SIGNIFICANCE

Some generic characteristics of impacts that point strongly towards significance include: (EPA, 1998) -

- violation of national laws or international protocols and norms;
- opportunity to contribute to cumulative impacts;
- chance of irreversible damage occurring;
- amount of contradictory opinion or controversy;
- degree of uncertainty or number of unknowns; and
- possibility of setting a precedent.

More specific impact characteristics that will probably be included as significant are those which (Adapted from DEA, 2002) -

- conflict with environmental plans and frameworks;
- interfere with the movement of migratory wildlife;
- destroy wildlife habitat;
- exceed published environmental standards and limits e.g. water and air quality standards;
- expose sensitive receptors to pollution;
- breach standards for transport, storage and handling of waste or hazardous goods;
- contaminate a public water supply;
- result in loss of prime agricultural land;
- terminate or substantially alter existing land uses;
- deface or devalue a cultural or heritage resource;
- cause changes in community or population dynamics;
- generate traffic beyond the design capacity of existing infrastructure;
- require resettlement of people;
- create a public health hazard; and
- interfere with emergency response plans

As can be seen from the above lists, the determination of significance is far from being a set method. In most cases, there is more than one aspect that will influence how significant a particular impact is. For instance, in judging whether or not the discharge of effluent into a stream is significant, the following may apply:

- a national standard for the discharge of effluent into rivers;
- the sensitivity of species that may live in the river;
- the value of the riverine vegetation;
- whether any people use the water downstream, for primary survival or recreation; and
- the conservation status of this and similar rivers.

8.2 CONSTRUCTION PHASE

8.2.1 INTRODUCTION

This phase of the project involves all those activities related to preparation of the site and subsequent construction/establishment of the various project structures and associated surface infrastructure thereon, once prepared (e.g. vegetation stripping, topsoil stripping, earthworks/levelling/excavations/foundations, building construction and engineering services installation, etc.).

It is envisaged that the construction period will last for approximately 30 months, until such time as mining and processing activities commence. The majority of construction work, in terms of ground- and civil works will however be undertaken in the first year thereof.

8.2.2 NOISE

Introduction

The influence of noise on the quality of life of people in the urban environment has over the time been associated with noise disturbance and/or noise annoyance. The urban acoustic environment is an aggregate of many sounds such as traffic, air craft, generators, wind noise, back ground music, hooting etc. which emerge from human activities in and around the house and public area. Soundscapes is therefore an integral part of the urban living environment. People get accustomed with certain sounds and does not recognize or hear it anymore such as traffic or wind noise which is part of a specific area and when there is no traffic or wind people will find it strange and will wait for it to happen again (Botteldooren et al, 2006).

Activities to be undertaken during the construction phase of the project that are likely to generate noise are, *inter alia*, as follows:

- The use of heavy machinery / vehicles to implement vegetation clearance from development footprints and opencast pit footprints;
- The use of heavy machinery / vehicles to strip topsoil from development footprints and opencast pit footprints;
- The use of heavy machinery / vehicles in undertaking bulk earthworks and preparation of foundations for proposed surface structures and infrastructure;
- The hauling of men and materials to development sites; and
- The assemblage/construction of the plant, smelter and associated supporting structures and infrastructure on the site.

The machinery that will be used during the construction phase of the project will include, *inter alia*, excavators, dozers, graders, earth-moving equipment, cranes, dump trucks, drilling rigs, generators and TLB's (Table 8-2).

The distance between 'noise sensitive areas' (i.e. as identified by dB Acoustics – full '*Noise and Vibration Assessment*' attached in Appendix 5 .10 Noise Impact Assessment Report) in proximity to the proposed mine site and the proposed opencast pits ranges from 500m to 6 140m (Table 8-1 and Figure 6-22); where the closest potential off site receptor is located approximately 1 100m west of the north pit, on the western banks of the Nyl River.

Table 8-2 provides a relative indication of noise levels generated from a range of construction machinery and equipment that could possibly be used during the construction phase, and the preparation of the blasting sections in the opencast pits. These readings were done at 5m from the subject equipment and/or machinery and the noise level at 1 275m is given on the basis that sound will reduce by 6.0dB in the doubling of distance from the source.

Table 8-1: Distance between proposed opencast pits and noise sensitive areas		
Noise sensitive area	Northern pit - m	Southern pit - m
A	700	500
B	2 500	1 050
C	3 530	2 010
D	4 140	2 780
E	4 400	3 440
F	4 550	5 250
G	3 100	4 180
H	2 930	4 630
I	4 660	5 300
J	4 420	3 250
K	5 720	6 140
Abdul Tayob Chalet	1 100	2 930

Table 8-2: Indicative sound pressure levels of construction machinery

Equipment	Line-of-Sight Estimated Noise Level Attenuation - dBA							
	5m	10m	20m	40m	80m	160m	320m	640m
Cumulative distance from source	5m	15m	35m	75m	155m	315m	635m	1 275m
Excavator 1200	78.3	68.3	58.3	52.3	46.3	40.3	34.3	28.3
Excavator 870	81.4	71.4	61.4	55.4	49.4	43.4	37.4	31.4
Excavator 650	81.6	71.6	61.6	55.6	49.6	43.6	37.6	31.6
Dozer D11R	89.4	79.4	73.4	68.4	62.4	56.4	50.4	44.4
Dozer D10T	88.4	78.4	72.4	66.4	60.4	54.4	49.4	43.4
Dozer D9T	96.1	86.1	76.1	70.1	64.1	58.1	52.1	46.1
Dozer D155	83.3	73.3	63.3	57.3	51.3	45.3	39.3	33.3
Dozer D6R	90.2	80.2	70.2	64.2	58.2	52.2	48.2	42.2
Grader 140H	97.4	87.4	77.4	71.4	65.4	59.4	53.4	47.4
Terex TR60	99.9	89.9	79.9	73.7	67.7	61.7	55.7	49.7
Volvo A40	85.6	75.6	65.6	59.6	53.6	47.6	41.6	35.6
HD 325	91.3	81.3	71.3	65.3	59.3	53.3	47.3	41.3
Diesel Browser Hino WHM 503GP	103.4	93.4	83.3	77.3	71.3	65.3	59.3	53.3
TLB	94.4	84.4	74.4	68.4	62.4	56.4	50.4	44.4
Lighting plant	85.8	75.8	65.8	59.8	53.8	47.3	41.3	35.3
Hitachi 670	102.9	92.9	82.9	76.9	70.9	64.9	58.9	52.9
Bell B40	86.1	76.1	66.1	60.1	54.1	49.1	43.1	37.1
Crawler Drill & Ingersol Rand compressor	96.5	86.5	76.5	70.5	64.5	58.5	52.5	47.5
Tornado – Tyre drill	102.0	92.0	82.0	75.0	69.0	63.0	57.0	51.0
Drill rig	99.3	89.3	79.3	73.3	67.3	61.6	56.6	50.6

Impact Discussion & Significance Assessment

The effect of noise (with the exception of long duration, high level noise) on humans is limited to disturbance and/or annoyance and the accompanying emotional reaction by the receptor. This reaction is very difficult to predict and is typically influenced by the emotional state of the receptor, his/her attitude towards the 'noisemaker', the time of day or night and the day of the week (dB Acoustics, 2011).

According to dB Acoustics, a receptor/community's response to noise can be classified as follows:

- An increase of 1dBA to 3dBA above ambient noise level will cause no response from the affected community. For a person with normal hearing an increase of 0dBA to 3 dBA will not be noticeable;
- An increase between 1dBA – 10dBA will elicit little to sporadic response. When the difference is more than 5 dBA above the ambient noise level a person with normal hearing will start to hear the difference;
- An increase between 5dBA and 15 dBA will elicit medium response from the affected community; and
- An increase between 10dBA and 20 dBA will elicit strong community reaction.

It must also be noted that SANS10103 of 2008 makes recommendations for continuous sound pressure levels for specific districts, and recommends 45dBA (daytime) and 35dBA (night time) *'equivalent continuous rating levels for ambient noise'* for rural districts (Table 3-10 has reference).

The greatest potential for noise generated during construction to cause impact off site lies to the west of the site; where Mr. Abdul Tayob's chalet on the farm Rondebosch 295 KR is located approximately 1 100m west of the north pit boundary. The intensity of the potential impact would be greatest when topsoil stripping activities take place across the north pit surface.

Anticipated increases in ambient noise levels at that location are likely to be audible, but the significance thereof is deemed low by virtue of i) the short-term nature over which topsoil at this location will be stripped in close proximity to the chalet, ii) the line of site noise attenuation and vegetation buffering that will occur between the noise source and the receptor at 1.1km away, and iii) mitigation available to the proponent to minimise increases in ambient noise levels beyond the site boundary.

All other construction sites are in excess of approximately 2.0 km from potential off site noise receptors; where line of site noise attenuation toward such receptors will render any increases in ambient noise levels largely inaudible. The presence of low lying hills and 'koppies' in the area further acts to screen the project from certain sensitive noise receptors (e.g. B, C, D and J, Table 8-1 and Figure 6-22).

The impact of noise on potentially sensitive receptors during the construction phase is thus not anticipated to be of notable significance (i.e. low relative significance), provided that the mitigation measures put forward in the attached environmental management programme (EMP) are adhered to by the proponent during the construction phase (Table 8-3); where the low significance of the impact is largely attributed to the limited extent, minor intensity and reversibility of the potential impact.

Table 8-3: Impacts on Ambient Noise Levels (Construction)			
Nature (N)	Negative: The activities to be undertaken during the construction phase will generate noise that will result in the intermittent elevation of ambient noise levels over the site and immediate surrounds, with may potentially be perceived as nuisance/intrusive by adjacent landowners.		1
Extent (E)	Locally: Noise generated though construction related activities is anticipated to be audible beyond the western site boundary, but will be largely limited to the farms Volspruit 362 KR and Zoetveld 294 KR		2
Duration (D)	Medium-term: The impact will persist for the duration of the construction period (2.5 years)		3
Intensity (I)	Minor: Given the relative location of potential noise receptors to the construction related activities, the intensity of the impact is deemed to be minor; where the impact on ambient noise levels is such that it is not anticipated to be intrusive toward sensitive noise receptors.		2
Probability (P)	Definite: Construction related activities will generate noise, such that the prevailing ambient noise levels at the mine boundary would be increased.		4
Mitigation (M)	Moderately mitigated: The impact can be substantially mitigated through restricting 'noisy activities' to daytime periods, as well as around selections of machinery to be used during the construction period.		3
Enhancement (H)	N/A		-
Reversibility (R)	Slightly reversible: The impact would persist into the operational phase (reversible at the end of life of mine)		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	16
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	28
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Mitigation/Management

The following are the applicable Environmental, Health and Safety Guidelines of the IFC of the World Bank, which have been taken into consideration in developing mitigation measures for the construction phase of the project:

- Selecting equipment with lower sound power levels;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment causing radiating noise;

- Taking advantage during the design stage of natural topography as a noise buffer; and
- Develop a mechanism to record and respond to complaints.

Further to the above, topsoil stripping and preparation of the north pit surface area for mining can be restricted to daylight hours and weekdays. The construction of the proposed 6m high flood protection berm around the western sections of the north pit perimeter (i.e. where the perimeter lies within the 1:100yr flood line of the Nyl river) will further act to partially screen noise receptors to the west of the site from noise generated onsite.

8.2.3 HERITAGE RESOURCES

Introduction

The large-scale clearance of indigenous vegetation, as well as topsoil stripping, required for the project has the potential to negatively impact upon /degrade / destroy identified elements of cultural and/or heritage significance over the surface of the project site (i.e. where such activities are indeed required). The optimisation of the mine development plan has to the greatest extent possible aimed to avoid such elements, but in certain instances, the disturbance/degradation of these elements is deemed unavoidable.

Topsoil stripping and bulk earth works required for the project, as well as the latter opencast mining itself, also have the potential to uncover further elements of cultural and/or historical significance that may have been buried, or obscured, at the time that the heritage specialists undertook their fieldwork. The relative significance of the projects impacts on heritage sites is deemed greatest during the construction period than for the operational phase of the mine.

Impact Discussion & Significance Assessment

Archaetnos cc., as well as Matakoma Heritage Consultants, have to date identified in excess of 30 cultural heritage sites over the study site (Figure 6-24). The location of these sites have been logged with a GPS and overlaid with relevant proposed surface structures and infrastructure for the project (Figure 8-1), so as to determine which of the aforementioned sites may potentially be influenced by the proposed mining, as well as activities supportive thereof (e.g. tailings storage facility, plant area and topsoil stockpiles). Table 8-4 provides a summary of the cultural heritage sites potentially impacted upon by the project. Five sites have been identified to either fall within-, or in close proximity to, the footprints of proposed surface structure and infrastructure.

The significance of the stone age sites identified in Table 8-4 are deemed by Archaetnos cc. to be low to medium; where provided that surface sampling of these sites (i.e. to obtain representative samples of the finds for the area) is undertaken, the disturbance of these sites is deemed to pose no fatal flaws to the project. The same is inferred for the single 'historical' site to be impacted upon; where it is recommended that the affected site be assessed, and documented if necessary, by an Architectural historian before it is destroyed through construction related activities for the project.

The presence of graves on a development site, as well as the potential for damage thereto, is always significant consideration. The proposed topsoil stockpile for the project is located in very close proximity to the identified graves at site 'Graves 1' (Table 8-4). The proponent should ensure that topsoil is stockpiled in such a manner that it does not impact with this site (i.e. there are no onsite constraints, to the EPA's knowledge, that would prevent the optimisation of the topsoil stockpile footprint at its current location in order to avoid impacting upon these graves).

Table 8-4: Potentially impacted cultural heritage sites		
Site Reference	**Description**	**Co-ordinates**
Historical 1	Recent ruins consisting of four brick structures, including a cement and corrugated iron farm dam	S24 21 01.5 E28 57 34.4
SA 1 Arch	Stone age site (flakes and tools)	S24 21 13.0 E28 56 53.1
SA 4 Matakoma	Stone age site (flakes and tools)	S24 21 14.2 E28 57 32.6
SA 5 Arch	Stone age site (flakes and tools)	S24 20 45.3 E28 58 27.2
Graves 1	Graveyard with nearly 20 graves. Most stone packed. Inscriptions on some illegible and no dates could be determined.	S24 21 13.4 E28 56 54.1

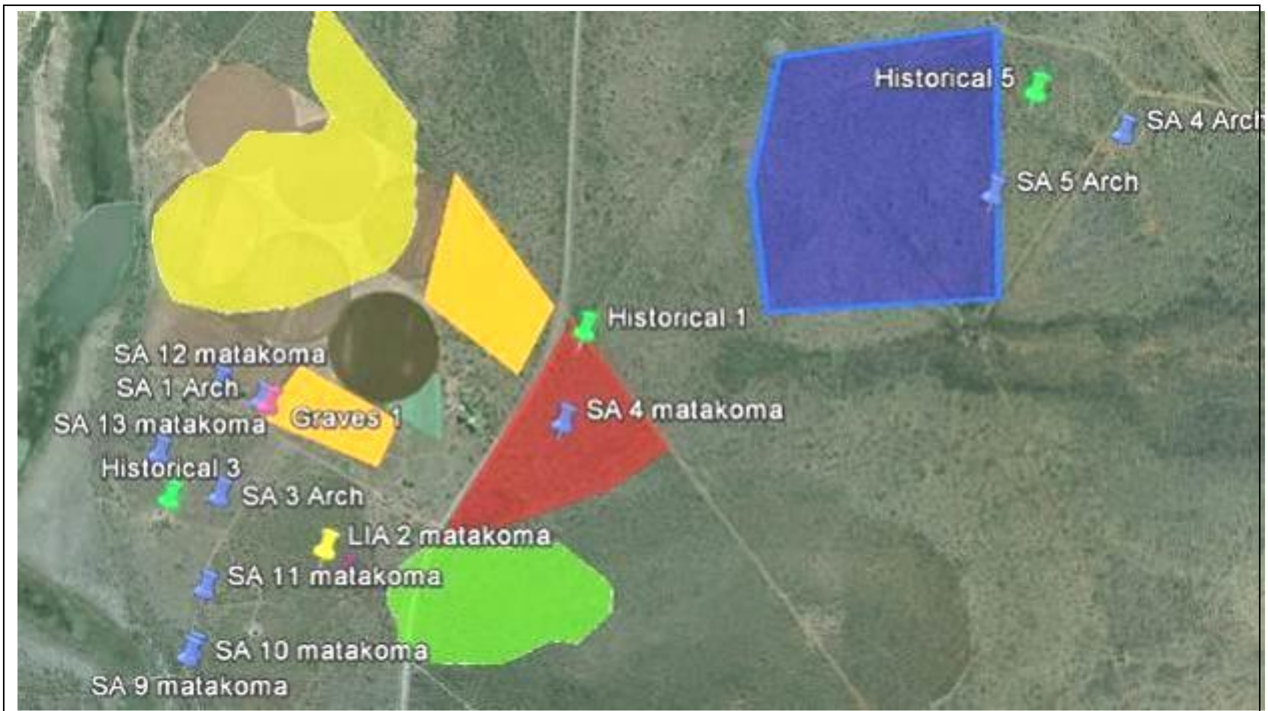


Figure 8-1: Overlay of identified elements of cultural/heritage significance with relevant surface structures and infrastructure

Table 8-5: Impacts on Heritage Resources (Construction)		
Nature (N)	Negative: Destruction of elements of cultural and/historic significance	1
Extent (E)	Site: The extent of the impact will be limited to the farms Volspruit 326 KR and Zoetveld 294 KR	1
Duration (D)	Permanent: The three identified stone age-, and single historical, sites would be destroyed in their entirety to accommodate the development footprints for the plant area and tailings storage facility.	5
Intensity (I)	Minor: The heritage significance of the subject sites is deemed to be low to medium by the heritage specialist (provided that graves are afforded	2

Table 8-5: Impacts on Heritage Resources (Construction)			
	appropriate protection and unaffected)		
Probability (P)	Definite: The three identified stone age-, and single historical, sites will definitely be impacted upon / destroyed entirety to accommodate the development footprints for the plant area and tailings storage facility.		4
Mitigation (M)	Slightly mitigated: The significance of the impact can be slightly mitigated through documenting the finds/sites for an archival/historic record prior to their destruction.		2
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: The impact on the identified sites cannot be reversed once it has occurred.		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	32
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	48
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Mitigation/Management

The following specialist recommendations are made regarding mitigation measures in order to minimize any negative impacts on the relevant sites (Table 8-4):

- that a surface collection of Stone Age material in the area is undertaken in order to obtain a representative sample of material. A permit for this action will be required from SAHRA, with the work to be carried out under the supervision of a Principal Investigator for Stone Age accredited at ASAPA;
- that an Architectural Historian be contacted to assess the significance and ages of any historical structures that are earmarked for destruction; and
- that all graves and graveyards located in the area be fenced-off, cleaned and access provided to family members/descendants that might want to visit these graves. A Graves Management Plan should also be implemented.

Finally, it should be noted that the subterranean presence of archaeological and/or historical sites, features or artefacts are always a distinct possibility. Care should, therefore, be taken during any development or operational activities, that if any of these are accidentally discovered, a qualified archaeologist be called in to investigate.

8.2.4 BIODIVERSITY

Introduction

Wetland Consulting services were commissioned to undertake a specialist biodiversity impact assessment in relation to the proposed establishment of the Volspruit Mine (attached under Appendix 5 .7: Biodiversity Impact Assessment Report– with the impact assessment findings in Section 7 thereof); where the assessment looked at the potential impacts of the proposed mine in relation to, *inter alia,* terrestrial-, wetland- and aquatic ecosystem functioning.

Impact Discussion & Significance Assessment

While Table 8-7 that follows provides a summary of the relative impact significance of construction phase impacts identified by WCS (2012), the most significant impacts on biodiversity during the construction phase can be summarized as, "*the potential for the loss of biodiversity, specifically also Red Data species and Protected species, through habitat loss and fragmentation*". During the construction phase, the establishment of the ore pits and supporting infrastructure and complexes will require the clearing of large areas of vegetation and (depending on the nature of the activity) topsoil and underlying rock.

This will result in a loss of habitat for those species currently utilizing the area. Even small losses in vegetation could have a serious impact on the remaining habitat and could negatively affect the biodiversity of the area, and the continued presence of unique and Red Data List fauna that these habitats support. The northern ore pit lies primarily within disturbed, cultivated fields, and will therefore not lead to a large loss of natural habitat, except where it extends toward the wetland habitat in the west. The southern ore pit lies completely within natural woodland vegetation and will lead to a large loss of this habitat type, which is currently considered able to support a number of the Red Data List species identified. Habitat fragmentation on a small scale is expected to occur related to the clearing of vegetation and the establishment of infrastructure, particularly linear infrastructure, such as roads and conveyors. Habitat fragmentation may affect the migration patterns of certain species and may reduce the viability of remaining habitat patches to support biodiversity.

Loss of faunal biodiversity, including Red Data List and Protected species is expected to occur indirectly as a result of habitat loss, but in addition, during construction the activities associated with, and the machinery required for, construction are likely to cause the accidental death of fauna on site. The increased number of people present will also increase the likelihood of contact between people and animals, which could lead to accidental or deliberate animal deaths and/or harm to humans should the animal be poisonous or dangerous. The elevated levels of human activity, the loss of habitat, and the potential deterioration of the surrounding habitats could also lead many individuals and populations to migrate out of the immediate area, resulting in reduced biodiversity within the area.

No fatal flaws were identified by WCS (2012) in relation to the construction phase of the project, provided that the comprehensive range of impact mitigation is appropriately implemented by the proponent. The EAP's impacts significance summary, based on the 2012 WCS report, is presented in Table 8-6 that follows.

Table 8-6: Impacts on biodiversity (Construction)		
Nature (N)	Negative: Negative impacts on biodiversity and the continued presence of unique and Red Data List floral and faunal species due to vegetation clearance to establish mine structures, infrastructure and opencast pits.	1
Extent (E)	Locally: Within the general vicinity of the site	2

Table 8-6: Impacts on biodiversity (Construction)			
Duration (D)	Very long term / Permanent: Vegetation clearance (and associated habitat loss) will be permanent in respect of the TSF, waste rock dump, PCD, smelter complex and opencast pit establishment.		5
Intensity (I)	Major: Even small losses in vegetation could have a serious impact on the remaining habitat and could negatively affect the biodiversity of the area, and the continued presence of unique and Red Data List fauna that these habitats support. Vegetation clearance would likely include Red Data List and Protected floral species		4
Probability (P)	Definite: The establishment of the mine will necessitate the large-scale clearance of indigenous Central Sandy Bushveld, comprising both Plains thornveld and hills woodland.		5
Mitigation (M)	Slightly mitigated through the consideration of appropriate layout alternatives and strict delineation of biodiversity 'no-go' areas, as well as maintaining development/construction disturbances to the smallest areas possible.		2
Enhancement (H)	N/A		-
Reversibility (R)	Slightly reversible through rehabilitation efforts at mine closure, as well as concurrently to mining (e.g. portions of the agricultural fields not sterilised through mining the north pit), but noticeable residual impacts would remain after mining.		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	70
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	93
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Table 8-7: Biodiversity Impact Assessment Summary – WCS, 2012 (Construction)		
Potential Impact	**Significance Rating without Mitigation**	**Significance Rating with Mitigation**
Vegetation		
Loss of populations of threatened species	Medium	Low
Loss of individuals of protected tree species	Medium	Medium
Loss or fragmentation of indigenous natural vegetation (terrestrial)	Medium	Medium
Damage to wetland vegetation	High	Medium

Table 8-7: Biodiversity Impact Assessment Summary – WCS, 2012 (Construction)		
Potential Impact	**Significance Rating without Mitigation**	**Significance Rating with Mitigation**
Establishment and spread of declared weeds and alien invader plants	Medium	Low
Terrestrial Ecology		
Habitat loss and fragmentation	High	High
Interruption of local migration routes	Medium	Medium
Loss of biodiversity including Red Data List and Protected species	Medium	Medium
Habitat degradation through air-, water- and soil pollution	Medium	Low
Habitat degradation through the encroachment of exotic species	Low	Low
Disturbances of biodiversity through noise and vibration	Medium	Medium
Disturbances through illumination	Medium	Medium
Hydrological changes	High	Medium
Increased access to previously inaccessible areas by mine staff / contractors	Medium	Low
Wetlands		
Loss of wetland habitat	Medium	Low
Increased sedimentation within the wetland	Medium	Low
Deterioration in water quality	Medium	Low
Aquatic Ecology		
Increased turbidity and sedimentation	High	Medium
Altered hydrology	Medium	Medium
Spread of alien fish species	Medium	Low
Increased pressure on fish stock	Low	Low
Water quality deterioration	Medium	Low

Mitigation/Management

Specialist 'biodiversity' mitigation measures proposed by WCS (2012) for the construction period are extensive and have been incorporated into the attached EMPR. There are, however, biodiversity patterns in the study area for which additional information would improve an understanding of potential impacts due to the proposed project.

A survey of protected plant tree species will also be required within the footprints of all proposed infrastructure, and permits must be obtained to remove these prior to being removed.

All activities taking place within 500m of the delineated wetland edge will require a Water Use License Application in terms of Section 21 (c) and (i) water uses. Activities falling within the 500m regulated area include the northern opencast pit, the flood protection berm and the explosives magazine.

8.2.1 AVI-FAUNA (BIRDS)

Introduction

Although the impacts of the construction phase on site 'biodiversity' are discussed in the preceding section, the relative abundance and diverse nature of birdlife in the area (particularly Red Data breeding / migratory waterbird species), as well as the location of the mine site within an internationally recognised 'Important Birding Area' (IBA), warrants a separate assessment of the project's potential impacts on avi-faunal populations during the construction and operational phases thereof. To this end, a specialist '*Avi-faunal Impact Assessment*' was commissioned in support of the EIA process (see the full specialist assessment report under Appendix 5.12 hereto).

Activities associated with the construction phase (i.e. mine development) could negatively impact on birdlife in the study area, either directly (e.g. habitat loss and transformation associated with vegetation clearance), or indirectly through disturbances, such as noise, dust generation and vehicular/human movement across the construction site(s). In the context of the mine's location adjacent to the Nyl river and its associated floodplain wetland (regarded as 'highly sensitive' avi-faunal habitat), the most notable potential for impact is on waterbird populations (including red data species) that use the floodplain wetland as a breeding ground and/or staging point for their annual migration.

The avi-faunal specialist delineated / classified three habitat sensitivity classes across the study area, from an avifaunal perspective (Table 8-8& Figure 8-2). This was done primarily according to the likelihood of Red Data species occurrence, as well as the potential use of the habitat by Red Data species. The north pit will be established immediately east of the wetland habitat with high avian importance, while the TSF footprint configuration was modified through the consideration of layout alternatives to move it out- and north of the mature dense woodland indicated as having medium avian importance. The construction phase will have limited direct impact on these habitats through vegetation clearance and associated habitat loss. The majority of the potential avi-faunal impacts during construction will likely act indirectly (e.g. noise, dust, movement), and may cause birds to move away from the floodplain areas associated with the project.

Table 8-8: Avifaunal Habitat Sensitivity Classes

Rating	Description	Potential Red Data species in study area
Least sensitivity	Agricultural lands – irrigated centre pivots Old lands Woodland	Lesser Kestrel Secretary bird Lanner Falcon
Medium sensitivity	Dense stands of mature wood-land located on the remainder of Farm Zoetveld 294 KR	Martial Eagle Red-billed Oxpecker
High sensitivity	Wetland and floodplain	Lesser Kestrel

Table 8-8: Avifaunal Habitat Sensitivity Classes		
Rating	**Description**	**Potential Red Data species in study area**
	habitats along the Nyl river	Black Stork Marabou Stork Greater Painted-snipe Yellow-billed Stork

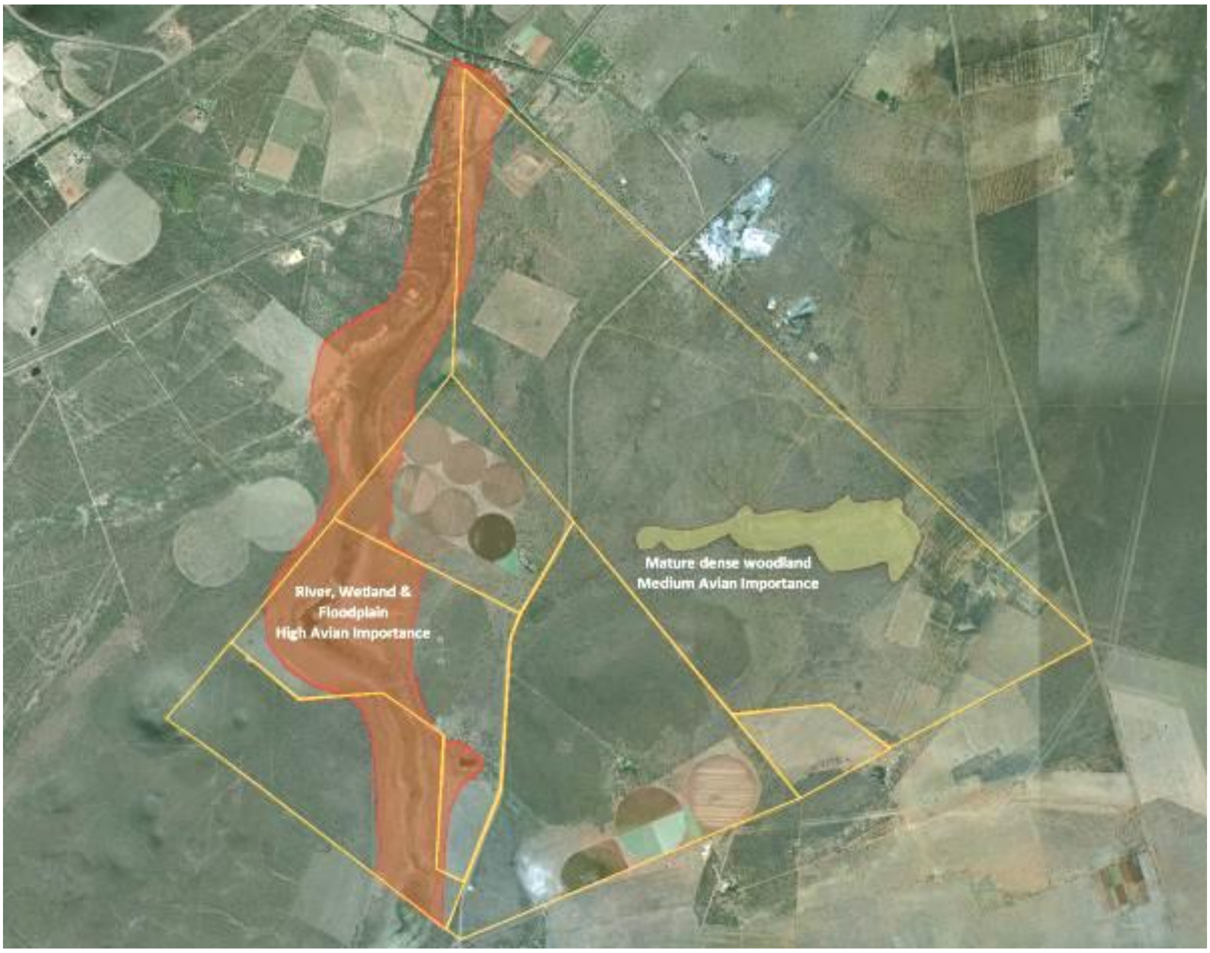


Figure 8-2: Sensitivity map indicating areas of high and medium avian sensitivity

Impact Discussion & Significance Assessment

The following conclusions were drawn by the avifaunal specialist:

- The proposed mining development falls within the boundaries of an internationally recognised important bird area (IBA)– the Nyl River Floodplain, which provides breeding habitat to numerous Red Data species;
- Although the proposed mining activities will take place down-stream of the majority of the floodplain, all or most of the birds using the wetlands migrate in and out of the system from the more tropical north thus passing through the area where mining is proposed;
- The mining activities – especially the north open cast pit will negatively influence the floodplain and wetland habitat used by birds on the site; and
- The impacts of the proposed mining development on surface water (i.e. the wetland habitat used by birds will largely be limited to the mining area itself and potentially also down-stream of the development).

The impact of habitat loss on bird species (including Red Data species) likely to occur in the area is deemed to have 'high' significance, while the indirect impact of noise (i.e. through displacement) on avi-faunal species biodiversity (i.e. wetland and woodland habitats) is deemed to have 'moderate' significance (Table 8-9 & Table 8-10 respectively).

Table 8-9: Impacts on avi-fauna due to habitat 'loss' (Construction)		
Nature (N)	Negative: The construction phase of the mine is likely to result in habitat loss for avian species occurring on the site.	1
Extent (E)	On site: The impact of avian habitat loss both during the construction and operation of the mine will be limited to the site itself.	1
Duration (D)	Very long-term: Construction of the mining site and infrastructure itself will in all likelihood take more than a year but the continued mining activities on the site will last for a much longer period. The overall avian habitat loss effect of the construction of infrastructure and the longer term operation of the mine (20 year lifespan of the mine) is therefore classified as very long term.	5
Intensity (I)	Severe: The habitat destruction as a result of the establishment of the mining infrastructure is classified as severe on avifauna as very few if any species currently occurring on the site will be able to inhabit or use the transformed habitat created by the establishment of the mine. It is also unlikely that birds displaced by the construction of the mine will just be able to occupy the surrounding similar habitat. This surrounding habitat (if similar in structure and composition) would already be supporting the same species most likely at a maximum carrying capacity and the displaced individuals would therefore have difficulty finding 'vacant territories'. The above argument applies more specifically to resident wetland and woodland species.	5
Probability (P)	Definite: The probability of the effect on birds is definite as the species will without doubt vacate the areas where habitat is lost and the landscape transformed by the establishment and operation of the mine.	4
Mitigation (M)	Mitigation of direct habitat loss is extremely difficult and can really only be achieved once the mine closes down and rehabilitation / restoration takes place.	1
Enhancement (H)	Enhancement of the construction phase or operation of the mine is not possible from an avian perspective. Enhancement will only be able to take place following the lifespan of the mine when areas where	1

Table 8-9: Impacts on avi-fauna due to habitat 'loss' (Construction)			
	infrastructure has been erected must be rehabilitated. No enhancement is thus possible from an avifaunal perspective during the construction or operational phase.		
Reversibility (R)	Due to the very long duration of the impact it is only slightly reversible.		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	80
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	80
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Table 8-10: Impacts on avi-fauna due to noise (Construction/operation)		
Nature (N)	Negative: The noise created by the mining activities both during construction and then during the operation of the mine would have mixed effects on the avifauna found in the area. Some of the more sensitive species (e.g. raptors would be driven away, but other more tolerant species would potentially not be affected). Birds are also known to become accustomed to noises and disturbances (e.g. vibrations from blasting activities). The exposure to continuous noise and intermittent vibrations as a result of blasting may indirectly result in sensitive species becoming more susceptible to the influence of other disturbances and environmental stresses.	1
Extent (E)	Local: The impact of noise and vibrations from blasting activities will have a definite effect locally on the site, but the impact would also extend to the surrounding areas – especially that of blasting. This in turn may influence more sensitive breeding birds in the nearby floodplain and wetland areas.	2
Duration (D)	Very long term: The duration of the impact on birds would last for the life-span of the mine (i.e. approximately 20 years).	5
Intensity (I)	Moderate: The intensity of the impact of noise would be moderate as it is possible that some bird species may become accustomed to the noise levels.	3
Probability (P)	Very likely: It is very likely that the noise and vibrations will influence more sensitive bird species.	3
Mitigation (M)	Slightly mitigated: Mitigation is not possible until such time as the mining activities are complete. Noise created by heavy vehicles using the road across the berm wall could be mitigated to some extent by	2

Table 8-10: Impacts on avi-fauna due to noise (Construction/operation)			
	placing another smaller mini berm to shield the traffic both visually and audibly from the sensitive wetland areas		
Enhancement (H)	N/A		-
Reversibility (R)	Mostly reversible: Once the mining operations come to an end the noise created by the operations will come to an end.		4
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	21
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	25
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Mitigation/Management

Based on the findings of the specialist study the following recommendations are made:

- If it is agreed / understood that mining activities at the north pit will commence in areas furthest away from the Nyl wetland. Monitoring of bird abundance and diversity could guide whether or not the mining in the immediate area (i.e. 110m buffer for the north pit from the delineated Nyl wetland) has an effect on sensitive wetland bird species (see below). Such information could then guide whether or not further mining could take place within a footprint in close proximity to the delineated wetland. With such a monitoring programme in place the mining in the north pit could provisionally take place. Such monitoring should also assess the disturbance effect of vehicular traffic across the berm wall;
- The floodplain area (as outlined above) is regarded as a highly sensitive avifaunal habitat and as such it is recommended that no infrastructure be erected inside the floodplain areas;
- Fixed point wetland avian monitoring by a qualified ornithologist (according the the Co-ordinated Waterbird Count methodology) should be conducted on a quarterly basis. Such monitoring should take place on site, along the river the below the site and at the Moorddrift dam to assess potential long term impacts on the avifauna;
- All areas affected by construction should be rehabilitated upon closure of the mine. This should be done to a point where natural processes are restored which will allow the pre-development ecological functioning and avifaunal diversity of the area to be re-instated;
- Construction of access roads in medium and high sensitivity areas should be avoided and vehicles must remain on designated areas and roadways; and
- Mining staff should stay strictly within the designated mining area, no trespassing should be allowed outside the designated mining areas.

It is further proposed that topsoil stripped from development footprints during construction be used to raise the height of the proposed north pit flood protection berm to approximately 1 to 2m above the height required to mitigate the entry of floodwaters into the north pit during a 1:100 year flood event (i.e. from approximately

6m to approximately 7 to 8m above ground level at its highest point closest to the Nyl river). The appropriate landscaping and re-vegetation of such a berm would act to partially screen (visually and acoustically) the activities undertaken at the north pit from the sensitive avian habitat immediately west thereof; where the pit haul/access road would be placed on the inside of such a berm with the aim of limiting human / vehicular exposure to nesting, wading, feeding and breeding bird species in the Nyl river floodplain wetland. Figure 8-3 that follows provides a conceptual illustration of what such a berm would entail.

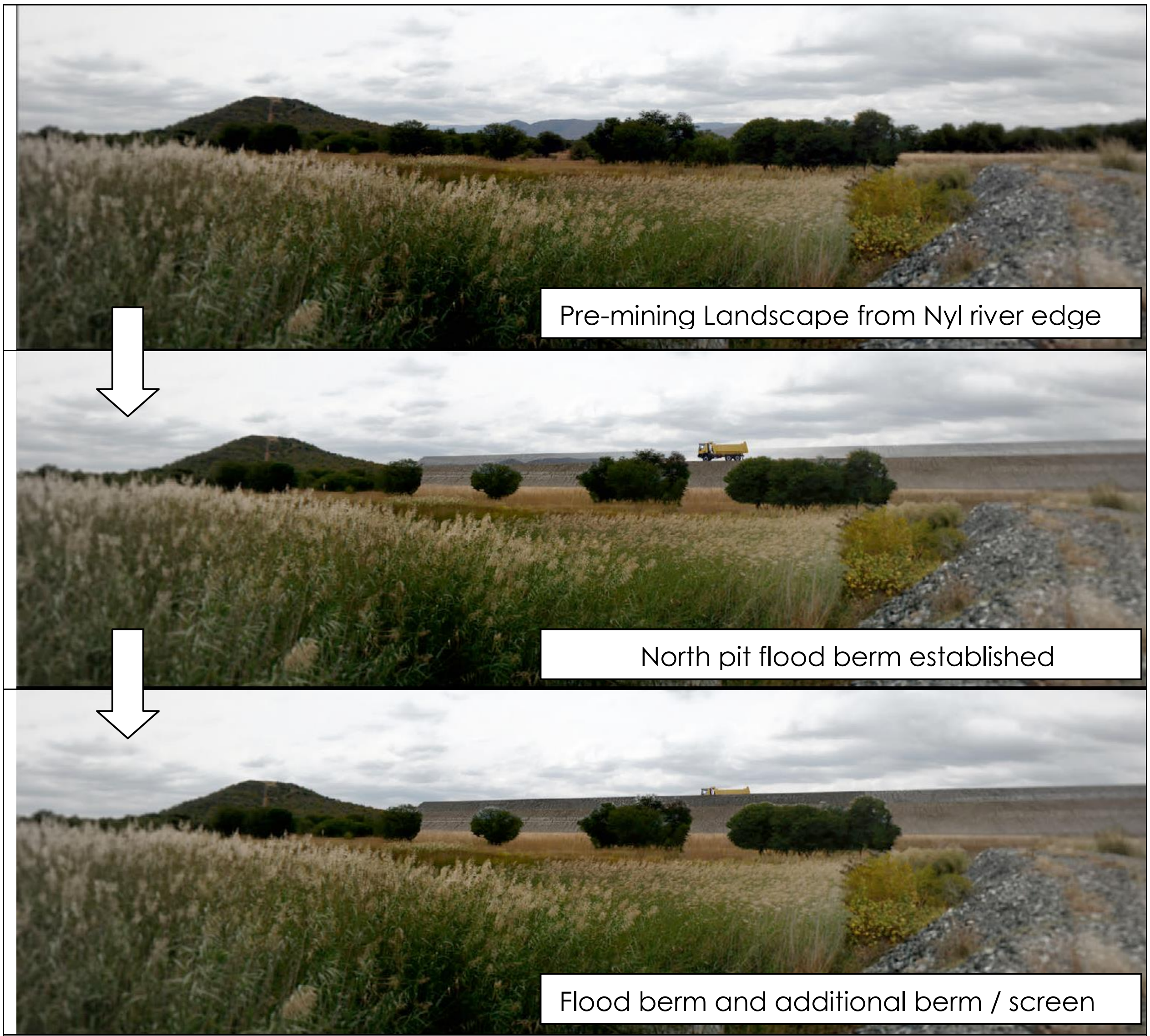


Figure 8-3: Conceptual illustration/rendering of proposed flood diversion berm and additional screening

8.2.2 AGRICULTURAL POTENTIAL / LAND CAPABILITY

Introduction

By way of introduction to the following section, the ratio of South Africa's agricultural imports to exports has reportedly increased since the mid-1960s, when the ratio of imports to exports stood at approximately 1 to 5. In the decade between 1995 and 2005, the ratio of agricultural imports to exports stood at 2 to 3. In 2007, agricultural imports temporarily exceeded agricultural exports by a ratio of 11 to 10 (http://www.southafrica.info/business/trade/export/agriculture-30212.htm#ixzz2Bo4p9K00).

According to the Limpopo Department of Agriculture (LDA), the total land area of the province is 11 960 600ha, of which 88.2% (10 548 290 ha) constitutes farmland. A total of approximately 135 000ha, which is about 10.5% of the South African total (ARC-IRI, 1999), is currently under irrigation, while a further 11 070ha is potentially suitable for irrigation. This total area currently under irrigation constitutes 1.4% of the total farmland in Limpopo province.

The potential impacts of the proposed project on the agricultural potential and land capability of the mine site itself (with potential indirect impacts relating to national food security) will predominantly be realised during the construction phase. These impacts will result from the stripping of fertile topsoil to accommodate the development footprints of proposed mine structures and infrastructure (incl. opencast pits).

A specialist '*Soil Survey and Land Capability Assessment*' was undertaken by Prof. A. Claasens to inform the EIA process (Full report attached in Appendix 5.8). Following this assessment, three aspects of the proposed mine were identified as having potential impacts upon soils classified as having high agricultural potential/capability (Figure 6-7). These are the north pit, the waste rock dump and the tailings storage facility (TSF); where the respective footprints of these particular project elements will be established on 'deep' (more than 50cm effective depth) Hutton form soils, and where these soils would be stripped to depth from the respective development footprints for stockpiling prior to proceeding with any bulk earthworks or mining activities.

An important factor to note, is that while the soil is stored on stockpiles over years, the organic material that is responsible for the unique physical properties of the site topsoil will decompose over time. At mine closure the quality of the topsoil would have deteriorated and it would be impossible to restore the soil to its original potential. Prof. Claasens goes as far as saying that, "*in fact it is never possible to restore any of the disturbed areas to their original potential after mine closure*".

The aforementioned mine aspects have a combined, effective, footprint of approximately 240ha. The waste rock dump and TSF will remain on site indefinitely beyond the end of life of mine, while the north pit void will not be back-filled to pre-mining elevations at the end of life of mine. It is also important to note that the development of the north pit would effectively sterilise approximately 100ha of high agricultural potential soils under irrigation (Figure 8-4), while the waste rock dump and TSF would also effectively sterilise soils considered to have high agricultural potential (approximately 140ha), but that these areas are not under irrigation; where the annual average rainfall in the area is a limiting factor toward crop production, irrespective of the soil fertility. As such these soils should more appropriately be classified, under present conditions, as having moderate agricultural potential.

The remaining project elements will predominantly be established in areas with shallow Hutton, Glenrosa and Mispah soils forms, which are classified as having low agricultural potential (even under irrigation).

Figure 8-4: North pit location relative to existing high agricultural potential cropland under irrigation on Ptn. 1 of the farm Volspruit and potential agricultural off-set corridor

Impact Discussion & Significance Assessment

The area of irrigated cropland (with high agricultural potential) to be permanently sterilised through mining activities accounts for approximately 0.07% of the total irrigated cropland in the Limpopo Province. The intensity of the impact on National food security and the sustainability of the provincial agricultural sector is thus deemed minor. This, together with the fact that the impacts can be moderately mitigated through the 're-establishment' of irrigated cropland elsewhere on the site, leads to the impact having a relative moderate significance (Table 8-11); where in the absence of any mitigation, the impact could be seen to have a relative high level of significance.

Table 8-11: Impacts on Soils with High Agricultural Potential (Construction)		
Nature (N)	Negative: Nett loss of high agricultural potential soils through proposed mining activities, with associated potential impacts on National food security	1
Extent (E)	National: The loss of high agricultural potential land may have National consequences in the context of food security; where the ratio of agricultural imports to exports has been steadily increasing since in the past number of decades	5

Table 8-11: Impacts on Soils with High Agricultural Potential (Construction)			
Duration (D)	Permanent: Permanent loss of high agricultural potential over the north pit, TSF and waste rock dump footprints		5
Intensity (I)	Minor: The agricultural output of the Province will be affected, but the impact would hardly effect the agricultural output of the Province. The sector would, however, become more sensitive to other impacts (e.g. further losses elsewhere in the Province through mining)		2
Probability (P)	Definite: The development of the north pit will effectively sterilise approximately 100ha of high agricultural potential soils under irrigation.		4
Mitigation (M)	Moderately mitigated: The impact can be partially off-set through the 're-establishment' of the impacted, irrigated, cropland on the north western extent of the farm Zoetveld, but there is still a net loss of approximately 100ha of high agricultural potential land (i.e. permanent residual impact would remain).		3
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: The subject soils cannot be restored to their previous potential, by virtue of the 'permanent' nature of the TSF and waste rock dump, as well as the void that will in fact be left after mining the north pit		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	40
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	80
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

<u>Mitigation/Management</u>

Topsoil and sub-soil removed from the respective development footprints will be stripped and separately stockpiled, for reuse in rehabilitation efforts at closure or concurrently to on-going mining operations. The proponent also proposes to assist with the re-establishment of an equivalent area of irrigated cropland on the farm Zoetveld (Figure 8-4), subject to:

- Confirmation of acceptance of this proposal by *inter alia* the Department of Agriculture and Department of Water Affairs; and
- Confirmation of the licenced volumes of groundwater abstraction for cropland irrigation on the farm Volspruit (i.e. the allocation used for irrigating the croplands that will be sterilised) where –

the nett 'agricultural' impact on the environment (with the exception of direct impacts on biodiversity through the clearance of indigenous vegetation for irrigated cropland establishment) would in essence then remain constant.

8.2.3 AIR QUALITY

The potential impacts on air quality during the construction phase (i.e. deteriorated ambient air quality, predominantly through dust entrainment from heavy vehicles and machinery) are not anticipated to be significant, relative to the potential operational phase impacts on air quality (which have been modelled to be of an acceptable level, with appropriate mitigation – section 8.3.2 refers). This view is based predominantly on the lesser duration, extent and intensity of impacts anticipated from the activities undertaken during construction, relative to those of the operational life of mine.

That is not to say that the proponent will not need to manage dust generation over the site during the construction period, and the attached EMPR indeed provides comprehensive mitigation toward ensuring that the above position holds true.

8.2.4 SURFACE WATER HYDROLOGY

Introduction

Both the 50- and 100-year flood lines are calculated to run through the proposed north pit. Mining will not be possible until some sort of contingency/ intervention has been put into place, in case a 50- or 100-year flood event is realised through the operational life of the mine. Accordingly a flood barrier, effectively a large earthen barrier wall that would keep the flood waters out of the pit in the event of a 100-year flood in the Nyl river, is proposed to be constructed along the applicable section of the north pit perimeter.

Briefly, this berm will be approximately 1.8 Km long, starting at 100mm above the 1 063.5 mamsl contour line, with the crest of the wall remaining at this elevation (1 063.6 mamsl) for the entire length of the wall. This means that the section of the barrier closest to the Nyl river will be approximately 6.6m high. The crest of the wall will be at least 3m wide and the slopes on either side of the wall will be at least 3:1. The berm would be created from, *inter alia*, overburden and waste rock and rehabilitated upon the completion its construction (i.e. topsoil and re-vegetation), according to an approved engineering design. The question arises then, as to what impact the construction of such a berm would have on the flood lines on the opposite side of the river?

Under normal circumstances the flood lines of a river generally mimics the topography of the land over which the river flows. In other words, the flood lines would progressively reduce in elevation as the riverbed reduces in elevation. Therefore, the elevation of flood lines become progressively lower as the riverbed becomes lower.

A flood line can, however, be elevated above the natural topography as a result of several physical factors along the riverbank, or the riverbed. Think for instance of a narrowing in a river due to a narrow gorge through which the river flows. In this case, the flood lines up-stream from the gorge would be slightly higher than what they would have been had the river's width remained the same. While flowing through the gorge, the speed of the water would increase and the elevation of the river would reduce rapidly. This is known as the 'Venturi Effect'.

Another example is when a river is dammed up. In this case, the flood lines of a river would remain at a single elevation for the entire length of the 'lake' formed behind the dam wall. In this case one normally refers to the flood lines of a dam as the 'high flood level lines, rather than 'flood lines. This high flood level in a dam, or for that matter, any level in a dam, not necessarily the highest level, is governed by the dimensions of the spillway and the sluice gates of the dam wall. The operator of the sluice gates can choose whether he wants to hold back the water entering the dam, increasing the level of the water in the dam, or allow the water to flow through (i.e. maintaining or lowering the water level in the dam).

The important thing to remember here is that, in respect to flood lines, when a dam is formed behind any obstruction in the flow of a river, be it a manmade or natural obstruction, the flood line of the 'lake' formed behind the dam becomes a water level or flood level (i.e. the flood line remains at a single elevation for the entire dammed distance of the lake behind the dam wall). Furthermore, when river water dams up in a lake behind a dam wall, the flow rate (speed) of the river decreases significantly for the length of the river through the elevated lake. In fact, it reduces so much that in most cases, the flow is not detectable at all in large dams. This reduction in flow rate is a direct result of the widening of the river beyond the width necessary to accommodate the water flowing in the river. In other words, the wider a river, the slower the flow rate.

Impact Discussion & Significance Assessment

In the case of the Nyl river, a similar situation is encountered where the N1 freeway crosses the river. What effectively will occur during a flood (i.e. with anything greater than about an 8-year flood), is that a temporary dam or lake will form upstream from the bridge for the duration of the flood. The filled embankment on either side of the concrete bridge would form a dam wall, while the opening under the bridge will form the spillway of this 'dam'. Once the flood is over, the lake would empty once again until the next flood arrives.

Please refer to Figure 8-5. In Figure 8-5, the original flood lines, and the elevated flood lines caused by the N1 bridge dam wall, are placed on a background of the study area. During AED's study (Full specialist surface water assessment report attached hereto under Appendix 5.3 Surface Water Impact Assessment Report), it was anticipated that the N1 bridge would have a negative impact on the flood lines at the proposed mine and they modelled two flood line sets, one ignoring the N1 Bridge (i.e. as the flood lines were before the bridge was constructed) and one including the N1 Bridge.

The green line in Figure 8-5 shows the historical 100-year flood line (i.e. where the flood line would have been, had the bridge not been constructed), while the red line shows the present 100-year flood line resulting from the lake formed behind the N1 Bridge dam. In certain areas (in particular at, and on the opposite side of the river from the proposed mine) there is a very significant difference between the two lines. So the blue line represents the 'high flood level' (HFL) line of the temporary dam formed behind the N1 Bridge dam during a 100- year storm. This HFL line is at a fixed elevation of 1 063.15 m above mean sea level for the entire length applicable to the study area.

The key finding of AED's study was that, through constructing the proposed 'flood barrier' in that particular part of the 'N1 Dam/lake', the proponent would not be increasing the discharge of the water flowing through the narrower part of the 'dam' to a speed greater than the speed through the 'dam' spillway (i.e. the opening under the N1 Bridge). So the flood barrier would not form a new 'dam', with a higher elevation behind it, than already exists.

The significance of the impact is thus deemed low; where the unlikely probability of the impact occurring, and the localised extent, are the main contributors thereto. The significance of the impact would have been far greater, by virtue of the potential intensity thereof (high), had the probability of occurrence been greater.

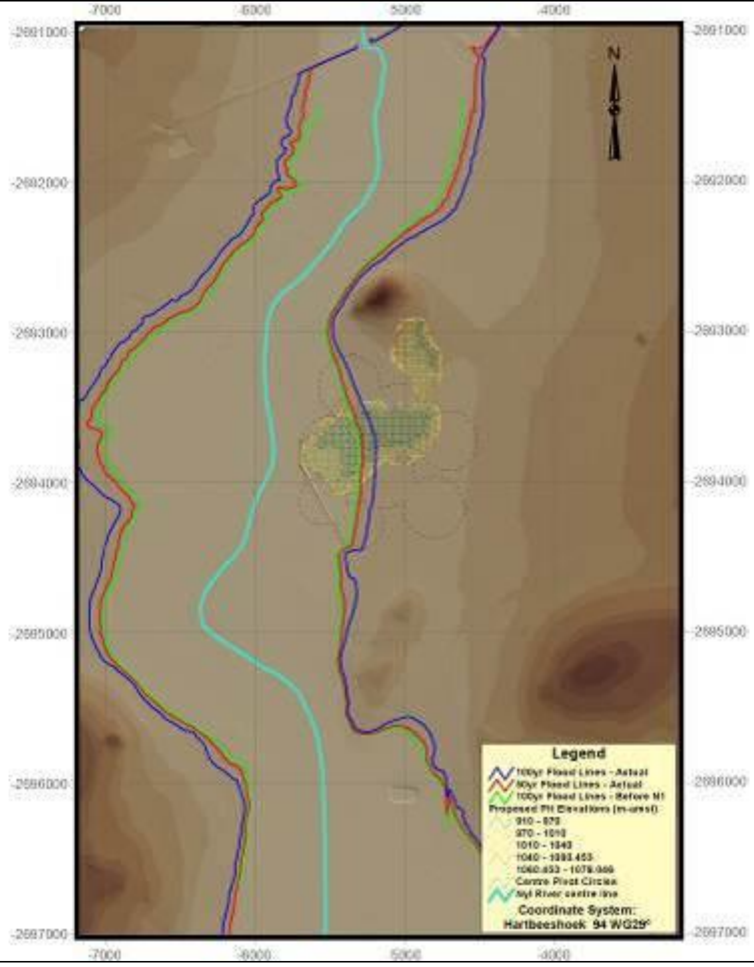


Figure 8-5: Nyl river flood lines before and after N1 bridge construction

Table 8-12: Impacts on Surface Water Hydrology / Flooding (Construction)		
Nature (N)	Negative: Potential alteration of Nyl river flood dynamics through construction of the north pit flood protection berm.	1
Extent (E)	Locally: In the vicinity of the site (i.e. up- and down-stream of the mine).	2
Duration (D)	Permanent: The flood berm would remain in place permanently beyond the life of mine.	5
Intensity (I)	Major: The potential alteration of flood lines and flood dynamics of the Nyl river could result in property damage during flood events, as well as damage to floodplain ecosystems and their functioning	4
Probability (P)	Unlikely: The impact has been modelled to be	1

Table 8-12: Impacts on Surface Water Hydrology / Flooding (Construction)			
	unlikely.		
Mitigation (M)	N/A		-
Enhancement (H)	N/A		-
Reversibility (R)	Slightly reversible: While the flood berm could be removed in theory to reverse the impact, its establishment is commensurate with the mining of the north pit. Once mining has occurred the berm will likely at least in part, remain in place indefinitely.		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	19
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	19
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Mitigation/Management

No management actions or mitigation is planned, or required.

8.2.1 GROUND AND SURFACE WATER QUALITY

Introduction

The inappropriate storage, management and handling of fuel, oil and other potentially hazardous chemicals and substances during the construction period could result in potentially negative impacts on surface- and ground water quality; where spillages of such could enter the groundwater environment in particular, through the ready infiltration of contaminated surface run-off into the groundwater environment. Poorly managed vehicle workshops and wash bays too will impact negatively on ground- and surface water quality. Contamination of this nature, associated with the construction phase of a project of this magnitude, would typically be hydrocarbon based (i.e. petrol, diesel and oil leaks and spillages to bare soil surfaces). Temporary concrete batching plants can also impact negatively on ground- and surface water resource quality if poorly managed.

Poor placement and maintenance of temporary sanitary arrangements (i.e. portable toilets) can also result in detrimental impacts on water resources in one or another of the following ways (Fugle and Rabie, 2009), depending on the nature and extent of potentially affected water resources:

- Eutrophication – referring to "*the enrichment of water with nutrients, such as nitrates and phosphates, which give rise to excessive growth of aquatic algae and cyanobacteria in surface water resources in particular*";
- Nitrification – referring to "*the contamination of drinking water supplies with elevated levels of nitrates*; and

- Microbial contamination – referring to "*the contamination of drinking water supplies with harmful pathogenic agents, such as E. coli bacteria and other faecal coliforms*".

Groundwater contamination would generally be restricted to the confines of the site, or in severe cases the immediate surrounds of the site. The presence of a major aquifer system beneath the site makes groundwater pollution prevention essential during the construction and operational phases. In the absence of a significant, continuous, point source of pollution, a groundwater pollution plume would likely develop and extend (i.e. in terms of lateral geographic extent) slowly within the underlying alluvial aquifer.

In addition, during construction, temporary stockpiles of building material, excavated soil, overburden and rock, as well as waste, will be produced. It is important that these stockpiles are located in a centralised area where temporary measures such as berms will prevent sediment run-off, specifically during heavy rainfall episodes. This would be particularly important until the site's storm water management system has been completed. These particular waste streams are, however, not expected to be hazardous, or pose a significant contamination risk to groundwater.

Impact Discussion & Significance Assessment

The proponent's proposed construction of a flood diversion berm on the western extent of the north pit, as well as the topsoil- and overburden stripping of that pit, present the most significant source of potential surface water pollution in close proximity to the Nyl river during construction; where sediments may be washed in surface storm water flows into the adjacent river during construction (i.e. prior to the rehabilitation/vegetation of the berm) and increase turbidity in this resource, with associated indirect impacts on flora and fauna in that system (berm to be constructed on the outer edge of the delineated floodplain wetland, between the wetland and the north pit).

All other construction elements are located well away from the Nyl river and associated floodplain wetland (i.e. ≥ 750m away), such that any contaminated surface water run-off from these locations is likely to infiltrate to groundwater before reaching the Nyl river, and where the Nyl river and its associated floodplain wetland are separated vertically from the underlying alluvial aquifer by natural clay deposition across the extent of the floodplain.

The potential impacts on the Nyl river can be well mitigated, as too can the potential impacts on groundwater resource quality, to the extent that the relative significance of the impacts are deemed to be of low significance with mitigation. The significance of the impact would be moderate in the absence of any mitigation; where the long duration and high intensity of the impact would be the major contributing attributes towards such a rating.

Table 8-13: Impacts on Water Resource Quality (Construction)		
Nature (N)	Negative: Potential impacts on surface- and ground water resource quality.	1
Extent (E)	Site and immediate surrounds: Localised development of a potential groundwater pollution plume (limited interconnectivity thereof with the surface hydrology of the Nyl river)	2

Table 8-13: Impacts on Water Resource Quality (Construction)			
Duration (D)	Long term: Treatment of groundwater contamination (i.e. once occurred) is a long and arduous process		4
Intensity (I)	Major: Adjacent farmers/farming communities reliant on groundwater for their livelihood		4
Probability (P)	Likely: The Impact is likely to occur, to the extent that provisions must be made for it		2
Mitigation (M)	Well mitigated: A comprehensive range of effective mitigation measures is readily available		4
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: No amount of time or money will sustainably reverse the impact on the groundwater resources		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	19
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	48
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Mitigation/Management

The remediation of contaminated groundwater is a long, arduous and costly process. Any such remediation efforts may also likely leave significant residual contamination, despite any such remediation attempts (dependant on the nature and extent of the contamination itself). As such, the proponent's management actions should focus on the prevention of any such potential hydrocarbon contamination, rather than post impact remediation thereof. A comprehensive range of effective, proven, mitigation measures will be implemented in this regard, which are in principle as follows:

- All hazardous substances to be stored within appropriately sized, impermeable, bund walls (outside of the 1:100 year flood line of the Nyl river);
- Storm water control measures to be implemented that prevent the free movement of 'clean' storm water run-off through the aforementioned storage areas, as well as any service yards and wash bays;
- Hazardous substances spill kits to be readily available at all points where hazardous substances will be stored and/or transferred (e.g. refuelling points);
- Vehicle and plant servicing to only take place in dedicated service yards on impermeable surfaces coupled with appropriate 'dirty' water containment systems/sumps and oil/water separators; and
- Drip trays to be appropriately placed under vehicles and plant that over-night on bare soil surfaces.

The Proponent is also required to establish an extensive groundwater monitoring network for the Volspruit Mine that will act to determine if any groundwater pollution is resulting from the proposed project. Contractors will also be required to provide a method statement in respect of how they propose to manage fuel storage, concrete batching- and workshop areas to minimise the potential for groundwater pollution.

Such method statements would need to be signed off by competent site environmental personnel / environmental control officer (ECO), prior to the start of construction activities.

8.2.2 TRAFFIC

Introduction

The project would create approximately 2 170 direct full time equivalent jobs over the approximate two and a half year construction period, which considering its duration, equates to about 836 people working on site on average for the entire duration of the construction period. If one assumes that a standard bus can transport approximately 65 people, and a mini-bus taxi 16 people, this would equate to the addition of approximately 13 buses, or 50 mini-bus taxis, (morning and afternoon) to the localised road network to transport construction workers to and from the site. The more likely scenario is to have a combination of bus and mini-bus transportation of workers to the site; where the proponent does not propose to establish facilities in the construction camp to house the construction workforce overnight.

Based on the geographical position of the mine, and the adjacent proximity of the communities, it is envisaged that most of the employees will be recruited from Mokopane and Mokopane's surrounding villages, which are about 30 minutes away from the site.

In addition to the above, the project will require that construction related goods and materials be transported to site on a near daily basis. This too will add additional light and heavy vehicle traffic to the localised road network; where the goods being transported could vary from documents in a courier van to abnormal plant loads on flatbed trucks. These additional volumes and distribution thereof during the construction period are not easily quantified / contextualised at this time. Deliveries of goods and equipment will predominantly be received during normal working hours, and as such the additional traffic load would be experienced during daytime hours.

The roads assumed to be most impacted upon (not quantified) will be i) the section of the N11 from the Singlewood road through to the T-junction with the R101, ii) the R101 itself (as a major transport spine between the N11 and Mokopane/Mookgopong/Polokwane, iii) the R518 out of Mokopane and iv) the 4km section of the Singlewood road to the site from the N11.

Impact Discussion & Significance Assessment

The significance of the impact is deemed low with and without mitigation, predominantly by virtue of the limited extent, medium-term duration and moderate intensity thereof. The proponent will, however, need to implement a safe workforce transportation strategy that reduces the nett addition of traffic to the localised road network during the construction period.

Table 8-14: Impacts on Traffic (Construction)		
Nature (N)	Negative: Negative impacts (nuisance traffic, road surface degradation, road user safety) on the localised road network due to increased traffic (heavy and light vehicle) during the construction period.	1
Extent (E)	Regionally (Largely within the Local Municipality): The	3

Table 8-14: Impacts on Traffic (Construction)			
	bulk of the impact will be experienced within Mokopane and its immediate surrounds (Exacerbated by the absence of an off-ramp to the N11 going south on the N1 national highway)		
Duration (D)	Medium-term: The impact will persist for the duration of the construction period (2.5 years)		3
Intensity (I)	Moderate: The intensity of the impact is anticipated to be minor in the context of the existing traffic volumes and flows on the localised road network (not quantified); where the existing volume and flow of traffic is anticipated to be hardly affected, but would be made more sensitive to further such stressors. The nuisance and annoyance to be created by the additional traffic on the quieter, less travelled sections, of the N11 and Singlewood road closer to the site may bare moderate intensity in assessing the significance of the impact		3
Probability (P)	Likely: There is a possibility that the impact may occur, to the extent that provision must be made to manage such		2
Mitigation (M)	Slightly mitigated: The impact is slightly mitigated through implementation of the measures to follow		2
Enhancement (H)	N/A		-
Reversibility (R)	Moderately reversible: The impact intensity would diminish with the end of the construction, but traffic related impacts would still persist into the operational phase of the project, albeit with reduced intensity.		3
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	14
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	18
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

<u>Management Actions</u>

The proponent will need to ensure that workers are predominantly transported either via bus, or mini-taxi, to the site (or combination thereof). The delivery of construction related goods and materials should be restricted to daylight working hours and to off-peak morning and evening traffic periods (to the extent that this is practical). The proponent should establish a bus terminal / drop off point at the site.

The proponent should furthermore ensure that appropriate traffic safety measures are implemented along the Singlewood road; where heavy and light vehicles will need to cross this road to gain access to work sites on each respective side thereof.

The above, principle, mitigation is formalised in the attached EMPR, and would become legally binding to the proponent if approved by the respective competent authorities.

8.2.3 SOCIO-ECONOMICS

Introduction

The proposed mine and mineral beneficial complex is expected to create both positive and negative impacts during the construction phase. From a socio-economic perspective, the positive effects, in terms of export earnings, economic development, job creation, household income, and government revenue that could be derived during the construction phase are deemed to outweigh the negative impacts that could ensue as a result of the mine's establishment and operation in the area.

However, the mine will be associated with a number of other negative effects that are more challenging to quantify and to offset. These are associated with the sense of place, property values, loss of family ties, crime situation and pressure on socio-economic infrastructure. Some of the impacts would only last during the construction period (such as 'crime' and impact on socio-economic infrastructure), while others will extend into the operational period and will therefore be of a considerable longer term. While the economic benefit of the mine's establishment in the area cannot be faltered, all efforts need to be made to ensure that the establishment and operation of the mine is conducted in the most sustainable way with the primary objective of minimising and where feasible completely eliminating the potential for altering human livelihoods in the area.

Positive impacts

a. Temporary stimulation of the national and local economies

The proposed Volspruit mine, smelter and the refinery plant will cost approximately R2 111 million (2012 prices) to establish, of which 81% or R1 703 million (2012 prices) will be spent in the country. The localised expenditure on the project will stimulate the local and national economies, albeit for a temporary period of two and a half years. Through production and consumption induced effects it will further stimulate new business sales in the economy to the amount of R4 573 million (2012 prices). Thus, the total contribution of the project towards production or new business sales in the South African' economy during the construction phase is estimated to be R6 684 million in 2012 prices. New business sales as a result of the project construction (through direct and spin-off effects) will contribute R2 080 million (2012 prices) to Gross Domestic Product.

Table 8-15: Impact on production and GDP-R during construction (R'ml, 2012 prices)

Sector	Direct	Indirect	Induced	Total
Production	R 2 111.1	R 2 559.7	R 2 013.4	R 6 684.2
GDP-R	R 279.1	R 911.3	R 889.6	R 2 080.0

These impacts on production and value added experienced during constructing will be temporary and will expire once the construction phase is completed. However, due to the extent of the impact that will spread the entire country and its relatively high intensive, the significance of the impacts is still high.

b. Creation of temporary employment opportunities nationally and locally

About 2 170 direct Full Time Equivalent jobs will be created during construction, which considering its duration, equates to about 836 people working on site on average for the entire duration of the construction period. The actual number of people working on site though will vary throughout the project's establishment phase. Through the production and consumption induced effects of the project, an additional 10 471 Full Time Equivalent positions would likely be created in the national economy during construction, which equates to about 4 188 jobs created and retained for the period of two and a half years. Thus, the total increase, albeit temporary, in employment that will ensue due to the establishment of the mine and its beneficiating complex will be 12 671 Full Time Equivalent jobs.

Most of Full Time Equivalent jobs (51% or 6 562 FTE jobs) to be stimulated by the establishment of the mine will be created through the production induced effects (i.e. along upstream activities of the construction value chain). The construction and manufacturing sectors are expected to benefit the most in this situation, as the construction activities will increase the demand for sub-contracting work and the demand for output of manufacturing sectors specifically non-mineral products manufacturing industries (e.g. cement, concrete, bricks), basic metals industries, fabricated metal products industries, and electrical machinery and equipment.

The increase in household income that would result from the creation of new employment opportunities will generate another round of economic effects that are induced by consumption of goods and services by these households. An additional 3 939 FTE jobs will be created through the induced effects throughout the construction period of two and a half years. Considering the expenditure pattern of households, industries that will experience the greatest increase in the FTE jobs will be manufacturing, agriculture and trade.

c. Temporary increase in household income during construction

Investment in the proposed development and subsequent creation of more than 12 thousand FTE jobs during the construction period will have a positive effect on income and standard of living of household affected directly and through multipliers effects of the project. Approximately R259.7 million (2012 prices) will be paid out in salaries and wages to employees directly involved in the establishment of the mines and its beneficiating complex. Some R426.6 million (2012 prices) will be paid out for FTE jobs created indirectly, with workers in the manufacturing and construction sector benefiting the most. An additional R394.6 million (2012 prices) will be paid out to FTE jobs created through induced effects with manufacturing, financing services, and trade benefiting the most. Thus, a total of R1 081 million of household earnings in 2012 prices will be created in the national economy throughout the construction period.

d. Contribution to skills development during construction

The extent of skills development that will partake during the construction period is difficult to quantify. However, any new positions created during construction offers opportunities for advancement of skills and knowledge sharing. Given that about three quarters of jobs to be created on site will require skilled people (i.e. people with experience in operating machinery or equipment), new skills development opportunities could be limited and would largely depend on the contractor's general practices; advancement of existing skills and gaining greater knowledge of the respective fields though will take place.

The impact is, however, expected to be negligible, as there is no certainty that skills development will take place during that period.

e. Temporary increase in government revenue

A minimum of R58 million in 2012 prices will be paid to government from direct activities in the form of personal income taxes and company's tax during construction. Government earnings will be distributed by national government to cover public spending, which includes amongst other the provision and maintenance of transport infrastructure, health and education services, and other public goods.

<u>Negative impacts</u>

The following sections describe the negative impacts that can be expected to ensue during the establishment of the proposed mine and refinery plant.

a. Negative impact on the balance of payments

The balance of payments can be described as a summary of all economic transactions between South Africa and all other countries in the world. Two sections make up the balance of payments, namely the current account and the capital account whereby the former refers to trade in the form of export and imports, whereas the latter refers to Foreign Direct Investment (FDI), Investment Portfolio, and other investments which reflect on national accounts.

Between 2003 and 2011, South Africa's trade balance has been at a deficit. The deficit was persistent and has grown between 2003 and 2007, when it reached a mark of 7.2% of the Gross Domestic Product (GDP). Thereafter, the deficit has been reducing only to grow again in 2011 to the level of 3.3% of the GDP. The increase in the deficit is also expected in 2012 due to the unsettlements in the mining industry and specifically industries that export their commodities that lead to the decline in mine's production and subsequently export earnings.

The current account can be broken down into five items, namely merchandise, services, income receipts/payments, gold and current transfers. Merchandise exports accounted for 75% (or R671.2 billion) of current account inflows in 2011. Income earned from exports of mineral commodities (excluding gold exports) is counted as merchandise exports. In 2011, they were valued at R216.2 billion, thus equating to 32.3% of the merchandise exports or 24% of the entire account inflows.

Persistent large, or consistently growing, trade deficit is associated with a number of negative effects:

- Increasing trade deficit implies that the nation needs to borrow more money from outside, which makes it more dependent on foreign funds. This in turn means that the national economy becomes more sensitive to the changes in the global financial markets and any instability or shocks that would lead to withdrawal of foreign investors' funds from the country would have a detrimental effect on the country's economy.
- Increasing trade deficit gives rise to inflation, which in turn makes the locally produced goods less competitive on both international and domestic markets, resulting in the slowdown of the domestic production and decline in employment.
- Rising inflation also tends to increase borrowing and as a result reduces internal savings. Lower savings in the economy means lower investment and slower economic growth and employment creation.
- Rising inflation could also lead to lower interest rates that from one side could stimulate domestic consumer spending but at the same time would make the

country less attractive for foreign investors, which have the potential to reduce the current account inflows and lead to the expansion of trade deficit.

The new mine establishment and construction of the concentrator plants, the smelter, and CVMR plant will require R479.2 million (2012 prices) to be spent on imported goods and services. This will have a temporary negative effect on the balance of the current account, as it will increase the import component of the current account and lead to the increase of the current account deficit. The effect, as was mentioned, will be temporary and will most likely be spread over the entire period of construction; which means that the actual impact on an annual basis will be about four to five times less than the total Rand value of imports.

These amounts are not expected to have any significant negative effects on macro-economic indicators and government policy. Moreover, a temporary increase of the deficit as a result of this project also means that in the future a greater quantity of PGM alloys manufactured through the refinery process could be exported. This means that in the medium to long-term, the project will stimulate the increase of merchandise exports, which will in turn translate into foreign exchange and profits.

The negative effect of the balance of payment during the construction period will be negligible. Mitigations thereof are possible, but only if goods and services required for the establishment of the project can be procured locally at a competitive price.

b. Loss of agricultural production due to land sterilisation

The proposed Volspruit mine and mineral beneficiation complex, if approved, will be established on the Portion 1 and Portion 2 of the farm Volspruit 326 KR, that are currently used for commercial agricultural activities. Farm Volspruit 326 KR Portion 1, where the majority of infrastructure will be established, currently derives its primary income from maize seed production for Panner or PHI during the August/January season and sugar beans/bake beans production during the January/April season. Farm Volspruit 326 KR Portion 2 derives its primary income from lucerne production.

Both of the farms make use of irrigation systems to produce the above. Besides the above agricultural activities, the two farms situated on the site where the Volspruit Mine and the smelter are proposed to be established supplement their primary incomes with the following commercial activities:

- Sunflower and wheat production during certain years depending on the demand;
- Lucerne production as game fodder;
- Maize production;
- Pecan nut production that will have fruit-bearing trees in a about five years with plans to expand to 30 ha and export to Asia;
- Cattle farming;
- Sheep farming; and
- Game farming with plans to establish accommodation facilities.

Overall the two farms generate between R5.7 million and R7 million in turnover and employ 25 permanent workers. During the harvesting season, though, the farms create temporary opportunities for up to 200 people for a few weeks due the highly labour-intensive processes involved in harvesting of certain crops.

The establishment of the proposed mine and the refinery plant will essentially sterilise the agricultural land, which will result in the loss of agricultural production mentioned above and subsequently jobs. Considering the average multiplier effects created by agricultural activities in Limpopo, the loss of agricultural production could result in the total loss of production in the economy to the value of R10 million to 12.2 million, which would also result in the loss of about 150 to 190 Full Time Equivalent positions throughout the provincial economy.

c. Negative changes to the sense of place

The sense of place is developed over time as the community embraces the surrounding environment, becomes familiar with its physical properties, and creates its own history. The sense of place is created through the interaction of various characteristics of the environment, including atmosphere, visual resources, aesthetics, climate, lifestyle, culture, and heritage. Importantly though it is a subjective matter and is dependent on the demographics of the population that resides in the area and their perceptions regarding trade-offs. Whilst a community living in poverty would be more accepting to the industrial development that would promise new employment opportunities, a more affluent residential area would most likely oppose to such intrusion, as it would not be associated with any gains to that community.

The area under analysis does not have high rise buildings in the vicinity and does not have any industrial activities taking place in the area. A chrome mine used to be located on the adjacent farm to the north east of the site. No mining activity is taking place on that site anymore; however tailing dams, some dilapidated building infrastructure and forgotten equipment can be visible from the gravel road that passes the site, which illustrates the poor rehabilitation that has been implemented on the site. Although the scenery does create a visual disturbance, it is not far visible; therefore, the area in its majority still maintains the sense of rural quiet surroundings. Therefore, any rapid notable change occurring with respect to one or more of the characteristics defining the sense of place would have a negative impact on it.

The establishment of the proposed mine and the smelter plant is expected to increase the noise levels in the area during day time largely due to movement of vehicles and light intrusion at night, which will alter the way the surrounding environment is experience by local residents and visitors. As construction activities advance, the footprint of the facility will grow. Most importantly as the operation of the mine increases and tailing dams grow in size and height, the visual impact will also become more apparent and the sense of place experienced by households residing within the visually affected area will become more altered.

Farms directly adjacent to the proposed site will experience the biggest change in the sense of place. Farms located further away may be less affected as far as noise and light intrusion are concerned but could still experience the change in the sense of place due to visual disturbances. Considering the information available, it could be estimated that between 50 and 120 people reside on the farms within ten kilometre radius from the site where the visual effect will be most notable. Many of the people living on the farms though stay on the farms during weekdays only as their families stay primarily in Mokopane and nearby townships.

As indicated earlier, the alternation of the sense of place in view of the local residents will start during the construction period. However, visual impacts and night illumination will remain for the entire operating period of the mine and the refinery plant. This means that although the effect on the sense of place could be relatively small considering the population to be affected, the duration of the impact significantly increases its significance. It is advisable that all efforts be made to address the drivers to the change of the sense of place, such as visual effects, noise, and night illumination to make them less intrusive.

d. Negative impact on surrounding agricultural and game farming activities

During construction, ground- and civil works, movement of vehicles and assembly activities would generate visual, dust, and noise pollution. Although the effects thereof are not expected to be significant (EScience, 2011), they could create disturbances for tourists coming to the area for game farming. Dust pollution could also potentially have an effect on production of vegetables, crops, and citrus that are farmed within the surrounding area. Furthermore, the establishment of the facility could lead to the loss of employees by the farmers due to the expectations of the farmers of greater pay that could be received on construction site compared to the farm.

This could also negatively impact on the agricultural and farming activities in the area as it could necessitate the farm owners to look for new staff and it could take time to appoint reliable and knowledge farm workers who would be willing to work on the farm in this situation. The significance of the impact is estimated to be low before mitigations and could be reduced to negligible level if mitigations are implemented.

e. Negative impact on households due to potential negative impacts on land sterilisation and surrounding economic activities

Sterilisation of land and potential environmental impacts that could be observed during the construction period will reduce the production of agricultural activities in the area and would negatively affect the livelihoods of the households that were dependent on these activities.

The impact of sterilisation of land on the livelihoods of households is of particular concern as it would imply a complete close down of agricultural activities as far as the Volspruit 326 KR Portion 1 is concerned, and highly probably close down of activities on the farm's Portion 2, which income is also used to support another farms of the owner. Based on information received, about 21 people are currently residing on the two farms (although some live only during weekdays) and 29 permanent farm workers are depending on the income derived from the activities on these farms. Additionally, up to 260 workers, who are mostly women and who are employed for only a few weeks a year during harvesting seasons, are also dependent on the farming activities on these farm portions.

In addition to the sterilisation of land, some negative impact on commercial activities on the surrounding farms could be experienced. It is not expected to be significant though and if pronounced, would have the biggest negative impact on the revenue derived by the nearby commercial game farm, which might result in the loss of employment opportunities. Possibility of the revenue decline on other farms in the area also exist and cannot be completely eliminated; however, aside from the citrus farm located north of the site, the effects are expected to be limited and to not extent to the primary income sources of these farms. Nevertheless, the probability of more revenue losses at the nearby farms resulting from construction activities cannot be entirely eliminated. Thus, there is a chance that greater numbers of people and workers than the ones mentioned above would be negatively affected. It is not expected though that these numbers to be significantly greater than the numbers of people and workers who will lose jobs due to sterilisation of land.

f. Pressure on social and economic infrastructure

The proposed establishment of the Volspruit mine and associated beneficiating activities will create employment for 2 170 Full time Equivalent positions. The number of workers on site will vary throughout the construction period, but considering the duration of the construction phase it will average at about 868 workers. Some of the workers will be migrant workers, which will create the demand for social and economic infrastructure in the area, including accommodation.

The project owner is not planning to establish a construction camp on site, which means that construction workers coming from outside the area would need to be accommodated in the nearby communities, and mostly in and around Mokopane (considering its relative proximity to the site). Therefore, the demand for rental accommodation is expected to increase in the area. Access to economic infrastructure in the area such as electricity and water is somewhat better than in other parts of the Limpopo Province, between 8% and 13% of households in the municipality still do not have access to these services.

A shortage of bulk water provision in the area is of particular concern to the local authorities. Therefore, the influx of migrant workers and job seekers will increase the demand for these services. Temporary increase in the population figures in the area due to influx of workers and jobs seekers would also lead to a greater demand for social infrastructure, such as medical services and recreational services.

Movement of people between the site and the residential areas, and most importantly the movement of vehicles bring materials and equipment will also lead to the greater traffic in the area. This could lead to significant deterioration of local road conditions, although considering that the site is located in proximity to the N1 and N11 national highways, the impact could be limited. Increase of the incidence of road accidents in the local roads could though be expected.

Given the above, the social and economic infrastructure in the area will be under strain during the construction period. The significance of the impacts is expected to be low; some mitigation could be introduced to reduce the intensity of the impact, its significance will though still remain low.

g. Temporary increase in crime and social conflicts associated with influx of people

The local economy of the Mogalakwena Local Municipality is not sufficiently diversified to supply the entire work force for the construction of the facility. Although the proponent plans to hire as many people from the local communities as feasible, there are chances that some construction workers will move to the area from other sites in the province or even country. In addition to the people who will be from outside the area and contracted to work on the project, the facility will most likely also attract job seekers from various parts of the province and South Africa.

The migration of people to the area could result in social conflicts between the local population and the migrants, as the former could perceive the latter to steal the employment opportunities in the area that are already in short supply in the local municipality. Influx of people into the area, especially by job seekers, could further lead to a temporary increase in the level of crime, prostitution, and possibly deterioration of health amongst the local communities due to the spread of sexually transmitted diseases.

The issue of semi-skilled and unskilled construction workers and job seekers who would migrate to the area from outside local communities and who would decide to stay in the area after the project's establishment is though a concern. Left without income, these individuals could resolve to crime and contribute to the increase in the level of poverty in the local communities.

Aside from the broader community issues, the influx of people to the site could lead to negative impacts in the surrounding area such as theft and burglaries, trespassing on adjacent properties, development of informal trading, and littering. The interviews held with the farm owners in the surrounding area revealed that security and poaching of livestock are amongst their biggest concerns. The influx of job seekers and loiterers to the area is expected to be limited considering that the mine is proposed to be located relatively far from the settlements, but there is still probability that this could occur.

The influx of job seekers and social conflicts associated with immigration of temporary workers is difficult to mitigate; however, appropriate awareness campaigns and strict adherence to the recruiting practices could potentially reduce the adverse effects. In any case, addressing the challenges related to potential social impacts is best to be done in partnership with the stakeholders, specifically the surrounding property owners, local communities, councils, and municipal authorities. This would promote transparency, information sharing, and build good relationships between the parties. In addition, all opportunities that would assist in engaging the community into the project should be investigated and if feasible should be realises. This specifically refers to employing the community in providing ancillary services (i.e. transportation and catering) to the project, which could eliminate the potential alienation of the local people towards the project as well as migrant workers.

h. Potential negative impact on property values

Local farm owners have raised their concerns that the establishment of the mine will affect the sense of place in the area and subsequently reduce the farm's marketability and diminish their land values. The changes in property values have limited direct impact on local economies as far as development is concerned; they however affect the value of real estate and subsequently the loans that could be applied for by farmers and their future income security.

In general, any development associated with some negative environmental effects can influence property values in two ways, as follows:

- On the one hand, it can reduce the value of the land if the proposed development has a negative image associated with it. This could be related to real, or perceived, adverse effects of the proposed development on air quality, noise levels, aesthetics, traffic congestion, health, and crime levels in the area; or
- On the other hand, the development could spike the demand for the surrounding properties and lead to the increase in property values in the area. This could occur in situations where nearby properties are found to carry valuable marketable natural resources or they offer improved accessibility of workers to the facility or other nearby developments.

The area surrounding the site where the proposed Volspruit Mine and the plant complex are to be established are classified as rural and are dominated by commercial agricultural activities, involving crop production using irrigation. Game farming is also taking place on some of the farms in the surrounding environment, although as was mentioned earlier, only one farm seems to derive its primary income from game hunting.

Furthermore, many of the farms rely on irrigation to derive their primary income and any impact on water availability for these farms would most likely reduce their value to potential buyers. Therefore, based on the above, it can be suggested that the effects of the land and property values in the area would be negative.

The discussions with real estate agents revealed that land value of farms located in close proximity to mines do decline and more so for farms located adjacent to the mining sites. The degree to which land values drop vary significantly and depend on the farming activity taking place on the affected farms and the distance of the farm from the mine's site; it could though range between 10% and 30%. Property values of game farms seem to be more negatively affected than property values of farms deriving their income from livestock or crop farming, for example, which is mainly explained due to the nature of revenue derived by these activities and sensitivity thereof to various environmental changes ensued due to mine's activities.

The effects on property values are expected to present themselves during the construction phase and even at the pre-construction phase when the knowledge about the proposed mining activity spreads. During this time the decline in property values could be greater than expected due to the uncertainty in the market regarding the actual extent of environmental impacts that can ensue from the construction activity. The negative effects on property values during operation usually continue; however, the extent of that impact could change (i.e. reduced or increased) depending on the actual changes that the construction of the mine and its operation brought to the surrounding environment. In some cases, the negative impact could be reduced and more so for properties located further away from the site and in some cases it could be increased if the perceived impacts have been underestimated or new impacts occur.

i. Potential loss of family ties

Three of the farms located in the area are owned by a family comprising of two generations (i.e. a farther, a son and an uncle). One of these farms is the farm Volspruit 326 KR (Portion 1), where the biggest portion of mine's activities and infrastructure are to be located. The other farms are located on portions of the farm Bokpoort 328 KR. If the mine is established, the family who owns Portion 1 of the farm Volspruit 326 KR will likely move away from the area, which will break close family ties that have been developed between family members by working in proximity to each other. Furthermore, it appears that the family works closely together and provides assistance to each other, which means that relocation of one of the members could also impact the running of the other farms.

Furthermore, since the closure of agricultural activities on Volspruit 326 KR will also mean the loss of employment opportunities for the farm workers, their households might also experience a negative effect on family ties, as they could be forced to look for employment further away from their families or relocate away from the area and their extended families due to relocation of the farm owner.

Summary

The specialist Socio-economic Impact Assessment Report (Appendix 5.11) provides further detail in respect of the attributing factors toward assessing the relative significance of the identified, potential, socio-economic impacts of the project. Table 8-16 that follows, and indeed the preceding sections, are aimed at providing a succinct summary of those potential impacts; where Table 8-16 provides a relative indication of the impact significance for each identified impact.

Table 8-16: Summary of socio-economic impacts during construction			
Impact	**Description**	**Significance rating**	
		BM	**AM**
Positive			
Temporary stimulation of the national and local economies	• R6.6 bn of production created in the national economy • R2.1bn of value added created in the national economy	-54	-54
Creation of temporary employment opportunities nationally and locally	• 2 170 FTE jobs created during construction directly • 12 671 FTE jobs created in the entire economy during construction	-54	-54
Temporary increase in household income during construction	• R260 ml earned in income directly during construction • R1 081 ml earned in income in the entire economy during construction	-54	-54
Contribution to skills development during construction	• Skills development opportunities in construction	-4.5	-9
Temporary increase in government revenue	• R58 million in government earning will be generated directly from construction activities	-4.5	NA
Negative			
Negative impact on the balance of payments	• R479.2 million worth of goods and services will be imported	9	9
Loss of agricultural production due to land sterilisation	• Loss of R10-12.2 million of production in the entire economy • Loss of 150-190 FTE jobs in the entire economy	96	72
Negative changes to the sense of place	• Between 50 and 120 people affected (excluding visitors) • Impact extends into operations	56	42
Negative impact on surrounding agricultural and game farming activities	• Visual, noise, air pollutions • Loss of farm workers to construction site • Potential loss of game hunting revenue	15	7
Negative impact on households due to potential negative impacts on land sterilisation and surrounding economic activities	• Min of 21 people to be affected • Min of 29 permanent workers to lose permanent jobs • Up to 260 seasonal workers to lose opportunities	45	34
Pressure on social and economic infrastructure	• Increase demand for medical services • Increased traffic and potential for road deterioration and accidents • Pressure on water and electricity provision	18	12
Temporary increase in crime and social conflicts associated with influx of people	• Conflicts between local population and migrant workers • Poaching of livestock • Increased burglaries • Development of informal settlements • littering	56	42
Potential negative impact on property values	• Possible decline of property values between 10% and 30% depending on activity taking place on the farm and the distance from the site • Impacts extends into operation	56	42
Potential loss of family ties	• Three of the farms in the area belong to the	56	42

Table 8-16: Summary of socio-economic impacts during construction			
Impact	Description	Significance rating	
		BM	AM
	same family • One of the family member owns Volspruit 326 KR portion 1 and would need to relocate		

Mitigation/Management

The attached EMPR provides for a comprehensive range of proposed mitigation to be implemented during the construction phase of the project. These measures are cross-referenced to the subject impacts in Tables 5-1 to 5-18 in the attached Socio-economic Impact Assessment Report Report (Appendix 5.11).

8.3 OPERATIONAL PHASE

8.3.1 INTRODUCTION

The operational phase of the project encompasses all those aspects associated with the on-going mining operations at Volspruit, from the end of the construction period, up until the closure, decommissioning and rehabilitation of the mine. The operational lifespan of the mine is approximately 19 years. This estimate is based on the extent of the available ore body, as well as the rate at which ore will be mined. It should be noted that the mining of the north pit will be undertaken from year 1 through to year 13 of the life of mine, with the mining of the south pit commencing in approximately year 12 of the life of mine and continuing through to the end of life of mine (anticipated for 19 years in total).

In broad terms, the ‘operational phase’ of the project life-cycle includes, *inter alia*, the following broad activities:

- Processing Plant operation;
- Smelter and CVMR Plant operation;
- The continued mining and primary crushing of ore from the respective pits, and transfer thereof to surface for processing;
- Waste rock management and deposition to the waste rock dump;
- Raw material receiving, handling and storage;
- Mine water management (potable and ‘dirty’ water streams);
- Sewage treatment and sludge management;
- Tailings management;
- General and hazardous waste management (incl. salvage yard);
- Vehicle/plant servicing, repair and washing; and
- Site access control and security measures.

All of the aforementioned operational activities have the potential to impact on one, or more, environmental parameters, as evaluated and described in the following sections.

8.3.2 NOISE AND VIBRATION

Introduction

This section assesses noise and vibrations in the context of the potential impacts thereof on human receptors. It is acknowledged that disturbance noise and vibrations can also impact indirectly upon elements of site biodiversity, which is more appropriately assessed under section 8.3.4 to follow.

The noise sources on the mine site that may create increased noise levels on a temporary and/or permanent basis during the operational phase are, *inter alia*, as follows:

- Blasting activities (north and south pit);
- Ore and waste rock handling (heavy haul vehicles and conveyers/railveyors);
- Plant operation (processing-, smelter- and CVMR Plants);
- Ore crushing at run-of-mine stockpile;
- Diesel emergency generators;
- Drilling;
- Mechanical ventilation, such as extract fans and/or blowers, at the plant area;
- Mine machinery activities; and
- Additional traffic to and from the plant.

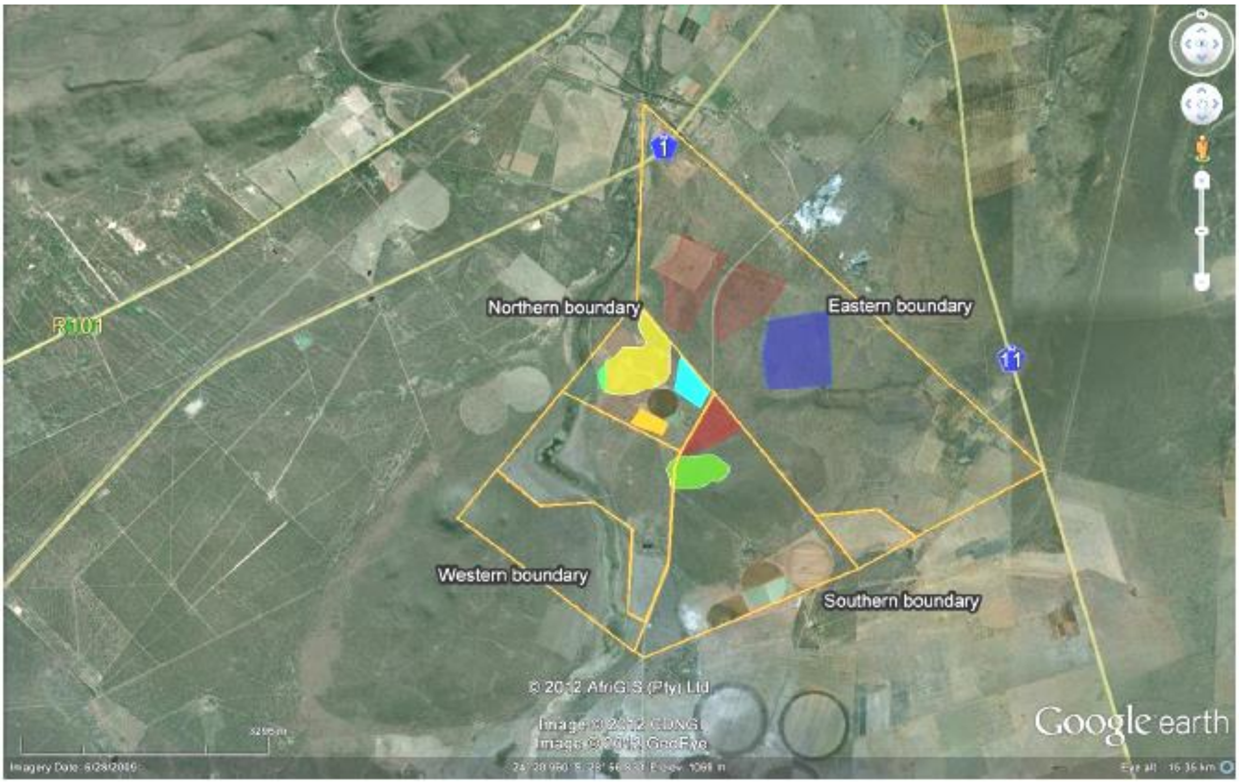


Figure 8-6: Mine boundary, in relation to Table 8-17 below

Table 8-17: Prevailing ambient noise levels along the boundaries of the mine

Boundary	Daytime – dBA	Night time – dBA
Northern	35.6	34.1
Eastern	30.6	32.5
Southern	33.9	30.2
Western	39.0	36.9

The preceding figure and associated table (Figure 8-6 & Table 8-17), relating to the measured ambient noise levels at the site boundary, are included for reference in relation to the discussion on potential noise and vibration impact significance that follows.

Impact Discussion & Significance Assessment

The modelled cumulative noise contours of the mining activity(ies), which includes the opencast mining activity and the processing plant, is illustrated in Figure 8-7. The noise sensitive areas are indicated with the letters A to K, and it is only noise sensitive area 'A' that will be directly affected by the activities at the mine. Noise sensitive area 'B' is behind a hill, and the natural topography will largely screen off the sound from the mining activities at this location.

The distances between the mining activities and the noise sensitive areas are given in Table 8-1, and except for noise sensitive area 'A', the distances between potential sensitive receptors and the mining activities exceeds 1 000m. Figure 8-7 shows the modelled cumulative noise levels, with mitigation measures in place to reduce the ultimate intrusion thereof at the point of the receptor; where relative distance and vegetation cover play an important role on sound reduction.

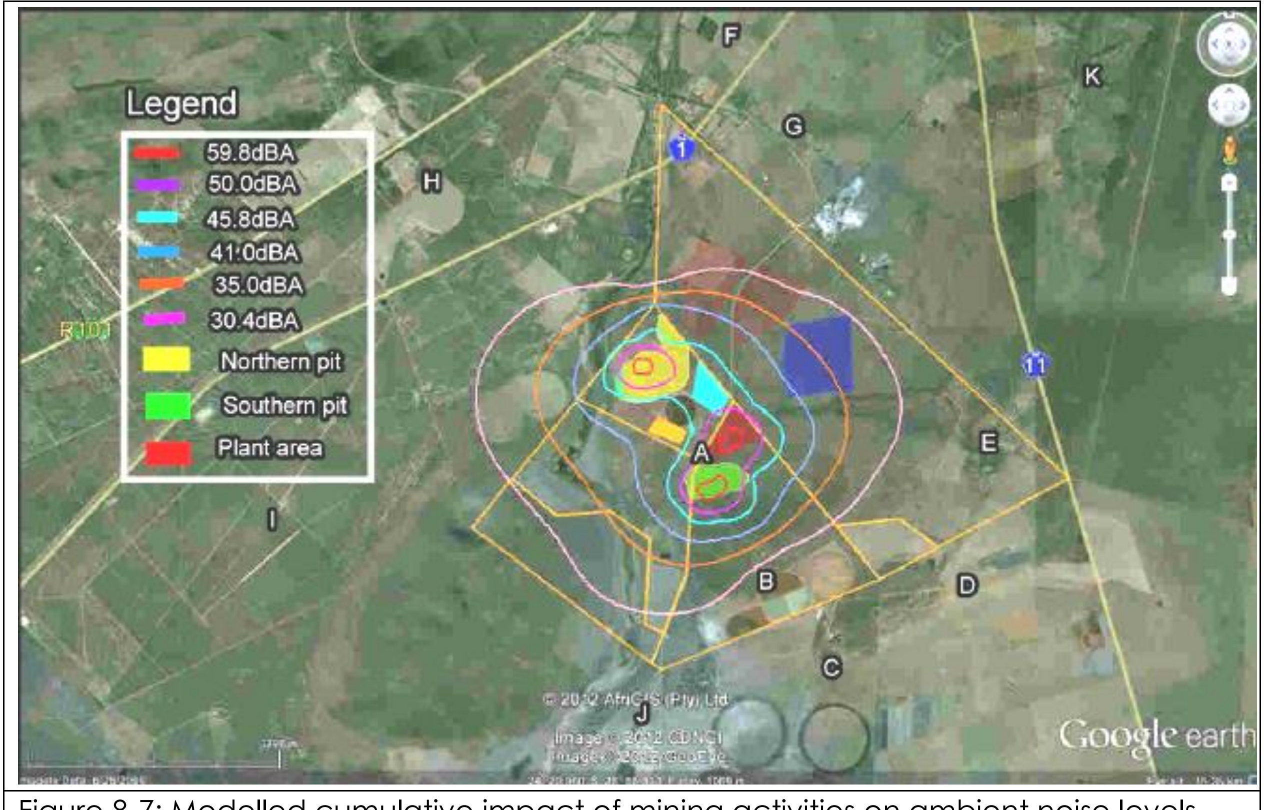


Figure 8-7: Modelled cumulative impact of mining activities on ambient noise levels

It is evident from Figure 8-7 that the mining activities (excluding blasting) will have the most impact on prevailing ambient noise levels over the northern site boundary; where the level of modelled intrusion along this boundary is in the order of 5.5 dBA. The modelled cumulative, continuous, noise levels are furthermore shown to be in the order of 30.4 to 35 dBA at the chalet located on the western bank of the Nyl River.

An increase in ambient noise levels between 1dB – 10dB is deemed to elicit little to sporadic response from a receptor. When the difference is more than 5 dB above the ambient noise level, a person (receptor) with normal hearing will start to hear the difference. The Noise Control Regulations (R 154 GG 13717 of 10 January 1992), promulgated in terms of ECA, defines:

- Nuisance noise, as "*any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person*"; and
- Disturbing noise, as "*any noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more*".

The proposed mining activities will thus likely be audible, and periodically create 'nuisance', to receptors at the chalet on the western side of the Nyl River. It must also, however, be stated that the modelled noise intrusion at the chalet across the northern mine boundary falls within the ambient day- and night time limits recommended in SANS 10103 of 2008 for rural districts (Table 3-10); where it is also questionable if the presence of the N1 national highway approximately 1.2km to the north west of the chalet fits with a 'rural' district description proposed under that standard.

The potential impact of cumulative operational phase noise beyond the site boundary would be of a very long-term nature (i.e. life of mine – 18-20 years). The impact is anticipated to have limited extent beyond the northern mine boundary (Figure 8-6). The low to moderate intensity of the impact (relating to a single point receptor), in combination with the aforementioned attributes, suggests the impact significance to be low to moderate with appropriate mitigation (Table 8-18).

Table 8-18: Impacts of operational activities on ambient noise levels (Operation)			
Nature (N)	Negative: Increases in measured ambient noise levels beyond the mine boundary		1
Extent (E)	Locally: The impact would only be realised over a kilometre or so beyond the northern mine boundary		2
Duration (D)	Very long-term: The impact would persist for the operational life of the mine (18-20 years)		5
Intensity (I)	Minor to moderate: The noise impact will nominally alter the living environment of a limited number of receptors in such a way that the modelled increase in ambient noise levels are not deemed to be disturbing (potential for periodic nuisance)		2.5
Probability (P)	Definite: The operational phase of the project will generate noise		4
Mitigation (M)	Slightly mitigated: A small reduction in noise impacts can be realised through the measures proposed		2
Enhancement (H)	N/A		-
Reversibility (R)	Mostly reversible: The impact would cease once all operational related activities have concluded at the end of the life of mine		4
Significance Rating with Mitigation -	N x (E+D) x I x P ÷ ½(M+R)	**Low to moderate**	23

Table 8-18: Impacts of operational activities on ambient noise levels (Operation)			
Negative Impact (S)			
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	28
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Human reaction to vibration will be in response to the resulting effects of both ground and airborne vibration and in particular the combined effects of such vibration; where the blasting process is the biggest contributor to vibration. Routine blasting operations regularly generate air over pressure levels at 15m of about 120 dB. A constant wind velocity of 5m/s-1 will generate the pressure equivalent of 120 dB at 15m from the blasting area. At 140 dB the wind velocity would increase to 8m/s-1.

Figure 8-8 and Figure 8-9 show the modelled noise contours in response to blasting at the north- and south pit surfaces respectively. This is the calculated noise level from a blast at the open cast pit at a sound pressure level of 120dB at 15m from the blasting point. This increase in the noise level is for a period not exceeding 3 seconds per blast.

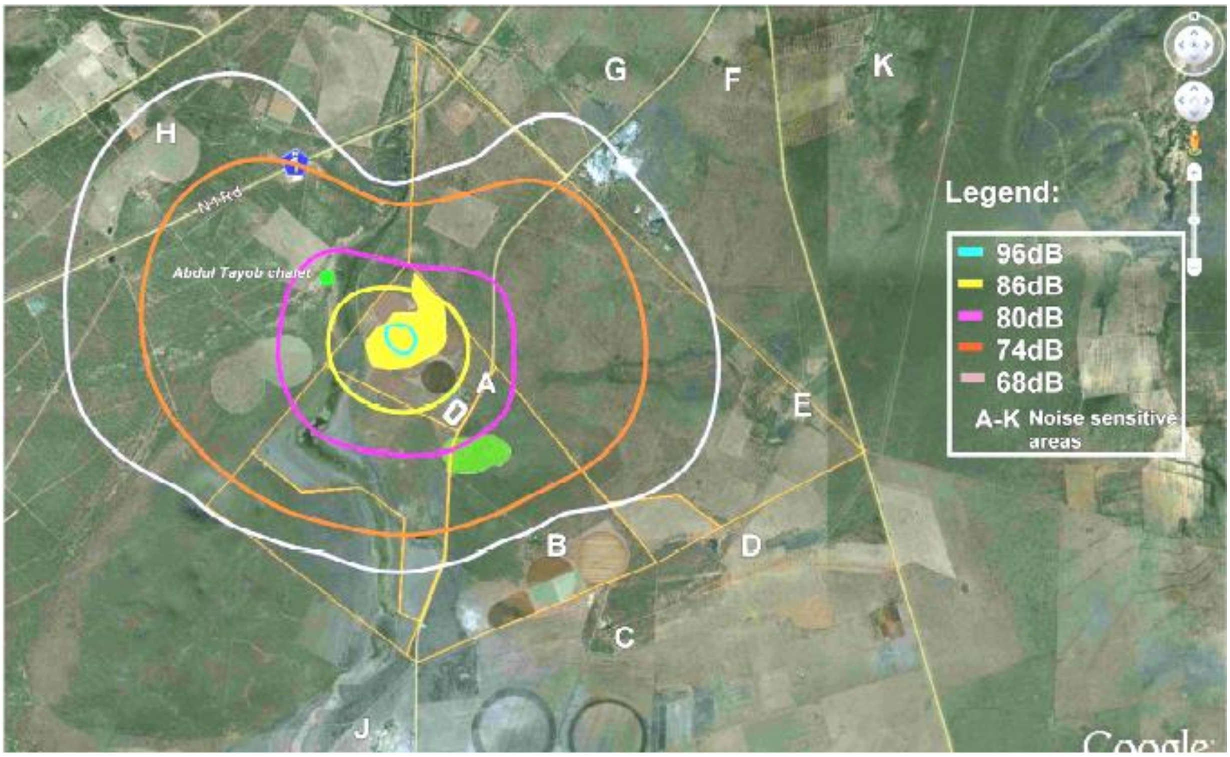


Figure 8-8: Illustration of noise contours during a 120dB blast at the north pit

It is evident that blasting activities will result in potentially significant increases in ambient noise levels (i.e. ambient levels at between 68 and 86 dBA) beyond the northern- (north and south pit blasting), as well as the southern and eastern mine boundaries (south pit blast only). Although basting activities will persist for the duration of the operational life of the mine (18-20 years), it is important to note that the frequency of blasting is estimated at three blasts per week, with the elevation in ambient noise levels resulting from a blast only lasting in the order of three seconds per blast.

Blasting will thus create disturbance noise (i.e. an increase of ≥ 7dBA above measured ambient noise levels) for a period of three seconds per blast. The intensity of the impact is deemed major, and would have been considered 'severe' were it not for the intermittent nature of the impact. The overall significance of blasting on ambient noise levels is considered moderate, should appropriate mitigation be implemented by the proponent (Table 8-19).

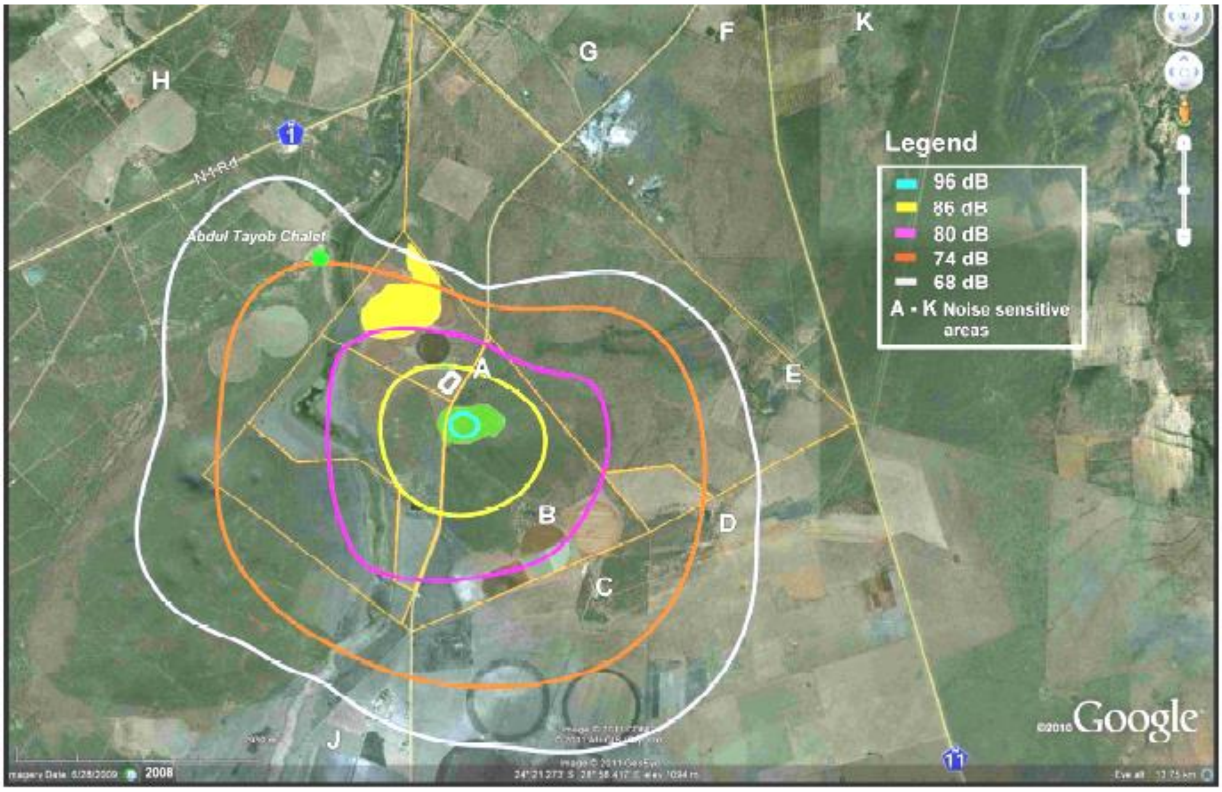


Figure 8-9: Illustration of noise contours during 120dB blast at the south pit

Table 8-19: Impacts of blasting (Operation)		
Nature (N)	Negative: Degraded ambient noise levels as a result if intermittent blasting	1
Extent (E)	Locally: The impact would only be realised over a couple of kilometres beyond the northern mine boundary	2
Duration (D)	Very long-term: The impact would persist (albeit it intermittently) for the operational life of the mine (18-20 years)	5
Intensity (I)	Major: The increases in ambient noise levels during a blast will create significant disturbance to receptors in proximity to the mine (significant exceedences of recommended SANS 10103:2008 continuous day time ambient limits for such a district); where it must, however, be acknowledged that such disturbance would last for approximately three seconds per blast	4

Table 8-19: Impacts of blasting (Operation)			
Probability (P)	Definite: Blasting will cause intermittent increases in ambient noise levels beyond the mine boundary		4
Mitigation (M)	Moderately mitigated: The impact can be substantially mitigated, but the residual impact would still be noticeable or significant relative to the original impact. The impact would inherently be mitigated as the blasting depths decrease below surface during pit development.		3
Enhancement (H)	N/A		-
Reversibility (R)	Moderately reversible: The impact would cease once all blasting activities have concluded at the end of the life of mine, but potential economic losses incurred by adjoining game farms during the operational phase of the mine cannot be recouped		3
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	37
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	56
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Mitigation/Management

The acoustic screening measures, based on best practicable methods, acoustic screening techniques and the IFC's Health and Safety Regulations, need to be implemented by the proponent to ensure that potential increases in ambient noise levels at the site boundary do not exceed the SANS 10103:2008 recommendation for continuous noise levels in the district (45dBA day- and 35dBA night time levels).

The following vibration screening measures for the control of vibration during blasting must be provided:

- The air over pressure levels and vibration level, (audible and the inaudible concussion noise), are to be monitored and controlled during each blasting operation. The standards implemented by the USA Bureau of Mine Standards, RU 8507, are used as a guideline to monitor and control blasting operations in South Africa.
    - The limit for ground vibration should not exceed 10mm/s at the nearest residential property;
    - An over pressure limit of 134 dB should not be exceeded. Near schools and churches not to exceed 128 dB; and
    - No blasting to take place when there are windy conditions.
- The Regulations under the Mines Health and Safety Act require the owner of the operation to ensure that the health and safety of employees and people will not be affected during blasting.
- Blasts must be designed so that ground vibration and air over pressure levels are adhered to. In order to comply with the above, the following measures should be implemented:

- o A scheme of vibration and air over pressure monitoring to be implemented by the Proponent;
- o A scheme by which air over pressure is controlled;
- o Days and times of blasting operations to be established;
- o Ensure that the correct design relationship exists between burden, spacing and hole diameter;
- o Ensure the maximum amount of explosive on any one day delay interval, the maximum instantaneous charge, is optimized by considering:
  - Reduce the number of holes per detonator delay interval;
  - Reduce the instantaneous charge by in-hole delay techniques;
  - Reduce the bench height or hole depth; and
  - Reduce the borehole diameter.

8.3.3 GROUNDWATER QUALITY

Introduction

Hydrogeological Investigations / Modelling:

A specialist hydrogeological assessment was undertaken in support of the EIA process by GeoPollution Technologies (GPT) to inform understanding around the subject hydrogeological system (i.e. a *status quo* assessment, through implementation of a comprehensive hydrocensus at up to 50km from the mine site). The full Hydrogeological Report can be viewed in Appendix 5.1: Groundwater Impact Assessment Report. Water samples were collected from boreholes and the quality thereof analysed by an accredited laboratory (Section 6.5.3 has reference). Furthermore, information was collected on the use of the boreholes in the area, the water levels and yields of boreholes, etc..

The above hydrocensus information was supplemented by extensive onsite investigations, *inter alia*, as follows:

- Geophysics surveys: The objective of the geophysical surveys was to image the subsurface resistivity / conductivity in order to investigate the geological structure of the area, which is considered to be of a complex nature with abundant fracturing and faulting which may act as preferential flow paths for groundwater as well as contaminants. A total of 13 traverses were implemented for this purpose;
- Borehole drilling and pump testing: A total of ten percussion boreholes were drilled on site. The objective being to establish the parameters of the aquifer underlying the site (i.e. transmissivity, hydraulic conductivity and storativitiy;
- Establishment of Piezometer boreholes: These 'piezometers' were installed to monitor groundwater levels as well as head stages of the Nyl river to determine the possible interaction of the Nyl river and groundwater in the floodplain. Nine piezometer holes were drilled during the week of 12 July 2011. These holes were drilled using the rotary air percussion method, to a maximum depth of 30mbgl, in the floodplain of the Nyl river;
- Packer testing: Packer tests are performed to determine the hydraulic conductivity of a fractured rock aquifer at different sections in a borehole, as well as the subsequent transmissivity of those sections. Three to five tests are performed by pumping water into the test section, which is sealed off by two air bladders, under a specified hydraulic pressure to determine the flow rate at that specific water pressure. These values are then used to determine the hydraulic conductivity and transmissivity of that test section. A total of four core holes were packer tested as part of the hydrogeological investigations;

The above investigations yielded the following key results:

- Groundwater levels were measured in 48 boreholes of a total of 72 identified boreholes during hydrocensuses conducted in between 2010 and 2011. The water levels ranged from 1.5 to 38 mbgl. The boreholes identified during the hydrocensuses around the proposed mine show an average yield of 6.25 l/s;
- Two geophysical surveys were performed on site in 2010 and 2011. For the surveys, the Geometrics "Stratagem" EH 4 CSAMT instrument and the ABEM "Lund" resistivity imaging system were used. Most of the traverses intersected inferred fault zones well;
- Ten percussion boreholes were drilled on the site between 2010 and 2011. Most of the holes were targeted on geophysical anomalies and showed raised blow yields. The holes may be used for monitoring purposes in the future as the depths range between 40 and 174mbgl. Nine piezometer holes were drilled along the Nyl river to study the head stages of the river. The depths of the piezometers ranged between 5.6 and 27.08mbgl;
- Pump testing was performed on the newly drilled percussion boreholes as well as additional existing boreholes. Transmissivities for the tested boreholes ranged between 1.4 and 171.6m^2/day indicating highly variable flow characteristics for the lithologies on site. An overall high transmissivity and hydraulic conductivity was observed in the pumping test data;
- Six existing exploration core holes were used for packer testing to determine which hydrogeological unit is the major water bearing unit on site. Hydraulic conductivity values obtained from the packer tests, which can only be performed in competent rock, were much lower than those obtained from pumping tests. This indicates that the upper weathered zone is most probably the major water bearing lithological unit; and
- Data obtained from data loggers installed in the newly drilled piezometer holes, indicates that the Nyl river and the groundwater on site are unlikely to be hydraulically connected.

All of the data / results derived from the above investigations, together with desktop data and inputs from academics and scientists with working knowledge of the Nyl system, were used to develop a numerical groundwater model for the subject groundwater system. The finite difference numerical model was created using the US Department of Defence Groundwater Modelling System (GMS8) as Graphical User Interface (GUI) for the well-established Modflow and MT3DMS numerical codes.

Potential Sources of Groundwater Pollution:

Activities undertaken during the operational phase of the project that could potentially degrade groundwater quality are identified, *inter alia*, as follows:

- Establishment of mine residue deposits:
    - Deposition of tailings waste to the tailings storage facility (TSF); and
    - Waste Rock disposition to the waste rock dump;
- The bulk storage of fuel and oil;
- Reagent storage for the processing plant;
- Raw material storage for smelter (i.e. anthracite, limestone);
- Sewage treatment plant operation;
- Slag and gypsum 'waste' storage;
- General and hazardous waste storage on site;
- Servicing of plant and vehicles in site workshops;

- The infiltration of unmanaged, contaminated, surface water flows from plant areas into the groundwater environment;
- Gypsum residue storage pond (in the event that limestone scrubbing is used to abate roaster off-gas SO_2 concentrations); and
- Potential hydrocarbon leaks and spillages from mine vehicles and equipment to bare soil surfaces.

Workshops and fuel and oil handling facilities are likely sources of hydrocarbon related contaminants. Oils, grease and other hydrocarbon products (such as petrol and diesel) handled in these areas may contaminate the environment by spillages and leakages. Oils and greases are removed and collected in oil traps. Run-off (contaminated with hydrocarbons) which is not collected may enter the storm water system from where it may contaminate surface water bodies and groundwater. Such impacts are, however, readily managed through the measures proposed in the attached EMPR.

Sewage treatment plants potentially contaminate groundwater. Contaminants associated with these plants include coliforms (e.g. E.coli), bacterial viruses, ammonia, phosphate, sulphate and nitrate. Effluent from these systems usually contains elevated concentrations of organic matter which may lead to elevated chemical oxygen demand (COD) and (BOD). Waste disposal areas may source a wide range of contaminants, ranging from metals, organic matter, hydrocarbons, phosphates, etc. Again, the EAP believes that the effective implementation of the mitigation measures proposed in the EMPR would render the significance of such impacts low.

According to the Parsons aquifer classification system, the aquifer can be classified as a sole source aquifer and should receive a high level of protection. Pathways for contaminant movement on site were identified as:

- The weathered and unsaturated zones;
- Faults and fracture zones; and
- Surface run-off.

<u>Impact Discussion and Significance Assessment</u>

General Discussion:
The majority of the aforementioned activities can be effectively managed to mitigate the potential impacts thereof on groundwater resources. The major contaminants associated with the proposed mining activities are likely to emanate from the TSF, waste rock dump, open pit voids/walls and metallurgical processing plant wastes. The contaminants are likely dominated by elevated major ion concentrations, salinity, metals and raised pH. The mobility and concentrations of most metals in the subsurface is likely to be governed by pH.

The acid generation capacity of the lithologies in the area was determined by acid-base accounting. Acid-Base Accounting is a static test which assesses the potential of a rock to produce or neutralise acid. This test is used as a first approximation of the acidity or alkalinity of leachate produced by the rock in the presence fluids. Based on the number of samples collected by GPT in 2012 and IGS in 2011, indicating that acid rock drainage is unlikely, the overall character of the rock underlying Volspruit is believed unlikely to generate acidity. Leaching tests indicate major ion and trace metal concentrations released from the rock material to be of low significance in the short term. Long term geochemical modelling indicates elevated sulphate, Cl, Ca and Mg concentrations discharging from waste rock material; similar elevated constituents upon mixing of leachate with groundwater; and from backfill material in the final voids after life of mine. However, pH is predicted to be alkaline, which was substantiated by leach test and ABA results, rendering the possibility of AMD formation unlikely.

Waste Rock:

The major controlling factor of mineral breakdown in waste rock dump is the wide distribution in the particle sizes of waste material as it governs the dominant processes responsible for contaminant generation. As rainfall infiltrates into the rock dump, fines are either washed out or consumed through sulphide and carbonate breakdown and neutralisation, while larger particles weather to smaller particles. Oxygen diffusing into and circulating in voids between particles together with water films covering particles provide optimum conditions for mineral oxidation and breakdown, especially as the dumps are unsaturated. It should be noted that AMD generation from the waste rock dump is unlikely due to the elevated buffering capacity of the minerals present. Dust originating from the rock dumps may also settle on surface water bodies and contribute to pollution.

Geochemical modelling was used by GPT to predict the nature of the leachate likely to be generated from the residues on the waste rock dump. The scenario modelled in this regard represents the waste rock dump as it would exist during mining. Life of mine was estimated at 20 years for this model. However, this period may be longer. The output for the north pit waste rock leachate can be observed in Figure 8-10. Sulphate concentrations in the leachate produced by the waste rock dump are elevated and may reach a peak after approximately 5 years of mining. Concentrations may reach levels up to 200 mg/L. Concentrations of Ca may also become elevated up to 80 mg/L and may aid in the precipitation of sulphate minerals such as gypsum. The pH of the leachate is slightly alkaline at a value of approximately 8 after 20 years. Only waste rock from the mining of the north pit will be deposited to the proposed waste rock dump.

The predictions of the waste rock leachate's chemical composition were used to then model the anticipated groundwater pollution plume that may result from the flushing of this leachate, via rainwater, into the underlying groundwater environment. The results of pollution plume modelling by GPT (Figure 8-11) indicate that the build-up of sulphate in the groundwater below the TSF and waste rock dump will be slow due to high dilution with the groundwater flowing underneath, with the exception of the tailings dam that is situated on a local groundwater high. It is only at the end of mine life that the groundwater will likely show any pollution. However, it must be cautioned that that the upper layer of the soil horizon could show signs of contamination at an earlier stage. The extent of the plume that was modelled to develop is highly localised, and it must also be acknowledged that the TSF was modelled as though the pollution containment barrier thereunder has failed (i.e. worst case). Groundwater pollution does not seem to be of major importance, as the rock material was proved to be non-acid forming during the geochemical study. Plume movements were modelled as slow moving and of concentrations well within acceptable standards for human consumption.

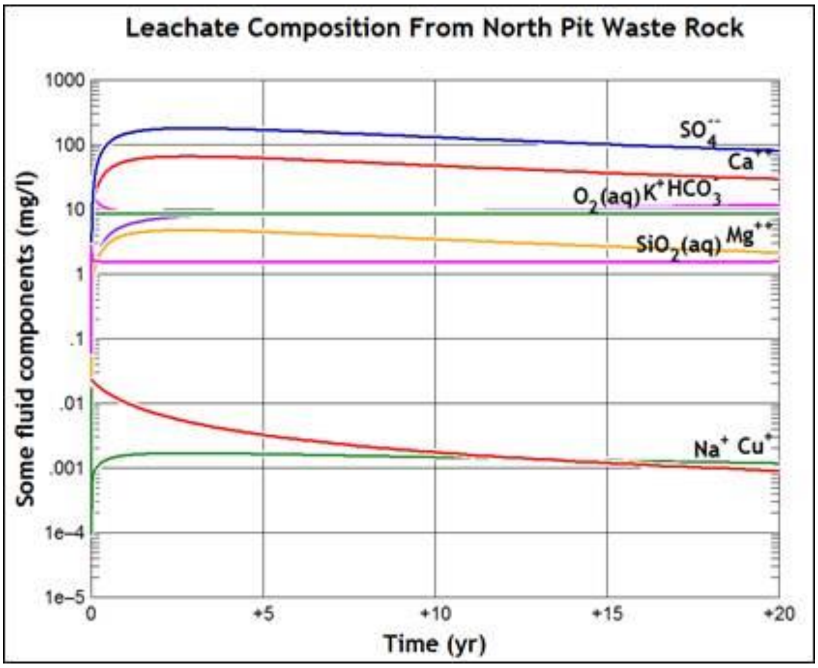


Figure 8-10: Chemical constituents in leachate produced by north pit waste rock

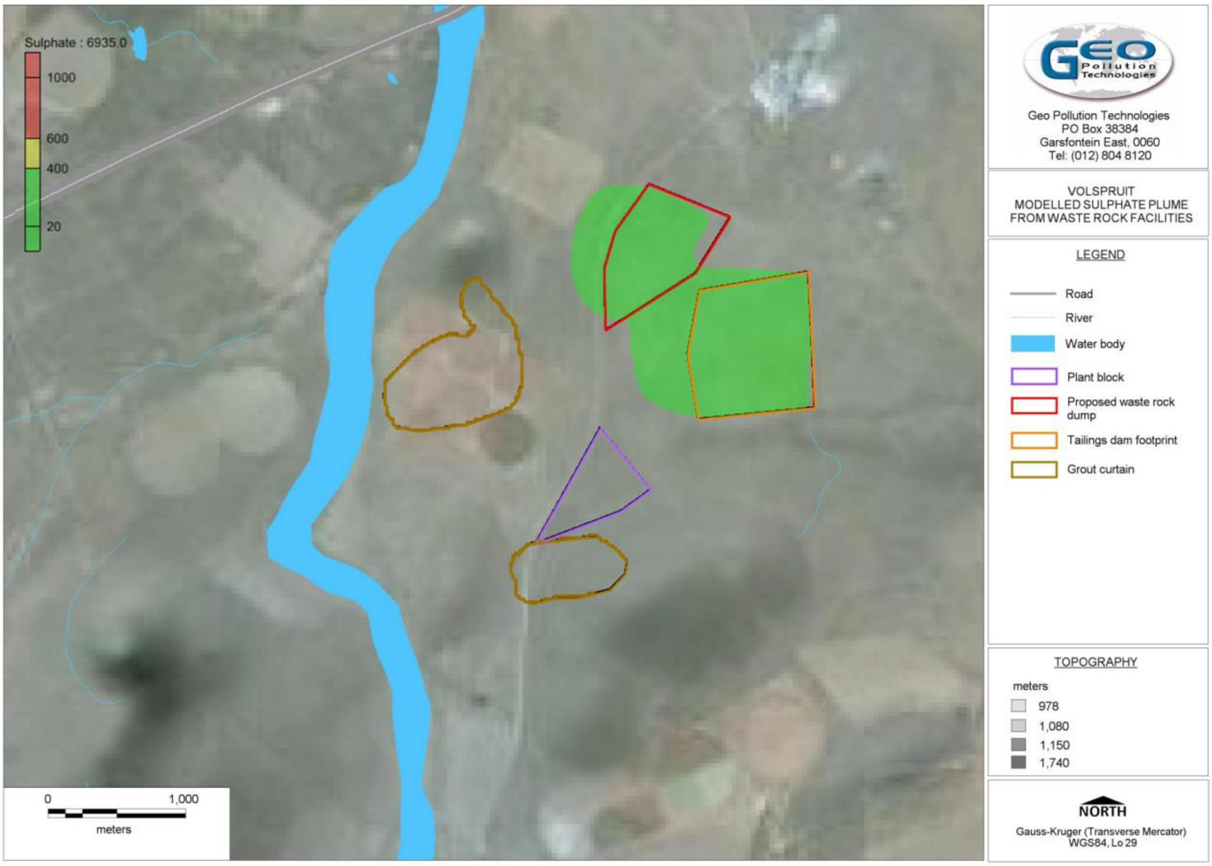


Figure 8-11: Plume migration from the waste rock dump and tailings dam in year 19

Tailings:

The tailings dam was modelled with a sulphate concentration increasing to 1 000 mg/litre in 20 years, as predicted by the geochemical model. In this case, the pollutant was also introduced *via* recharge, also taken as 100% of rainfall to model a worst case.

While it is believed that the tailings dam will be lined, it was also modelled as if the liner would leak. The results indicate that the build-up of sulphate in the groundwater below this structure will be slow due to high dilution with the groundwater flowing underneath. It is only at the end of mine life that the groundwater will show signs of pollution (Figure 8-11). However, it must be cautioned that that the upper layer of the soil horizon could show signs of contamination at an earlier stage.

As stated previously, the results must be viewed with caution as a homogeneous aquifer has been assumed, while the aquifer is known to be heterogeneous. Furthermore, no chemical interaction of the sulphate with the minerals in the surrounding bedrock has been assumed. As there must be some interaction and retardation of the plume, it is hoped that this prediction will represent a worst-case scenario. These facilities usually consist of an unsaturated upper zone and saturated lower zone. In the unsaturated zone oxygen penetrates to some depth and sulphide oxidation as well as mineral breakdown can occur more rapidly. The saturated zone forms due to infiltration resulting in a rise in the phreatic surface in the dams. The presence of water in this zone suppresses chemical reactions.

The tailings is characterised by a small particle size, resulting in large exposed surface area of reactive minerals. This enhances the rate of weathering processes resulting in the formation of contaminant bearing leachate. Due to the fine particle size of the tailings, oxygen penetration in the dam is limited in the saturated zone. Normally these dams have a low impact on the groundwater quality. The soil below the dam is also likely to act as a secondary source of contamination. It is important to note that the generation of AMD from the tailings facility is unlikely, based on the elevated buffering capacity of the minerals present.

Slag waste:
Based on previous experience in dealing with ferroalloy and PGM slags, the slag waste produced through the smelting of the PGM concentrate will likely be found to be inert in terms of National Standard for the Assessment of Waste for Landfill (i.e. the contaminants present in the waste will be largely immobile through leaching utilising). The slag is thus not deemed to pose a discernable risk to groundwater through leaching. The slag will, however, need to be subjected to a 'risk profiling' exercise, in terms of the National Standard for the Assessment of Waste for Landfill, in order to determine / quantify suitable long-term disposal requirements thereof.

It is thus proposed that the proponent develop disposal site designs and line the proposed slag storage area within the smelter complex with at least a 'Class C' pollution containment barrier, as set out in terms of the draft National Standard for the Disposal of Waste to Landfill, until such time as the waste can be laboratory tested [i.e. in terms of the total –TC) and leachable concentrations (LC) of contaminants reasonably believed to be contained therein] so as to be able to verify the pollution generating potential thereof; where the submission of a detailed design for the facility to the DEA (for their approval) is proposed as a condition of any waste management licence to potentially be issued to the proponent.

Should the slag ultimately prove to be a 'very low risk / inert' waste, the future disposal thereof to the mine's waste rock dump can be considered feasible, subject to DEA confirmation of acceptance in this regard.

Table 8-20: Impacts on groundwater quality (Operation)			
Nature (N)	Negative: Potential for degraded groundwater quality through vertical contaminant leaching into groundwater resource.		1
Extent (E)	On site: Any groundwater pollution resulting from mining is likely to remain localised, as shown through modelling.		1
Duration (D)	Very long term: The pollution of groundwater would likely persist over the very long term in the absence of significant efforts by the proponent to remedy such.		5
Intensity (I)	Major: Any significant contamination of groundwater would potentially affect the quality of surplus water from pit dewatering and the associated availability thereof toward augmenting agricultural and domestic supply.		4
Probability (P)	Likely: There is a possibility of groundwater contamination occurring during the operational life of mine, to the extent that appropriate mitigatory provisions need to be made to manage such		2
Mitigation (M)	Moderately mitigated: The impact can be substantially mitigated, but residual impacts on groundwater quality may still be noticeable beyond the life of mine		3
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: No amount of time or money will sustainably reverse the impact on the groundwater resources		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	24
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	48
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Mitigation/Management

The following principle mitigation is, *inter alia*, proposed, and formally presented in the attached EMPR:

- All bulk fuel and reagent storage areas to be bunded;
- All smelter raw materials to be stored on impermeable concrete floors beneath roofed structures;
- All potentially contaminated storm water run-off to be appropriately diverted and contained in the mine's process water circuit for re-circulation;
- TSF to be lined;
- Interim slag stockpile to be lined;
- Gypsum storage ponds (should they ultimately be established) to be lined in accordance with the minimum requirements specification for 'lagoons';
- Comprehensive groundwater monitoring network to be established on site prior to commencing with operational activities;
- All general and hazardous wastes to be stored in water-tight steel skips / waste containers with closable lids; and
- Treated sewage effluent to be re-circulated in the mine's process water circuit.

8.3.4 GROUNDWATER QUANTITY

Introduction

GeoPollution Technologies (GPT) was commissioned to undertake specialist groundwater investigation and impact assessment in order to inform the subject EIA process (full report attached under Appendix 5.1: Groundwater Impact Assessment Report). The commencement of opencast mining (i.e. vertical pit development below the static groundwater table of the area) will require Sylvania to effectively 'dewater' the pits in order to maintain safe working conditions within the opencast voids.

The modelling undertaken investigated ingress of water both with and without grouting (GPT, 2014). It must be noted that the model assumed the 'effective' implementation of the proposed pit grouting strategy toward 'isolating' the pit(s) from the adjacent groundwater resources (i.e. isolation of the pits hydraulically, through the establishment of a semi-permeable grout curtain, from the surrounding aquifer, Appendix 8.1: Grouting Strategy & 'Buffer' Illustrations), as well as the inclusion of significant faulting and various aquifer conductivities.

The dewatering of the pits will result in the development of a zone of groundwater drawdown around each respective pit. This zone of depression could have potential impacts on the borehole yields of adjacent farmers, as well as the hydrology of the Nyl River as

The decline of water levels around pumping boreholes near surface water bodies creates gradients that capture some of the ambient groundwater that would have discharged as groundwater baseflow. At sufficiently high pumping rates this water level decline also induces flow out of the surface water body, a process known as induced recharge, which results in transmission losses from the channel.

Royal Haskoning DHV was appointed to undertake a hydrological analysis of the Nyl River in tertiary catchment A61 to investigate hydrological implications of groundwater-surface water interaction. Considerable effort was undertaken by both Bill Pitman and

Allan Bailey on the surface water aspects and Karim Sami on the groundwater aspects to get a good correlation between simulated and observed streamflow at this streamflow gauge.

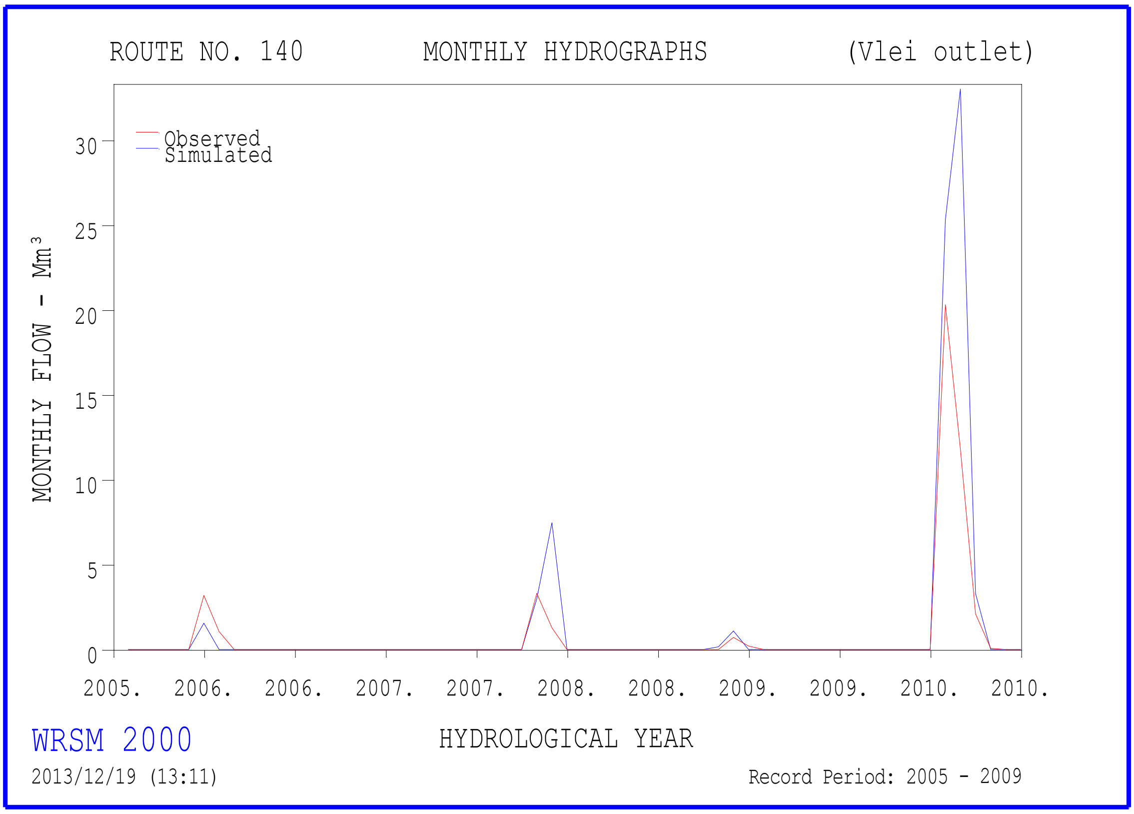


Figure 8-12: Monthly hydrograph at streamflow gauge A6H033

Irrigation will be reduced by 0.75 Mm3/a due to suspension crop irrigation at Voslpruit 326 KR Portion 1 to enable the establishment of the North Pit (Section 6.4.1). In addition, Pit inflows will increase to 1.70 Mm3/a. This results in a net increase in abstraction of groundwater of 1.00 Mm3/a with irrigation of excess water and without tailings seepage recovery. If tailings seepage is recovered no irrigation is undertaken and excess production is recharged to the Grassvally mine then demand will be 0.5 Mm3/a.

To investigate the long term impact of irrigation and mining, the model was run for A61E2 with constant abstraction from 1920-2010 to compare the ground water balance under virgin conditions and under irrigation scenarios. The objective was to provide water balance figures against which the MODFLOW model could be calibrated in terms of river leakage and baseflow, and evapotranspiration.

The increased abstraction of 0.55 Mm3/a above 6.5Mm3 of utilised currently results in a 2.47% decrease in mean annual runoff as a result of an 11% increase in transmission losses. This can be attributed to a lowering of the saturated area, which allows more runoff emanating from the high lying areas in to infiltrate into the ground before saturation is reached. Abstraction of additional 0.55 Mm3/a (which equates to 21.01 mm/a) exceeds the aquifer recharge of 19.76 mm/a, hence the aquifer becomes increasingly reliant on transmission losses from interflow and storm events.

Impact Discussion and Significance Assessment

The nature and extent of the cone of depression modelled by GPT (2014) utilising a transient model is shown in Figure 8-13 to Figure 8-16. Figure 8-13 and Figure 8-14 depict a modelled, realistic, worst case scenario of the potential drawdown realised as a result of mining the north pit to its maximum depth (approximately 180m below ground level) in year 13 of the life of mine with grouting and without grouting respectively, Figure 8-15 and Figure 8-16 depict a modelled, realistic, worst case scenario of the potential drawdown realised as a result of mining the south pit to its maximum depth (approximately 180m below ground level) in approximately year 19 of the life of mine with and without grouting respectively.

This depression in the groundwater table will result in a cone of depression around the opencast, with the radius depending on the hydraulic conductivity of the host material. It is evident from the referenced figures that the cone of depression resulting from both pits will significantly undercut the Nyl River at the specified periods; where the level of Drawdown below the Nyl could be as much as 20 - 25 metres). Without grouting, the drawdown is more than 5 metres for most of the life of mine. However, with grouting, this reduces to a period of less than nine years, again proving the value of grouting.

Furthermore, privately owned boreholes are now at risk to experience a lowering of groundwater level and an associated decrease in yield. Especially to the west of North Pit and to the south of South Pit the boreholes are all at risk and must be monitored and depending on combined abstraction by farmers and the mine the potential cone of depression and will require comprehensive monitoring to be undertaken.

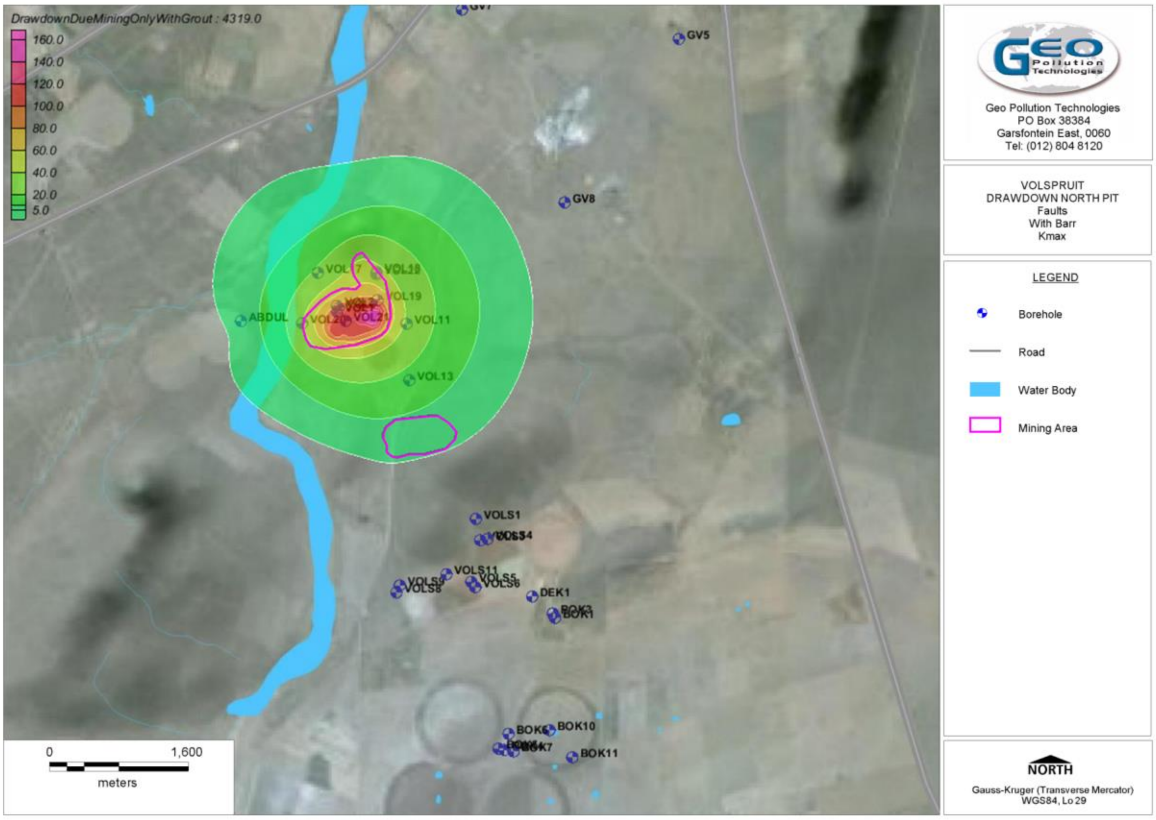


Figure 8-13: Modelled 'worst case' North pit drawdown (year 13) with modelled faults, grouting and max hydraulic conductivity (Transient state – contours at 5m)

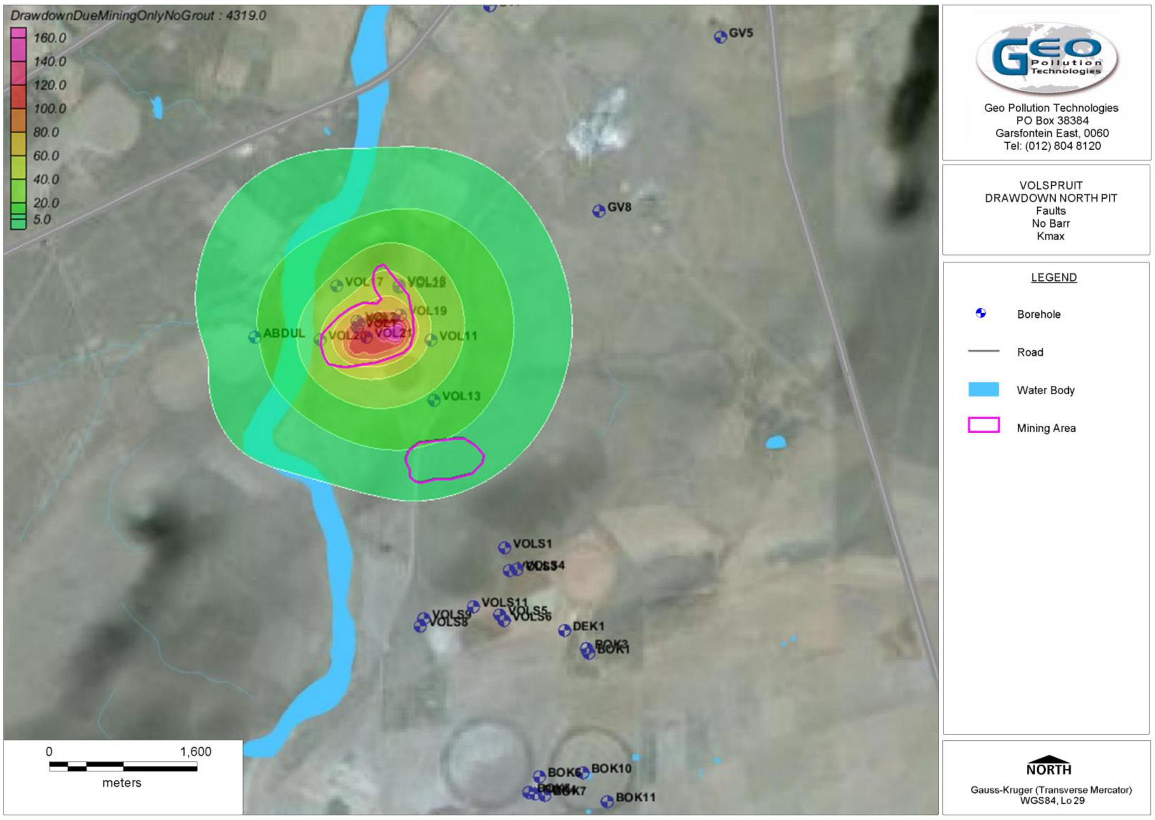


Figure 8-14: Modelled 'worst case' North pit drawdown (year 13) with modelled faults, No grouting and max hydraulic conductivity (Transient state – contours at 5m)

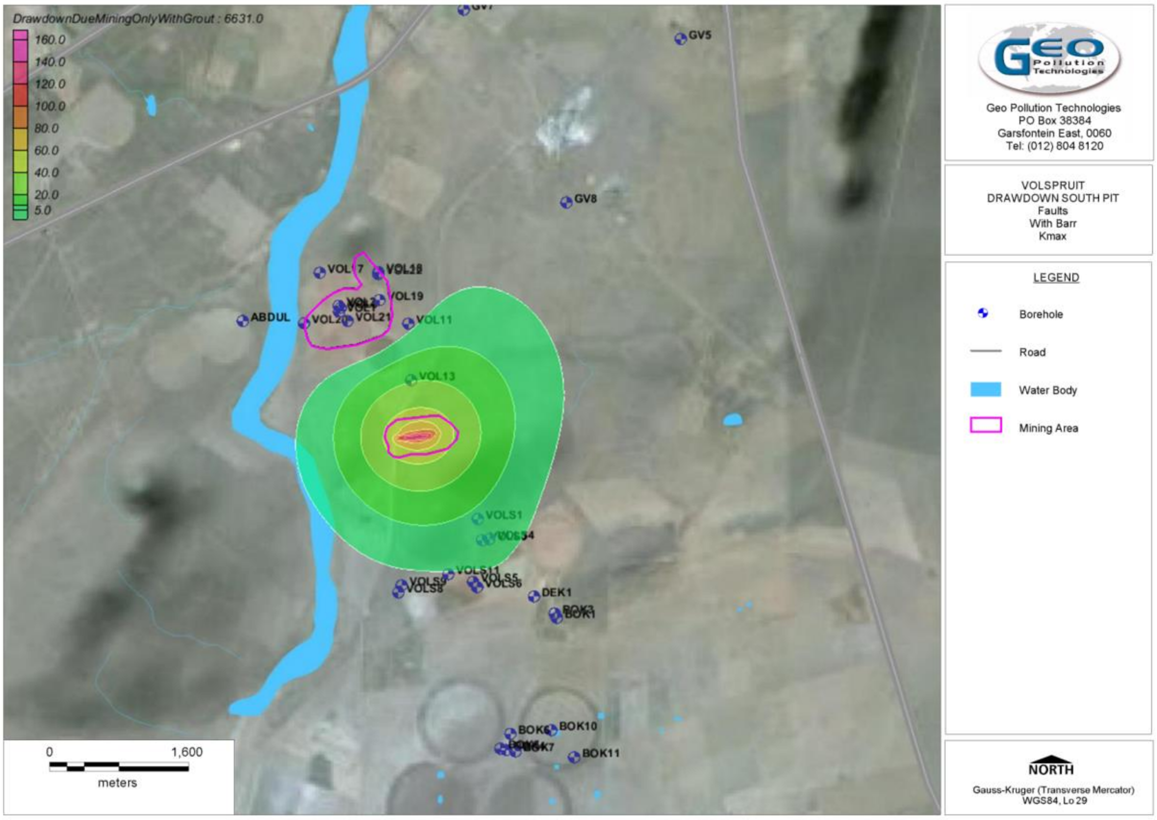


Figure 8-15: Modelled 'worst case' South pit drawdown (year 19) with modelled faults, grouting and high hydraulic conductivity (Transient state – contours at 5m)

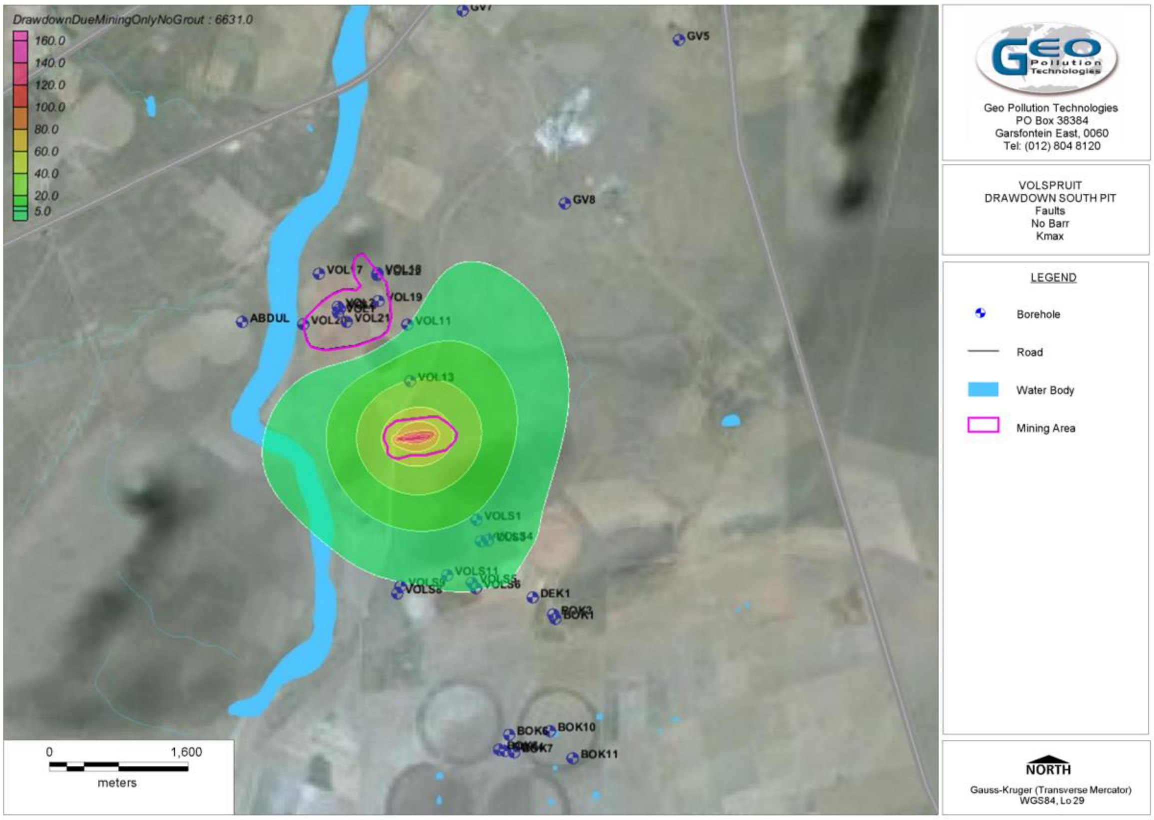


Figure 8-16: Modelled 'worst case' South pit drawdown (year 19) with modelled faults No grouting and high hydraulic conductivity (Transient state – contours at 5m)

With the inclusion of the major faults in the model, an increased drawdown both to the south and the north along the fault is seen. In this model, the drawdown at the Zebediela Fault could be in the order of 10 metres directly south of Volspruit. However, the potential dewatering in the Zebediela Fault is limited to the area directly south of the proposed Volspruit mine, and does not extend significantly along the fault to the west or east.

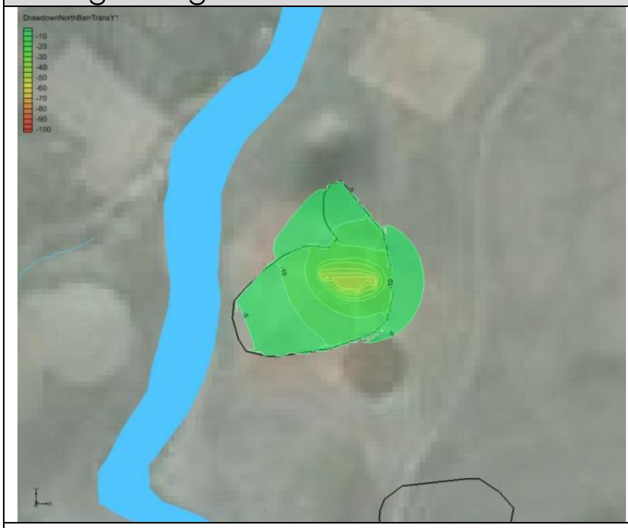
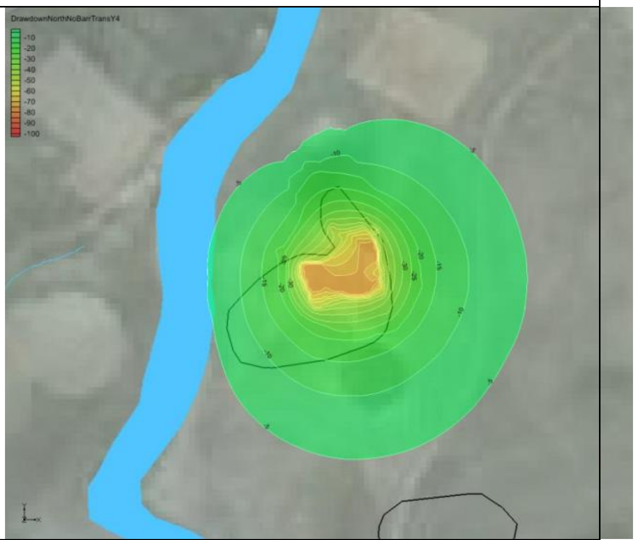
Groundwater modelling (GPT, 2012) has indeed shown pit grouting to be largely ineffectual in controlling ingress of water to the pit under steady state conditions beyond approximately year 3/4 of mining at the north pit (Figure 8-17). Similar results have been achieved with more advanced transient state model that has been developed.

Already in the modelling performed by GPT (2012) it was observed that the groundwater flow in the lower layers of the pit dewaters the upper layer with time and leaves the 'grouted' sections dry. As the lower layers are only grouted where mayor fractures are encountered, the hydraulic conductivity of the lower layer stayed very much unaltered. Thus, on the long term approaching steady state, grouting does not affect the recharge or pumping volumes required to dewater the pits.

That is not to say that the implementation of the grouting strategy is unnecessary. Pit 'isolation' though grouting is still deemed essential in managing groundwater ingress during the initial phases of mining; where mining would take place in highly fractured/weathered parent material. The grouting of the pits would also play a potentially crucial role in protecting the pit walls from potential piping during localised flood events / heavy rainfall; where the groundwater level rises in the adjacent alluvial aquifer may place a potentially significant hydraulic head on the pit wall. Without any clay barrier and grouting, it was found that the North Pit opencast could indeed decant due to the reduced inflow into the backfilled opencast from the east, which is preventing excessive build-up of the groundwater level in the pit. Grouting in the western section of the North Pit (upstream) is thus vital to prevent decanting at the North Pit. Furthermore, grouting has been demonstrated through modelling to be critical toward maintaining northerly groundwater flows around the pits, such that flow toward Mokopane is not significantly altered.

Transient state modelling by GPT has, furthermore, shown grouting to be necessary during potential localised 'flood' events (i.e. rapid groundwater recharge) in order to reduce groundwater ingress into the north pit in particular by as much as 20-25% compared to the 'non-grout' scenario. Groundwater ingress into the north- (year 13) and south pits (year 19) following rapid groundwater recharge (i.e. resulting from localised high intensity rainfall events) is modelled to potentially increase to a maximum of approximately 4.5Ml/day and 5.3Ml/day beyond steady state conditions when such groundwater recharge is experienced.

The proponent has indicated that appropriate pit wall design (e.g. 42° angle on the pit slope in the upper friable/highly fractured *in situ* material) will abate the potential for any pit wall failure resulting from the forming of such a hydraulic head of pressure. The EAP, however, advocates the potential for pit wall failure (as per detailed pit design) be independently quantified, as per the mitigation to follow, due to the potential environmental catastrophe that could ensue form a potential pit wall collapse along the Nyl river.

With grouting	Without grouting
	
North pit: Year 1	
	
North pit: Year 4	
Figure 8-17: Steady state Modelled drawdown with and without grouting (Year 1 Vs. year 4 – North pit)(Steady state – contours at 5m) (GPT2012 Hydrogeological Investigation Report)	

A large body of empirical evidence and academic research / opinion (e.g. McCarthy, Tooth and Morgan - 6.4.2 and 6.4.3 refer) exists that suggest the presence of a clay layer / lens over the Nyl river floodplain; where such clays act to create hydraulic separation between surface water flows over the wetland (which predominantly occurs as slow moving sheet flow during flood events) and the alluvial aquifer which underlies the wetland. An extensive survey of the area that is expected to be undercut by the mine dewatering drawdown cones was carried out so as to determine the lateral and vertical extent as well as permeability of the clay layer associated with the Nyl River. It was found that the permeability of the clay soil is low and that very little water would be lost from the river bed over time due to the thick clay layer.

From the soil profiling undertaken it is clear that flood water will mostly remain trapped on the clay layer and only peripherally decant during flood extremes. Dewatering below the clay layer may affect the volumes decanted from wetland margin to the extent that the mine dewatering will increase depth below ground of groundwater level.

Based on the soil profiles from transects it seems that the recharge from the flood may takes place in a localised area on the western side of the Nyl on the toe of the alluvial fan due to combination of the flatter slope which allowed the flood line to extend further on the western periphery and an area where clay layers associated with the Nyl are also substantially thinner.

When mining at the North Pit has reached final depth, drawdown of groundwater below the Nyl could be as much as 20 m (groundwater modelling GPT 2014), and compared to levels of around 10 m currently as a result of irrigation abstraction (groundwater measurements GPT 2013). The difference in volumes that will be lost from the flood event between current irrigation abstraction regime and future mining abstraction regime is not considered to be meaningful.

Data made available by GPT of another borehole (apparently a DWA monitoring borehole A6Volspruit) in the area that had been equipped with a data logger for a number of years showed a very sudden increase in groundwater levels to just below ground level during periods of the wet season, followed by a very gradual drop over several months to two years to the original lower levels. This could be interpreted as groundwater levels potentially responding to flooding within the Nyl system (not necessarily to flooding within the direct area of the borehole, but to flooding within the greater Nyl system). The data suggested that there is possibly some connection between shallow groundwater in the alluvial aquifer beneath the wetland and flooding within the Nyl wetland itself. Investigation however would suggest a combination of recharge reporting via the alluvial fan to the North West with contribution from area of potential flood decant.

It is recommended that additional shallow boreholes must be drilled along the Nyl identified by the clay layer investigation as an area of potential decant where flooding may recharge aquifer (depending depth and period of inundation) so as to further improve knowledge of surface water/groundwater interaction and connectivity.

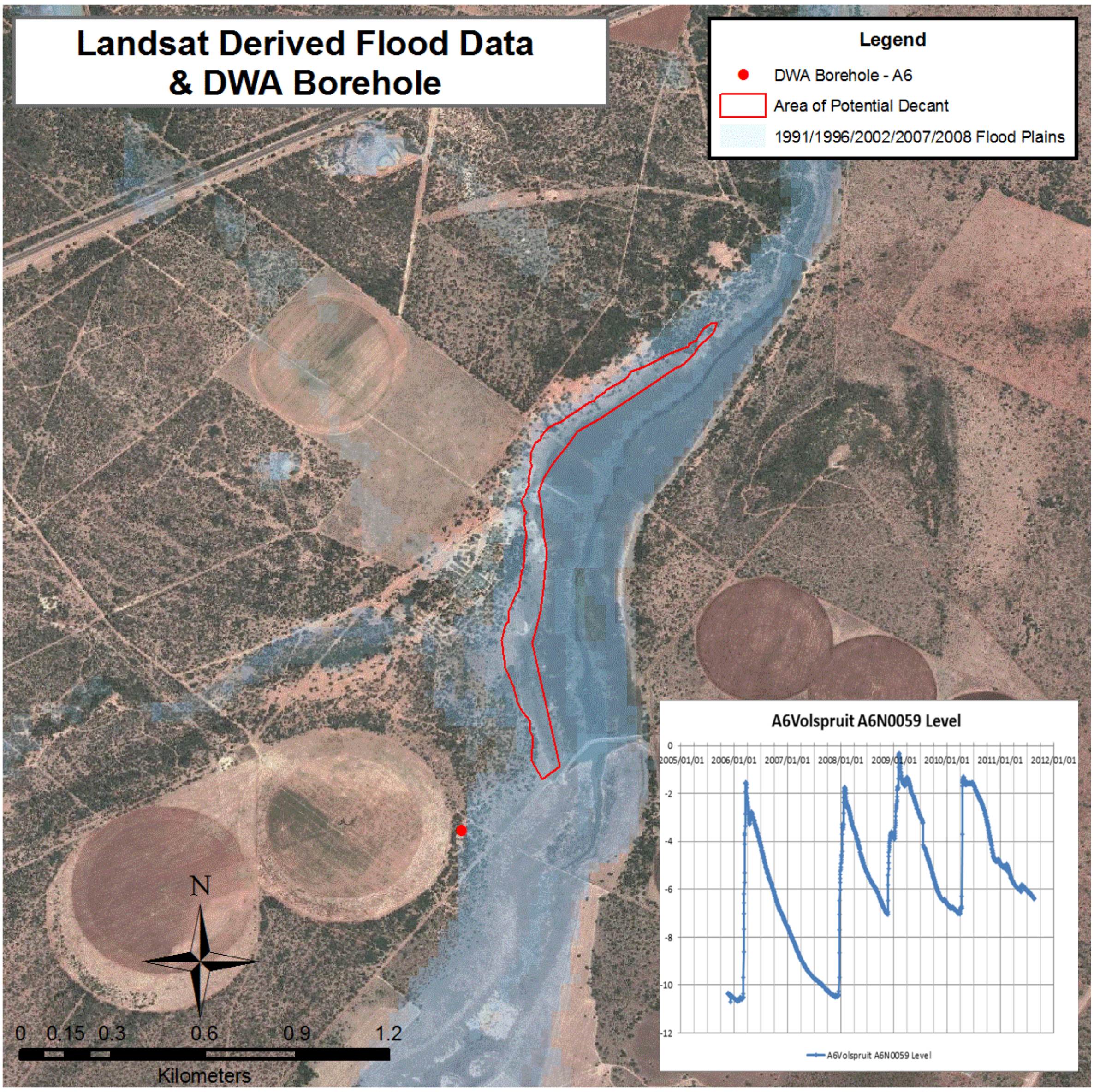


Figure 8-18: Area within which floods may decant to recharge aquifer showing location of DWA monitoring borehole A6Volspruit response to flooding

Table 8-21: Impacts on groundwater quantity – adjacent boreholes (Operation)		
Nature (N)	Negative: Potential negative impacts on Nyl river hydrology due to drawdown beneath the river, as well as on neighbouring farmers' boreholes due to the extent of drawdown.	1
Extent (E)	Locally: Within the vicinity of the site	2
Duration (D)	Long-term: The north pit dewatering at the mine is conservatively modelled to impact upon adjacent farmers' boreholes (west and north of the mine) between years 6 and 13 of mining; while the south pit dewatering is conservatively modelled to impact on farmers' boreholes between year 15 and 19 of mining. The period of potential impact on any one	4

Table 8-21: Impacts on groundwater quantity – adjacent boreholes (Operation)			
	receptor is thus modelled to be within 7 years.		
Intensity (I)	Severe: Any significant drawdown of farmers' boreholes that impedes their access to domestic or agricultural (i.e. access within licensed water use volumes for agricultural purposes) water supplies could have severe consequences on their ability to reside at their current locations and continue with current agricultural practices.		5
Probability (P)	Definite: A precautionary approach based on conservative modelling shows that the impact will definitely occur beyond year 6 of mining at Volspruit.		4
Mitigation (M)	Moderately mitigated: The impact can be moderately mitigated through the measures that follow, as well as those documented in the attached EMPR.		3
Enhancement (H)	N/A		-
Reversibility (R)	Mostly reversible: The cessation of pit dewatering and subsequent 'restoration' of static groundwater levels would act to reverse the impact.		4
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	35
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	45
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Table 8-22: Impacts on groundwater quantity – Nyl river hydrology (Operation)		
Nature (N)	Negative: Potential direct negative impacts on Nyl river hydrology and flood characteristics due to groundwater drawdown beneath the river. Indirect impacts on Nyl river wetland biodiversity and vegetation composition due to the alteration of flood dynamics.	1
Extent (E)	National/International: Such an impact, should it occur, would have potential National / International consequence (i.e. in the context of the Nylsvley Nature Reserve up-stream of the site and ecological connectivity between that site and the Volspruit wetlands, as well as the position of the mine within an internationally recognised IBA).	5
Duration (D)	Very long term: Pit dewatering would undercut the Nyl river wetland at one point or another for a period exceeding 10 years	5
Intensity (I)	Severe: The impact may disrupt aquatic species migrations from down-stream to the Nylsvley Nature	5

Table 8-22: Impacts on groundwater quantity – Nyl river hydrology (Operation)			
	Reserve, as well as modify highly sensitive wetland habitat supportive of *inter alia* breeding Red Data waterbird populations.		
Probability (P)	Unlikely: Precautionary principle was previously applied additional investigation into the hydrological connectivity between surface and groundwater and extent of clay layer associated with wetland has allowed revision.		Revise from 3 to 2
Mitigation (M)	Slightly mitigated: The duration and extent of dewatering beneath the Nyl river wetland can be slightly reduced through the implementation of the proposed grouting strategy.		2
Enhancement (H)	N/A		-
Reversibility (R)	Slightly reversible: The direct impact on the hydrology of the system would largely reverse upon ceasing with pit dewatering and the 'restoration' of static groundwater levels, but potential indirect impacts on the vegetation structure and composition of the Nyl river wetland would not likely reverse to a pre-mining state (at least not over the short- to medium-term).		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High** **Moderate**	Revise from 75 to 50
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High/Severe** **High**	Revise from 100 to75
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

<u>Mitigation/Management</u>

Further work that should be undertaken before mining is to commence:

In a study with such complexity, an investigation more often than not identifies further uncertainties that will need to be addressed in order to be able to adequately cater for groundwater management during the design of a potential mine. The following follow-up work is recommended before mining may commence:

- Improved knowledge of the variation of hydraulic conductivity with depth is needed, and several additional packer tests are recommended;
- Access to pump rates and groundwater levels of existing boreholes neighbouring the opencast sites is vital and admittance must be arranged;
- Additional shallow boreholes must be drilled along the Nyl in the affected area to improve knowledge of surface water/groundwater interaction and connectivity;

- It is postulated that groundwater could flow to the east rather than the north. This could be important for the mine and must be investigated by expanding the study regionally to the east; and
- A detailed hydrocensus of boreholes within modelled cone of depression.

A host of mitigation measures are proposed to manage and monitor pit water ingress during the life of mine (as per the attached EMPR). Key mitigation is *inter alia* listed below:

- The proponent must implement a grouting strategy capable of limiting pit water ingress to 4.1Ml/day (north pit) and 4Ml/day (south pit) under steady state conditions; where such should aim to achieve the permeabilities indicated in Table 8-23 for the geological strata identified on site (Figure 2-11);
- *Ad hoc* grouting at depth in the opencast pits could be difficult if zones of high hydraulic conductive zones are not detected early enough, even before mining progress to those depths. Progressive detection of such structures through geophysical means, followed by confirmation by advanced drilling, is recommended;
- Mining at the eastern section of north pit must be used as a proving phase for groundwater control measures. Piezometer placed in and outside the clay embankment is essential to quantify the effectiveness of the clay and grout curtain. Records must be kept for analyses;
- Dewatering rates from the opencasts must be measured on a continuous basis and records be kept for analyses;
- The piezometer levels at the edge of the Nyl river must be measured monthly during the dry season, and the frequency should be doubled during high rain seasons;
- A groundwater monitoring network should be designed once the mine design has been completed. The network should comply with the requirements of an ISO 14000 monitoring system. The boreholes identified during the hydrocensus as well as the newly drilled boreholes can be used to in the network;
- Quarterly groundwater sampling must be done to establish a database of plume movement trends, to aid eventual mine closure;
- All groundwater data must be analysed annually by a qualified hydro-geologist, and interpreted in terms of the reaction of the groundwater to mine dewatering to date and extrapolated to the future mining depths according to the latest mining plans;
- Based on such reports, an annual update of the groundwater management plan must be performed. This groundwater management plan must include the grouting and dewatering plans for the life of mine as well as the monitoring plan;
- These reports must also be submitted to authorities and presented to interested and affected parties annually, to satisfy all role players that sound groundwater management practices is adhered to;
- The recommended Department of Water Affairs best practice guidelines must be adhered to at all times as a minimum;
- Finally, all mined areas should be flooded as soon as possible to bar oxygen from reacting with remaining sulphides in the waste rock back-filled thereto; and
- The mining of a 60m '*precautionary environmental buffer*' from the inside edge of the grouting at the north pit (Appendix 8.1 refers), must be maintained as a last phase of mining in the north pit; where the feasibility (technical and environmental) of mining the ore body within this buffer should be proven at the

hand of monitoring (e.g. *inter alia* groundwater and avi-faunal) and assessments (e.g. pit wall stability assessment based on detailed pit design) undertaken during prior phases of mining, to the satisfaction of the DMR, DWA and LDEDET.

Table 8-23: Targeted permeability for grout sections (Appendix 8 and 9 refer)

Depth (m)	Barrier type	K (m/s)	K (m/d)	Width (m)	Hydraulic parameter (m/d/m)=(d^{-1})
0 – 30	Clay Cut-off /Jet-grouting	1.00E-08	0.001	5	0.0002
30 – 60	Curtain Grouted zone	1.50E-07	0.013	5	0.003
60 – 180	*Ad hoc* grouting	5.00E-07	0.043	5	0.01

8.3.5 BIODIVERSITY

Introduction

Wetland Consulting services were commissioned to undertake a specialist biodiversity impact assessment in relation to the proposed establishment of the Volspruit Mine (attached under Appendix 5.7: Biodiversity Impact Assessment Report) – with the impact assessment findings in Section 7 thereof); where the assessment looked at the potential impacts of the proposed mine in relation to, *inter alia*, terrestrial-, wetland- and aquatic ecosystem functioning.

Impact Discussion and Significance Assessment

To allow for the mining of the northern opencast pit, abstraction of groundwater will be required. This will result in a zone of groundwater drawdown extending around the pits and, given its proximity to the Nyl wetland, likely extend under the wetland (Figure 8-13 and Figure 8-16). The specialist geo-hydrological study undertaken by GeoPollution Technologies (GPT) indicated that at year 13, when mining at the North Pit has reached final depth, drawdown below the Nyl could be as much as 20 meters; where given the nature of the rock strata at the north ore pit location, modelling has shown the grouting of the pits to be largely ineffectual in limiting the extent of the cone of depression.

From the soil profiling undertaken it is clear that flood water will mostly remain trapped on the clay layer and only peripherally decant during flood extremes. Dewatering below the clay layer may affect the volumes decanted from wetland margin to the extent that the mine dewatering will increase depth below ground of groundwater level.

From the survey results and test done is seems that water flowing through the larger extent of the clay layer would be minimal. The hypothesis is that water losses can be significant only when the river is flooded and decant to the surrounding areas along peripherals where soil permeability are higher and/ or clay layers are thinner.

Changes in the supporting hydrology could lead to a reduction in the extent of the floodplain, changes in flood depths and reduced periods of inundation, all of which would have potentially significant influence on habitat extent and suitability, particularly for aquatic or semi-aquatic fauna. The extent of Subtropical Freshwater Wetlands (Mucina & Rutherford 2006) in the Limpopo Province is limited, and changes in the hydrology of this wetland could have impacts.

As part of the geo-hydrological study a number of shallow piezometer boreholes were drilled along the edge of the Nyl wetland to determine groundwater levels and changes in groundwater levels due to flooding in the Nyl. Groundwater was found to be at around 5m below ground (Dec 2012) at the edge of the floodplain. During the period these boreholes were monitored no flooding of the Nyl wetland occurred and groundwater levels have further fallen to 10m below ground (Nov 2013). During a period of higher rainfall a slight increase in the groundwater levels was observed.

At the time of the issue of the preliminary EIA the connection between the Nyl and groundwater was undertrain, at the time a pre-cautionary approach was adopted in assessing the impact and the worse-case scenario is assumed (Table 8-24 – 'probability rating of '3').

Due to potential changes in flooding characteristics on the floodplain brought about through groundwater abstraction, it is likely that the vegetation on site will undergo changes to adapt to the altered flooding regime. Changes in elevation of as little as 90mm (and thus changes in flooding depth and duration) lead to statistically significant changes in vegetation composition. Changes in vegetation will then also affect other biodiversity reliant on the vegetation for food, shelter or breeding sites. In addition, increased noise levels, especially from blasting, could lead to the displacement of sensitive species from this section of the floodplain. Disturbances to the edge of the floodplain through mining activities could also lead to an increase in alien vegetation, while the influx of labour to the area could result in increased poaching of small birds and mammals in the area.

From the soil profiling undertaken it is clear that flood water will mostly remain trapped on the clay layer and only peripherally decant during flood extremes. Dewatering below the clay layer may affect the volumes decanted from wetland margin to the extent that the mine dewatering will increase depth below ground of groundwater level.

Based on the soil profiles from transects it seems that the recharge from the flood may takes place in a localised area on the western side of the Nyl on the toe of the alluvial fan due to combination of the flatter slope which allowed the flood line to extend further on the western periphery and an area where clay layers associated with the Nyl are also substantially thinner.

When mining at the North Pit has reached final depth, drawdown of groundwater below the Nyl could be as much as 20 m (groundwater modelling GPT 2014), and compared to levels of around 10 m currently as a result of irrigation abstraction (groundwater measurements GPT 2013). The difference in volumes that will be lost from the flood event between current irrigation abstraction regime and future mining abstraction regime is not considered to be meaningful.

Data made available by GPT of another borehole (apparently a DWA monitoring borehole A6Volspruit) in the area that had been equipped with a data logger for a number of years showed a very sudden increase in groundwater levels to just below ground level during periods of the wet season, followed by a very gradual drop over several months to two years to the original lower levels. This could be interpreted as groundwater levels potentially responding to flooding within the Nyl system (not necessarily to flooding within the direct area of the borehole, but to flooding within the greater Nyl system). The data suggested that there is possibly some connection between shallow groundwater in the alluvial aquifer beneath the wetland and flooding within the Nyl wetland itself. Investigation however would suggest a combination of recharge reporting via the alluvial fan to the North West with contribution from area of potential flood decant.

Therefore, given the possibility that surface water flooding on the floodplain contributes to groundwater recharge, and that the drawdown cone associated with the opencast pits could result in increased recharge of groundwater from the floodplain and thus decreased depth and duration of flooding in a limited area, groundwater abstraction could locally result significant changes may have an effect on wetland associated biodiversity, and reduced run-off to downstream. Water abstraction within the A62E2 catchment causes groundwater to be increasingly recharged by surface water via transmission losses due to the lowering of water levels. Evapotranspiration from groundwater via plant growth mostly is also significantly reduced. The increase in transmission losses increases the duration of zero flow in the river, and abstraction from 6.5 Mm3/a to 8.5 Mm3/a indicates reduction in in mean annual run-off similar to run-off reduction from 0mMm3/a to 6.5 Mm3/a abstraction and system is therefore at a limit where further abstraction will significantly affect duration of flooding

The expected decrease in flow will not affect the wetland system upstream of the study area or within the confines of the study area, but will place additional strain on an already stressed system downstream of the study area for a number of years during mine operation. An updated assessment has been undertaken (Table 8-24 refers).

Table 8-24: Impacts on biodiversity(Operation)		
Nature (N)	Negative: Potentially negative impacts on flood characteristics of the Nyl river due to groundwater drawdown beneath the Nyl wetland, resulting from pit dewatering (indirect impacts on floral and faunal species composition, aquatic migrations, etc.)	1
Extent (E)	National/International: Potential impacts on the greater Nyl river floodplain wetland could have international consequences [Ramsar site up-stream, and the site is within an Internationally recognised important birding area (IBA)]	5
Duration (D)	Very long term: Altered floral and faunal species composition could take decades to revert back to a pre-mining state, and may never do so entirely.	5
Intensity (I)	Severe: Any alteration to the flood characteristics of the Nyl river could throw the entire system out of balance and certain ecological components thereof could collapse without major intervention (e.g. fish migrations may be affected, breeding Red Data waterbird populations may be impacted, etc.).	5
Probability (P)	Unlikely: Precautionary principle was previously applied additional investigation into the hydrological	Revise

Table 8-24: Impacts on biodiversity(Operation)			
	connectivity between surface and groundwater and extent of clay layer associated with wetland has allowed revision.		from 3 to 2
Mitigation (M)	Slightly mitigated through pit grouting / isolation		2
Enhancement (H)	N/A		-
Reversibility (R)	Slightly reversible: The impact would mostly be reversed with the cessation of pit dewatering and the return of groundwater levels to a static, pre-mining, state. Residual impacts resulting from changes in the floral species composition of the wetland system may never fully reverse to a pre-mining state.		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High** **Moderate**	Revise from 75 to 50
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High/Severe** **High**	Revise from 100 to75
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Table 8-25 below presents a summary of all potential impacts on biodiversity assessed by WCS (2012).

Table 8-25: Biodiversity Impact Assessment Summary – WCS, 2012 (Operation)		
Potential Impact	**Significance Rating without Mitigation**	**Significance Rating with Mitigation**
Terrestrial Ecology		
Interruption of local migration routes	Medium	Medium
Loss of biodiversity including Red Data List and Protected species	Medium	Medium
Habitat degradation through air-, water- and soil pollution	Medium	Low
Habitat degradation through the encroachment of exotic species	Medium	Low
Disturbances of biodiversity through noise and vibration	High	Medium
Disturbances through illumination	Medium	Medium
Hydrological changes	High	High
Increased access to previously inaccessible areas by mine staff / contractors	Medium	Low
Wetlands		

Table 8-25: Biodiversity Impact Assessment Summary – WCS, 2012 (Operation)		
Potential Impact	**Significance Rating without Mitigation**	**Significance Rating with Mitigation**
Decreased extent and duration of flooding in the Nyl river	High	High?
Changes in habitat and loss of biodiversity	High	High?
Water quality deterioration	Medium	Medium
Aquatic Ecology		
Increased turbidity and sedimentation	High	Medium
Altered hydrology	Medium	Medium
Spread of alien fish species	Medium	Low
Increased pressure on fish stock	Low	Low
Water quality deterioration	Medium	Low

Mitigation/Management

Any mining activity which could lead to an alteration in the natural hydrology of the Nyl River should be strongly reconsidered if the magnitude and nature of potential hydrological changes and any resultant changes to the floodplain characteristics cannot be established with a high level of confidence. Effective management of the floodplain hydrology during the life-of-mine and after cannot be ensured if the dynamics of the system and the full extent of expected and potential impacts are not fully understood.

In addition, any mining activity which could lead to an alteration in the natural hydrology of the Nyl River should be strongly reconsidered if identified potential changes to the natural hydrology cannot be completely mitigated against and/or the natural hydrology within the landscape cannot be successfully and completely reinstated at the end of the mines life.

It is thus recommended that the interaction between surface water in the floodplain and groundwater be determined in detail in order to assess the contribution of surface flood waters to groundwater recharge, and the likelihood that the drawdown cone associated with the proposed opencast mining areas will impact on the volumes of surface water within the floodplain on site and discharge to downstream areas. In the absence of detailed, high confidence information in this regard, it is recommended that no mining be allowed to take place where the drawdown cone associated with the opencast pits extends under the floodplain.

An exception to this would be where the extent of the drawdown cone could be limited through the application of technological interventions (e.g. grouting) that seal off the proposed opencast pit and thus prevent the ingress of water into the pit. In this way the drawdown cone could be limited, if the technology is practically and financially viable for the proposed opencast pits. However, the geo-hydrological study found that "The effect of the clay and grout curtain is pronounced in the first year, but the difference becomes less pronounced as mining progress. At year 4 there is very little difference in groundwater drawdown between the grouted and un-grouted scenarios." It therefore appears unlikely that the opencast pit could be isolated.

Should mining proceed, it will further be important that the full extent of the alluvial aquifer be defined within the study area and that no mining be allowed to take place within the alluvial aquifer.

8.3.6 AVI-FAUNA

Introduction

While the construction phase of the project will have potentially significant impacts on avi-faunal species, predominantly through habitat destruction (Section 8.2.1 refers), the on-going operational phase of the mine (approximately 20 years) will too have potential impacts on sensitive avian habitat associated with the location of the mine immediately adjacent to the Nyl river floodplain wetland, as well as Red Data bird species making use thereof (e.g. breeding, feeding and migration staging). These potential impacts are identified as follows:

- Continued disturbances and potential displacement resulting from on-going noise and visual (human / vehicular) intrusions;
- Potential impacts on the hydrology and flood dynamics / regime of the Nyl river and its associated floodplain wetland (incl. downstream sections of this habitat); and
- Potential impacts on migratory bird species (including Red Data species) as a result of night time illumination (i.e. plant and mine lighting) and the establishment of surface infrastructure (e.g. electrical power lines).

The proximity of the proposed mine operations to the Nyl river, with the north pit extending into the 1:100 year flood-line, and the depth of the pits reaching the ground water levels could result in the following potential impacts on surface- and groundwater resources (with the nature and extent to which ground- and surface water resources will be impacted upon having been dealt with in more detail by the preceding sections):

- Reduction in flows and flooding within the Nyl River floodplain adjacent to- and downstream of the proposed mining area due to groundwater abstraction, specifically from the unconfined aquifer;
- Change in the seasonality of flows within the downstream Nyl River due to release of abstracted groundwater into the Nyl River;
- Concentration of flood flows and alteration of the flood-lines;
- Water quality deterioration within the Nyl River downstream of the mining area; and
- All of the above will have potential significant impacts on the wetland avifauna found on site and along the Nyl river especially downstream from the mine.

It is, furthermore, likely that the mine will be illuminated at night (i.e. to comply with relevant, non-negotiable, mine safety standards), and it is widely published that smaller birds often collide with light towers and buildings during migration events. Most waterbirds migrate during the night also exposing them to similar disorientation and collision risks. It is, therefore, expected that an 'illuminated' mine in the path of possibly tens of thousands of migratory waterbirds could potentially affect the movement patterns-, or lead to fatalities, as birds fly in the vicinity of the proposed mine (Figure 8-22 refers). The infrastructure could be that of the mine itself, or that of associated supporting structures such as overhead power-lines. Birds colliding with any of the infrastructure would be classified as a negative impact.

The bird species found further south on Nyl river floodplain (e.g. in the '*Nylsvlei Nature Reserve*') are likely to also occur within the boundaries of the study site along the northern end of the same floodplain. It is also extremely important to note (with reference to the impact identified in the preceding paragraph) that all the species moving in and out of the floodplain system, as it floods and dries up, will follow the route of the river as they migrate north, or south. The topographical landscape features also indicate that birds are most likely using the valley through the Waterberg mountains as they migrate to and from the main Nyl river floodplain (see Figure 8-19).

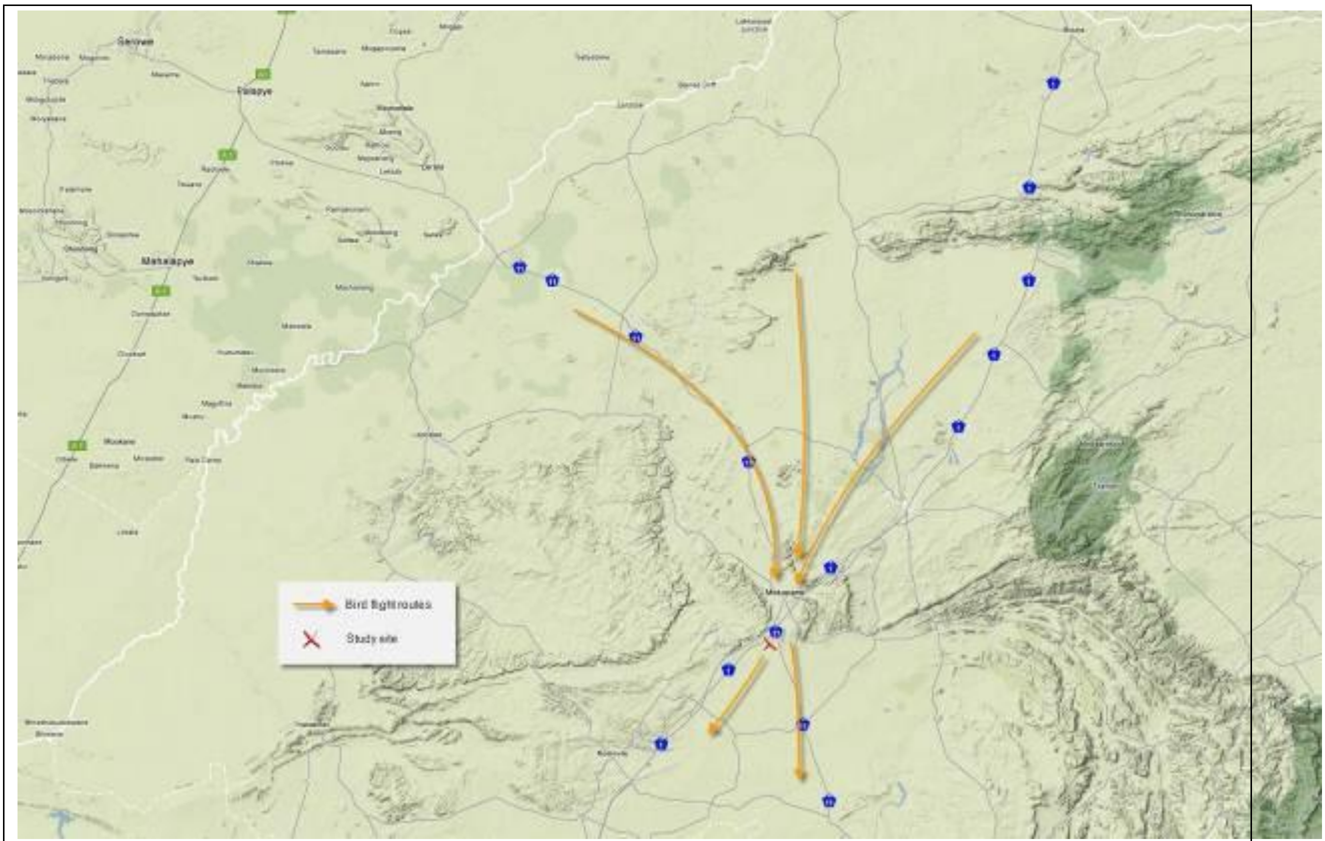


Figure 8-19: Likely bird migratory flight paths passing through the Nyl river valley at Mokopane as they move to and from the Nyl river floodplain wetlands

Impact Discussion and Significance Assessment

The avi-faunal specialist's assessment of the indirect impacts on avian biodiversity in the Nyl river floodplain wetland (i.e. as a result of potential impacts of opencast mine dewatering) deems there to potentially be severe consequences from undertaking the mining. The said specialist's assessment in this regard adopts what the EAP believes to be a 'worst case' view in this respect; where the impacts of the opencast mining on the surface water resources adjacent to the site (i.e. the Nyl river and associated floodplain wetland) is in fact likely to have low impact on the surface hydrology, by virtue of the zone of separation that is understood to exist (i.e. as a result of natural clay deposition across the floodplain system) between the underlying alluvial aquifer and surface water system. Thus essentially separating these systems from one another.

None the less, and adopting what is perceived to be a 'worst case', the potential impacts on avi-faunal diversity in the Nyl river floodplain wetland (on- and downstream of the mine site) that could potentially result from the opencast mining and associated dewatering are deemed to have potentially sever significance. This predominantly due to the highly sensitive nature of the floodplain wetland and its national / international importance to, *inter alia*, inland Red Data waterbird species and waterfowl populations. The potential impact of night illumination and establishment of surface infrastructure on migratory birds is deemed to have potential moderate significance.

Table 8-26: Indirect Impacts on avifauna due to ground and surface water 'impacts' (Operation)		
Nature (N)	Negative: The proximity of the mining operations to the Nyl river, the north pit extending into the 1:100 year flood-line and the establishment of a berm wall on the western edge of the north pit: • Possible minor changes in the seasonality and concentration of flood flows (especially high flood events) within the downstream Nyl River due to the establishment of the north pit and its berm wall; and • The existing delineated wetland edge is not being infringed. The potential impacts on the wetland avifauna will therefore primarily be limited to disturbance.	1
Extent (E)	Local: The extent of the impact on the wetland on site and that of the Nyl river downstream of the mine will be regional. Birds using the wetland / floodplain habitat on site as well as those using the river and Moorddrift dam downstream of the mine could be negatively affected by any changes in the flow and flooding regime of the river.	2
	Local: The hydrogeological specialist study has indicated that the abstracted ground water from the mining pits is unlikely to have an effect on the upstream Nyl River and its associated floodplain. The Nyl river floodplain is recognized by Birdlife International as an Important Bird Area and it is imperative that no negative impact on the upstream wetland be brought about by the mining activities.	2
Duration (D)	Long term: The duration of the impact on birds inhabiting the adjacent wetland will be long term. Birds would in all likelihood become accustomed to the disturbance created by the mine. It must however be noted that many of these species are local migrants which would move into the area when conditions are favourable. Once they move back into the area they would again have to habituate to the disturbances being created by the mine.	4
Intensity (I)	Major: The fact that flood regimes may be affected and a portion of the floodplain on site (which is currently largely under agriculture) be spoiled by the mining development will result in some potential	3

Table 8-26: Indirect Impacts on avifauna due to ground and surface water 'impacts' (Operation)			
	effects on the bird communities on site and downstream of the mine.		
Probability (P)	Very likely: An impact on the water birds both onsite and downstream will likely occur.		3
Mitigation (M)	Unmitigated		1
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: Due to the extent to which the avian wetland habitat on site will be changed and the downstream effects on the Nyl river over the life span of the mine there is little chance of reversing the effects thereof on the avifaunal communities in the area.		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	54
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	54
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Table 8-27: Visual (illuminated mine at night) & collisions with infrastructure and overhead power-lines Indirect Impacts on avifauna due to ground and surface water 'degradation' (Operation)		
Nature (N)	Negative: It is likely that the mine will be brightly illuminated at night and it is widely published that smaller birds often collide with light towers and buildings during migration events (Fatal light awareness program, 2004) Most waterbirds migrate during the night also exposing them to similar disorientation and collision risks. It is therefore expected that a brightly illuminated mine in the path of tens of thousands of migratory waterbirds could potentially affect the movement patterns or lead to fatalities as birds fly into the infrastructure. The infrastructure could be that of the mine itself, or that of associated support structures such as overhead power-lines. Birds colliding with any of the infrastructure would be classified as a negative impact.	1
Extent (E)	International: The direct impact would be limited to the site itself as birds move through the area but indirectly it could have both national and international implications if it	5 (Conservative)

Table 8-27: Visual (illuminated mine at night) & collisions with infrastructure and overhead power-lines Indirect Impacts on avifauna due to ground and surface water 'degradation' (Operation)			
	influences vast numbers of migratory waterbirds.		
Duration (D)	Very long term: The impact on birds would remain for the entire life span of the mine i.e. the duration would be very long.		5
Intensity (I)	Major: The intensity of the impact would be major as numerous birds could potentially be killed as a result of the collisions with infrastructure.		4
Probability (P)	Likely: The probability of the impact occurring is likely but the site specific bird flight paths and the height at which the different species of waterbirds move through the area is not known.		2
Mitigation (M)	Slightly mitigated		3
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible: If birds are influenced by the infrastructure the effect thereof will be irreversible as the mine has a very long life span.		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	40
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	80
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Mitigation/Management

The impact of birds colliding with overhead power-lines can to a limited degree be mitigated by means of installing devices on the lines themselves which make them more visible to birds. The impact of a brightly illuminated mine and birds altering their flight paths as a result or colliding with other mining infrastructure would be more difficult or impossible to mitigate. Overhead power-lines should also not be allowed to cross over the river or the floodplain. Power should preferably be sourced from existing power-lines which run to the east of the site.

The effect of disturbance created by vehicular and pedestrian traffic could be mitigated by constructing another mini berm on top of the proposed flood berm to 'hide' the visual disturbance of movement across the skyline adjacent to the wetland

8.3.7 VISUAL AND AESTHETIC CHARACTER

Introduction

The establishment of the proposed mine and supporting surface structures and infrastructure will likely bring about visual impacts, with associated disturbance to the visual and aesthetic character of the area (sense of place). The establishment of the proposed waste rock dump, tailings storage facility (TSF) and plant site are most notable in this regard, by virtue of the relative height (approximately 40-45m) and horizontal extent thereof on the landscape.

It is acknowledged that the potential visual intrusion of the mine may have potential indirect impacts on biodiversity [wetland/aquatic avi-fauna (birds) in particular], as a result of visual intrusion/disturbance in close proximity to the Nyl river floodplain. Night light illumination is of particular importance in this regard. This potential, indirect, impact is more appropriately discussed under section 8.3.4 of this report.

A Visual Impact Assessment was undertaken by Propaganda Studios in support of the EIA (Full specialist report attached under Appendix 5.14) to assess the potential significance of this impact in the context of the receiving environment and presence of potential visual receptors. While the extent of visibility of the mine can largely be quantified through GIS, the assessment if visual impact significance is largely qualitative (e.g. photo montages, 3D view simulations), with semi-quantitative assessment (Section 5 of the attached Appendix 5.14: Visual Impact Assessment Report) of the relative significance thereof being done to allow for a relative, but not absolute, comparison of impact significance against other identified impacts.

According to the said study, visual sensitivity will vary with the '*type of users*' exposed to changes in the visual and aesthetic character of a landscape. Recreational sightseers, for example, who visit the area may be highly sensitive to any changes in visual quality, but since the sensitive receptors of the development are largely centered around roads (the N1 highway stretching from Cape Town in the South to Beit Bridge at the northern border of the RSA, the N11 and the Singlewood road leading to the mine entrance), it can be assumed that the predominant type of viewers will be 'passers-by', who, in general, perceive changes to the landscape as neutral. The distance to the development from the vantage point identified along the N1 is 3,6 km, and the closest distance measured from the N11 is 1,6km.

Some residents of the immediate environment may welcome the augmentation for the purposes of job creation, while a few eco-tourist facilities (hunting farms and lodges) in the proximity might view it as a negative augmentation. Other guesthouses, potentially providing overnight facilities mainly to visitors to the mines or temporary employees of the mines, can be assumed to be 'host viewers', who predominantly will perceive changes to the landscape as neutral, or positive. Because of its visibility from a few points along the N1 and N11, substantial numbers of viewers will be exposed to the development.

The current scenic quality of the area is described by the aforementioned specialist as being 'moderate' (Section 3.1 of the attached specialist Visual Impact Assessment Report refers, Appendix 5.14, refers). This is based on the '*scenic quality inventory and evaluation*' undertaken by the specialist, which assessment incorporates consideration of attributes such as existing landforms, existing vegetation cover, the presence/absence of 'water', colour on the landscape, adjacent scenery, the scarcity of the scenery in the physiographic region and existing cultural modifications/disturbances present on the landscape.

In the context of the visual impact assessment, the proposed development is deemed to be a 'Category 5' development, which includes, " *high density township / residential development, retail and office complexes, industrial facilities, refineries, treatment plants, power stations, wind energy farms, power lines, freeways, toll roads, large-scale infrastructure generally, large-scale development of agricultural land and commercial tree plantations, quarrying and mining activities with related processing plants*". One can, as a first order assessment, use the development category, in combination with the assessment of scenic quality (i.e. 'moderate' in this instance), to categorise the anticipated visual impact intensity for the project.

The anticipated visual impact intensity, based on the above method alone, categorised the proposed mine to potentially result in 'high visual impact', with potential –

- intrusion on protected landscapes or scenic resources;
- noticeable change in visual character of the area; and/or
- establishment of a new precedent for development in the area.

This categorisation is, however, not to be interpreted as an assessment result, since all other factors (i.e. proximity to receptors, contrast, visibility and viewer statistics) are further factored into the visual impact assessment, as follows, to augment the assessment of visual impact intensity.

A viewshed analysis was undertaken for the project in order to quantify the extent to which the mine may be visible on the landscape; where, "*a viewshed is an area, dispersed over the area's topography, from which the proposed development area or project activities may be visible*" (Figure 8-20). Identifying and mapping the proposed development's viewshed is a key component in developing its visual setting (Figure 8-21). In this step, the specialist used computer-aided line-of-sight analysis to determine which parts of the landscape will be visually exposed to the project.

The viewshed analysis showed the proposed mine to be most visible from the north, north east, south, west and north west (Figure 8-21). Figure 8-21 incorporates 'site boundary buffers' at 5km and 10km from the waste rock dump, TSF and plant site; where it can be argued that, while the development constitutes a possible medium to high visual impact on sensitive receptors within a distance zone of 5km, the impact is illustrated to be somewhat diminished at a distance of 10km, while becoming insignificant (though visible) at distances beyond 10km.

Impact Discussion and Significance Assessment

Three main sensitive receptors were identified, as indicated in Figure 8-22 as 'Vantage Points' 1, 5 and 6, as follows:

- Vantage point 1 is situated on an incline along the N1, just south of a bridge connecting the Grassvalley Mine to the R101;
- Vantage point 5 is situated along an intersection of the N11 and the Marble Hall road; and
- Vantage point 6 is situated on an elevated area on the N11, in close proximity to the tailings dams.

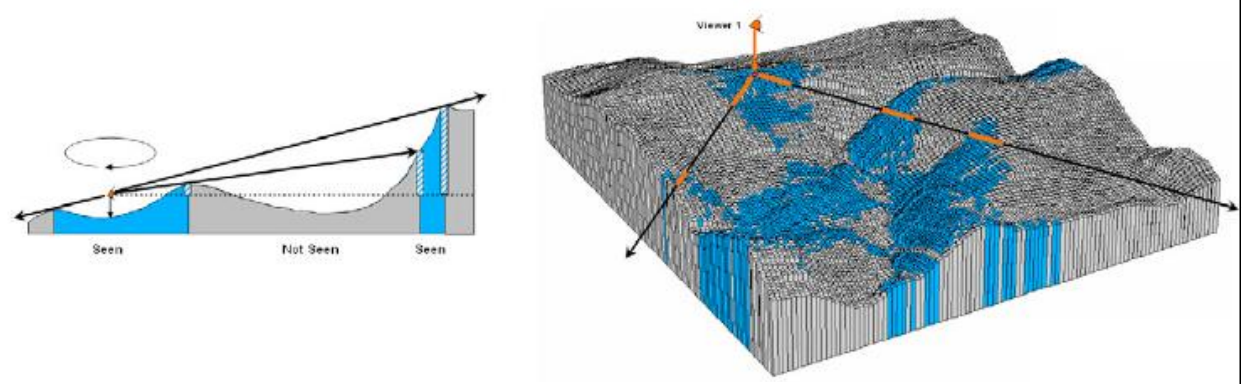


Figure 8-20: Illustrative examples of the concept of viewshed analysis

Vantage points 2 (view from the 'koppie' north of the north pit), vantage point 3 (close-up of plant) and vantage point 4 (road connecting the Grassvalley mine to the R101) are considered less sensitive since, while from these vantage points exposure to the development will be highly visible, it also has to be inferred that the kinds of viewers exposed to the change in scenic quality will have a predominantly neutral to positive attitudes towards it, since this will be the only causeway allowing access to employees of, and visitors to, the mine.

While the entire proposed development would cover a large area, visual exposure to the development will be focused on the surface structures, since the open cast pits will largely be obscured from view from most sensitive receptors. The auxiliary structures, in the form of washers, crushers, smelter complex, administrative buildings, warehouses, workshops, etc., will be concentrated in a relatively compact area. Additional surface developments, such as the waste rock dump and tailings dams, comprising a rather large footprint, are also expected to be highly visible from sensitive receptors. The development is, therefore, anticipated to have high visual exposure.

Vantage point simulations have been developed for the aforementioned vantage points, showing day- and night time pre- and post-mining conditions. The full set of simulations can be viewed in Annexure A of the attached Visual Impact Assessment Report – attached hereto under Appendix 5.14). These simulations aim to contextualise (qualitatively) the visual change to be created through mine establishment. An example of which is provided in Figure 8-23 that follows.

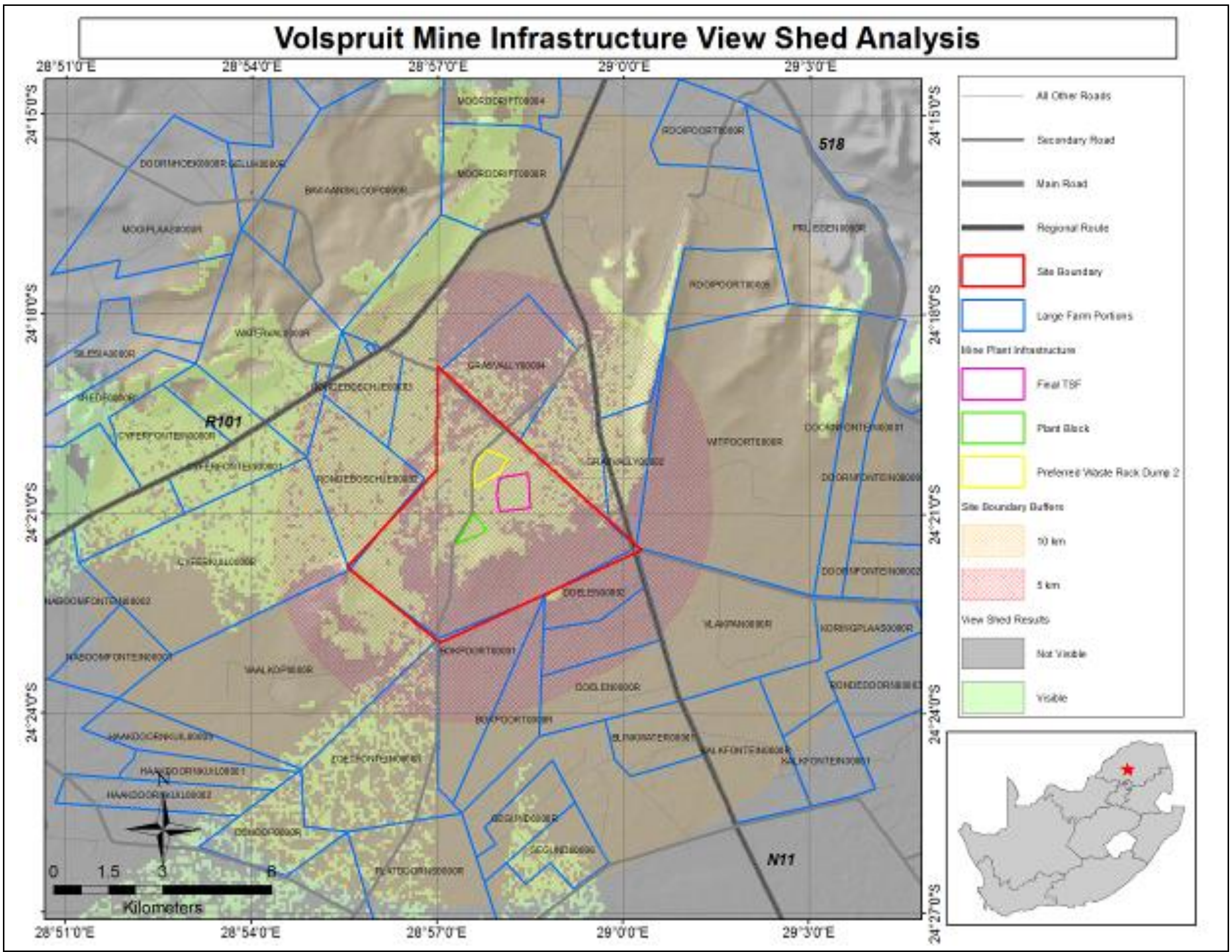


Figure 8-21: Results of viewshed analysis for the TSF, waste rock dump and plant site

The vegetation of the area grows at heights of between 1m and 6m. From vantage point 5 it will contribute substantially to visually absorbing parts of the development into the landscape. The stockpile, plant and tailings, because of their distance from this vantage point and the observer's height (approximately 1,7m above ground) relative to the height of the vegetation (a maximum of 6m above ground), will be almost entirely obscured from view. Other temporary stockpiles and above ground infrastructure which do not exceed the height of the vegetation will also be greatly obscured, both during day and night-time.

The bulk of the above ground infrastructure though, such as the processing plant (with structures measuring up to 40m and situated 600m from there), the tailings, waste rock stockpile and smoke stack (measuring an estimated 65m above ground), as well as its emissions, will not be impacted upon through the process of Visual Absorption Capacity (VAC) of the landscape, or vegetation.

Vantage point 1, being situated on an area of the N1 that is elevated on a bridge over the Nyl River, will not enjoy a great degree of VAC offered by vegetation. The processing plant will not be obscured from view through line-of-sight, but will be perceptibly adjacent to the koppie, making up one element in a grouping of objects.

Insofar as VAC during night-time and twilight is concerned, it must be noted that light has the ability to bleed through (and to be refracted around) thinner or smaller obstacles like trees and branches, as well as to reflect off the ambient air particles in the direct vicinity of the development, causing a dome above the development to glow. As can be seen in the night-time view simulations, the area's vegetation's ability for VAC during night-time is somewhat diminished. Horizontal light spill at night-time will be visible, but with no concrete lighting plan available, no definitive or quantifiable impact can be anticipated. The view simulations have been executed with a typical lighting setup in mind. There are also no hills, mountains or high ground in line-of-sight behind the development to absorb the installation by means of 'back-clothing'.Two more sensitive receptors were studied at the hand of the viewshed analysis (indicating the site's visibility in higher lying areas to the north east of the mine) and in relation to the proposal to increase the flood berm height to 3m above the functional height thereof. These are shown as vantage points 7 and 8 (Figure 8-24, Figure 8-3).

The proposed development, according to Propaganda Studio (i.e. the specialists responsible for the VIA), poses a moderate visual impact in the context of the receiving environment. The assessment methodology used by Propaganda Studios is unique to the assessment of visual impact/change, and assesses visual impact in the context of –

i) visual exposure;
ii) the relative visibility of the proposed mine;
iii) the mine's compatibility with the receiving environment;
iv) the visual absorption capacity of the receiving environment;
v) changes to the visual environment of the site; and
vi) viewer sensitivity.

The following conclusions were drawn from the specialist VIA (Appendix 5.14):

- The existing scenic quality of the area is indicated as being moderate;
- The level of contrast the development will have in relation to its receiving environment is deemed high (i.e. low anticipated compatibility with surrounding scenery);
- The development is anticipated to have high visual exposure to vantage points closer than 1km. Since the main sensitive receptors are further away than 1,7km, visual exposure will be somewhat diminished;
- Due to the size of the development, the surface structures, as will be seen from vantage points 1, 4 and 6, at distances of 1,9km, 700m and 1,7km respectively, are anticipated to be Moderately to Highly Visible. From vantage point 5, at a distance of 2,7km, the development is anticipated to be Moderately Visible. While the development constitutes a possible medium to high visual impact on sensitive receptors within a distance zone of 5km, the impact is illustrated to be diminished at a distance of 10km, while becoming insignificant (though visible) at distances beyond 10km;
- In terms of viewer sensitivity, the proposed development is deemed to pose a moderate visual change rating; and
- The vegetation of the area grows at heights of between 1m and 6m. From vantage point 5 it will contribute substantially to visually absorbing parts of the development into the landscape, while from all other main sensitive receptors except vantage point 1, vegetation will partially absorb the development into the landscape, diminishing visual impact.

Table 8-28 aims to present a succinct summary by the EAP, based on the detailed findings and assessment in the VIA, of potential visual impact significance / change (i.e. relative impact significance).

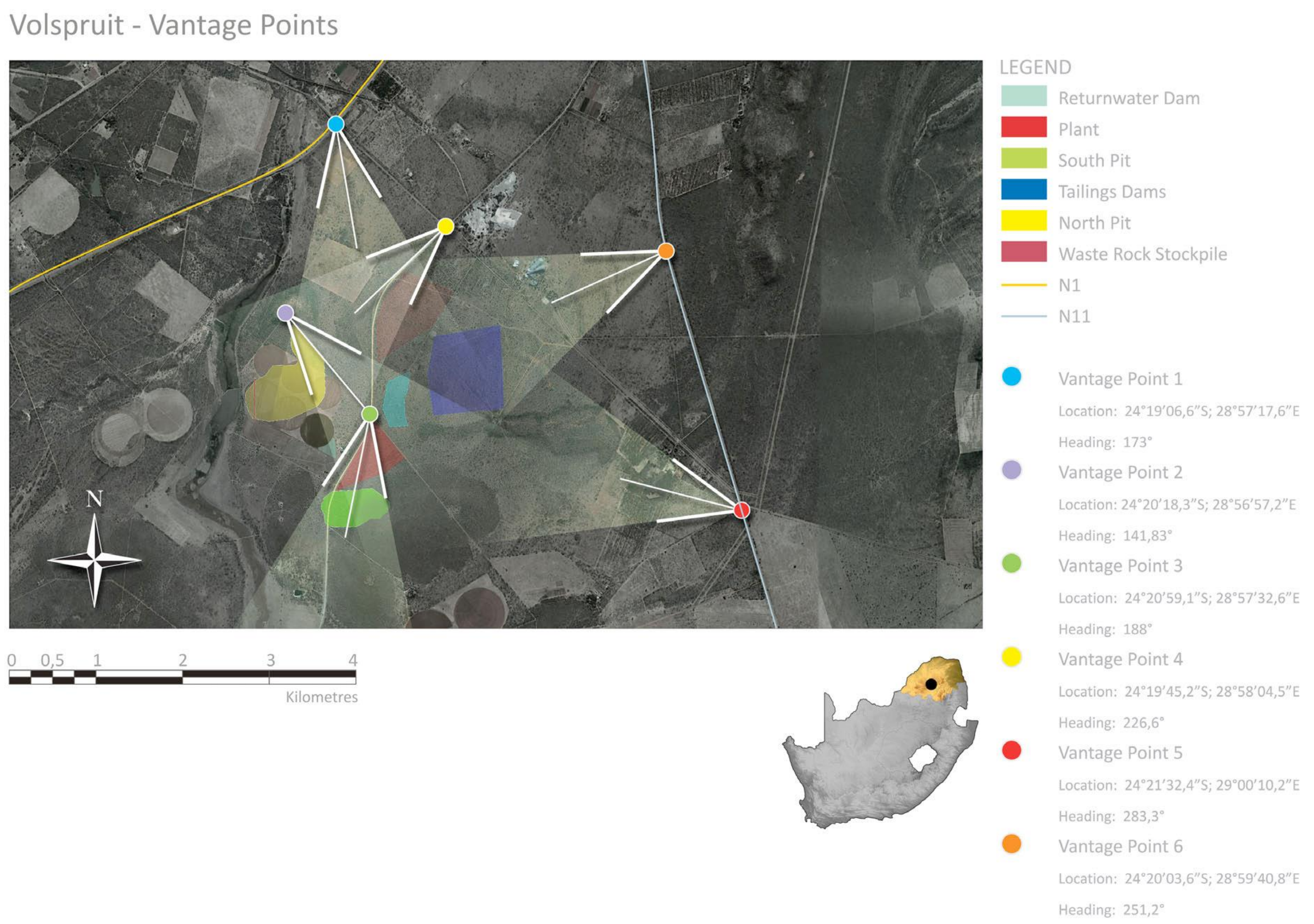
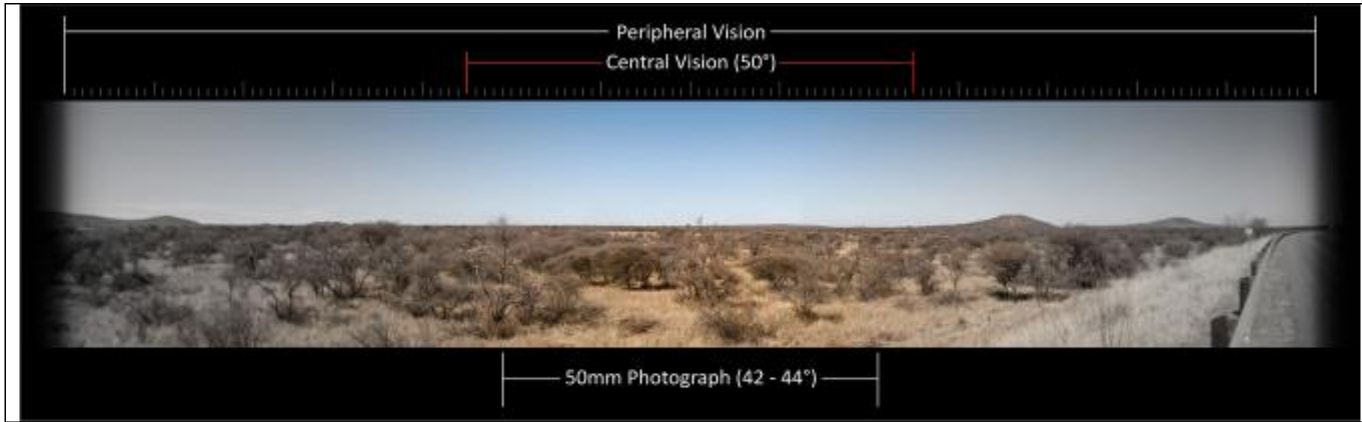
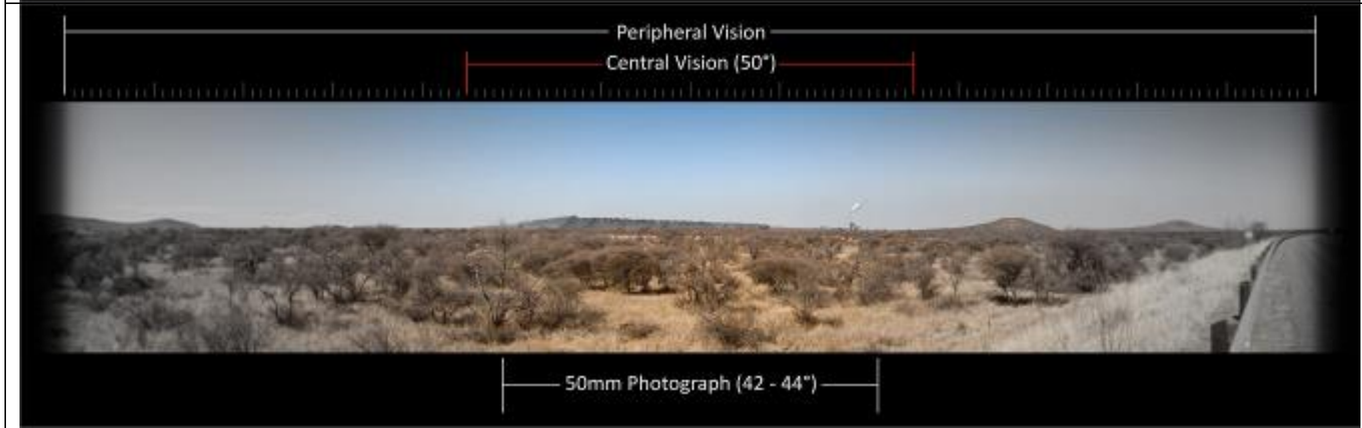
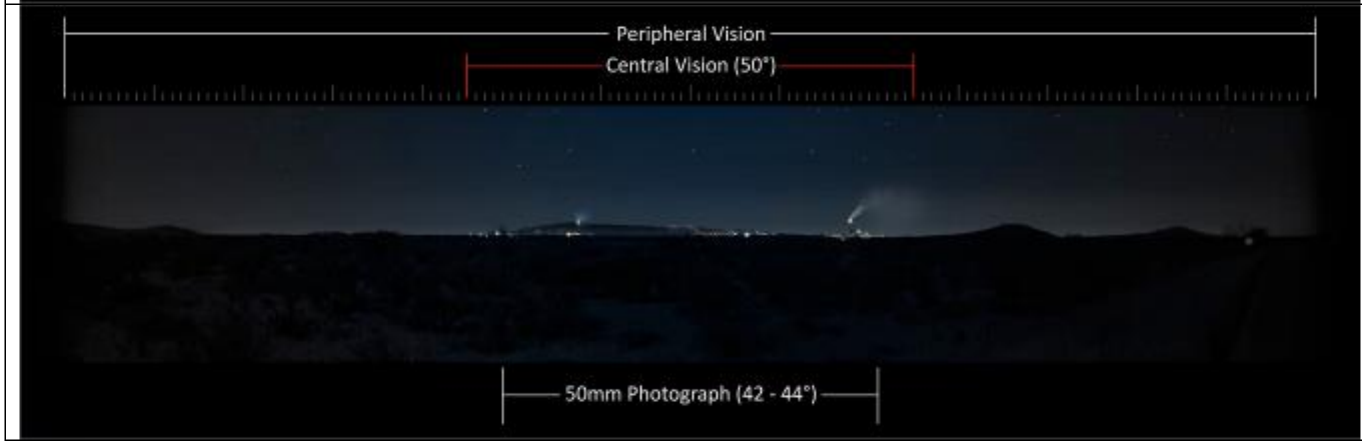


Figure 8-22: Sensitive receptors identified for Visual Impact Assessment

	Figure 8-23 (A): Vantage Point 1 – Daytime (Pre-mining)
	Figure 8-18 (B): Vantage Point 1 – Daytime – Operational mine
	Figure 8-18 (C): Vantage Point 1 – Night time – Operational mine

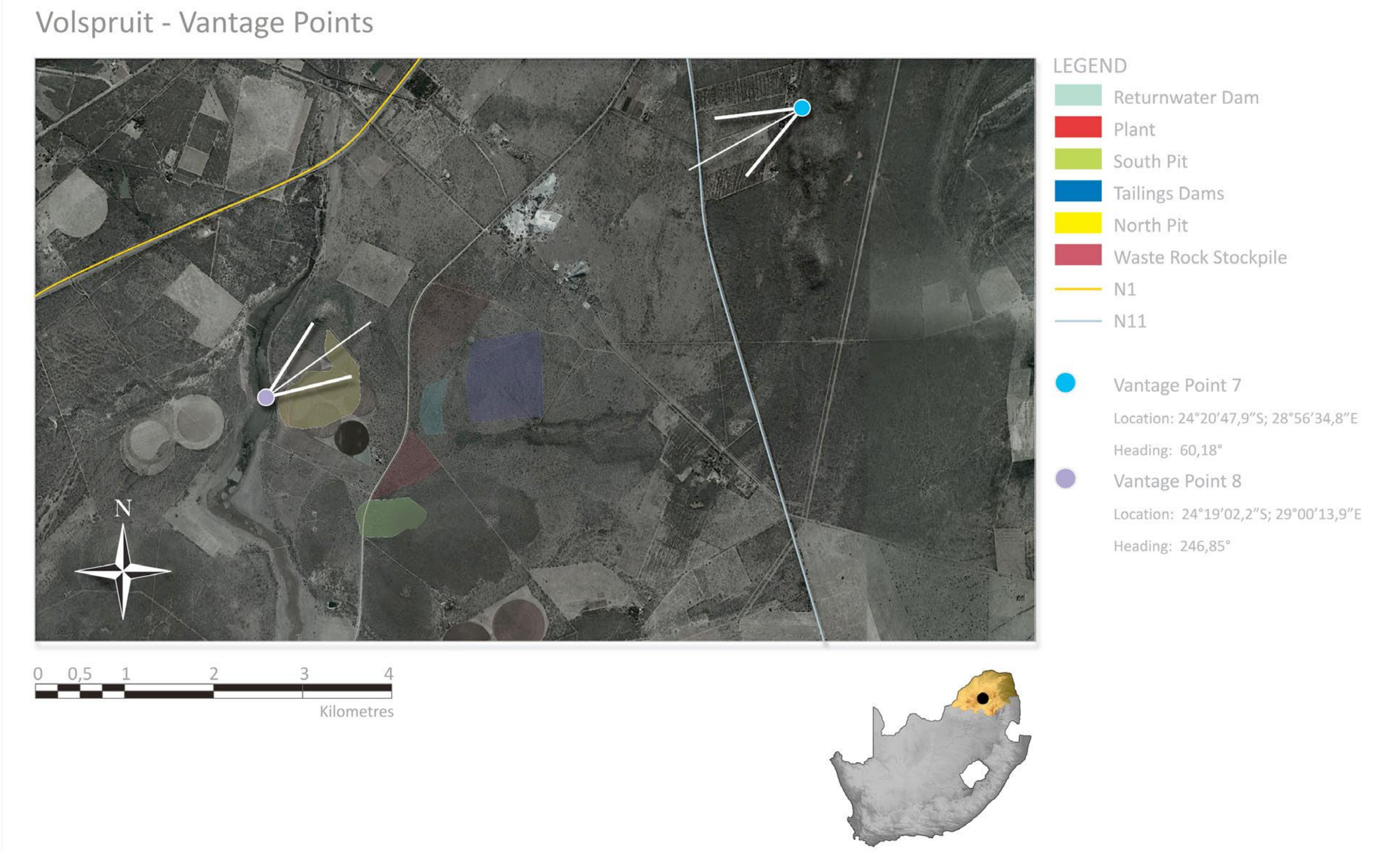


Figure 8-24: Additional vantage points considered in assessing the visual impact of the project

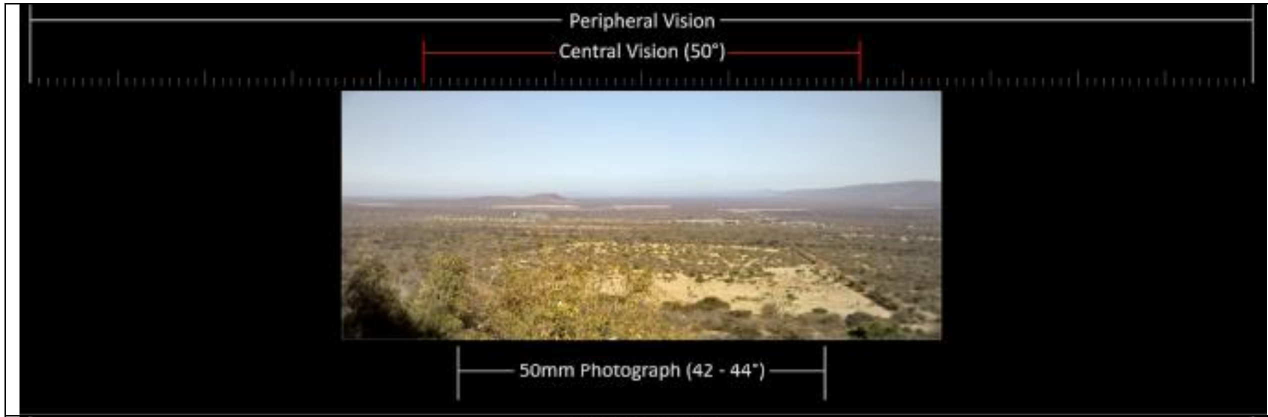


Figure 8-25 (A): Vantage Point 7 – Daytime (Pre-mining)

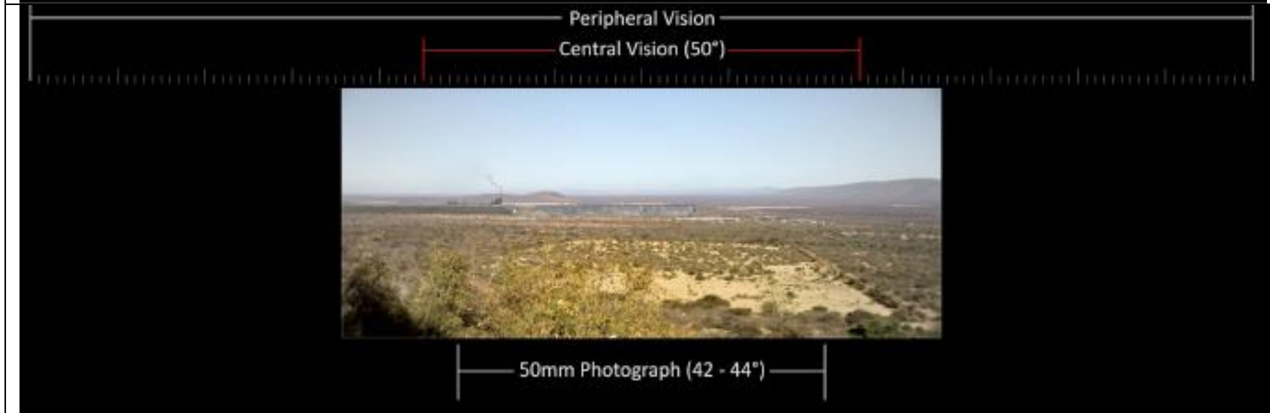


Figure 8-22 (B): Vantage Point 7 – Daytime – Operational mine

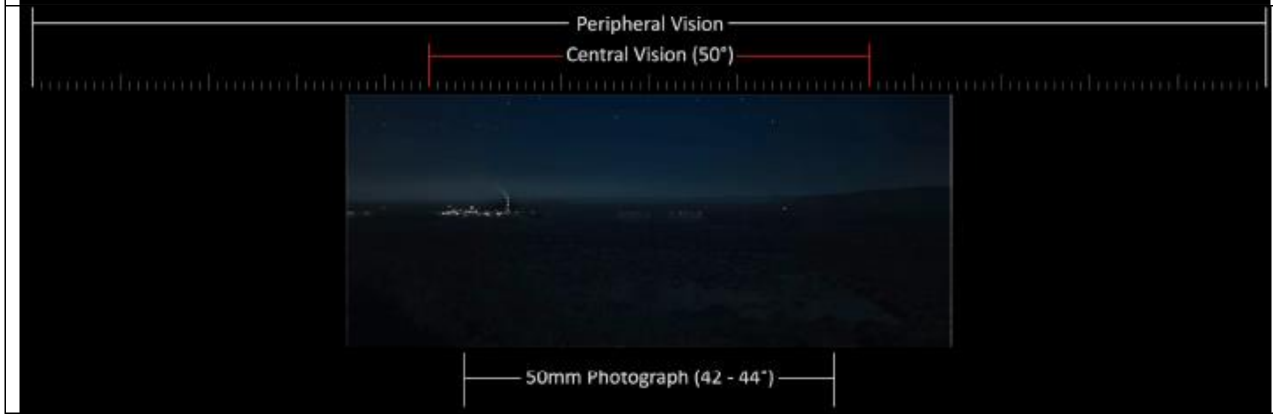


Figure 8 -22 (C): Vantage Point 7 – Night time – Operational mine

Table 8-28: Impacts on visual and aesthetic character (Operation)			
Nature (N)	Negative: Changes to the visual and aesthetic character of the area (sense of place).		1
Extent (E)	Locally: The impact would be limited to the immediate surroundings		2
Duration (D)	Permanent: The waste rock dump, TSF and smelter complex would remain visible beyond the life of the mine.		5
Intensity (I)	Moderate: The visual and aesthetic character of the area will likely be modified, but social and economic functions and processes will continue, albeit in a modified way.		3
Probability (P)	Very Likely: The development will likely impact on the visual and aesthetic character of the site.		3
Mitigation (M)	Slightly mitigated: The impact will be slightly mitigated through waste rock dump- (starting at approximately year 9) and TSF rehabilitation (starting at approximately year 19 – end of life of mine) as well as through implementation of the		2
Enhancement (H)	N/A		-
Reversibility (R)	Irreversible		1
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	42
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	63
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Mitigation/Management

To mitigate, as much as possible, the effect of lighting during twilight and night-time, the following is suggested:

- Lighting masts should not exceed a height of 20m;
- Where possible, lights should be aimed in a southerly direction, away from vantage point 1 and 3; and
- Cut-off luminaries should be employed where possible

8.3.8 AIR QUALITY

EScience was appointed by the proponent to undertake an air quality impact assessment (AQIA) for the proposed mining activities (Full specialist report attached in Appendix 5.9 hereto). The following section aims to provide a succinct summary of the findings of that AQIA, as well as the methodology used to determine the potential extent of the proposed project's impact on ambient air quality; where the predominant sources of emissions to atmosphere resulting from the project are identified as i) fugitive particulate matter (e.g. wheel-entrainment by haul vehicles), and ii) point source emissions (e.g. SO_2, NO_2, and particulate matter] resulting from the proposed drying, roasting, and smelting stages of production in the smelter complex).

A best practice approach, utilising computerised numerical dispersion modelling techniques to predict the maximum ground level pollutant concentrations, was used. In this respect, an assessment of the ground level pollutant concentrations (temporal and spatial distributions) was undertaken through the following process:

- Identification of potentially significant atmospheric pollutants and emission sources. The following potentially significant pollutants were identified:
    - Inhalable particulate matter (PM_{10})
    - Sulphur dioxide (SO_2)
    - Oxides of nitrogen (NO_x)
    - Sulphuric acid (H_2SO_4) as a consequence of SO_2 abatement.
- Compilation of an emissions inventory for the existing and anticipated emission sources, namely:
    - Material transfer operations from the north and south pits to the waste rock dumps.
    - Smelter complex emission from the dryer, roaster and smelter off gases.
- A review of South African and international ambient air quality standards and guidelines against which the predicted impact of the proposed process was evaluated.
- Mesoscale and fine scale meteorological modelling with input from South African Weather service stations in the modelling domain.
- Dispersion modelling and compilation of isopleth maps, indicating predicted ground level concentrations of significant pollutants according to the applicable averaging periods and frequency of exceedance where relevant.
- Air quality impact assessment and recommendations for air quality management.

Emissions Quantification

Fugitive site emissions focused on the dust emissions from vehicle traffic on unpaved roads on the mining property and were estimated from operation schedules, truck capacities and haul requirements. Road surface wearing course characteristics were determined from samples taken (moisture and silt analysis). Emissions were quantified through the use of emission factors and modelled accordingly. The run of mine processing plant is largely a wet process thus significant emissions therefrom are not anticipated.

There are three main point emission sources from the smelter complex considered in the air dispersion modelling for the AQIA, as follows (i.e. each with their own emission stack):

- Dryer off gases: After grinding, milling, screening and floating of the ore at the processing plant, the resultant PGM metal concentrate is dried in a flash drier before being subjected to further roasting and smelting. Off gases are passed through a bag filter (with the captured fines being returned to the process) before exiting through a stack;

- Roaster Off gases: As the target ores are high in sulphur, the metal concentrate derived from the processing plant is passed through a roaster before being smelted. The high concentration SO_2 flue gas is sent through a Sulphuric acid production plant before being exhausted through a stack; and
- Smelter off gases: The off gases from the arc furnace are combusted [to oxidise carbon monoxide (CO) content] and then cooled before being sent through abatement (including emergency SO_2 scrubbing, in case the roasters fail). After abatement the flue gas is exhausted through a stack to the atmosphere.

GN893:2013 stipulates the emission limits for each of the aforementioned processes, as indicated in Table 8-29(i.e. the maximum allowable concentration of each of the indicated pollutants in the stack emissions). These concentrations have been used as the maximum inferred output for the respective pollutants from each of the three point sources in undertaking the air dispersion modelling for the project.

Table 8-29 : Emission Limits for Relevant Scheduled/Listed Activities (GN 893:2013)

Listed activity (Subcategory)	PM	NO_x	SO_2	Cl_2	HCl	HF	NH_3	SO_3
	mg/Nm³							
4.1: Drying	50	500	1000	n/a	n/a	n/a	n/a	n/a
4.16: Smelting and converting of sulphide ores	50	350	1200	n/a	n/a	n/a	n/a	n/a
4.17: Precious and base metal production and refining	50	300	400	50	30	30	30	n/a
7.2 Acid Production	n/a	n/a	350	350	n/a	n/a	n/a	25

There are no significant industrial sources that fall within the AOI. The areas surrounding the site are sparsely populated and thus atmospheric emissions related to domestic fuel burning are concluded to be insignificant. Fugitive dust emissions are also deemed to be insignificant, given the nature of land and activities surrounding the site. Emissions from the Grass Valley Chrome Mine to the north west of the proposed mine are not quantified, however these emissions are expected to be non-bouyant and emitted ayt low height and thus drop out in relative proximity to source.

Impact Discussion & Significance Assessment

Quantification of impact was predicted through pollutant dispersion modelling. The predicted ambient concentrations were assessed in terms of regulated ambient air quality limits for the respective pollutants of concern; where the Regulated ambient air quality/concentration limits are 'health-based' limits, aimed primarily at ensuring receptor's access to air quality that is not harmful to their health, or well-being. The National Ambient Air Quality Standards stipulate maximum allowable ambient concentrations of various atmospheric pollutants, for various averaging periods, as well the permissible number of times permitted that these maximum may be exceeded per annum (so-called allowable frequency of exceedences (FoE) limit).

Inhalable Particulate Matter

Dust entrainment from mine haul roads was modelled in accordance with a worst case emissions scenario. The predicted maximum concentrations for the 24-hour and annual averaging periods indicate potential exceedences of the ambient standards/limit beyond the mine boundary (Figure 8-26) should there be no emission controls in place.

If a palliative abatement with an 85% efficiency is applied to the unpaved roads used to transport waste rock, the impact is predicted to be within the maximum FoE as stipulated in the National Ambient Air Quality Standards (Figure 8-27). The application of 85% palliation to the unpaved roads results in the predicted ambient concentrations being reduced to within the ambient standards. Without palliative measures the 24hr average ambient PM_{10} concentrations and allowed FoE are both expected to be exceeded beyond the site boundary.

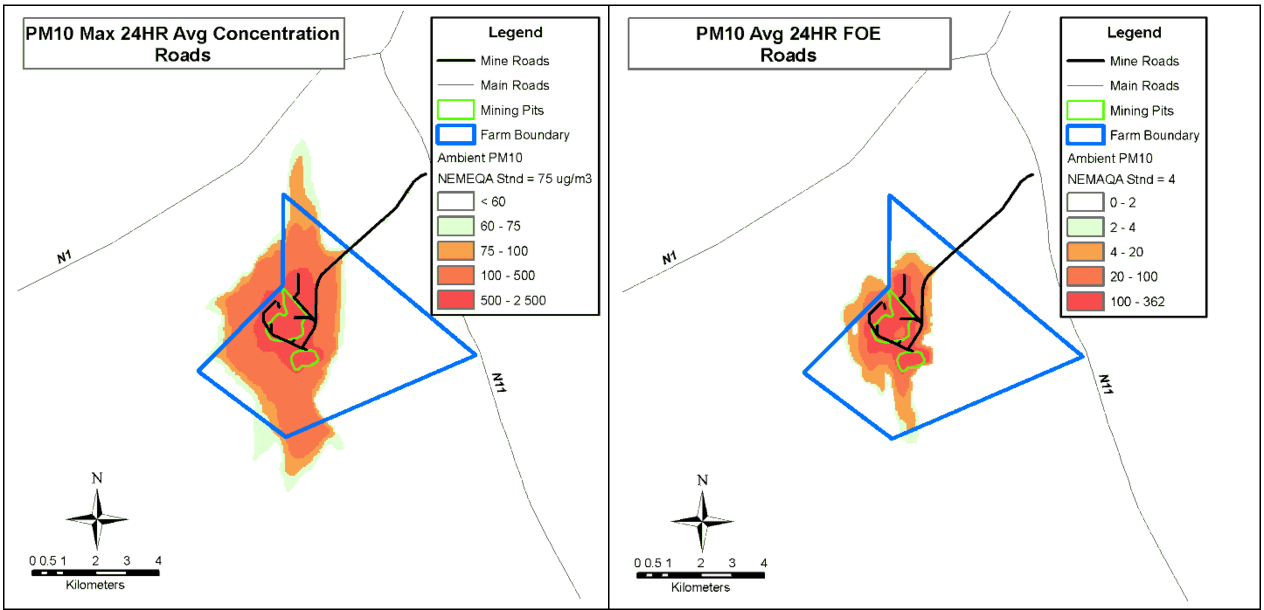


Figure 8-26: Predicted maximum 24-hour average ambient PM_{10} concentrations and frequency of exceedance due to unpaved road entrainment (without palliation)

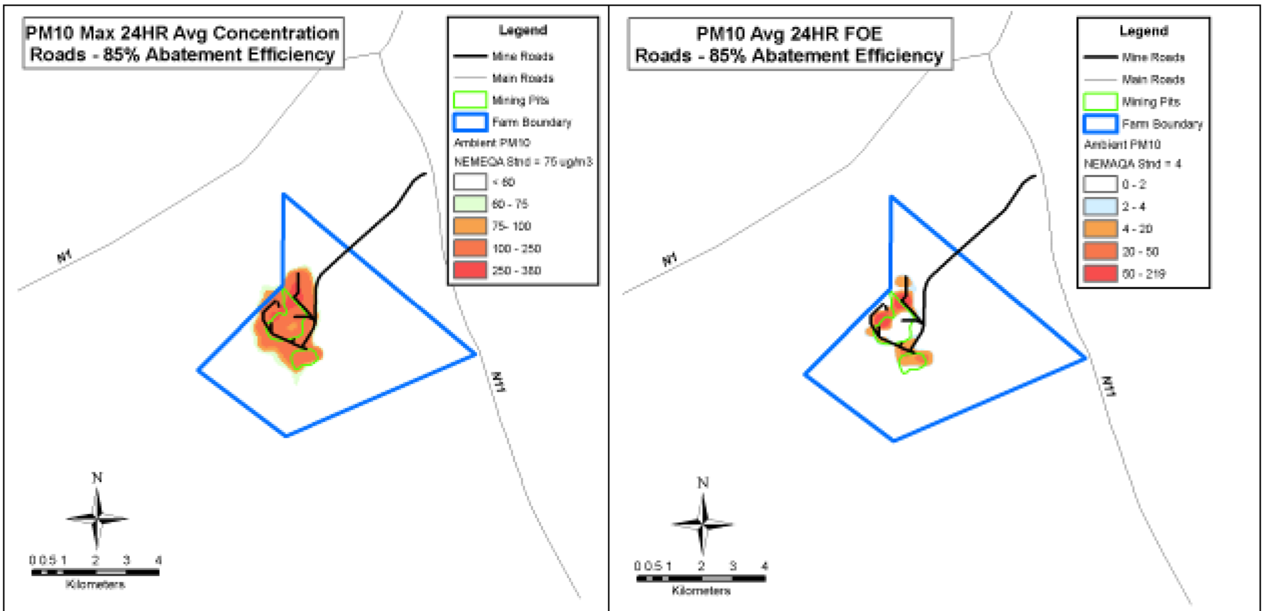


Figure 8-27: Predicted maximum 24-hour average ambient PM_{10} concentrations and frequency of exceedence due to abated unpaved road entrainment (with 85% palliation)

Effects of PM_{10} emissions from the smelter complex are predicted to be well with within the 24 hour and annual ambient air quality limits (Figure 8-28: Predicted maximum 24hr average ambient PM_{10} concentrations).

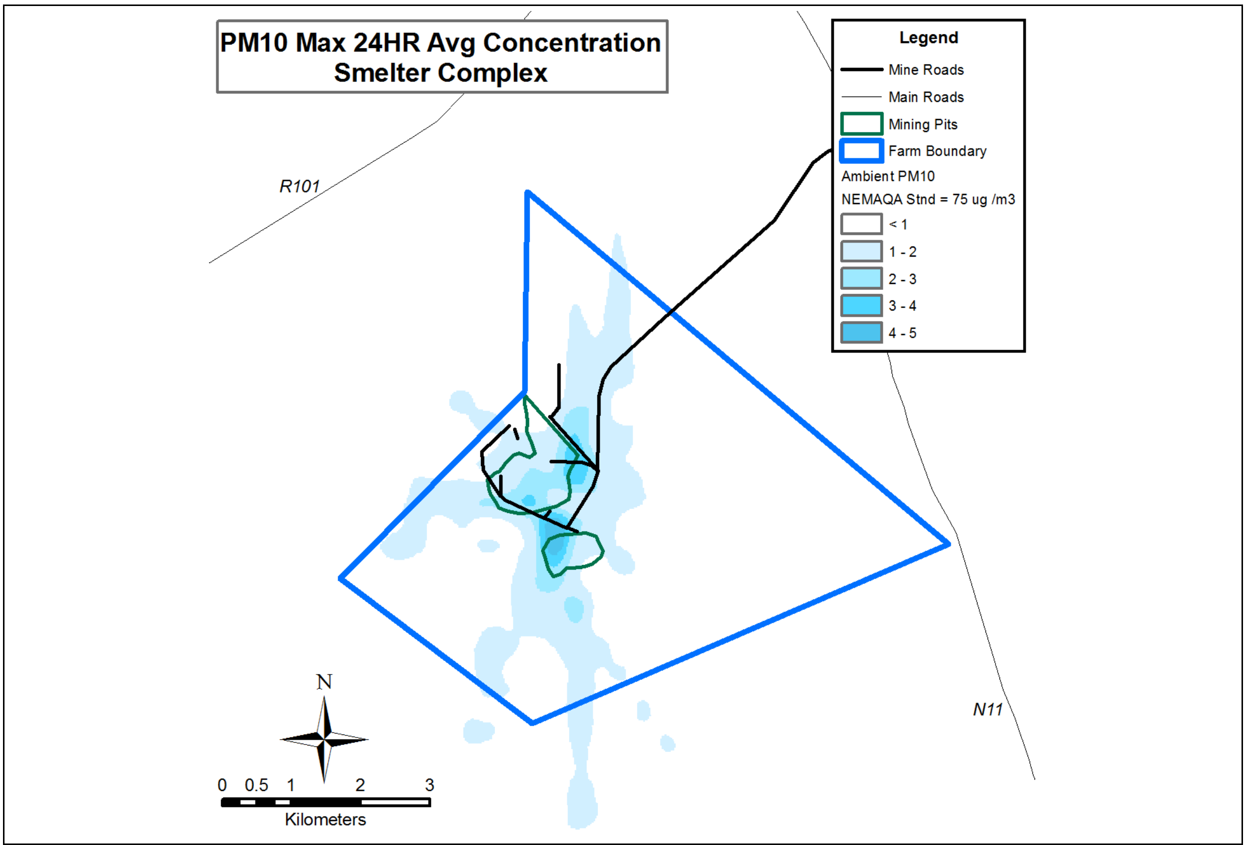


Figure 8-28: Predicted maximum 24hr average ambient PM_{10} concentrations

$PM_{2.5}$ emissions are estimated as a fraction of PM_{10}, by virtue of the fraction of $PM_{2.5}/PM_{10}$ being in the order of 15%, meeting the PM_{10} ambient standards implies that the $PM_{2.5}$ standards are necessarily met as well.

Sulphur dioxide (SO_2)

Predicted maximum hourly ambient concentrations of SO_2 attributable to the smelter plant are within the ambient limits outside the site boundary (Figure 8-29: Predicted maximum 1-hour average ambient SO_2 concentrations and frequency of exceedence). Although there are predicted exceedences of the hourly standard inside the mine boundary, the predicted frequency of exceedences is well within in the allowed 88 exceedences per annum. Predicted maximum 24-hour averages and annual average are also within the ambient standards.

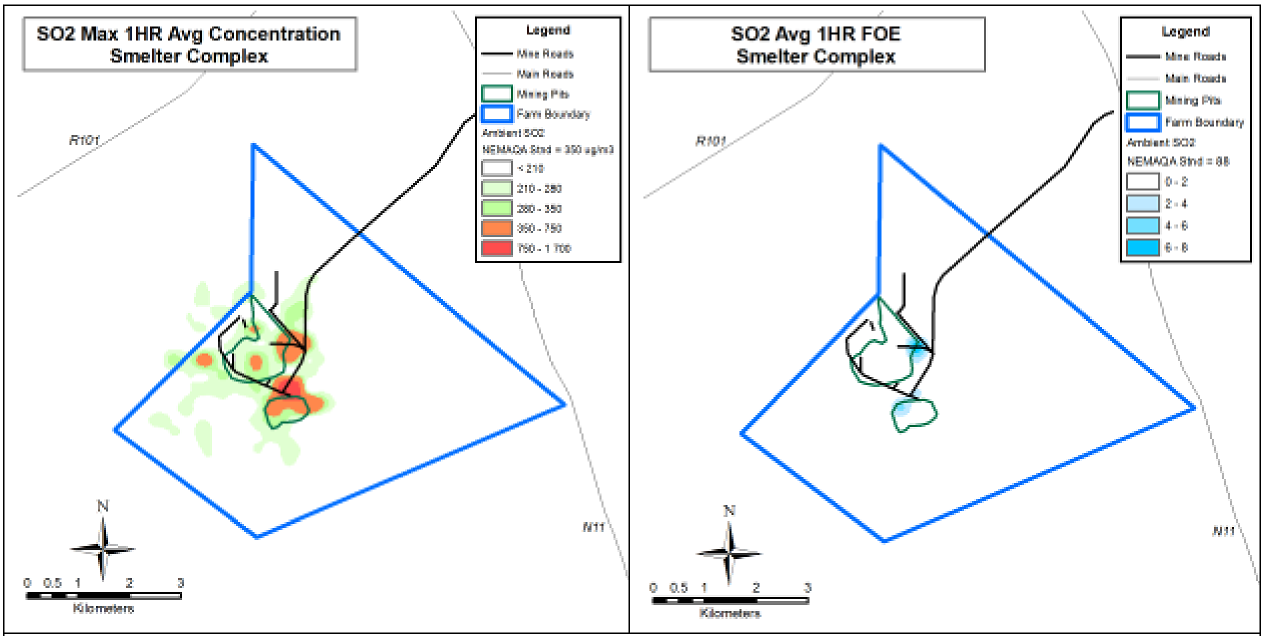


Figure 8-29: Predicted maximum 1-hour average ambient SO_2 concentrations and frequency of exceedence

Oxides of Nitrogen (NO_x)

Predicted maximum hourly ambient concentrations of NOx attributable to the smelter plant are well with within the hourly and annual ambient air quality limits set for NO_2 (Figure 8-30).

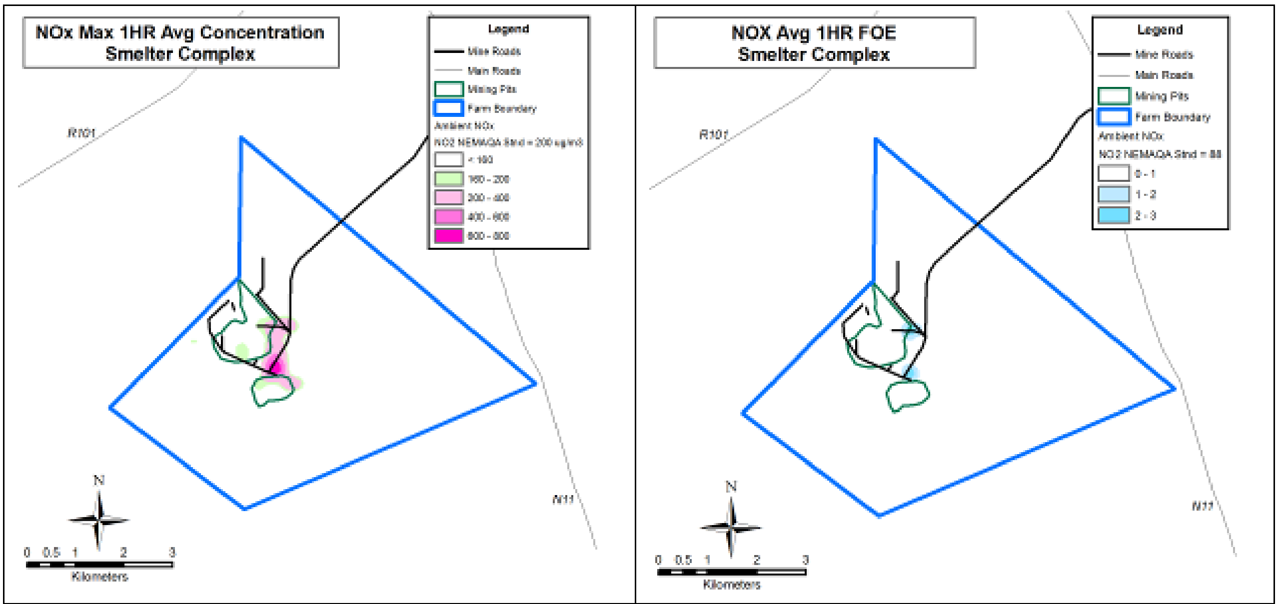


Figure 8-30: Predicted maximum 1-hour average NO_x ambient concentrations and frequency of exceedences

<u>Summary</u>

It is predicted that emissions from the smelter complex will not have an impact exceeding the national ambient air quality limits, provided that the emissions meet the requirements of GN893:2013.

It is predicted that particulate entrainment from unpaved haul roads will result in exceedance of the national ambient PM_{10} standards if no palliation is applied to the roads. If a palliative abatement with an 85% efficiency is applied to the unpaved roads used to transport waste rock, the impact is predicted to be within the ambient standard. Therefore application of palliatives with an effectiveness of at least 85% is required.

Targets and action limits for dust deposition are summarised in Table 8-30. In the absence of an applicable category it is recommended that the mine adopt the threshold for residential areas as a target.

Table 8-30: Target, action and alert thresholds for dust deposition

Level	Dust-fall rate, D ($mg/m^2/day$, 30-d average)	Averaging period	Permitted frequency of exceeding dust-fall rate
Target	600	Annual	
Alert Threshold	600	30 days	Two within a year, not sequential months
Action threshold	1 200	30 days	Two within a year, not sequential months

Where the alert threshold is exceeded, Sylvania must investigate the cause of the exceedances, and formulate an action plan to bring the impact toward the target value. From a legal perspective the mine must meet the limits for "no-residential areas", this a maximum 30-day mean of 1 200 $mg/m^2/day$, and may be exceeded twice within a year but nit for consecutive months.

It is noted that sulphur recovery from roasting flue gases may be achieved through the installation of a sulphuric acid producing plant. The dispersion potential of emissions from such a plant, and thus the predicted ambient air quality impact, would be similar to that of the processes assessed herein provided that:

1. The pollutants emission rates are the same or less.
2. The Stack height, exit temperature and velocity are the same or higher.

Given that acid plant's stack release temperature will be higher than a roasting plant scrubber (300°C versus 80°C), and the emission rates for sulphur compounds and oxides of nitrogen are lower, it is predicted that the use of an acid plant as a means of sulphur fixation, as opposed to scrubbing roaster off-gases, will result in an improved impact on ambient air quality, with the added economic advantage of producing sulphuric acid. Based on the predicted SO_2 impact and emission ratio of H_2SO_4, it is predicted that the ambient impact of H_2SO_4 will be within the most stringent of the ambient standards identified (i.e the Alberta-Canada standard).

Should the above be met then it is reasonably expected that the impact on air quality would be similar or better, and such a process should proceed. Should these conditions not be met then an Air Quality Impact Assessment would be required to predict the impact and whether it would be within acceptable levels.

It is therefore recommended that the proposed development proceed provided that the conditions noted above are met.

Given the limitations of the modelled meteorology it is further recommended that the emissions from the proposed project be re-modelled with actual monitored data from the site. This will allow for improved accuracy of the predicted ambient air quality impact.

Table 8-31: Impacts on Ambient Air Quality (Operation)			
Nature (N)	Negative: Potential for decreased ambient air quality through operational mining activities		1
Extent (E)	On site: The only exceedences of ambient air quality limits was observed on the mine site itself, with there being no discernable, modelled, impacts on ambient air quality beyond the mine boundary		1
Duration (D)	Long-term: Life of Mine (approx. 20 years)		5
Intensity (I)	Major: Given that ambient air quality limits are health-based, any exceedance(s) thereof are inferred to have potentially major consequence(s).		4
Probability (P)	Definite: The proposed activities will result in the emission of pollutants to atmosphere, such that ambient air quality may be impacted upon		4
Mitigation (M)	Well mitigated: A host of readily available mitigation can be implemented by the Proponent to ensure compliance with i) regulated stack emission limits and ii) ambient air quality standards		4
Enhancement (H)	N/A		-
Reversibility (R)	Moderately reversible: The impact, locally, will almost entirely reverse through time if the activities of the mine were halted and rehabilitated		3
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	27
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	48
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

<u>Mitigation/Management</u>

It is predicted that particulate entrainment from unpaved haul roads will result in exceedences of the national ambient PM_{10} standards if no palliation (dust suppression) is applied to the roads. If a palliative abatement with an 85% efficiency is applied to the unpaved roads used to transport waste rock, the impact is predicted to be within the ambient standard. Therefore application of palliatives with an effectiveness of at least 85% is required.

Relevant emission abatement equipment will need to be fitted to the three smelter complex stacks in order to meet the stack emission limits modelled in the AQIA (Table 8-29); where no fatal flaws in respect of the mine's potential down-wind impacts on ambient air quality have been demonstrated, provided that these limits are indeed met (together with the proposed 85% efficiency required for palliation).

8.3.9 TRAFFIC

Introduction

The project would employ approximately 480 permanent staff. This is approximately half the staff contingent anticipated to be onsite during the construction phase of the project. The operational phase of the project will too experience the regular delivery of goods and raw materials in order to meet the mine's operational requirements (e.g. anthracite, limestone, plant reagents, etc.). The nature of the delivery vehicles will again be highly varied, but limited abnormal loads can be anticipated during the operational phase.

Impact Discussion and Significance Assessment

The relative significance of the impact is deemed to remain low during the operational phase, as with the construction phase, both with and without mitigation. The increased traffic volumes experienced on the localised road network may create annoyance amongst road-users unaccustomed to such volumes. The intensity of the impact is not anticipated to change from the construction phase, but the duration of the impact would certainly increase.

Table 8-32: Impacts on local road infrastructure (Operation)		
Nature (N)	Negative: Negative impacts (nuisance traffic, road surface degradation, road user safety) on the localised road network due to increased traffic (heavy and light vehicle) during the operational life of mine.	1
Extent (E)	Regionally (Largely within the Local Municipality): The bulk of the impact will be experienced within Mokopane and its immediate surrounds (Exacerbated by the absence of an off-ramp to the N11 going south on the N1 national highway)	3
Duration (D)	Very long-term: The impact will persist for the life of the mine	5
Intensity (I)	Moderate: The intensity of the impact is anticipated to be minor in the context of the existing traffic volumes and flows on the localised road network (not quantified); where the existing volume and flow of traffic is anticipated to be hardly affected, but would be made more sensitive to further such stressors. The nuisance and annoyance to be created by the additional traffic on the quieter, less travelled sections, of the N11 and Singlewood road closer to the site may bare moderate intensity in assessing the significance of the impact	3

Table 8-32: Impacts on local road infrastructure (Operation)			
Probability (P)	Likely: There is a possibility that the impact may occur, to the extent that provision must be made to manage such		2
Mitigation (M)	Slightly mitigated: The impact is slightly mitigated through implementation of the measures to follow		2
Enhancement (H)	N/A		-
Reversibility (R)	Mostly reversible: The impact would largely cease at the end of life of mine		4
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	16
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Low**	19
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

<u>Mitigation/Management</u>

The proponent will need to ensure that mine staff are predominantly transported either via bus, or mini-taxi, to the site (or combination thereof). The delivery of goods and materials should ideally be restricted to daylight working hours and to off-peak morning and evening traffic periods (to the extent that this is practical). The proponent should establish a bus terminal / drop off point at the site.

The proponent should furthermore ensure that appropriate traffic safety measures are implemented along the Singlewood road; where heavy and light mine vehicles will need to cross this road to gain access to work sites on each respective side thereof.

The above, principle, mitigation is formalised in the attached EMPR, and would become legally binding to the proponent if approved by the respective competent authorities.

8.3.10 SOCIO-ECONOMICS

The following sections describe both the potentially positive- and negative impacts that can be expected to ensue during the operation of the mines and its mineral beneficiation complex.

<u>Introduction</u>

From a socio-economic perspective, the positive effects, in terms of export earnings, economic development, job creation, household income, and government revenue that could be derived during the operational phase of the mine are deemed to outweigh the negative impacts that could ensue as a result of the mine's establishment and operation in the area.

However, the mine will be associated with a number of other negative effects that are more challenging to quantify and to offset. These are associated with the sense of place, property values, loss of family ties, crime situation and pressure on socio-economic infrastructure. Some of the impacts would only last during the construction period (such as 'crime' and impact on socio-economic infrastructure), while others will extend into the operational period and will therefore be of a considerable longer term.

While the economic benefit of the mine's establishment in the area cannot be faltered, all efforts need to be made to ensure that the establishment and operation of the mine is conducted in the most sustainable way with the primary objective of minimising and where feasible completely eliminating the potential for altering human livelihoods in the area.

Positive Impacts

a. Effects on balance of payment due to production of PGM alloy

The majority of South African earnings received from the export of mineral commodities come from the sale of Platinum Group Metals (PGM), iron ore, and coal. In 2011, the export of PGM metals contributed almost R80 billion to South African exports. This meant that PGM exports accounted for 11.5% of the country's total exports during that year. If the project exports the entire amount of produced PGM alloy, which is the most likely scenario in the current conditions unless the domestic market structure changes, it will contribute an estimated R1.4 billion per annum to South Africa's export earnings, which equates to an increase of PGM exports observed in 2011 by 1.8%.

Exports bring stability and growth to the country. They allow the country to earn foreign exchange, which in turn means that the nation has a greater purchasing capacity on the international market that can be used to acquire goods and services necessary for the development of other industries within the nation. Since 2003, South Africa had a negative trade balance, which means that its exports were lower than its imports. Running a trade deficit is not necessarily harmful, particularly if it is stimulated by the shortage of capital goods required to develop the economy. The establishment of the facility will have a negative impact on the South African balance of trade to the value of R479.2 million over a two and a half year period (i.e. during the construction period). The expected revenue to be generated by the production of PGM alloy at the mine and its mineral beneficiation complex (i.e. the operational phase of the mine), though, will offset this negative impact in the first year of operation. This illustrates the benefit of importing services, machinery and equipment over the short-term, in order to create the opportunity to increase export earnings at a later stage over the long-term.

b. Sustainable increase in production and GDP-R in national and local economies

The mine and the PGM beneficiation complex are expected to average an annual turnover of some R1.4 billion during the operational years of the project (life of mine estimated at 19 years). More specifically, it is estimated that the project would deliver 300 000 tonnes of concentrate per month from the concentrator, 40 000 tonnes of concentrate per annum from the smelter and 6 000 tonnes of alloy from the CVMR plant, which will then be sold on the global commodity market.

The resulting operating expenditure will have a positive impact on the local, provincial and national economy. As illustrated in Table 8-33, the effects on production in the country ensuing from the project amounts to a total of about R2.2 billion (2012 prices) per annum. Assuming that the production will be accounted in the same municipality where the mine's output is generated; about three quarters of this annual production increase will be registered in the Mogalakwena LM, which will significantly increase its economy.

Table 8-33: Average annual impact on production and GDP-R during operations (R'ml, 2012 prices)

Sector	Direct	Indirect	Induced	Total
Production	1,409	592	189	2,189
GDP-R	**817**	**282**	**86**	**1,184**

The new business sales generated by the mine per annum through direct and spin-off effects will translate into R1 184 million (2012 prices) of Gross Domestic Product per Region. Assuming that the mine's value added will be accounted in National Accounts as generated entirely in the local municipality and considering the sizes of the economies, this implies that the mine will contribute significantly to the South African (0.1%), Limpopo (1.1%) and Mogalakwena (18.1%) economies.

Due to the composition of the local and Limpopo economies, not all inputs required for the operation of the project will be possible to source from within the local municipality and even Province. Overall it is predicted that about R226 million of operating expenditure will be spent on goods procured from beyond the provincial boundaries; thus about R86 million of value added that is to be stimulated by this expenditure will most likely also be generated outside the provincial boundaries.

Assuming the above, it could be estimated that more than 90% of the value added to be generated by the project will be retained within the Province and the rest will be created in the rest of the country. Considering that the provincial economy was valued at about R108 billion in 2011, project operations could increase the size of the Limpopo economy by 1.0% per annum. This is a significant contribution, particularly given the fact that the provincial economy in the past decade has been growing at a relatively slow average rate of 3.2% per annum.

c. Creation of sustainable employment opportunities nationally and locally

The operating expenditure of R1 409 million (2012 prices) per annum during full operational capacity will generate, and thereafter support, on an annual basis 1 869 FTE jobs throughout the country. Some 476 employment opportunities will be created directly at the following facilities proposed for establishment on site:

- Mine – 263;
- Concentrator Plant- 104;
- Smelter – 74; and
- CVMR Plant – 34.

Through the indirect effects, an additional 838 FTE jobs will be created along the supply chain. Lastly, factor spending will create and support 555 additional FTE jobs. The attainment of the above-mentioned job creation level will be gradual and will only be fully realized when the project is in full operation. Once the mine is fully operation, it will sustain 1 869 FTE jobs.

In terms of the distribution of employment opportunities between the local, provincial economy, and the rest of the country it is estimated that 1 500 FTE jobs will be created within Limpopo and the rest will be created in other parts of South Africa. The direct jobs to be created by the operations of the project will be created in Mogalakwena itself. In 2011, Mogalakwena was estimated to have 12 388 unemployed people. If this remains unchanged, the creation of an additional 617 employment opportunities would reduce the unemployment rate from 19.1% to 18.1%.

It should however be noted that that the mine and the CVMR plant would mostly require skilled workers. Given the situation in Mogalakwena, it is unlikely that the area will be able to satisfy the demand for all the skills needed in the operations. Therefore, the project will most probably have to attract skilled workers from other parts of the country or the Province, which means that new jobs will not all be created for the local communities and the effect on the unemployment situation would be smaller. It is estimated that at least 307 employment opportunities (of the 476) would be filled by local people.

d. Improved living standards of positively affected households

The creation of 1 869 FTE jobs through this project's operations will have a beneficial impact on household income levels. It is estimated that households benefiting from the project directly will earn a total of R91.4 million per annum in income. This will allow these households to improve their standards of living, considering that the average income earned by workers employed at the mine and its other operations on site will earn about 64% more than the average household income in the municipality.

Furthermore, the mine will implement an all-inclusive wage package which will include a Living out Allowance (LOA) and will consider providing a housing loan together with the LOA to improve the chances of its workforce to find quality accommodation. This will provide employees with opportunities to invest in their own homes and live in permanent sustainable housing with their families, which again would improve the living standards of the households. Considering that the area has housing shortages, the mine will consider engaging in an assisted home ownership scheme with relevant parties on behalf of their employees whereby housing units will be made available on a "first refusal" basis.

e. Sustainable increase in government revenue

The project, through its operations, will contribute a significant amount to government revenue through payments of income taxes, Secondary Tax on Companies (STC), royalties, and payroll taxes. It is estimated that the project would contribute some R76 million in 2012 prices to government revenue on an annual basis, which equates to R1.4 billion over the entire 19 year odd operation of the mine.

f. Skills development of permanently employed workers

The operations of the mine, concentrator plant, smelter and refinery will offer numerous opportunities for skills development and knowledge transfer. The mine already has a Social and Labour Plan (SLP) in place. As part of the Skills Development Plan (SDP) included in the SLP, the mine intends to provide training to 367 workers with regards to *Further Education and Training (FET)* and *Higher Education and Training (HET)*.

Such training would skill workers between NQF (National Qualifications Framework) Levels 2 and 8. The SDP also outlines a five-year budget for Adult Basic Education and Training (ABET), Core Business Training, Internal & External Learnerships and training for Artisans. A further R220 000 will be spent on School Support and Post Matric programmes. The project will also facilitate mentorship programmes as well as internal and external internship opportunities.

g. Local economic development benefits derived through mine's social responsibility programme

The operation of the mine will have a positive effect on the local economic development in the area. According to the SLP (2011) formulated for the mine, various Local Economic Development projects are planned to be implemented. These include, mentoring and training by accredited agricultural and business schools of a small number of emerging small scale farmers. Volspruit Mining Company plans to invest about R70million into establishing a network of small growers that would be supplying nutritious food to a central processing plant that is to be constructed by the Mining Company. This project is expected to create an additional 50 sustainable employment opportunities in the local community and around the Mogalakwena Local Municipality.

<u>Negative Impacts</u>

a. Potential losses of sustainable revenue by agricultural activities and game farming industry

The operations of the mine and its mineral beneficiation complex will have a number of potentially negative environmental impacts, amongst which are water abstraction issues (pit dewatering), visual impacts, and possible noise and air pollution impacts. The effects thereof on the agricultural activities in the area are described below:

- **Water abstraction**: The mine is expected to abstract water to the value of up to approximately 4.1Ml per day. The two farms where the proposed mine is to be established are estimated to use 2Ml per day for their irrigation and other purposes. With the establishment of the mine, 2 Ml per day will be made available and at the same time, revenue generated by these agricultural activities will no longer be created (the aspects that has been discussed in greater depth under the potential impact of the mine on economic activities due to agricultural land sterilisation). Thus, if the mine is established and land use changes, the demand for water in the area will also be reduced. Aside from Ptn, 1 and 2 of the farm Volspruit 326 KR, the pit dewatering by the mine will also potentially impact the static groundwater levels on the nearby farm Rondebosch 295 KR, which also makes use of irrigation to produce maize, sugar beans, bake beans, as well as goroh and sugar grace for fodder for cattle. Considering the estimated agricultural revenue generated on the farm Volspruit 326 KR, and assuming that the extent of agricultural activities taking place on Rondebosch 295KR is not greater than those taking place on Volspruit, the lowered groundwater table on the farm Rondebosch 295K could lead to the loss of between R2.5 million and R3.5 million of revenue per annum.

- **Visual effects:** The visual impact of the mine and specifically its tailings dams and other visible infrastructure could have a negative effect on the surrounding economic activities, and specifically game hunting. Based on the information provided by the farmers interviewed, which was limited, it is deduced that only two of the farms in the area appears to derive their primary income from game hunting, which is most sensitive to visual effects. Therefore, the negative effect on the local economic activities from visual disturbance will most likely be present, but it will have a significant impact only a couple of farms in the area.

- **Noise and air pollution**: Noise and air pollution could also have a socio-economic implications for farms that derive their income from activities that are sensitive to these impacts. The most sensitive economic activities to these impacts are expected to be citrus farming and game hunting activities. Only one farm in the immediate area is deriving income from citrus farming. Game hunting is taking place on some of the adjacent farms to the site, although they do not form part of the main income source. Farms that rely on game hunting as their main income sources are located further away from the site of the proposed mine. Therefore, it can be argued that the effects of noise and air pollution will most likely be not significant on the overall local economic activities if the noise and air pollution are properly mitigated.

The above suggests that environmental impacts ensued by the mine during operations could have a negative impact on the economic activities on the surrounding farms. However, considering the entire surrounding area of the farm, sensitivity of economic activities on the farms to various environmental impacts, and expected extent thereof, it is estimated that the most significant impact will be largely limited to the Volspruit 326 KR farm itself (due to sterilisation) and Rondbosch 295K. A smaller but nevertheless notable impact could be exerted on the local game hunting outlets, of which only two farms are entirely dependent on game hunting. Lastly, citrus farming could also be affected, but its magnitude is expected to be considerably smaller than the effect of water abstraction, for example.

b. Reduced opportunity to earn foreign exchange due to environmental impacts on surrounding farms

If the effect of air, visual and noise pollution on the local agricultural and farming activities transpire, there is a potential of the decline in export earnings generated by the local activities, and specifically citrus farming and possibly game hunting (assuming that the farms in the area do attract international tourists). The extent of the potential losses is difficult to estimate with a greater certainty as no detailed information was provided by the farms, specifically those involved in game hunting. However, considering the average profile of a game hunting facility and what little is known about citrus farming in the area, it could be suggested that the potential losses could be in the range between R1 million and R5 million per annum.

c. Negative impact on the livelihoods of people dependent on the affected agricultural and game farming activities

Potential negative impacts on the economic activities in the surrounding site environment would negatively impact livelihoods of households who are dependent on the activities on these farms. This could either be translated in the form of job cuts or reduced income.

Summary

The specialist Socio-economic Impact Assessment Report (Appendix 5.11) provides further detail in respect of the attributing factors toward assessing the relative significance of the identified, potential, socio-economic impacts of the project during the life of mine thereof. Table 8-34 that follows, and indeed the preceding sections, are aimed at providing a succinct summary of those potential impacts; where Table

8-34 provides a relative indication of the impact significance for each identified socio-economic impacts.

Table 8-34: Summary of socio-economic impacts during the operational phase of mining

Impact	Description	Significance rating	
		BM	AM
Positive			
Effects on balance of payment due to production of PGM alloy	• R1.4 billion of potential export earnings on an annual basis	-40	-
Sustainable increase in production and GDP-R in national and local economies	• R2 189 million of production sustained in the entire economy on an annual basis • R1 184 million of value added sustained in the entire economy on an annual basis	-80	-80
Creation of sustainable employment opportunities nationally and locally	• 476 sustainable employment opportunities at the mine • 1 869 FTE annual employment opportunities throughout the entire economy	-60	-60
Improved living standards of positively affected households	• R91.4 million earned by households benefiting from the project directly • About 1 869 households to benefit financially from the project throughout the entire economy	-60	-60
Sustainable increase in government revenue	• R76 million paid to government in the form of taxes and royalties on an annual basis	-40	-
Skills development of permanently employed workers	• 367 workers to enter FET and HET • ABET, Core business training and learnerships will be offered	-36	-48
Local economic development benefits derived through mine's social responsibility programme	• Development of small scale farmers and new processing plant • Creation of at least 50 sustainable employment opportunities	-64	-96
Negative			
Potential losses of sustainable revenue by agricultural activities and game farming industry	• Water abstraction, visual, noise and air pollution • Loss of agricultural revenue	34	22
Reduced opportunity to earn foreign exchange due to environmental impacts on surrounding farms	• Loss of R1 to R5 million per annum	14	9
Negative impact on the livelihoods of people dependent on the affected agricultural and game farming	• Loss of employment opportunities in the agricultural sector	34	22

Table 8-34: Summary of socio-economic impacts during the operational phase of mining			
Impact	**Description**	**Significance rating**	
		BM	AM
activities			

Mitigation/Management

The attached EMPR provides for a comprehensive range of proposed mitigation to be implemented during the construction phase of the project. These measures are cross-referenced to the subject impacts in Tables 5-19 to 5-31 in Appendix 5.11: Socio-economic Impact Assessment Report.

8.4 DECOMMISSIONING, CLOSURE AND REHABILITATION

The bulk of the activities undertaken in relation to the decommissioning and closure of a mine would typically occur at the end of the life of mine. It is, however, important to note that certain aspects of the mining operations may indeed be decommissioned prior to the end of life of mine, and that the rehabilitation of certain mine components may too commence well in advance of the planned closure of the mine.

In the case of the proposed Volspruit mine, it is notable that the mining of the north pit would be concluded at approximately year 13 of the planned 19 year life of mine, with mining at Volspruit between years 13 and 19 being undertaken almost exclusively at the south pit. In addition, the deposition of waste rock from the respective pits to the proposed waste rock dump will cease at approximately year 8 of the mining campaign. This allows for the rehabilitation of the north pit and waste rock dump to essentially commence in year 14 and 9 of the life of mine respectively.

Reference to the rehabilitation of the north and south pits should not be construed as meaning the back-filling and surface level, terrestrial, rehabilitation of the respective pits. Only partial back-filling of waste rock to the north pit will occur, with no back-fill of waste rock to the south pit planned.

The pits will be allowed to fill with water when active mining ceases, where the pits would essentially then form ‘open water’ features in the landscape and such that the final resting level of water therein will overlie a rehabilitated ‘beach-head’ that is to be planned to create a variety of habitats around the pit perimeters. The eastern and southern perimeter of the south pit would be the exception to the above, where the higher lying topography would not allow for the feasible creation of a beach-head, but where the aforementioned areas would be left as a hanging wall above the ‘lake’.

At the planned end of life of the Volspruit mine (i.e. year 19), decommissioning and closure would thus entail, *inter alia*, the following activities:

- Closure and rehabilitation/re-vegetation) of the TSF;
- Closure and rehabilitation of the south pit;
- Removal of the processing plant and the rehabilitation of the associated footprint;
- The removal of conveyers / railveyors used to transport run-of-mine to the processing plant, and the rehabilitation of the associated footprints;
- The rehabilitation of access and haul roads used during the operational life of mine; and
- The removal of all supporting service infrastructure (i.e. that which is not supportive of the smelter plant) from site and the rehabilitation of the associated footprints (e.g. water, electrical, road and sewage infrastructure).

The above activities will have potentially positive and negative consequences on the receiving environment of the site and surrounds. These potential impacts are discussed and evaluated in terms of their relative significance in the sections that follow. The assessment of impacts resulting from the closure and decommissioning of the mine in effect relates to the potential for residual environmental impacts following mine closure.

8.4.1 NORTH PIT CLOSURE PLANNING

An opportunity however exists for the creation of wetland habitat within the mined out and partially backfilled pits, specifically the North Pit. Partial backfilling of the mined out pit would result in the formation of a large 'open water body' directly connected to the shallow groundwater table. Water levels within the 'open water body' would be directly maintained by the shallow groundwater aquifer and respond to changes in water levels within the aquifer.

The natural rise and fall of shallow groundwater levels would thus also result in a rise and fall of water levels within the 'open water body'. Such an 'open water body' would provide opportunities for habitat creation that could support or enhance the biodiversity support function of the area post-mining, and potentially create opportunity for additional ecotourism use of the area. Prior to adopting such a strategy for final end land use, the following is however recommended:

The closure landscape should be designed and constructed so as to create habitats that closely approximate the Nyl River habitats including riverine floodplains, flooded basins, seasonally flooded grassland, groundwater fed woodland savanna and open savanna.

Consideration should be given to the establishment of an optimal a mosaic of habitat types ranging from woodland, floodplain thornveld and semi-permanent wetland areas such that bird species under pressure may be optimally provided with refuge feeding and breeding habitat. With respect to wetland areas a wide diversity of habitat types should ideally be established ranging from open shallow shoreline to reed fringed open water and refuge areas such as islands with tall dead trees.

The development of the IWWMP pit water management and closure plan component will need to involve relevant specialists including amongst other geohydrological, wetland, fish and avifaunal specialists. Various biodiversity specialists should be consulted on the requirements for habitat creation to support specific species, specifically the following specialists:

- Fish specialists to comment on the habitats required to support indigenous fish species of the area and the potential/desirability of the 'open water body' to act as a fish reservoir connected to the floodplain wetland system
- Avifaunal specialists to comment on the habitat requirements of waterbirds likely to make use of the habitat
- Wetland specialists experienced in wetland creation to determine suitable species that could be used and their requirements for establishment

The viability of establishing and maintaining the desired habitats under the hydrological regime likely to occur with the 'open water body' should also be assessed in detail, specifically:

- Water levels that are likely to fluctuate by several meters and the implications thereof on establishing and maintaining a vegetated shoreline
- Expected water quality within the 'open water body'. In this regard the threat of excessive algal growth due to potentially high background nitrate levels within groundwater needs to be assessed.

No groundwater abstraction should be allowed on mine owned land post closure so as to minimise groundwater fluctuations and, by implication, also minimise water level fluctuations within the open water body. Water levels within the open water body will however respond to fluctuations in the groundwater table due to local and regional abstraction.

The 'open water body' should be isolated (in terms of surface water connections) from the adjacent floodplain wetland until such a time as the creation of habitat has proved successful and water quality has been shown to present no threat to the floodplain wetland. Once this has been achieved, a link between the floodplain and the 'open water body' could be investigated.

Surrounding land use during both operational and closure of the mine should remain utilised for agricultural, conservation and related uses and ideally with an increasing tendency to the natural state and higher conservation state as the north pit wetland area is approached.

8.4.2 GROUNDWATER QUANTITY / QUALITY

Introduction

The pit dewatering to be undertaken during the operational life of the respective opencast pits will create a cone of groundwater depression around these respective pits. This drawdown of the groundwater table will effectively 'pull' groundwater towards the pits themselves. Once the pit dewatering ceases at the end of mining, and the pits are allowed to fill, any pollutants in the water contained therein would then potentially migrate away from the pits and into the adjacent alluvial aquifer, or possibly even decant at surface toward the Nyl river (north pit).

Impact discussion

Groundwater 'Quantity':

After closure, the water table will rise in the rehabilitated pits to reinstate equilibrium with the surrounding groundwater systems. However, the mined areas will have a large hydraulic conductive compared to the pre-mining situation. This will result in a relative flattening of the groundwater table over the extent of the rehabilitated opencast, in contrast to the gradient that existed previously.

The end result of this will be a permanent lowering of the groundwater level in the higher topographical area and a rise in lower lying areas. Intuitively, it would be expected that this raise in groundwater could result in decanting of the opencast. Without any clay barrier and grouting, it was found that the north pit opencast could indeed decant, as depicted in Figure 8-31. However, the proposed clay wedge in the upper 15m and grouting to depth below this seems to be very effective in eliminating this decant (Figure 8-32), even though the barrier extend only to surface in the model.

Inspection shows that it is mainly due to the reduced inflow into the backfilled opencast from the east, which is preventing excessive build-up of the groundwater level in the pit. Grouting in the western section of the north pit (upstream) is thus vital to prevent decanting at the north pit. No decanting from the south pit is, however, predicted.

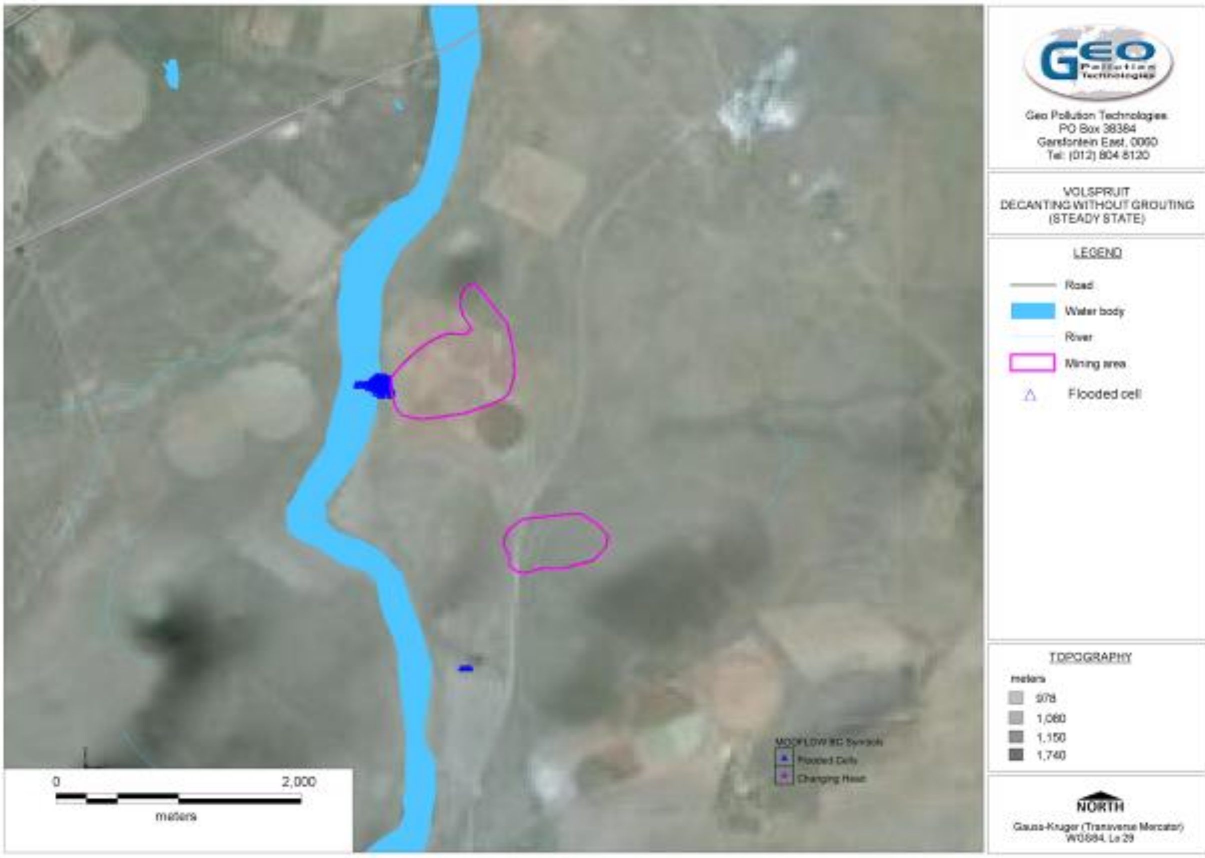


Figure 8-31: Post mining opencast pit decant (No clay barrier / grouting installed)

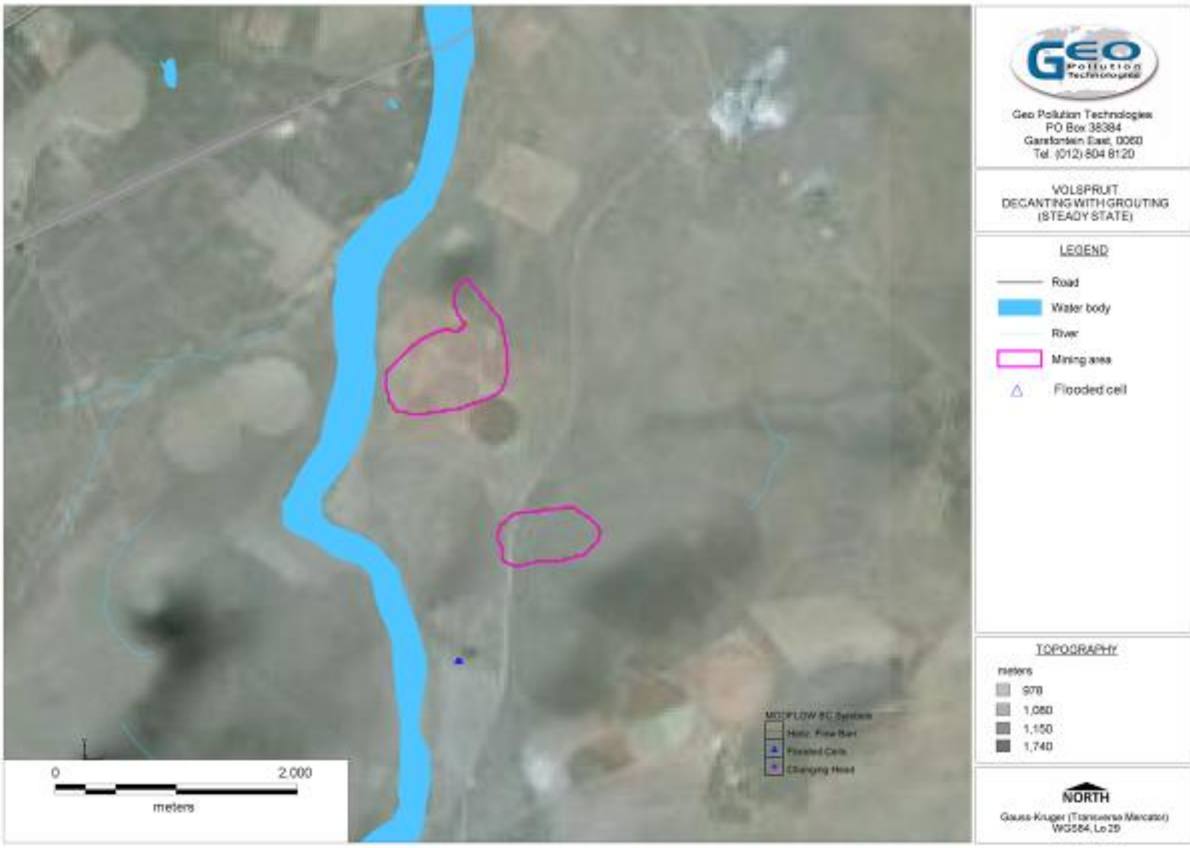


Figure 8-32: Post mining opencast pit decant (With clay barrier / grouting installed)

Groundwater 'Quality':

Once the normal groundwater flow conditions have been re-instated, polluted water could potentially migrate away from the rehabilitated opencast pits. In the absence of large scale abstraction to maintain a zone of drawdown, groundwater flow will be towards the opencast from higher lying areas (i.e. from the east), and away from the pit towards the river. Currently groundwater is abstracted in the area for crop irrigation and could change groundwater flow directions from those modelled. But future land use is unpredictable. Thus, no abstraction has been assumed for this 'worst case' scenario. There is also the scenario of groundwater flow to the east rather than the west, as postulated by the surface water report, but groundwater flow the west (i.e. towards the Nyl river) is considered the 'worst case' scenario in the context of assessing the impacts of a potential groundwater pollution, and has accordingly been assessed in a precautionary manner.

Although the overburden (i.e. waste rock) at Volspruit has been shown to be likely non-acid generating, the geochemical studies undertaken for the EIA predict the production of sulphate from this material once it becomes exposed to oxygen and water through the mining thereof. Thus, seepage from the partially back-filled north pit (the only pit to which the back-filling of waste rock will occur) will potentially be contaminated as a result of neutral mine drainage. As sulphate is normally a significant solute in such drainage, it has been modelled as a conservative (non-reacting) indicator of mine drainage pollution from the north pit.

The geochemical model indicated that the sulphate concentration in the waste rock back-filled to the north pit will build up from 0 to about 1 000 mg/litre over a period of 100 years following the back-fill of the north pit. It has been assumed as a possible scenario, and pollution plume migration modelled under these auspices.

As the back-filled opencast (especially north pit) are currently planned to be an open lake after rehabilitation, recharge of 100% of rainfall have been assumed. The south pit has not been modelled as a potential pollution source, as it is currently planned to be left open with no back-filling of waste rock. The only possible source of pollution would be the sides of this particular pit that are exposed to the water in the pit, and the reacting surface will be minuscule in comparison to an opencast pit back-filled with sulphate generating waste rock (i.e. the north pit).

The migration of contaminated water from the mining area has been modelled, and the results are presented in Figure 8-33 in terms of the extent of the potential pollution plume at 10, 25, 50 and 100 years after the mine has been closed and rehabilitated. Acknowledging the limitations and assumptions in GPT's geochemical modelling, it can be estimated from these figures that:

- Movement of the plume will be downstream towards the Nyl River to the west of the opencast, as can be expected;
- However, concentrations of sulphate in groundwater outside of the pit are relative low and only start to reach class 2 levels at isolated spots in about 50 years. These isolated spots are the result of concentration through evapotranspiration, and might be unrealistic due to the inferred clay layer below the river;
- Despite the high hydraulic conductivity of the aquifer, the movement of the plume is predicted to be relatively slower than expected, due to the flat topography (assuming no groundwater abstraction); and
- However, after about 25 years the front will have moved the distance to the river and could start impacting on the water quality of this resource. With current best knowledge, the surface water in the river is not connected to the groundwater;

therefore the plume would rather spread underneath the confining clays layer and resume flow to the north in the absence of pumping.

In summary, according to the geochemical model, due to mineral oxidation, weathering and dissolution an increase in pH and major ions in groundwater as well as salinity over the life of mine and beyond, can be expected, however due to dilution groundwater impacts associated with oxidation of back-filling are low and plume concentrations should not impact water abstracted from neighbouring boreholes

Figure 8-33: Modelled plume migration from opencast pits at 10, 25, 50 and 100 years post mine closure (with grouting)

Table 8-35: Impacts on groundwater quality (Decommissioning / Post closure)			
Nature (N)	Negative: Negative residual impacts on groundwater resource quality, with associated indirect impacts on the availability thereof for human consumption and/or irrigation.		1
Extent (E)	Regional: The impact could potentially have regional consequence (i.e. within the local municipality) if the Mogalakwena Local Municipality (MLM) wish to pursue access to 'Volspruit' groundwater as part of their strategic plans to sustain increased water potable/domestic demand in the town of Mokopane.		3
Duration (D)	Permanent: The pollution of groundwater would persist *ad finitum* without significant interventions to address such.		5
Intensity (I)	Major: The impact would potentially impact upon a source of domestic/agricultural water supply (i.e. sulphate concentrations in adjacent boreholes could reach levels making water unfit for human consumption unless treated).		4
Probability (P)	Very likely: There is a good possibility that the impact could occur (as per GPT's modelling thereof), to the extent that provision should be made for it.		3
Mitigation (M)	Moderately mitigated: Polluted groundwater could be treated with readily available treatment technologies (at great cost, relative to conventional water treatment for domestic supply)) to make it fit for human consumption / irrigation again, but residual impacts on groundwater quality would likely remain.		3
Enhancement (H)	N/A		
Reversibility (R)	Slightly reversible: The impact is not easy to reverse once it has occurred. It would take significant effort on the proponent's behalf to reverse the impact *in situ*, and even then, residual impacts on groundwater resource quality would remain.		2
Significance Rating with Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**Moderate**	38
Significance Rating without Mitigation - Negative Impact (S)	N x (E+D) x I x P ÷ ½(M+R)	**High**	65
Significance Rating -Positive Impact (S)	N x (E+D) x I x P x (H).		-

Mitigation/Management

The implementation of the pit grouting strategy, or equivalent engineering solution, is, according to GPT, imperative in limiting the extent of any decant or significant groundwater pollution plume post mine closure. Additional measures will include the control of both ingress and abstraction from the pits.

No groundwater abstraction should be allowed from the North Pit and surrounding land within pit groundwater recharge area (significant part of Volpsruit 326 KR Portion 1, 5, 6 and other) so as to minimise groundwater fluctuations in the pit that will affect wetland habitat and function.

The management of water quality and potential links with the Nyl River will have to be managed as part of the closure plan and will need to be developed in greater detail in the IWWMP to be submitted as part of the WULA. The development of the IWWMP pit water management and closure plan component will need to involve relevant specialists including amongst other geohydrological, wetland, fish and avifaunal specialists.

The proponent will, furthermore, need to establish a comprehensive groundwater, wetland and avifaunal monitoring programme on- and around the mine site (as detailed in the attached EMPR Monitoring Plan) to identify any pollution plume, and impacts on wetland health, as well as bird and fish populations and implement measures to remedy such in line with Section 28 of NEMA, " Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment".

9. ALTERNATIVES SELECTION

9.1 SITE ALTERNATIVES

The difficulty lies predominantly in the fact that the position of underground ore bodies constrains open cast mining activities to a very specific area. The position of the ore bodies underground will not change, and so the position of the open cast pits that will be established to access the target ore bodies will fall more-or-less over these areas. Site alternatives have thus not been assessed as part of the EIA process.

9.2 LAYOUT ALTERNATIVES

Figure 9-1 provides an overview of the preferred layout alternative(s) selected for the project, in relation to all the layout alternatives identified in section 2.9 'Alternatives'. The sections that follow aim to provide a brief summary of the contributing factors towards the selection of the preferred layout alternative(s), relative to the other alternatives identified.

9.2.1 WASTE ROCK DUMP

The preferred waste rock dump position has been selected on the basis of the following key contributing attributes of potential impact significance (i.e. relative to the remaining alternatives considered):

- By positioning the waste rock dump in relative close proximity to the TSF, the relative intensity and extent of the potential visual impact thereof is reduced (relative to the other layout alternatives considered); where the distance and extent to which such structures are visible on the landscape is a function of, *inter alia*, the lateral scale at which they occupy a receptor's central field of vision (i.e. the distance of the side profile on the landscape);
- The preferred alternative is furthest removed from the Nyl river, as well as sensitive noise receptors to the west of the site; where such would act to -
    - reduce the likelihood and intensity of potential impacts on surface water quality; and
    - reduce the intensity of potential noise nuisance/disturbance along the western mine boundary.
- The preferred location keeps a larger tract of consolidated land (i.e. with high agricultural potential) available along the eastern side of the Nyl river open for the proposed 're-establishment' of irrigated cropland to be lost through the mining of the north pit (Figure 2-20).

9.2.2 TAILINGS STORAGE FACILITY

The preferred TSF location that emerged from SRK Consulting's 'TSF site selection process' (Full report attached under Appendix 5.16) was 'TSF 1' (Figure 9-1). A further refinement was effected on the layout of the TSF footprint (i.e. 'TSF 1B') with the objective of –

- reducing the relative intensity of the TSF's potential impact on terrestrial biodiversity by placing the footprint of this structure outside of an area of habitat with medium-high sensitivity (i.e. in favour of habitat deemed to have medium sensitivity - Figure 6-11); and

- reducing the relative intensity and extent of the potential visual impact (relative to the other layout alternatives considered) by consolidating the proximity of the TSF with the preferred waste rock dump position; where the distance and extent to which such structures are visible on the landscape is a function of, *inter alia*, the lateral scale at which they occupy a receptor's central field of vision (i.e. the distance of the side profile on the landscape

9.2.3 PLANT

The preferred plant site location was largely decided upon based on logistical grounds and space constraints on the farm Volspruit around the 100m blast radius of each respective pit. The preferred plant location does, however, see the plant moved further eastward from noise receptors to the west of the site, although only marginally. Without a smelter and refinery at the mine, the project is not deemed financially viable according to the proponent. Whilst it is true the smelter complex could be positioned at distance from the mine, the fact that the smelter complex has a very limited impact (emissions, noise etc.) makes this option unpractical and/or unfeasible.

9.3 TECHNOLOGY ALTERNATIVES

Section 2.9.5 already discusses the advantages and disadvantages of various alternatives for roaster off-gas sulphur fixation at some length. The EAP's preferred alternative in this regard is the establishment of a 'sulphuric acid production' sulphur fixation plant. This opinion is expressed predominantly in relation to –

- the lower energy and water consumption of the technology, relative to the other alternatives;
- the fact that a potentially saleable by-product is produced out of the process (i.e. sulphuric acid);
- the fact that the technology produces no discernable wastes or effluents, relative to other technologies; and
- the technology does not consume significant volumes of reagents / raw materials.

It must, however, be said that the capital costs in establishing such a plant are significantly higher than those of the other technologies considered. It is thus proposed that the proponent be authorised for the establishment of either i) the sulphuric acid production technology, or ii) the limestone scrubber technology; where both are deemed capable of achieving the required SO_2 emission limits for the roaster off-gas, but where the establishment of the scrubber would necessitate appropriate, environmentally sound, gypsum waste management onsite for the duration of the operational phase of the project as a consequence.

9.4 END LAND-USE ALTERNATIVES

Reasonable and feasible end land-use alternatives for the project are somewhat limited. The end land-use proposed by the proponent for the Volspruit mine site, is thus to have the pits fill with water once mined, and to establish/continue a combination of conservation, agricultural and limited recreational uses around the 'lakes' to be created. The back-filling of the north pit is to be structured so as to create habitats that closely approximate the Nyl River habitats including riverine floodplains, flooded basins, seasonally flooded grassland, groundwater fed woodland savanna and open savanna. The establishment of an optimal a mosaic of habitat types ranging from woodland, floodplain thornveld and semi-permanent wetland areas such that bird species under pressure may be optimally provided with refuge feeding and breeding habitat. With respect to wetland areas a wide diversity of habitat types should ideally be established ranging from open shallow shoreline to reed fringed open water and refuge areas such as islands with tall dead trees.

There are not deemed to be any reasonable, or feasible, alternatives to the proponent's proposal. This is largely due the reasons mentioned previously, as well as the relative location of the site in its present day rural/agricultural setting. No residential or commercial land-uses are considered feasible by virtue of the removed location of the site relative to Mokopane and the bulk service infrastructure already in place in the town (i.e. limitations of 'urban sprawl').

The proponent's preferred land-use is deemed most fitting in respect of the land-use character of the 'unaffected' portions of the farms Volspruit and Zoetveld, as well as the surrounding farms. The farming of the irrigated croplands to be established during the life of the mine (Figure 2-21) would continue, with the remaining green-fields areas and areas to be rehabilitated on the site, to be used for a combination of game farming / cattle grazing.

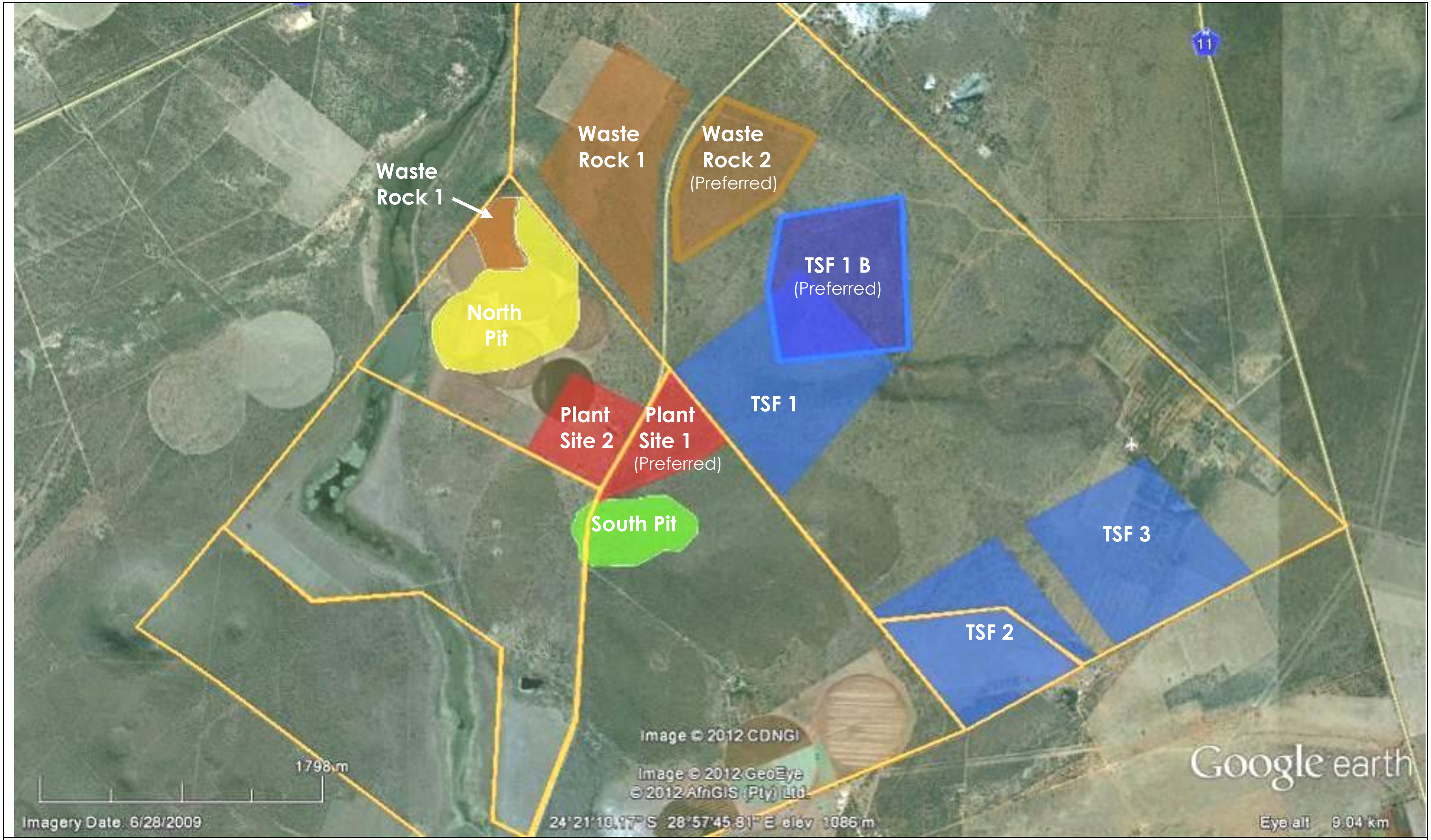


Figure 9-1: Summary of preferred alternatives for the placement of mine residue deposits (Waste Rock and Tailings Storage Facility, TSF) and plant infrastructure

10. ASSESSMENT OF CUMULATIVE IMPACTS

The NEMA 2010 Regulations states that a 'cumulative impact', in relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area. The outputs of a cumulative impact assessment can be -

1. the identified sources of cumulative impacts;
2. the sequence of events from source to effect; or
3. the resultant effects.

Cumulative impact assessment methods are evolving and there is no single accepted state of global practice. Key is to consider cumulative impacts as integral to the assessment of impacts and that activity induced impacts not be seen in isolation but considered using a wider systems based approach to consider both the assimilative capacity to absorb cumulative impacts.

Several potential cumulative impacts have been identified for the proposed mine, as follows, and have been intrinsically assessed in specialist studies utilising state of the art modelling and also as part of the EIA itself and relevant supporting specialist assessments:

- The groundwater modelling and assessment and the associated modelling undertaken for the EIA took cognisance of the existing groundwater abstraction being undertaken by farmers in the area for cropland irrigation, in order to determine the significance of the cumulative impact of pit dewatering and agricultural abstraction on groundwater drawdown and down-stream users access to this resource;
- The integrated surface and groundwater hydrological modelling considered the entire Nyl catchment and effect of catchment wide abstraction, cumulative impacts being determined through the combination of surface and hydrogeological models;
- The assessment of impacts on site biodiversity took cognisance of the fact that there are host of site activities and related indirect impacts that cumulatively act to potentially compound the project's impacts on site biodiversity (e.g. noise, water resource quality degradation, vegetation clearance and light illumination may act together to create a larger cumulative impact on site biodiversity);
- The specialist air quality impact assessment undertaken in support of the EIA took due consideration of the potential existence of other potentially significant emission sources in the area (i.e. that may contribute toward cumulative impacts on ambient air quality, together with the proposed mine's emissions). No such source was identified, with the closest mine to the Volspruit site being located some 35km north west thereof;
- The air quality impact assessment further considered the cumulative impacts of criteria pollutant emissions on ambient air quality resulting from all relevant onsite sources; and
- The noise impact assessment undertaken in support of the EIA took cognisance of existing sources of noise disturbance in the area (e.g. N1 and N11) in assessing the cumulative noise impact of all significant noise generating activities proposed by the proponent (construction and operation).

It must be noted that several mining licence applications (in the order of 8-9 proposed mines in close proximity to the greater Nylsvlei wetland system) have been noted from the specialist technical groundwater workshops undertaken for the EIA.

These are understood to include a combination of PGM and coal mining applications. The cumulative impacts of such mining on the Nylsvlei has not been assessed in any discernable level of detail in this EIA; where such assessment would best be undertaken in the form of a Strategic Environmental Assessment (SEA).

11. SUMMARY FINDINGS AND EAP RECOMMENDATIONS

11.1 ENVIRONMENTAL / BIO-PHYSICAL IMPACT SUMMARY

The tables that follow provide a concise overview of the relative impact significance of potential biophysical impacts they may result from the establishment, operation and decommissioning/closure of the proposed Volspruit Mine.

11.1.1 CONSTRUCTION

It is evident that the construction phase impacts with greatest potential significance are impacts on site biodiversity; where the impact would result predominantly from large-scale clearance of indigenous vegetation (i.e. direct impacts on biodiversity through habitat loss), as well as indirect impacts of construction on site biodiversity (i.e. noise, vehicular movement, water pollution, etc.). The relative impact significance of these aspects is deemed high. This is predominantly by virtue of the highly sensitive nature of the wetland habitat on site, as well as ecological linkages (direct and indirect) thereof with the greater Nylsvlei wetland and the Nylsvley Nature Reserve (Ramsar site), and the location of the site within an internationally recognised important birding area (IBA).

No identified construction phase impacts are identified to pose a fatal flaw to the project, provided that the mitigation put forward in this EIA and the attached EMPR are complied with by the proponent during mine establishment.

Table 11-1: Tabular Summary of construction phase Impact Assessment

Aspect	Impact Significance (No mitigation)	Impact Significance (mitigation)
Construction		
Noise	Moderate	Low
Cultural / Heritage Resources	Moderate	Moderate
Biodiversity	High	High
Avi-fauna (Habitat loss)	High	High
Avi-fauna (Noise)	Moderate	Moderate
Agricultural Potential / Land use	High	Moderate
Surface Water Hydrology	Low	Low
Ground- & Surface Water Quality	Moderate	Low
Traffic	Low	Low

11.1.2 OPERATION

The operational phase too has the potential to result in impacts with high relative impact significance on site-, as well as regional biodiversity (both directly and indirectly). This is again by virtue of the highly sensitive nature of the Nylsvlei wetland (ecological and hydraulically) and the linkage of the ‘Volspruit’ wetland both up- and down-stream with the remainder of this system [incl. the Nylsvley Nature Reserve up-stream (a Ramsar site)]. The aforementioned impacts are a potential indirect consequence of groundwater drawdown to be created around the opencast pits as a result of pit dewatering.

An extensive survey of the area that is expected to be undercut by the mine dewatering drawdown cones was carried out so as to determine the lateral and vertical extent as well as permeability of the clay layer associated with the Nyl River. It was found that the permeability of the clay soil is low and that very little water would be lost from the river bed over time due to the thick clay layer.

From the soil profiling undertaken it is clear that flood water will mostly remain trapped on the clay layer and only peripherally decant during flood extremes. Dewatering below the clay layer may affect the volumes decanted from wetland margin to the extent that the mine dewatering will increase depth below ground of groundwater level. Based on the soil profiles from transects it seems that the recharge from the flood may takes place in a localised area on the western side of the Nyl on the toe of the alluvial fan due to combination of the flatter slope which allowed the flood line to extend further on the western periphery and an area where clay layers associated with the Nyl are also substantially thinner.

When mining at the North Pit has reached final depth, drawdown of groundwater below the Nyl could be as much as 20 m (groundwater modelling GPT 2014), and compared to levels of around 10 m currently as a result of irrigation abstraction (groundwater measurements GPT 2013). The difference in volumes that will be lost from the flood event between current irrigation abstraction regime and future mining abstraction regime is not considered to be meaningful.

No fatal flaws have been identified for the project during the operational phase thereof, provided that the full range of mitigation and monitoring requirements put forward in this EIA and the attached EMPR are complied with by the proponent during mining and processing activities.

Table 11-2: Tabular Summary of operation phase Impact Assessment		
Aspect	**Impact Significance (No mitigation)**	**Impact Significance (With mitigation)**
Operation		
Noise	Moderate	Moderate
Blasting	High	Moderate
Groundwater Quality	Moderate	Moderate
Groundwater Quantity – aquifer and borehole yields)	Moderate	Moderate
Groundwater Quantity - wetland hydrology / flooding 2013 precautionary rating)	High/Severe	Moderate
Groundwater Quantity - wetland hydrology / flooding 2013 precautionary rating)	High	Moderate
Biodiversity (2013 precautionary rating)	High/Severe	Moderate
Biodiversity (2014 after additional study)	High	Moderate
Avi-fauna (Nyl hydrology impacts)	High / Severe	Moderate
Av-fauna (Light illumination / collisions)	High	Moderate
Visual & Aesthetic Character	High	Moderate
Air Quality	Moderate to High	Moderate
Traffic	Low	Low

11.1.3 DECOMMISSIONING

The most notable potentially negative impact identified for the decommissioning and closure of the mine is for potential decant from the flooded pits post mine closure, as well as the development of a potential sulphate pollution plume within the adjacent aquifer following the flooding of the pits; where such is modelled not to reach any adjacent boreholes at up to a 100 years post mining. The plume has, however, been modelled to undercut the Nyl river at approximately 25 years following the flooding of the north. The impact is deemed to have potential moderate significance, providing that the mitigation put forward in this EIA, as well as the attached EMPR are complied with y the proponent.

The remaining impacts would act to partially restore pre-mining conditions over the site, with positive consequences (i.e. relative to the operational phase); where rehabilitation would act to revert as much of the mine site footprint as possible back to Central Sandy Bushveld as is feasible / practical.

Table 11-3: Tabular Summary of Decommissioning (Post closure) Phase Impact Assessment

Aspect	Impact Significance (No mitigation)	Impact Significance (mitigation)
Operation		
Groundwater Quality and Quantity	High	Moderate

11.2 SOCIO-ECONOMIC IMPACT SUMMARY

The proposed mine and mineral beneficial complex is expected to create both positive and negative impacts during the construction and operational phases. From a socio-economic perspective, the positive effects in terms of export earnings, economic development, job creation, household income, and government revenue that could be derived during both construction and operations by far outweigh the negative impacts that could ensue as a result of the mine's establishment and operation in the area.

However, the mine will be associated with a number of other negative effects that are more challenging to quantify and to offset. These are associated with the sense of place, property values, loss of family ties, crime situation and pressure on socio-economic infrastructure. Some of the impacts would only last during the construction period (such as crime and impact on socio-economic infrastructure), while others will extend into the operational period and will therefore be of a considerable longer term.

While the economic benefit of the mine's establishment in the area cannot be faltered, all efforts need to be made to ensure that the establishment and operation of the mine is conducted in the undertaken in the most sustainable way with the primary objective of minimising and where feasible completely eliminating the potential for altering human livelihoods in the area.

Table 11-4: Tabular Summary of Construction Phase Impact Assessment (Socio-economic)		
Aspect	**Impact Significance (No mitigation)**	**Impact Significance (mitigation)**
Positive		
Temporary stimulation of the national and local economies	High	High
Creation of temporary employment opportunities nationally and locally	High	High
Temporary increase in household income during construction	High	High
Contribution to skills development during construction	Negligible	Negligible
Temporary increase in government revenue	Negligible	Negligible
Negative		
Negative impact on the balance of payments	Negligible	Negligible
Loss of agricultural production due to land sterilisation	High	High
Negative changes to the sense of place	High	Moderate
Negative impact on surrounding agricultural and game farming activities	Low	Negligible
Negative impact on households due to potential negative impacts on land sterilisation and surrounding economic activities	Moderate	Moderate
Pressure on social and economic infrastructure	Low	Low
Temporary increase in crime and social conflicts associated with influx of people	High	Moderate
Potential negative impact on property values	High	Moderate
Potential loss of family ties	High	Moderate

Table 11-5: Tabular Summary of Operational Phase Impact Assessment (Socio-economic)		
Aspect	**Impact Significance (No mitigation)**	**Impact Significance (mitigation)**
Positive		
Effects on balance of payment due to production of PGM alloy	Moderate	Moderate
Sustainable increase in production and GDP-R in national and local economies	High	High
Creation of sustainable employment opportunities nationally and locally	High	High
Improved living standards of positively affected households	Moderate	Moderate
Sustainable increase in government revenue	Moderate	Moderate
Skills development of permanently employed workers	Moderate	Moderate
Local economic development benefits derived through mine's social responsibility programme	Moderate	Moderate
Negative		
Potential losses of sustainable revenue by agricultural activities and game farming industry	Moderate	Moderate
Reduced opportunity to earn foreign exchange due to environmental impacts on surrounding farms	Low	Negligible
Negative impact on the livelihoods of people dependent on the affected agricultural and game farming activities	Moderate	Moderate

11.3 GAPS, ASSUMPTIONS AND LIMITATIONS

11.3.1 GAPS IN INFORMATION

Explicit documentation of the assumptions, models, information sources used, as well as information from which conclusions have been drawn have been set out in the specialist studies. Few environmental assessment processes will have all the information required to make predictions with absolute certainty, it is important that adequate information be provided so as to allow informed and defensible decisions to be made by authorities. A summary of key information to be considered by decision-makers is set out in Table 11-6 below.

Table 11-6: Information considered important for decision-makers	
Decision-making stage	Project background and the most important environmental issues involved
Policy Context	Basic development issue or problem being addressed
	The relationship to environmental policies and plans
Alternatives	Alternatives to the proposal (including the best practicable environmental option (BPEO) or equivalent designation)
Impact analysis	Costs and benefits
	Distribution of benefits and losses
Mitigation and monitoring	Adequacy of proposed mitigation measures
Conclusion and recommendations	Main economic benefits, significant environmental effects and proposed mitigation measures
	The extent to which the proposal conforms to the principles of sustainable development
	Design and operational changes to improve the environmental acceptability of the project

It is the view of the EAP that adequate information to allow an informed decision has been collated.

11.3.2 ASSUMPTIONS AND LIMITATIONS

This report is in a large part derived from specialist reports and the information contained in these reports. Assumptions made within this report and its attachments depend on the accessibility to, and reliability of, relevant information, including maps and other secondary information sourced from third parties, information provided by the proponent as well as data assimilated by monitoring contractors and analyses performed by laboratories.

Specifically, some of the data used in hydrogeological modelling has not been determined through measurement in the field, but has been used from literature, or applied through expert judgement, and therefore model outputs have a degree of associated uncertainty. The input parameters applied in the groundwater model were reviewed through a series of technical workshops that involved various specialists, academics and NGOs that have intimate knowledge of the Nyl system. The extent to which model input parameters may influence model predictions was further tested through scenario modelling and sensitivity analysis.

Although the modelling undertaken is invaluable in providing an understanding of the dynamics of the Nyl surface- and groundwater systems, the complexity of the system and its sensitivity in terms potential impacts that dewatering may have on flood events and ecological processes (e.g. migration and breeding cycles of fish), may demand high levels of confidence in mode predictions. In order to confirm the veracity of the groundwater model and the conceptual understanding of the Nyl system assumptions made need to be verified.

In the context of the Nyl wetland system and its flood dynamics there is simply no surrogate for the actual measurement and empirical correlation of the relationship between surface and groundwater flows, and accordingly there is consensus that a surface flow event will need to be monitored along with groundwater response before adequate certainty can be afforded to a model (conceptual or otherwise) of links between surface flood events and groundwater, as well as the separation of the systems and/or degree thereof.

11.4 EAP SUMMARY AND RECOMMENDATIONS

11.4.1 SUMMARY OF CONSIDERATIONS

The potential socio-economic benefits of the proposed project have been demonstrated to be significant; where the positive effects in terms of export earnings, economic development, job creation, household income, and government revenue that could be derived during both construction and operations are deemed by a socio-economic specialist to outweigh the potentially negative socio-economic impacts that could ensue as a result of the mine's establishment and operation in the Mokopane area. The need and desirability of the project has further been demonstrated, in terms of *inter alia* the alignment thereof with the following development growth plans, policies and strategies:

- New Growth Path;
- IPAP 2011/2012-2013/2014;
- Industrial Development Corporation (IDC) and Development Bank of South Africa (DBSA) financing plans;
- Mineral Beneficiation Strategy for South Africa;
- Limpopo Economic Development Plan;
- Waterberg LED; and
- Waterberg Mining Strategy.

A project of this nature cannot, however, be motivated solely on socio-economic grounds alone, and needs to take due consideration of the potentially negative environmental impacts that may result from the project in order for defensible, sustainable, decision-making to occur at the hand of the respective competent authorities. In this regard, the following points are noteworthy for decision-makers:

- The farms on which the proposed Volspruit Mine fall (i.e. the Farms Volspruit and Zoetveld) are located in Zones one 1 and 10 of the Waterberg environmental management framework (EMF).

- The EMF describes Zone 1 as an area where "Protection of natural vegetation, scenic landscape and rock painting areas, with limited appropriate tourism" should exist, and Zone 10 as: "Agriculture areas with commercial focus". The EMF goes further to list 'undesirable activities' for each zone, as described above, where mining is listed as an 'undesirable activity' in both Zone 1 and Zone 10.
- When discussing undesirable activities the EMF does state the following: "It does not however mean that undesired activities for example will not be allowed under any circumstances but rather that such activities will have to meet very high standards and be considered very carefully by the relevant competent authorities before they are allowed"
- The EIA process followed addresses the extreme standards to which the mine will need to perform specifically with respect to managing impact to water including grouting and pollution control system performance.

- The Waterberg District Municipality SDF, 2009 states that: "While mining is recognised as a pillar of the local economic base and key job provider, the long term impact thereof should be carefully considered. Current indications are that with the exception of one or two protected areas there is no direct conflict between mining and prospective mining activities and the major tourism and conservation areas in the municipality".
  - The preceding statement clearly indicates that mining is recognised in the SDF as an economic pillar, however, the impact thereof should be carefully considered. The EIA process followed has indeed sought to better understand and quantify these potential impacts through a series of linked models as the EIA process has highlighted that issues relating to water supply and wetland integrity and protection demanded detailed analysis careful consideration.

- The Mogalakwena SDF (2009) states that: "The increasingly important role of mining in the local economy is recognised by the Council. However, mining is driven by international commodity prices and economic conditions. The Council will therefore support the mining sector in terms of land and services availability but in such a way that it does not take on responsibilities in terms of business risks of the mines".
  - The Mogalakwena SDF contains various sections on water; Land use; biospheres etc. and the SDF requires protection of 'Environmental Features' as follows: *"The environmental features of the municipal area are dominated by the river (Nyl) and specifically the river buffer along it… River buffers are ecologically important for the protection of ecosystems and should, therefore, be avoided and not disturbed through development. In this respect, river buffers should be protected".*
  - Significant efforts have been made with the siting of infrastructure and development of pollution control systems to ensure the Nyl River is protected.

Although mining is recognised as an important economic activity locally, regionally and nationally, the potential impacts thereof in appropriate mining activity is pertinently cautioned against and accordingly the sensitive components of the receiving environment need to be well understood before allowing informed decision-making around mining applications. Importantly, the presence of the Nyl River and its ecological importance in the region is recognised in the aforementioned frameworks and thus need to be addressed to consider whether a project can operate within the framework of the above guidelines. In this respect the framework within which decision making need to place need to consider that:

- The Nyl River wetland system (also referred to as Nylsvlei wetland system) and associated wetland/aquatic habitat it offers [including the Nylsvley Nature Reserve in the upper reaches thereof (a Ramsar site)], a section of which traverses immediately west of the proposed mining operations, is deemed by ecological and avi-faunal specialist to be highly sensitive to potential disturbances from the proposed mining activities.
- Accordingly the potential impacts of mining on this sensitive habitat that formed a key focus of the EIA. The EIA and various specialist studies assessed the potential environmental impacts of the project across all relevant environmental aspects and over the full project life cycle, with the attached EMPR documenting the mitigation and monitoring measures required to ensure that such impacts are reduced to within acceptable levels of significance.
- The EIA finds none of the environmental impacts identified are deemed to be of such significance that they constitute a fatal flaw to the project (when adequate mitigation measures are implemented):
  - Mine dewatering will lead to the groundwater cone of depression undercutting the Nyl River (and concerns in respect of potential impact to the Nyl River flood dynamic prevented the EAP to favourably recommend the development in terms of prior MPRDA application), specialist studies have indicated that the Nyl flood event is divorced from the regional aquifer by a comprehensive clay layer; furthermore, current groundwater abstraction for crop irrigation already undercuts the Nyl River and allows the continued function of the surface flood event.
  - The Nyl River catchment and associated groundwater aquifer is water stressed and volumes of water estimated to be abstracted for crop irrigation is significantly higher than water uses registered with the Department of Water Affairs. The dewatering of the mine will produce more water than the mine will required for its own operations. Limited additional groundwater abstraction from the mine over and above what is currently abstracted for crop irrigation on the site will lead to marginal reduction in Mean Annual Runoff. The specialist studies undertaken cannot substantiate claims that inadequate water resources exists to allow the mine and catchment wide approach to water use and water use licensing is recommended.

11.4.2 BACKGROUND TO CONSIDERATION

Given the sensitive nature of the receiving environment within which the mine is proposed, as well as the complexity of the associated hydrological regime associated therewith, a cautionary approach was taken the preliminary EIA issued found that there was inadequate information for authorities to make an informed and defensible decision and recommended that additional work be undertaken to address uncertainty around the prediction of impacts relating to dewatering and potential disruption of flood dynamic and wetland habitat.

The preliminary EIA further made the recommendation that no decision-making in respect of this project should be undertaken by competent authorities until such time as specialist investigations have been undertaken so as to allow predictions about the impact of mine related aquifer dewatering with adequate certainty, and until the findings of such studies have been integrated into an updated EMPR and EIA.

It is the view of the EAP that the work undertaken to address uncertainty around the prediction of impacts relating to dewatering and potential disruption of flood dynamic and wetland habitat allows the prediction of impacts relating to dewatering and potential disruption of flood dynamic and wetland habitat with adequate certainty to make a defensible decision as the links between surface flood events, groundwater and mine water consumption are understood on various scales ranging from

- the level of the Nyl catchment A61, to
- the quaternary catchment A61E and its sub-catchment A61E2 corresponding with the groundwater modelling domain; to
- pit dewatering models and dynamic water balances

The refinement of conceptual understanding of the clay layer associated with the Nyl wetland as well as the development of integrated hydrological models and their verification against hydrograph data alongside the refinement of groundwater models and their coupling has provided a clear understanding of the links between aquifers and surface flows and the extent of separation between floods the underlying aquifer. Furthermore, catchment hydrological models have successfully been linked with groundwater models and catchment water balances, the output of which in turn have been linked with mine drainage models and dynamic water balances.

11.4.1 RECOMMENDATION ON PROJECT PROPOSAL

The preliminary EIA indicated that approval is only to be considered by competent authorities if separation of the Nylsvlei wetland from the underlying aquifer is found to be such that the function of the wetland is not destroyed or disrupted through the interruption of the flood dynamic through aquifer dewatering,

The EIA process followed has concluded that the proposed mine will not destroy the wetland or disrupt it through aquifer dewatering and limited additional water demands can be accommodated by the system, however it is noted that the system is already under significant pressure.

The EAP accordingly recommends that the respective applications be viewed favourably subject to certain key requirements being fulfilled most importantly that water use would need to be minimised and water conservation would need to be optimised. In this respect the WULA application process should seek to identify opportunities to save water not only at the mine but also in the study domain (the A61E2 catchment/ groundwater modelling domain). Considering that agriculture uses approximately 6Mm^3/a opportunities must exist where the proposed mine can seek to further water conservation practises within the agricultural community that is proposed to receive it.

<u>Further work that should be undertaken before mining is to commence</u>

In a study with such complexity, an investigation more often than not highlights aspects of interaction between environmental systems to adequately cater for the management during the design of a potential mine.

The following follow-up work around surface and groundwater management is recommended before mining may commence:

- Establishment of a Volpsruit /Mokopane Chapter of the Mogalakwena Water Users Association Water Forum with representation from conservation, agriculture, and local authority, amongst others; the funding of the water forum administration to be carried by the applicant (Volspruit Water Forum).
- The establishment of an Environmental Control Officer team comprised of at least three independent specialist competent by training education and experience with backgrounds in groundwater, wetland management and

mining environmental management that will audit the project on a quarterly basis against the EMPR, IWWMP, EIA Authorisation, Atmospheric Emission License and Waste Management license during construction at least on a 2 monthly basis and during operational phase at least on a six monthly basis and reporting to DMR, LEDET, DWA, Volspruit Water Forum and Environmental Monitoring Committee if such an entity is formed by I&APs

- A detailed hydrocensus of boreholes within modelled cone of depression utilising the cone of depression as modelled in steady state (a wider area surveyed as precautionary measure). All boreholes utilised for groundwater production by Volpsruit mine as well as those of farmers on neighbouring farms that irrigate crops should have electronic level measurement equipment installed so as to allow for more holistic aquifer management to be undertaken by all water users through the Volspruit Water Forum
- Access to water abstraction rates and groundwater levels of existing boreholes located within pits and neighbouring properties to be secured through Volspruit Water Forum;
- Improved knowledge of the variation of hydraulic conductivity with depth is needed, and several additional packer tests are recommended to enable grouting design; and
- Additional shallow boreholes must be drilled along the Nyl identified by the clay layer investigation as an area of potential decant where flooding may recharge aquifer (depending depth and period of inundation) so as to further improve knowledge of surface water/groundwater interaction and connectivity.
- Further groundwater and dynamic water balance modelling from which detailed design of all water pollution control infrastructure including grouting can be designed and mine water management programmes are to be developed.

Further attention also needs to be given to the closure plan (at the end of the lifespan of the proposed mine) of specifically the northern pit as a unique opportunity would then exist to create additional suitable habitat and expand the existing wetland habitat. The following follow-up work around mine closure is recommended before mining may commence:

- The closure landscape should be designed and constructed so as to create a mosaic of habitats that closely approximate the Nyl River habitats including riverine floodplains, flooded basins, seasonally flooded grassland, groundwater fed woodland savannah and open savannah with open shallow shoreline to reed fringed open water and refuge areas such as islands with tall dead trees.
- Avifaunal and wetland biodiversity monitoring at quarterly intervals to determine a comprehensive pre-mining baseline form which mining impact can be measured and from which further mitigation measures

Key Recommendations

1. The mine will establish a 'precautionary environmental buffer zone' of at least 110m in extent from the delineated eastern edge of the Nyl wetland into the proposed North pit (as shown in the sequential mining diagram in Appendix 8.1); although this buffer may be considered for extraction in a final 'cut-back' in the north pit, any opencast mining within this buffer will be made conditional to an EMPR amendment and application for exemption from NWA Reg. GN704 for approval by DMR and DWA respectively. The mining of the ore body that falls

within the buffer area (i.e. the western extremities of the north pit) must be done at the end of the north pit life, when adequate understanding of the ore body and mining impacts has been gained from inter alia:

c) Comprehensive ground- and surface water monitoring prior to establishment of, and during the operational life of mine;
d) A geo-technical pit wall failure risk assessment for the final pit wall position within the buffer, based on detailed pit design; and

This buffer aims to provide a margin of safety with respect to potential groundwater flood induced pit wall instability along the north pit perimeter in close proximity to the Nyl River and its associated floodplain wetland. If a grouted 'curtain' is constructed in weak material e.g. (soil, or weathered rock) around an opencast pit (as is understood to be the case at Volspruit, with such material extending to approximately 30m below surface), it can lead to geotechnical instability unless a suitable barrier is left between the 'curtain' and the edge of the pit wall.

- The width of such a barrier/cut-back depends on the thickness and properties of the material in which it has been created.
- For weathered rock, the width of the barrier should typically be at least twice its thickness (hence the 2 X 30m = 60m buffer proposed as a precaution).

Although surface floods will not affect the pit as a result of the flood protection berm, although seen as unlikely, a rapid rise in groundwater levels associated with a flood event may affect pit wall stability and due to the sensitivity of the adjacent wetland the buffer is proposed as a precautionary measure.

2. Further attention also needs to be given to the water management and closure plan of the mine as part of IWWMP:
   - Post-mining, water levels will return to normal levels and groundwater abstraction within mine in general should be managed and in North Pit specifically should limited terminated to achieve a groundwater dynamic with little more than natural seasonal fluctuation, this will allow the establishment of a mosaic of habitat types such that bird species under pressure may be optimally provided with refuge feeding and breeding habitat.
   - The viability of establishing and maintaining the desired habitats under the hydrological regime likely to occur with the 'open water body' should also be assessed in detail, specifically:
   - Water levels that are likely to fluctuate by several meters and the implications thereof on establishing and maintaining a vegetated shoreline abstraction should be limited with the possible exception of limited abstraction for human use or as part of water quality management measures within the mined-out pit
   - Expected water quality within the 'open water body'. In this regard the threat of excessive algal growth due to potentially high background nitrate levels within groundwater needs to be assessed.
   - It is proposed that this land use or similar mix of extensive agricultural and conservation also be adopted as the final end land use and be stipulated as a condition of approval.

3. A number of water management scenarios have been identified and modelled in the dynamic water balance and it was established that the mine will initially be a producer of excess water, a number of options have been identified for management of excess water:
   - Base Case (Conservative inflows to the pit areas (grouted, no faults – conservative water take) utilising Grassvally as buffer (both sourcing and recharging – with sourcing at sustainable yield levels as identified in Grassvally WULA) with irrigation of excess water to farmers apply (irrigation stepped to provide constant supply)
   - Base case with 20% saving on TSF seepage water losses
   - Base case with no irrigation and all excess water recharged to Grassvally

   The scenarios should be further investigated alongside closure planning for the North Pit and report to Volspruit /Mokopnae Water Forum and I&APs so as to form the basis for IWWMP and WULA
   - It is recommended that the mine should achieve 20% saving on TSF seepage water losses (this may be through optimal combination of tailings cut-off trench, herringbone drain, seepage recovery well field and thickened talings disposal)
   - It is recommended that excess water irrigated to croplands Subject to the approval thereof by the Department of Water Affairs through the WULA process) in the area, to the extent that surplus water dewatered from the pits beyond their own process water requirements allows them to do so sustainably with a targeted saving of 20% of tailings seepage losses to be recovered as per Dynamic Water Balance; and

4. The proponent must comply with all mitigation and monitoring measures put forward in this EIA, as well as the attached environmental management programme report (EMPR);

5. The proponent must comply with any additional conditions of authorisation / approval by the respective competent authorities, and other reasonable measures that may be stipulated by authorities that have jurisdiction in matters relevant to this application and update the EMPR accordingly.

11.5 WAY FORWARD- ENGAGEMENT WITH THE COMPETENT AUTHORITIES AND STAKEHOLDERS

Apart from email distribution, notice of the above is delivered through email, fax and post indicating links to the available download and location of hard copies of the EIA. Further opportunity for engagement exists through attending the following meetings:

This EIA report is available for comment for a period of 30 days, from Tuesday 14 January 2014 to Friday 14 February 2014 in terms of the MPRDA application and for comment for a period of 60 days from Tuesday 14 January 2014 to Monday 17 March 2014 in terms of NEMA EIA application.

Public meetings were held as set out in detail in Appendix 4: Stakeholder and Public Participation and comments and responses captured in the meeting minutes. Comments and responses not captured as part of the EIA public meetings that took place from 20-24 January 2014 will be captured and an updated Comments and Responses Report submitted to the DMR on 22 February 2014 and LEDET on 24 March 2014.

It is anticipated that authority decision making will take place over the period of April to June 2014 and appeals process in July and August 2014.

Table 11-7: Timeline including key stakeholder and authority engagement

Process Phase	Details	Estimated Date
EIA & EMPR ↓	Draft EIA and EMP report issued to IAP's for comment	14 January 2014
	Focus Group and Public meetings	20-24 January 2014
	EIA report issued to the DMR and LEDET	28 January 2014
	EIA and EMPR comments period closed for submission to the DMR	14 February 2014
	Comments and Responses Report updated and submitted to the DMR and LEDET	22 February 2014
	EIA and EMP comment period closed for submission to LEDET	17 March 2014
Final EIA and EMPR ↓	Comments and responses report updated and submitted to LEDET	24 March 2014
	Authority decision-making	April, May, June 2014
Decision and appeals	Appeal period (Chapter 7 – 2010 NEMA EIA Regulations)	July / August 2014

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