Booysendal Platinum Proprietary Limited

Booysendal South Expansion Project

Section 24G Environmental Impact Assessment

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LP30/5/1/2/3/2/1(188) EM & MP30/5/1/2/3/2/1(127) EM

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Executive Summary

Introduction

Booysendal Platinum (Pty) Ltd (Booysendal) is a platinum group metal (PGM) mine located in the Eastern Limb of the Bushveld Igneous Complex approximately 40km south-southeast from Steelpoort, 33km west from Mashishing and 21km northeast from Roossenekal.

Booysendal holds two mining rights: the Booysendal Mining Right (LP 30/5/1/3/2/1 (188) EM); and the Everest Mining Right (MP 30/5/1/2/3/2/1 (127) EM). The Booysendal section of the operation was purchased from Rustenburg Platinum Pty Ltd in 2008, whilst the Everest portion was acquired from Aquarius Platinum Pty Ltd in 2015. The Booysendal and Everest mining rights (MR) have not been consolidated, although the Booysendal project is managed and operated as one integrated project. The Section 11 transfer of the Everest MR to Booysendal was approved on 11 October 2015. Everest has been under care-and-maintenance since the underground working collapse in 2012.

The Limpopo-Mpumalanga provincial border runs from west to east through the Booysendal MR area. The northern section of the Booysendal MR area falls in the Limpopo Province while the southern section is in the Mpumalanga Province. The Everest MR falls entirely in the Mpumalanga Province.

The operational division of Booysendal follows that of the provincial border, which divides it into two main operational areas, namely Booysendal North (BN), which falls in Limpopo Province and Booysendal South (BS), which falls in the Mpumalanga Province. BN is in the northern section of the Booysendal MR area and is a fully operational underground PGM and Merensky mine whilst development of BS is ongoing. BS is further subdivided into BS1/BS2, BS3, Everest Mine (BS4) and two new Merensky south adit expansions. BS1/2, the Merensky portals and BS3 forms part of the Booysendal MR area, while BS4 is the old Everest mine.

Background

Booysendal has identified a window of opportunity to increase production to meet short to medium term projected demands for platinum. Having acquired BS4, the mine believes it could expedite its expansion, utilizing and recommissioning existing infrastructure at BS4 and through developing additional mining and infrastructure components. Having acquired the MR for the full extent of the project area which is currently being developed, the mine proceeded with construction to meet the window of opportunity. This expansion is known as the Booysendal South Expansion Project. The expansion is divided into two phases:

The development of mining and infrastructure at BS1/2, BS4 and the development of two Merensky adits. It also involves the construction of associated surface and linear infrastructure (refer to Section & Annexures

- Project description for a detailed project description). This development commenced in September 2016.
- Future mining activities at BS3 and potentially elsewhere with linear and supporting infrastructure.

The development currently undertaken consist of a portal and terrace complex at BS1/2 with workshops, offices, pollution control dams (PCD), clean and process water storage facilities, a crusher and conveyor system, crusher feed, run of mine (ROM) stockpile, silo, transformer station and others. Development at BS4 involves the upgrade of the stormwater management system, expansion of the Run of Mine (ROM) stockpile, reworking of TSF1, deposition of tailings underground, to stabilise underground workings, and re-deposition of tailings on TSF1 and upgrading of the stormwater management system which involves upgrading PCD, construction a new PCD, decommissioning of an existing PCD and upgrade of the clean-and dirty water system. Construction on most the Section 24G Project activities have commenced.

Although some of the phase one expansion activities at BS1/2 were approved in terms of the 2002 Environmental Management Programme (EMP) for Booysendal under the Mineral and Petroleum Resources Development Act, 28 of 2002 (MPRDA), environmental authorisations under the National Environmental Management Act, 107 of 1998 (NEMA) for listed activities promulgated in terms of Section 24 of the Act were not obtained. Authorisations for the waste activities under the National Environmental Management: Waste Act, 59 of 2008 (NEMWA) and water uses in terms of Section 21 of the National Water Act, 36 of 1998 (NWA) are also outstanding.

Booysendal recognised that the commencement of activities without authorisation required a rectification application in terms of Section 24G of NEMA and, upon its own initiative, commenced with the process in November 2016 requesting the Minister of the Department of Mineral Resources(DMR) to delegate the component authority (CA). In a letter dated

Process:

A Section 24G application was submitted to the Minister of DMR's Office and to the Regional Directors of Limpopo and Mpumalanga on 3 March 2017. The delegated competent authority ("CA") (Limpopo Regional Manager) acknowledged receipt of the Section 24G application in a letter dated 24 March 2017. Booysendal was further instructed in a letter dated 8 May 2017 to conduct an Environmental Impact Assessment (EIA) and submit an Environmental Management Programme (EMP) within 106 days in terms of the NEMA EIA Regulations. Subsequently specialist studies in support of the EIA have been concluded and the public consultation process has commenced. This Environmental Impact Assessment Report (EIR) and associated EMP will be made available for public comment and the final submitted by the 19th of August 2017 to the DMR.

Public Consultation Process

As part of the EIA process public consultation commenced through the compilation of a stakeholder database. This database is a living document and is being updated continuously through the process of interested and affected party registering as (I&AP). Registered I&APs will be kept informed of the Project throughout the process. The Project as announced through the distribution of notification letters, background information documents (BID), placement of site notices at several places, in a wide radius around the project area, and advertisements in the regional Sun newspaper and the local Steelburger. Public meetings and authority's meetings are currently ongoing. The purpose of the meetings is to inform the community at large of the outcome of the EIA process and to obtain comments, local knowledge and to document concerns around the Project. All comments received throughout the process are logged in an issues and response report, which will be submitted to the CA with the final EIR and EMP. This Draft EIR and EMP will be made available for public comment from the 7th of July to the 7th of August. Once final comments have been incorporated the Final EIR and EMP will be submitted to the DMR Regional Office Limpopo. All registered I&APs will be notified of the decision of the CA.

Baseline Studies, Impacts and Management:

Specialist investigations for the Booysendal South Expansion Project commenced in January 2016. Some unauthorised activities have since been started by Booysendal. The initial specialist studies provided the baseline for the Section 24G specialist investigations. The overall purpose of the Section 24G baseline specialist investigations were to establish baseline conditions, assess the impacts of the Section 24G activities and to provided mitigating, management and monitoring measures which must be implemented with the Project.

<u>Air Quality:</u>

Baseline: Impacts on air quality is dependent on the emissions and the baseline climatic conditions. In this area, the average summary high is 30°C and the average minimum of 17°C. Average maximum temperature for July is 21°C and the average minimum 3°C. The general wind direction is from the south east. The steep valley location, however, influences wind movement giving rise to anabatic and katabatic winds in the valley, leading to downward flow along the valley sides and further down the Dwars River valley at night and outward flow during the day.

Impacts: During the air quality impact assessment, the potential increase in particulate emissions from the wider project (including BN) and dust outfall was modelled through AERMOD, using the project emissions factor and calculated anticipated particulate emissions. The outcome of the dispersion model indicated that unmitigated, the dispersion of particulates should not reach any of the sensitive receptors, although they will get close. Assuming a 50% dust mitigation will be implemented, the dispersion will be reduced to within the project footprint, and mainly the within the Groot Dwars River Valley. Dust deposition will follow the direction of the Valley, with deposition mainly occurring along the Valley in a northerly direction. The model indicated that none of the sensitive receptors will be affected.

The separate greenhouse gas emissions (GHG) calculation used the emissions factors for NO2, CO2 and CH4 to obtain an indication to what extent the Project could contribute to climate change. The mine will likely be responsible for emissions of Scope 1 carbon equivalents of not more than approximately 19 500 tons per year. At the current assumed carbon tax rate of R120 per ton, this may result in a tax liability of not more than R2 340 000 per year. However, with offsets and other rebates, this amount per ton should be drastically reduced to between R6 and R40 per ton, or a potential liability of between R43 000 and R286 720.

No final decision has been made on carbon taxation as yet and these figures are indicative only.

Mitigation and management: Required mitigating and management measures include:

- Enclose the crushing operations;
- Design and construct with telescopic shute with water sprays;
- Ensure that hoods with filters area installed at the crusher;

- Vegetation / rock cladding or the sidewalls or the TSF facilities;
- Spray on the outer dry surface when wind speed exceeds 4m/s;
- Risk assessment at decommissioning and closure to identify dust suppression requirements;
- Dust control open areas during construction and decommissioning through wet suppression, chemical supernatants, vegetation cover, wind breaks etc.;
- Implementation of the dust suppression plan included in the Air Quality Impact Assessment; and
- Expansion of the dust monitoring network.

Soil, Land Use and Land Capability Assessment:
Baseline: Eighteen soil forms were identified in the study area. Due to the topography, most of the soil forms in the Project area are relatively young soils, with a shallow A horizon and a hard bedrock B horizon. A sensitivity analysis on the different soils was done and no-go areas identified. The land capability of the soils area is mainly suitable for grazing or as wilderness areas. Hydromorphic soils are associated with the water courses and wetland areas.

Impacts: The impact assessment found that the construction activities had a significant impact on the soil profiles. The activities also contribute significantly to soil erosion.

Mitigation and Management: Recommendations for soil management include:
- Minimisation of construction footprints;
- Avoidance of sensitive soils;
- Implementation of stormwater control measures; and
- Revegetation and stabilisation of impacted and exposed soils.

Hydrogeology and Waste Classification:
Baseline: The hydrogeological assessment found that there are two types of aquifers in the study area, the deeper fractured aquifer and a shallow weathered zone aquifer. The latter is the main source of groundwater to the surrounding population.

Impacts: The following are the main impacts from the groundwater and waste classification study:
- The contamination model indicated that groundwater contamination and formation of a drawdown cone should be fairly local and not impact on surrounding groundwater users;
- Dewatering of the Aquifer at BS1/2 and the Merensky and BS4 as the latter will serve as make-up water for BS1/2;
- Recovery of groundwater levels in the underground BS1/2 and Merensky mines;
- Cumulative impact on water quality of the regional aquifer as a result of contamination of the aquifer at BS1/2; the Merensky mines and at the BS4 TSF1 and underground backfill areas; and
- Increased volume of underground water at BS4 due to backfilling and an increase of decanting at the valley boxcut.

Mitigating and Management measures recommended by the hydrogeologist include amongst others:
- Sealing off of major underground aquifers causing inflows into the underground mine;
- Lining of the PCDs with an high density polyethylene (HDPE) liner and the TSF with a Class 3 liner in terms of the National Environmental Waste Management Act, 59 of 2008;

- Follow-up studies to get a better understanding of the potential impact that backfilling can have on the groundwater quality; and
- Continuous groundwater monitoring and expansion of the groundwater monitoring network.

Hydrological Assessment:
Baseline: A hydrological assessment was carried out to delineate the catchments and sub-catchments applicable to the various infrastructure components; determine the flood calculations, map the 1:100 year floodlines, the 100m buffer lines, the water and salt balance and assess the required stormwater management requirements.

Impacts: The main outcome of the study indicated that there is an increase in salt loads further downstream in the Groot Dwars River. The cumulative impacts on water quality has resulted in the Groot Dwars River system being under threat as a result of an increasing number of mines along the river system.

Mitigating and Management measure proposed included:
- The location of mining infrastructure must be outside the 1:100 years floodlines or where the 1:100 yr foodlines are not known outside of the 100m lines.
- All chemical, hydrocarbon and potential hazardous substance containment infrastructure need to be bunded and provided with an impervious base;
- Clean-and dirty water infrastructure need must be constructed outside of the 100m or 1:100 year floodline, whichever is the greater, and must be designed to accommodate a 1:50 year floodevent.

Terrestrial Ecology:
Baseline: The Project is located in the Sekhukhune Centre of Plant Endemism (SCPE). The Section 24G activity falls within the Sekhukhune Mountain Bushveld, while BS4 falls in the Sekhukhune Montane Grassland Biomes of the SCPE. NSS recorded more than 80 conservation important (CI) species within and/or near BS, including almost 30 locally endemic, two Vulnerable (VU), several Near Threatened (NT), numerous Declining and 60 Protected Species (PS).

A large number of CI faunal species were found to occur in and around BS. Wetlands provide important habitat for the African / Cape Clawless Otter (NT), Serval (NT), Blue Crane (VU), African Marsh Harrier (Endangered; EN), Southern African Python (PS), and Marsh Sylph butterfly (Rare). Grassy hillslopes and rocky ridges provide important habitat for Mountain Reedbuck (EN) and the geographically restricted Long Tom Widow, Tite's Copper, Lydenberg Opal and Steelpoort Spotted-eyed Brown. The cliff face to the west of BS4 provides important habitat for Verreaux's Eagle (VU) and potentially Cape Vulture (EN), Southern Bald Ibis (VU), Cohen's Horseshoe Bat (VU), and the (NT) Geoffroy's Horseshoe and Natal Long-fingered bats. Sheet rock represents critical habitat for three locally endemic and threatened species: the flat rock scorpion *Hadogenes polytrichobothrius* (VU) and the Sekhukhune and FitzSimon's flat lizards (NT). The Valley bushveld provides important habitat for Leopard (VU), Brown Hyena (NT) and most importantly, the locally endemic *Pycna sylvia* cicada, which under IUCN Red List assessment criteria should be regarded as globally EN. Various other CI faunal taxa potentially occur in BS.

Impacts: The terrestrial ecology study indicated that the main impacts of the project are the loss in CI species, habitat fragmentation. Further impacts are the loss of scientific knowledge and opportunities with the possible loss of locally endemic or near-endemic taxa, which are unknown, undescribed, Data Deficient or extremely rare. Examples include: two *Asclepias* plant and a *Camponotus* ant species.

The cumulative loss of the critical biodiversity areas and CI species is a concern.

Mitigating and management requirements include:

- Even though Booysendal has MRs for certain areas, offset measures for BS, which are approved by relevant authorities, must be legally binding, as stated in the draft National Biodiversity Offset Policy (GG 40733, GN 276, 31 March 2017).
- There are certain areas which need to be avoided from any further or unnecessary disturbance of the High CI floral communities including: the cliff face and Kloof Habitat, the Tulbaghia – Eleocharis Sheet Rock Wetland, Fuirena - Leersia - Phragmites Vlei System, Searsia- Diospyros - Rhoicissus Rocky Outcrops, Aloe - Myrothamnus - Xerophyta Sheet Rock Formations, and the Brachiaria - Tristachya Exposed Rock, and their associated buffers.
- Construct and maintain carefully engineered bridges to avoid impacting wetland communities, habitats, hydrology, and water quality, wherever a BS road crosses a drainage line - especially where the Main Access Road crosses the Groot-Dwars River at BS1/2.

<u>Aquatic Biodiversity</u>:
Baseline: The mine falls in quaternary catchment B41G. The main river in the project area is the Groot Dwars River which is a National Freshwater Ecosystem Priority Area. The desktop assessment of the Ecological Importance (EI) and Ecological Sensitivity (ES) of the sub-quaternary reach of the Dwars River within the study area (B41G-721), classified it to be of HIGH Ecological Importance and VERY HIGH Ecological Sensitivity (DWS 2013). One IUCN Red-Listed fish species (IUCN 2016), namely *Enteromius motebensis*, is known to be present within the Groot Dwars River and the upper reaches of the Everest Tributary.

Impacts associated with the Section 24G activities include It should be noted that the effect of mine dewatering on base flows was not known at the time of writing this report; nor was the impact to the tributaries that augment the flows in the Groot Dwars River. Nevertheless, impacts to flow rates and volumes do not necessarily equate to impacts to aquatic biodiversity.

The residual impact of these activities, even with mitigation, is likely to remain high. This is due to the sensitivity of this reach of the Groot Dwars River, as well as the presence of threatened species. There will be a loss of sensitive species and an overall decline in ecological integrity. There will also be loss of habitat for the Vulnerable fish species, Enteromius cf. motebensis.

Mitigation and management:

- The Groot Dwars River bridge design need to be altered to ensure free migration of the *Enteromius motebensis*.
- A Biodiversity Action Plan and a Rehabilitation Plan should be compiled and implemented to manage biodiversity and ecological integrity;
- Undermining of wetlands and watercourses should be avoided;
- Erosion must be effectively mitigated by limiting the development footprint, cordoning off wetland and riparian areas, responsible storm water management and the use of sediment trapping, erosion protection and flow attenuation structures; and
- Stormwater should be channelled into grassed verges and not directly into the river.

Wetland and Riparian Vegetation:
Booysendal South region. The entire Groot Dwars River catchment is considered a river Freshwater Ecosystem Priority Areas (FEPA). Two wetlands on site can be classified into two classes; namely the Mesic Highveld Grassland Group 7 which is classified as endangered and the Central Bushveld Group 1 wetlands which are classified as critically endangered. These wetlands are further subdivided into channelled valley bottom, unchanneled valley bottom, riparian, seep and sheetrock wetlands. The wetlands in the study area cover an area of approximately 133 ha.

PES, EIS and functional assessment were undertaken for each of the wetland systems expected to be impacted by the proposed project activities. The findings of the PES assessment reflect a catchment and wetlands that are largely intact with roughly 40 % of wetlands and watercourses considered largely natural (PES category B) and a further 37 % moderately modified (PES category C). 47 % of wetlands and watercourses were classified as High importance and sensitivity while 50 % were classed as Moderate importance and sensitivity.

Impacts: The main areas of concern are the construction activities which have taken place in the Groot Dwars River wetland, the increase in sediment loads in some of the wetlands and further deterioration of the wetlands.

Mitigation and management: Rehabilitation of suitable remaining wetlands on site, ideally within the TKO catchment, to compensate for expected wetland loss.
Protection of wetlands as part of a greater biodiversity offset proposal to compensate specifically for expected degradation of wetland habitat associated with the Groot Dwars River.

The wetland specialist recommended that the ecosystem conservation target requiring the protection and maintenance of wetland habitat be pursued as part of the greater biodiversity offset required for the project activities. In this regard it is strongly recommended that a like-for-like offset be targeted, i.e. an offset area within the Groot Dwars catchment be identified that includes representative wetlands of the area.

Noise: A baseline noise assessment was undertaken which covered all possible sensitive receptors in the area. The findings from the baseline noise assessment indicated that the arithmetic prevailing ambient noise levels near the residential areas (eastern and southern sides) were 34.0dBA during the day and 34.7dBA during the night time periods for the summer period and 31.0dBA during the day and 26.7dBA (east, south and west) during the night for the winter period. These areas are some distance from the roads and there were no mine activities at BS4 however the BN mine was fully operational. The ambient noise levels are therefore within the rural parameters. No vibration or over-air pressure levels were measured during the survey periods as there was no blasting undertaken during these periods.

Impacts: The noise impact assessment indicated the cumulative noise intrusion levels, taking consideration of all project related and BN noise levels at the various receptor points. The two highest summer daytime increase points in baseline noise level will experience an increase of 2.3dBA and 2.6dBA respectively. These two points will also experience the highest summer night increase in baseline noise, by 2.0dBA and 2.3dBA respectively. The noise Regulations indicates that noise levels should not increase by more than 7dBA. It has, however been accepted that an increase of 5dBA becomes audible. The natural topography and implementation of noise management measures will ensure that noise intrusion levels remain within an acceptable range.

Mitigation and management:

The following management measures have been proposed:

- Equipment and/or machinery which will be used must comply with the manufacturer's specifications on acceptable noise levels and any noise sources above 85.0dBA to be acoustically screened off;
- The ventilation shaft outlets which is one of the major contributors to noise must face away from any residential area.
- Noise monitoring at the residential areas and the mine boundaries to be done on a quarterly basis.

Traffic: Traffic counts were done on the intersection where the Petla/Chroma village road ties into the D876 and where the D876 ties into the R577. For both the counts very low traffic volumes were counted. Morning traffic at the D876/R577 intersection was 39 vehicle per hour and in the afternoon 46 vehicles per hour. The village/D876 counts were 17 in the morning and 21 in the afternoon.

Impacts: It is expected that the new access road will contribute an additional 128 trips in the morning and 94 in the afternoon. The biggest potential impact is accidents associated with the village/D876 intersection and the deterioration of the road condition.

Mitigation and management:

- Speed humps and a speed limit of 40km per hour should be imposed at the start of the downhill approach on the D874 between km 1.85 and 3.0km followed by two sets of rumble strips/ cosbi lines between the speed hump and the D874/village intersection;
- The trees at the D874/village intersection need to be removed to improve line of sight and safety; and
- A maintenance plan to be implemented for the main access road and the D874.

Social:

Baseline: The Integrated Development Plan (IDP) for Ehlanzeni District Municipality in which the development is located states that in 2011 the unemployment rate for people between the ages of 15 and 65 was 32,32%, and majority of the population in Ehlanzeni are dependent on social grants. A large portion of the population in the Thaba Chwue Local Municipality (25.17%) is under the age of 14 years. This all contributes to a high dependency ratio. Social infrastructure is limited. There are no clinics in the immediate area and water and sewage facilities are absent.

Booysendal indicates that a total of total of 2,132 direct and contract employment opportunities will be created and a further 13,750 indirect employment opportunities. With the high dependency ratio in the area, it is expected that a total of 49,476 people will benefit from the project. Booysendal indicates that currently 60% of the employees at the mine come from local communities. This means that a significant amount of the current annual wages of R505,372,151 filters through to the local communities.

In addition, Booysendal indicates that preferential procurement from Historically Disadvantaged South Africans (HDSA) at Booysendal is 87.18%. The expansion project will require further procurement and will enhance benefits and business development in communities. Booysendal also contributes R86,639,513 to Government revenues.

Local eEconomic development spent by the mine since 2014 was R8,926,913. Booysendal indicates that the expansion of the mine will assist in continuous development spend, including investment into schools and development centres.

During construction:
At the peak of construction, a labour force of up to 3200 labour will be required. The project has an estimated capital spend of R4,199,800,000 over 5 years. The projected turnover (2016 values) is R2.7 billion of which some 8-10% (about R250 million) will represent ongoing capital investment for the projected life of mine.

Indicate the benefits that the activity has/had for society in general and also indicate what benefits the activity has/had for the local communities where it is located:
The expansion project has economic benefits for SA due to increased platinum production and local socio-economic benefits as a result of job creation, capital expenditure on contractors, materials and equipment, and ensuring the life of mine in the long term which will prevent retrenchments and early mine closure.

Impacts: It is anticipated that there will be positive and negative socio-economic impacts. Positive impacts include the fact that Booysendal has a labour policy that 60% of the workforce need to be sourced from local people. With the likely trickledown effect in the local economy and the high dependency ratio, the benefit that could be created through local employment and procurement would be significant.

The Government will derive revenue from the Project through various forms of taxes, including but not limited to import duties, corporate tax, contributions to social funds, and value added tax.

Negative impacts include the influx of people into the local communities which will put additional strain on the available infrastructure and in the environment. An increase in communicable disease is also likely. Increase in social pathologies e.g. alcohol misuse, violence and crime may also occir.

Mitigation and Management:
Skills development and capacity building is fundamental to local employment generation, sustainable development and poverty alleviation in the area, particularly amongst the youth.

Booysendal Mine must:

- prioritise partnering with local government to improve the quality and sustainability of existing social services and infrastructure development programmes,
- work with the government and local implementing partners to support an integrated HIV and TB prevention and management programme that considers the workplace, local communities and high risk populations such as women and truckers.

<u>Cultural Heritage</u>

Baseline: There area various graves and gravesites, iron age, stone age and historic cultural heritage finds in the project area. A total of 49 sites were identified within the footprint areas. SAHRIS Paleo sensitivity map indicates that most of the study area is classified as being of zero palaeontological sensitivity.

Impacts: Clearing in the area of BS1/2 and construction of the BS1/2 terrace lead to the destruction of:

- Historical ruins (indicated as 355 and 356 in Figure 4-42); and
- Iron Age features number 610, 6111, 612, 614, 615, 616 and 617 have been destroyed.

Mitigation and Management:

- Implementation of a heritage management plan;
- Fencing of cultural-heritage site;
- Further reseach on the Village which may be affected by the ARC.

<u>Visual:</u>
The various project components have the potential to impacct visually and on the sense of place.

Baseline: Typically, the vegetation profile consists of open and closed savannah areas with average height of 2.5m to 5m. This will contribute in screening the proposed infrastructure to some extent. The sense of place in the various areas can be described as a combination of rural character to that of a typical mining area. The visual quality and character of the landscape which were once a spectacular and 'wild', rural landscape, , is being compromised by the presence of 'foreign', seemingly 'out of place' activities.

Impacts: The most significant is the ARC and the potential for night glow.

Migitation and management: Long-term monitoring of light pollution should be implemented to assess effectiveness of mitigation measures. Lights should be directed downwards and shielded to avoid illuminating the sky and minimizing light spills. A grievance mechanism must be put in place in order for them to have a vehicle to raise their concerns. This could include environmental forum meetings and grievance register.

Natural screeing through the planting of vegetation should be done.

Recommendations:
The main recommendations associated with the EIA include:

- The Waterfall Tributary should not be under-mined via the Merensky Portal North before authorisation from the Department of Water Affairs has not be obtained as this will pose a potential risk of subsidence and loss of surface water to groundwater, thus reducing flows in this tributary (which is currently perennial).
- A biodiversity management plan which addresses impacts, mitigation, monitoring, management of offsets, rehabilitation targets, and alien and invasive irradiation must be prepared within three months should authorisation been granted.
- The PES of the river downstream of the confluence with the Everest Tributary should not drop below a Category C.
- Backfilling of the defunct Everest Mine with tailings from TSF1 should not proceed until the long-term water quality impacts to the receiving Groot Dwars River (particularly in terms of the quality and quantity of decant water post-closure) is known and can be effectively mitigated to minor significance. In addition, construction of the Tailings Storage Facility (TSF2) should only proceed on condition that all mitigation be strictly applied and that groundwater quality impacts to the Everest Tributary can be reduced to minor significance. No additional road or infrastructure crossings across the Groot Dwars River other than

those proposed as part of this application. All other crossings need to be rehabilitated to enhance aquatic biodiversity and fish migration; and
- A community liaison stragety needs to be developed and grievance mechanism needs to be developed.

Gap Analysis:
The main gaps in the study are:
- The effect of mine dewatering on base flows was not known at the time of writing this report; nor was the impact to the tributaries that augment the flows in the Groot Dwars River. Nevertheless, impacts to flow rates and volumes do not necessarily equate to impacts to the aquatic biodiversity;
- The lack of information on the *Enteromius motebensis*, will require further investigations;
- The potential impact of backfilling in terms of contribution to groundwater, discharge and impacts on water quality is unknowns and will require further analysis and investigations;
- Some areas were not surveyed by the specialists as a result of alignment changes and the potential impacts in these areas are unknown.
- No hydro-pedological modelling of wetland flow inputs was undertaken.
- It should be noted that the effect of mine dewatering on base flows of the rivers were not known at the time of writing this report; nor was the impact to the tributaries that augment the flows in the Groot Dwars River. Nevertheless, impacts to flow rates and volumes do not necessarily equate to impacts to the aquatic biodiversity. This should, however be confirmed;
- The lack of information on the Enteromius motebensis, will require further investigations;
- The potential impact of backfilling in terms of contribution to groundwater, discharge and impacts on water quality is unknowns and will require further analysis and investigations;
- Some areas were not surveyed by the specialists as a result of alignment changes and the potential impacts in these areas are unknown.
- No hydro-pedological modelling of wetland flow inputs was undertaken.

Conditions for Authorisation:
The main conditions for consideration by the competent authority include:
- Genetic work must be done to gain a better understanding of the IUCN Red Listed Barbus motebensis;
- The successful conclusion of the Biodiversity Offset implementation agreement should be finalised no later than the decision reached by the authority on the Section 24G. Should this be delayed work on listed activities should be suspended until the agreement is concluded.
- All new footprint areas must avoid biodiversity sensitive areas. Ares to be cleared must be surveyed by an experienced, qualified terrestrial ecologist before any clearance commence to assist in identify CI species and rescuing these to the nursery. Rescuing of fauna should as far as feasibly possible be done;
- The potential impact of drawdown on wetlands must be better understood. It is therefore recommended that wetland modelling be undertaken and that potential risks be mitigated before the operational phase commence;
- Genetic work must be done to gain a better understanding of the IUCN Red Listed Enteromius cf. motebensis. The water quality, including water temperature of any water decanted or discharged need to comply to the Reserve water quality limits;
- The main contractor with Booysendal should be ultimately responsible for environmental compliance;
- Each contractor must appoint an ECO/EO to manage environmental compliance with the support of the contractor project manager.
- The Waterfall Tributary should not be under-mined via the Merensky Portal North before authorisation from the Department of Water Affairs has not be obtained as this will pose a potential risk of subsidence and loss of surface water to groundwater, thus reducing flows in this tributary (which is currently perennial).

Opinion:

For authorisation to be granted the EAP believes the current biodiversity off-set strategy must be conclude and implemented. The off-set needs to be agreed with the relevant authorities, meet the offset requirements stipulated in the Draft National Biodiversity Off-set Policy (GG40733 GN276 of 31 March 2017) and must take consideration of the off-set requirements stipulated in the EMP and the specialist studies. The successful conclusion of an implementation agreement (including reference to appropriate management plans for Mining Right area and Offset area) with DMR, MTPA and DEA will be the only acceptable mitigation for this impact.

In addition, it is of the utmost importance that the management measures summarised in the EIA and detailed in the EMP are implemented immediately and that compliance to these be externally audited on a monthly basis pending the decision of the authorisation and for the duration of the operation should the project be authorised.

On the other hand, the positive impacts which can result from the project cannot be denied. The project has the potential to create a significant amount of much needed local jobs, contribute to business development and social investment and be an economic impetus in an area where socio-economic conditions can, from the social data provided, be described as dire. The positive socio-economic trickle-down effect that a development of this nature can have can be significant in terms of social upliftment, investment, skills development and investment into community infrastructure as stipulated in the SLP. The national and regional socio-economic advantages through tax contribution is also significance in an industry where it becomes increasingly difficult to operate in. With a life of mine more than 40 years the long term positive socio-economic impacts are much needed. The potential negative social impacts which are normally associated with mining developments could be manged and mitigated but it will be necessary to take hands with local government and develop and implement strategies.

It might be more detrimental to the environment and the surrounding people who can so desperately benefit from the project to now cease the operations. It is therefore, the EAPs opinion that authorisation be granted with the condition that the off-set requirements, the requirements set out in the EMP and any requirements which the commenting authorities or competent authority have are met.

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List of Abbreviations

ABBREVIATION	Meaning
ABA	Acid Base Accounting
ADT	Average Daily Traffic Volumes
AEL	Air Emissions License
AMD	Acid Mine Drainage
AoI	Area of Influence
AQIA	Air Quality Impact Assessment
ARC	Arial Rope Conveyor
ASPT	Average Score Per TAXON
BID	Background Information Document
BN	Existing Approved Boosyendal Operation located on the farm Booysendal 43JT and Der Brochen 7JT
BS	Booysendal South (excluding Booysendal North)
BS1/2	Main Booysendal Central Mining Complex on the farm Buttonshope 51JT
BS3	Future Underground Mine on the farm Buttonshope 51JT
BS4	Everest Mine
CA	Competent Authority
CARA	Conservation of Agricultural Resources Act, 43 of 1998
CI	Conservation Importance
CRR	Comments and Response Report
DDT	Data Deficient
DMR	Department of Mineral Resources
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EC	Electric Conductivity
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMP	Environmental Management Programme
EN	Endangered
ES	Ecosystem Service
FRAI	Fish Response Assessment Index
FREPA	Freshwater Ecosystem Priority Area
GGP	Gros Geographic Product
GHG	Greenhouse Gas Emissions
GTLM	Greater Tubatse Local Municipality
HA	Hectares
HDPE	High-density Polyethylene
IDP	Integrated Development Plan

ABBREVIATION	Meaning
IHI	Index Habitat Integrity
I&Ap	Interested and Affected Party/ies
IWUL	Integrated Water Use License
IWULA	Integrated Water Use License Application
ktpm	Kilo tonne per month
LC	Least Concern
LCPE	Mashishing Centre of Plant Endemism
LOS	Level of Service
MAR	Mean annual run-off
mbgl	Meters below ground lower
mbs	Meters below surface
MHSA	Mine Health and Safety Act, 29 of 1996
MNCA	Mpumalanga Nature Conservation Act (No.10 of 1998)
MPDRA	Mineral and Petroleum Resources Development Act, 28 of 2002
MR	Mining Right
NEMA	National Environmental Management Act, 107 of 1998
NEMBA	National Environmental Management: Biodiversity Act, 10 of 2004
NEMAQA	National Environmental Management: Air Quality Act, 39 of 2004
NEMWA	National Environmental Management: Waste Act, 59 of 2008
NFA	National Forestry Act, 84 of 1998
NFREPA	National Freshwater Ecosystem Priority Area
NHRA	National Heritage Resources Act, 25 of 1999 (NHRA)
NT	Near Threatened
NWA	National Water Act, 36 of 1998
OEL	Occupational Exposure Limits
PCD	Pollution Control Dam
PES	Present Ecological Status
PGM	Platinum Groupe Metals
ROM	Run of Mine
SANBI	South African National Botanical Institute
SANRAL	South African National Road Agency
SCPE	Sekhukhune Centre of Plant Endemism
SECTION 24G	Section 24G as provided for in terms of the National Environmental Management Act, 107 of 1998
SIA	Social Impact Assessment
SLP	Social and Labour Plan
SMP	Social Management Plan
SWMP	Storm Water Management Plan
TCLM	Thaba Cheweu Local Municpality
TIA	Traffic Impact Assessment
VU	Vulnerable

ABBREVIATION	Meaning
WMA	Water Management Area
WML	Waste Management License
WRD	Waste Rock Dump
WUL	Water Use License
ZVI	Zone of Visual Influence

1. INTRODUCTION & BACKGROUND

1.1 INTRODUCTION

Booysendal Platinum Proprietary Limited (hereafter referred to as Booysendal) is an operational platinum group metal (PGM) mine complex located in the Eastern Limb of the Bushveld Igneous Complex (Booysendal Mine). Development of the Booysendal operation commenced in 2010 initially focused on mining the Upper Group 2 (UG_2) reef from two portals with associated supporting infrastructure and processes.

The Booysendal Mine consists of two mining rights, namely the Booysendal Mining Right (LP 30/5/1/3/2/1 (188) EM); and the Everest Mining Right (MP 30/5/1/2/3/2/1 (127) EM). Northam Platinum Limited (Northam) a mid-tier Platinum Group Metal (PGM) mining company, listed on the Johannesburg Stock Exchange acquired the Booysendal Mining Right from Rustenburg Platinum Limited (Anglo Platinum) in 2008 and thereafter purchased the neighbouring Everest Mining Right from Aquarius Platinum Proprietary Limited in 2014. The Everest Mining Right has been incorporated into the Booysendal operations (Booysendal Mine operations). Operations under the Everest Mining Right have been under care-and-maintenance since the underground workings collapse in 2012. The Booysendal Mining Right and the Everest Mining Right have not been consolidated. However, the Booysendal Mine operations (which includes operations under the Everest Mining Right) are managed and operated as one integrated mine operation.

The Booysendal Mine is located approximately 33km west of Mashishing (Lydenburg), 40km south-southwest of Steelpoort, 32km north of Dullstroom and 21km northeast from Roossenekal. The operations are situated in sections of the Limpopo Province and Mpumalanga Province respectively and, as a result, fall within the Greater Tubatse Local Municipality of the Sekhukhune District Municipality (Limpopo Province), as well as the Thaba Chweu Local Municipality of the Ehlanzeni District Municipality (Mpumalanga Province). The northern section of the Booysendal Mining Right falls within the Limpopo Province while the southern section is located in the Mpumalanga Province. The entire Everest Mining Right falls within the Mpumalanga Province.

The Booysendal Mine operations are divided into two main operational areas, namely Booysendal North (BN), which falls in Limpopo Province and Booysendal South (BS), which falls in the Mpumalanga Province. BN is located in the northern section of the Booysendal mining right and is a fully operational underground PGM and Merensky mine, whilst the development of BS is ongoing. BS is further subdivided into BS1/BS2, BS3, BS4 (Ex Everest Mine) and two new Merensky south portal expansions. BS1/2, the Merensky portals and BS3 form part of the Booysendal Mining Right, while BS4 is the previous Everest Mining Right. Refer Figure 1-1 for general location and Figure 1-2 for illustrations of the operational subdivision.

1.2 BACKGROUND

Booysendal identified an opportunity to expand its operations and increase production so as to meet the projected short to medium term platinum market demands. Booysendal having acquired BS4, intends to expedite its expansion by utilizing and recommissioning the existing infrastructure at BS4. Having acquired the mining rights for the full extent of the project area earmarked for the expanson, the mine proceeded with construction to meet this window of opportunity. This expansion is known as the Booysendal South Expansion Project.

The Booysendal South Expansion Project is divided into two phases:

Phase 1:

- The development of mining infrastructure at BS1/2, BS4, the development and construction of two Merensky adits.
- The construction of associated surface and linear infrastructure (refer to Section 0 for a detailed project description). This development commenced in September 2016.

Phase 2:

- The development of future mining activities at BS3 and potentially other areas with linear and supporting infrastructure.

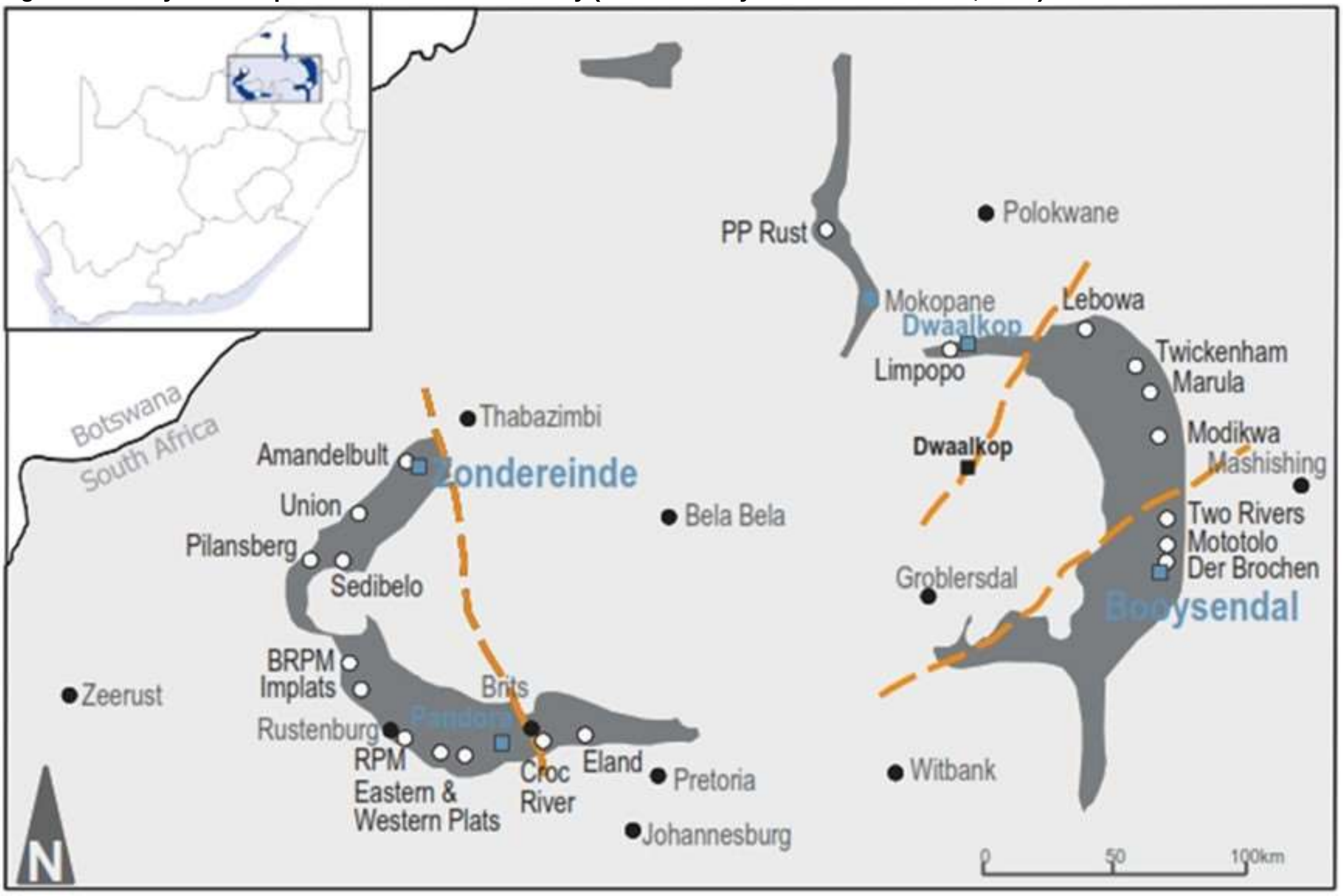
Various activities under the Phase 1 expansion were approved under the 2002 Environmental Management Programme (EMP) for Booysendal in terms of the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA). However, environmental authorisations under the National Environmental Management Act, 107 of 1998 (NEMA) for listed activities promulgated in terms of Section 24 of NEMA were not obtained. In addition, authorisations for the waste activities under the National Environmental Management: Waste Act, 59 of 2008 (NEMWA) and water uses in terms of Section 21 of the National Water Act, 36 of 1998 (NWA) are also not in place.

Section 24F of NEMA states that:

"*no person may: (a) commence an activity listed in terms of section 24(2)(a) or (b) unless the competent authority of the Minister responsible for mineral resources, as the case may be, has granted an environmental authorisation for the activity; or (b) commence and continue an activity listed in terms of section 24(2)(d) unless it is done in terms of an applicable norm or standard.*"

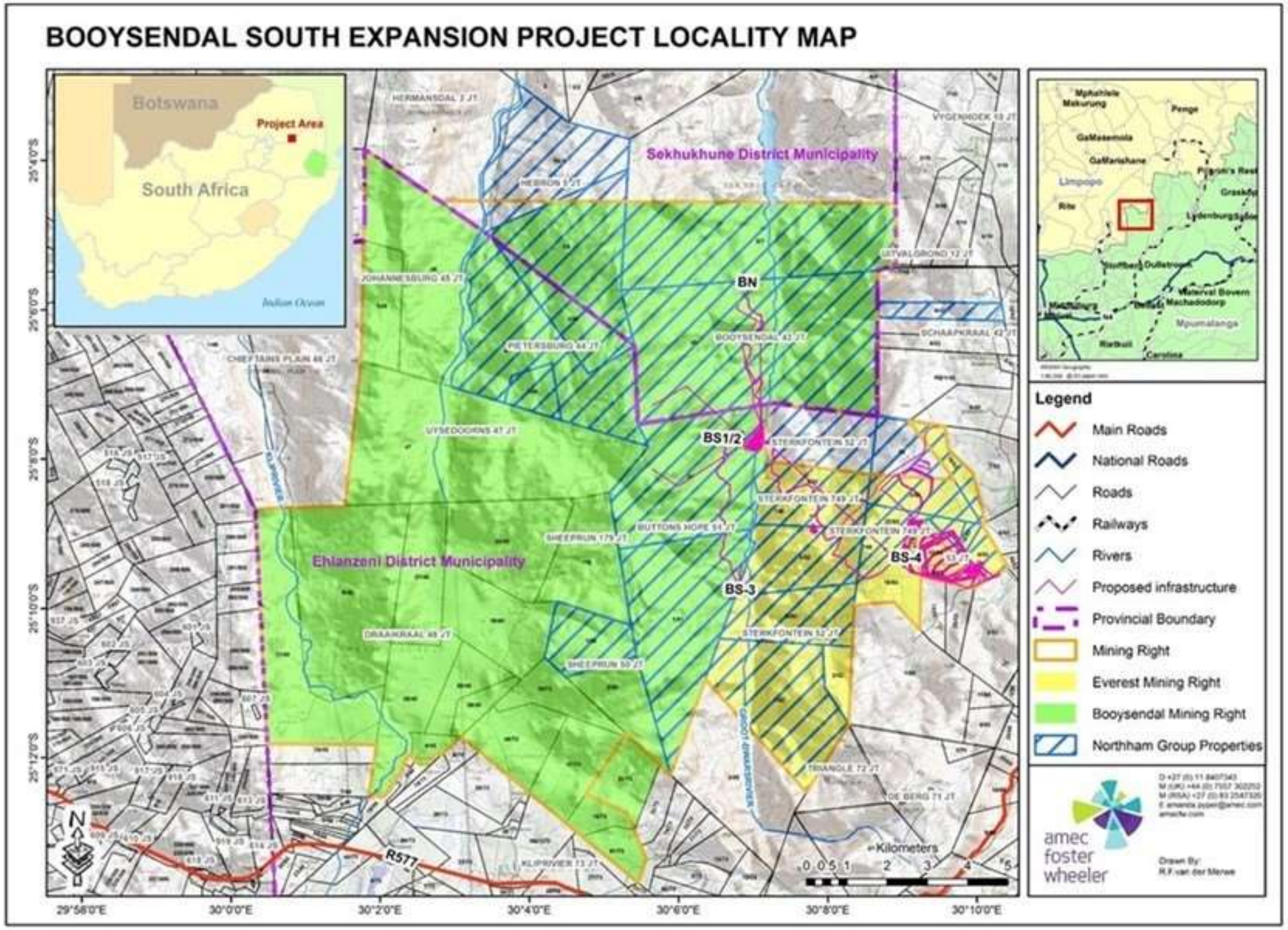
As a result of developments which have already commenced without the required authorisations, Booysendal appointed Amec Foster Wheeler to assist with compiling and submitting an application in terms of Section 24G of NEMA (Section 24G Application) for the Booysendal South Expansion Project; specifically construction of the supporting linear infrastructure and developments taking place at BS1/2,and BS4 .

Figure 1-1 Booysendal Operations - General Locality (Source: Booysendal Presentation, 2016)



Booysendal intends for the expansion at BS1/2, BS4, the Merensky portals, linear and supporting infrastructure to form one overall project development and have therefore opted to include activities which have commenced as well as associated activities which are to commence in the near future, as part of this phase of the Booysendal South Expansion Project in the Section 24G Application and required EIA process.

Figure 1-2 Operational and Provincial Division and Mining and Surface Rights of the Booysendal Operations



1.3 LOCATION

1.3.1 Operation Area

The operating mine of BN falls within Ward 31 of the Greater Tubatse Local Municipality (GTLM) of the Sekhukhune District Municipality in the Limpopo Province. BS is located in Ward 5 of the Thaba Chweu Local Municipality of the Ehlanzeni District Municipality in the Mpumalanga Province (refer to Figure 1-2). The details of the applicable district and local municipalities for the activities covered by this Section 24G application are included in Table 1-1. The ward and municipal demarcations are depicted in Figure 1-3.

Table 1-1 Details of the Local and District Municipalities Applicable to the Section 24G Application

Mpumalanga Province		
District Municipality	Ehlazeni District Municipality	Acting Municipal Manager: Mr Hubert Shabangu T: (013) 759 8531 M: 0825345653 E: hshabangu@ehlanzeni.gov.za
Local Municipality	Thaba Chweu Municipality	Municipal Manager: Mr Lesley Mokwena T: (013) 235 7307 M: 0794977466 E: lesleymphaka@gmail.com
Limpopo Province		
District Municipality	Sekhukhune District Municipality	Manager: Ms Mapule Makoko T: (011) 262 7300 M: 0823041629 E: Mahlangu@sekhukhune.gov.za
Local Municipality	Greater Tubatse Local Municipality	Municipal Manager: Mr JNT Mohlala T: (013) 231 1121 / 1000 M: 0828031629 E: **jntmohlala@tubatse.gov.za**

1.3.2 Water Management Area

The Booysendal operation falls within the Olifants Water Management Area (WMA). The entire Booysendal South Expansion Project falls within quaternary catchment B41G of the Olifants River. The Groot Dwars River, and several of its non-perennial drainage lines run through the Booysendal operation flowing from south to north. The Groot Dwars River then is joined by the Klein Dwars River which is located upstream of the bridge on the R577 near African Rainbow Minerals Two Rivers Platinum Mine, north west of BN. From there the Groot Dwars River flows into the Steelpoort River (a tributary of the Olifants River) at Ga-Mampuru, south of Steelpoort. The Olifants River eventually runs through the Kruger National Park into the Limpopo River. The river system that Booysendal operations is located in is thus of significant national importance. The quaternary catchment delineation for the Booysendal South Expansion Project is shown in Figure 1-4.

Figure 1-3 Municipalities, Towns and Wards

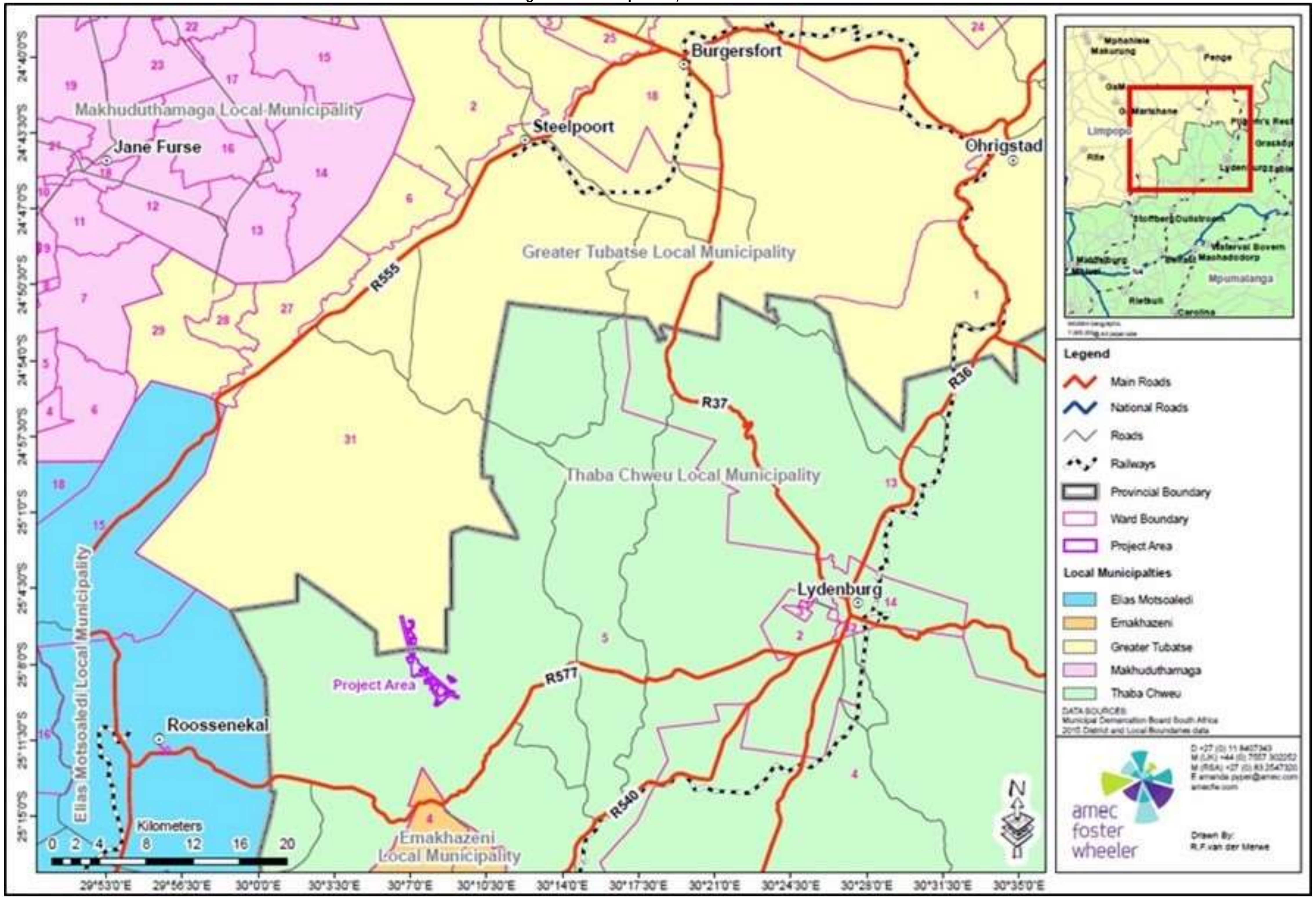
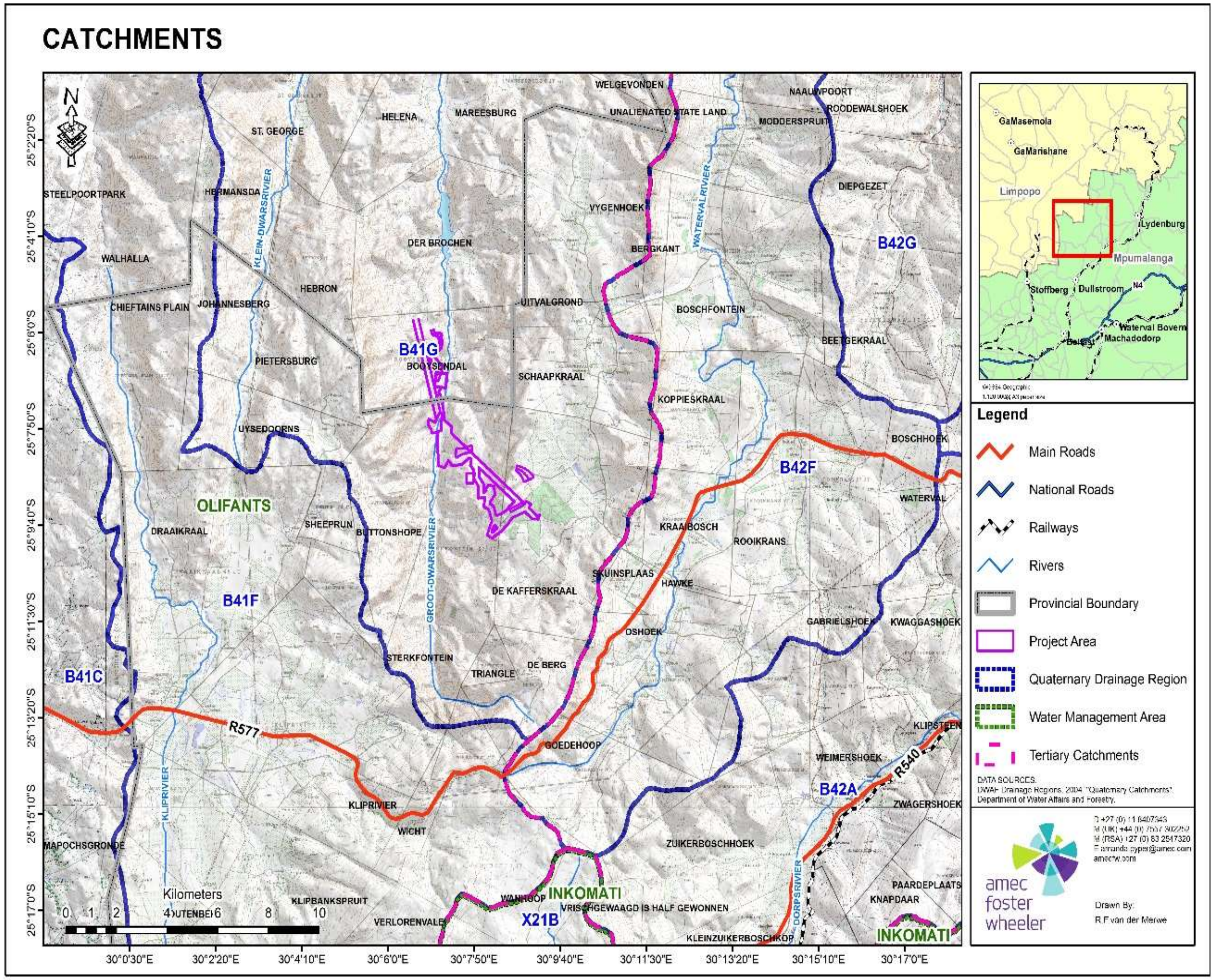


Figure 1-4 Quaternary Catchment Delineation for Booysendal Operations



1.4 PROPERTY DETAILS

An outline of the properties, on which the footprint of the project is located, are presented in Figure 1-2. A description of the properties applicable to the Section 24G expansion is included in Figure 1-5 and Table 1-2.

1.5 SECTION 24G PROCESS

The Section 24G process were conducted in accordance with the requirements stipulated in NEMA and involved:

- *Confirmation of the Competent Authority (CA):* In terms of NEMA, the Minister of Mineral Resources (Minister) is the CA empowered and authorised to issue environmental authorisations for mining-related activities. The Booysendal South Expansion activities fall under the Booysendal Mining Right and the Everest Mining Right and within the Mpumalanga and Limpopo provinces. As a result, a formal request was submitted to the Minister's office on 2 November 2016 requesting clarity in respect of the delegation of authority for the S24G process. The DMR delegated authority for this S24G process to the Limpopo Region of the DMR. A formal letter was received from the DMR Regional Office in Limpopo, dated 24 March 2017 that notified Booysendal that the DMR Limpopo is the CA (Annexure T);
- *Submission of a section 24G Notice of Intent to the Minister and the Regional Managers of the Limpopo and Mpumalanga DMR offices*: A Notice of Intent letter was submitted on 3 March 2017;
- *Acknowledgement letter of the Notice of Intent from DMR Limpopo Regional Office*; A letter of acknowledgement, dated 24 March 2017, was received;
- *Instruction to submit an Environmental Impact Report (EIR) and an Environmental Management Programme Report (EMPr)*: A letter, dated 8 May 2017, instructing Booysendal to submit an EIR and an EMPr in terms of NEMA Environmental Impact Assessment (EIA) regulations was received from the CA;
- Relevant commenting authorities and potential interested and affected parties (I&APs) were identified and *Background Information Documents (BIDs)* translated into English, Afrikaans, Southern Sotho and Northern Sotho (Sepedi) were distributed to all I&APs on the compiled database;
- *Notification letters* were distributed together with the BIDs to all I&APs, including commenting authorities and non-governmental organisations (NGOs). *Advertisements* were placed in local and regional newspapers and *signs* erected as required by NEMA;
- All baseline and impact assessment specialist studies were undertaken; and
- *Pre-consultation meetings* were held in July 2017 with in the form of focus group meetings and open meetings (Please refer to Section 0 and Annexure B) as part of the public participation process.

Drafting and compiling the initial EIR and EMPr is the next step of the Section 24G Application process and will these documents will be made available for a period of thirty (30) days for comment, which period will run from 07 July to 07 August 2017. The draft EIR and EMPr can be viewed on www.amecfw.com/booysendal or at the following public places:

- Mashishing (Mashishing) Public Library; and
- Maartenshoop Police Station.

Once the commenting period is completed, the next step of the Section 24G Application process will be to:

- Incorporate all comments made and received during the consultations, meetings, focus group meetings and public review period into the final EIR which will thereafter be submitted to the DMR; and
- Once the DMR has made a decision on the Section 24G Application, notify all registered I&APs of the outcome of the Section 24G Application, including the legislated appeal procedures.

Figure 1-5 Booysendal Project Mining and Surface Rights

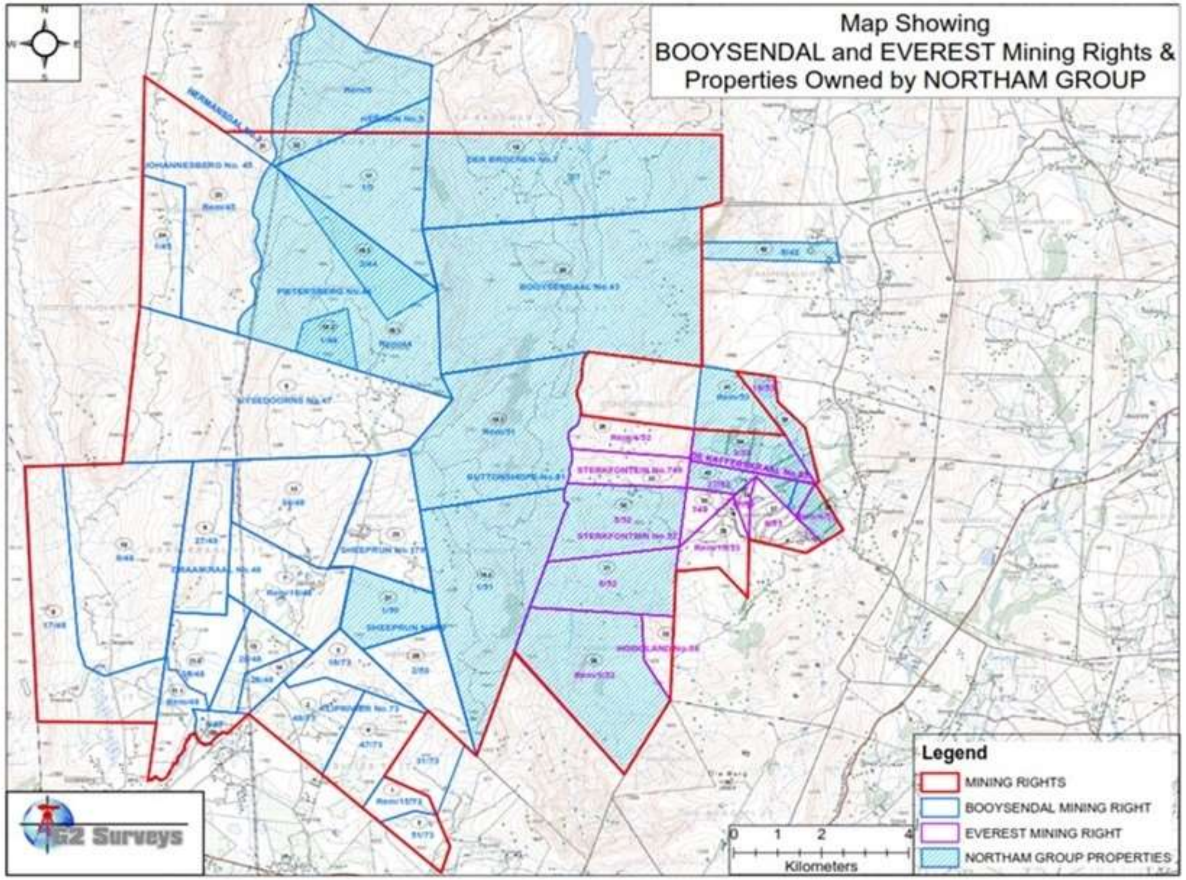
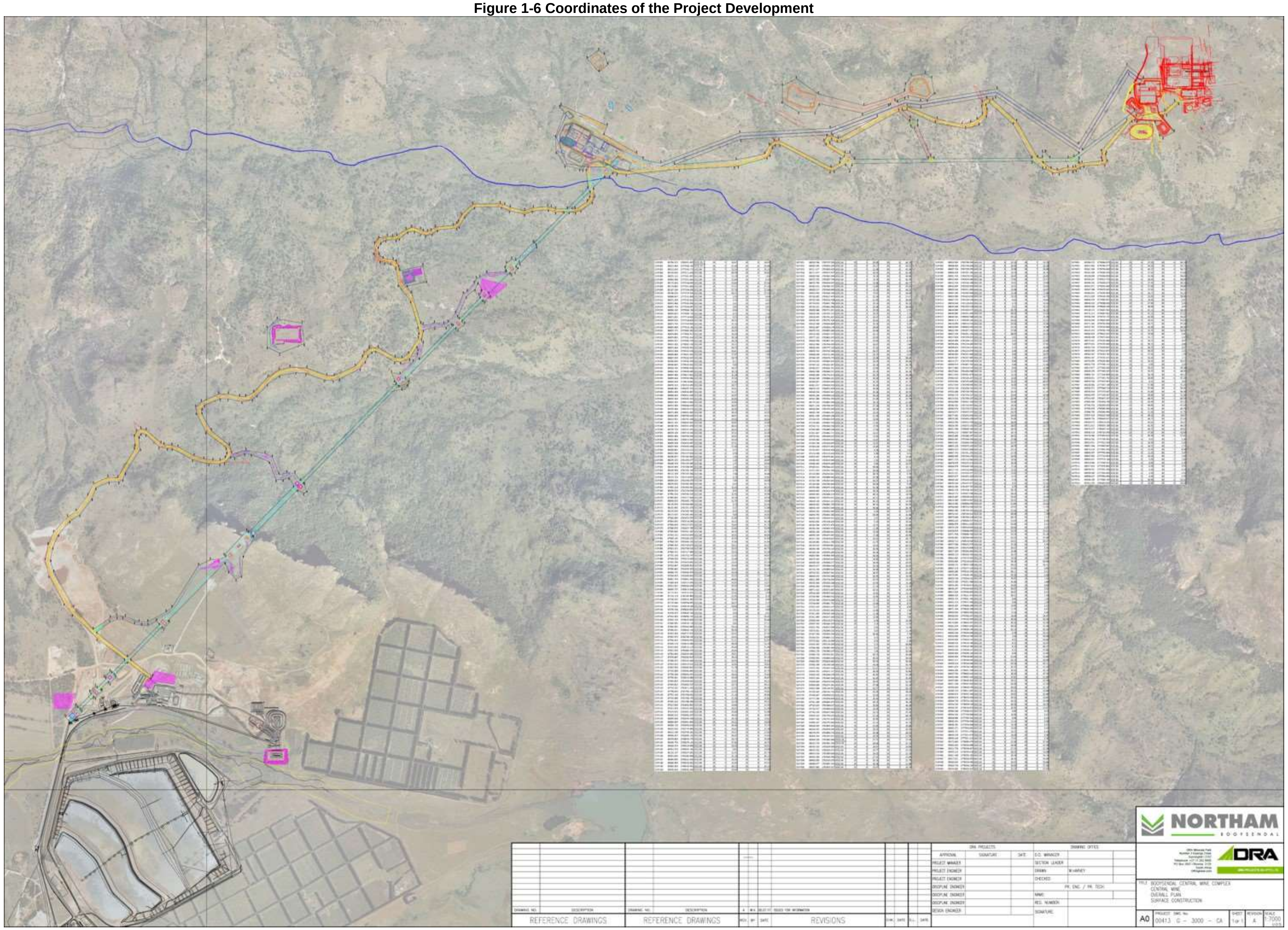


Table 1-2 Section 24G Activities Property Details

FARM	PROPERTY DESCRIPTION	OWNER	PROVINCE	TITLE DEED NUMBER	SURVEYOR GENERAL CODE	EXTENT (ha)
Buttonshope 51JT	Remaining Extent	Micawber 278 Pty Ltd (Booysendal's previous name)	Mpumalanga	T6075/2009	T0JT00000000005100000	934.8152
Booysendal 43 JT	Farm	Booysendal	Limpopo	T38487/2009	T0JT00000000004300000	1807.2269
Sterkfontein 52 JT	Portion 4	Bakoni Baphetla Communial Property (Bakoni CPA)	Mpumalanga	T173287/2006	T0JT00000000005200004	178.6939
Sterkfontein 52 JT	Portion 5	Booysendal	Mpumalanga	T15314/2015	T0JT00000000005200005	393.3623
Sterkfontein 52 JT	Portion 6	Booysendal	Mpumalanga	T15314/2015	T0JT00000000005200006	371.5165
Sterkfontein 749 JT	Farm	Bakoni CPA	Mpumalanga	T171108/2006	T0JT00000000074900000	248.5382
De Kafferskraal 53 JT	Portion 3	Booysendal	Mpumalanga	T16257/2016	T0JT00000000005300003	197.89474
De Kafferskraal 53 JT	Portion 8	Bakoni CPA	Mpumalanga	T7052/2016	T0JT00000000005300008	131.9059
De Kafferskraal 53 JT	Remaining Extend of Ptn 15	Bakoni CPA	Mpumalanga	T7052/2016	T0JT00000000005300015	179.8717
De Kafferskraal 53 JT	Portion 17	Bakoni CPA	Mpumalanga	T7052/2016	T0JT00000000005300017	24.9550
De Kafferskraal 53 JT	Portion 27	Booysendal	Mpumalanga	T16257/2016	T0JT00000000005300027	122.8744
Sterkfontein 52 JT	Remaining Extent	Bakoni CPA	Mpumalanga	T166144/2005	T0JT00000000005200000	352.2488

The coordinates of the development are included in Figure 1-6

Figure 1-6 Coordinates of the Project Development



1.6 APPLICANT DETAILS

Northam is the holding company of Booysendal. However, Booysendal is the registered holder of the Booysendal Mining Right and Everest Mining Right respectively. Therefore, for purposes of the Section 24G Application, Booysendal's company details are included in Table 1-3 below.

Table 1-3 Applicant Details

Name of Applicant	Booysendal Platinum (Pty) Ltd
Contact Person	Paul Anthony Dunn
Company Registration No	2002/016771/07
Postal Address	PO Box 412694, Craighall, 2024
Project Physical Address	Farm Booysendal 43JT
Telephone No	011 325 4795
Mobile No	0828088364
Email	Paul.Dunne@norplats.co.za

1.7 DETAILS OF THE INDEPENDENT ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP)

1.7.1 General

Amec Foster Wheeler was initially appointed by Booysendal to undertake the environmental authorisation (EA) processes for the Booysendal South Expansion Project, including the NEMA/MPRDA EA, the Integrated Water Use License Application (IWULA) and the Waste Management License Application (WML) in one integrated process. Upon advisement and instruction from the DMR to submit a Section 24G EIA and EMP, the processes have since been separated. Therefore, the Section 24G Application process makes provision for NEMA and NEMWA activities which have commenced or will commence in the future. A separate IWULA process will be undertaken for all the Section 21 water uses associated with the overall Booysendal South Expansion Project as advised by the Department of Water and Sanitation (DWS) during a pre-consultation meeting held on 28 Mach 2017. A concurrent EA process for future listed NEMA and NEMWA activities will be undertaken with the IWULA.

The details of the EAP are included in Table 1-4. A declaration of independence by the EAP is included in Section 0.

Table 1-4 Details of the Environmental Assessment Practitioner

Name of EAP	Amec Foster Wheeler South Africa Pty. Ltd.
Contact Person	Amanda Pyper-Rocher
Postal Address	Building 2, Silver Stream Business Park, 10 Muswell Road South, Bryanston, 2021, South Africa
Physical Address	Second Road, Midrand, Gauteng 1683
Telephone No	+27 (0)11 840 7457
Mobile No	+44 (0) 7557 302252
Email	Amanda.pyper@amecfw.com

1.7.2 Credentials of the EAP

Amanda Pyper is a Principal Environmental Scientist with 26 years' experience, of which the past 10 years have been as an environmental and social scientist. Her experience spans the whole project life cycle and includes strategic advisory roles; due diligence assessments; prefeasibility, feasibility and bankable feasibility input, environmental compliance audits; external IFC reviews; managing large international ESIAs and ESMPs, often in remote locations and involving large multidisciplinary specialist teams; and developing closure and rehabilitation plans. This experience gives her a detailed understanding of overall project requirements through all stages of development. She is frequently involved in projects at the scoping and prefeasibility stages, her guidance on project design and optimization in the early stages of project development resulting in increased benefits to project cost and schedule in the later stages of study and permitting.

Her experience includes roles in the extractive, linear infrastructure, water sector and industrial developments for both greenfields and brownfields projects. He role furthermore involves business development and strategic advisory services. She has undertaken several environmental impact assessments in South Africa, amongst others the 2010 EMP Amendment for Booysendal North.

She has worked on projects in Liberia, Côte d'Ivoire, Republic of Congo (Brazzaville), South Africa, Mozambique, Guyana, Taiwan, Singapore, Malawi, Kyrgyzstan and the Kingdom of Saudi Arabia. She holds a Master's Degree in Environment and Society, completed at the University of Oulu (Finland) and the University of Pretoria, and an Honours Degree in Environmental Impact Assessment and Environmental Management. She is a qualified QEF for Chevron and holds an ISO 14001 Advanced EMS Lead Auditor qualification.

Amanda Pyper-Rocher full CV is included as Annexure O.

1.8 STRUCTURE OF THIS S24G EIA

Section 1: Introduction and Background (this section)

Section 2: Project Description

Section 3: Legislation, Policies and Guidelines

Section 4: Description of the Receiving Environment

Section 5: Public Participation Process

Section 6: Need and Desirability

Section 7: Alternatives

Section 8: Impact Assessment, Management and Mitigating Measures

Section 9: Recommendations of the EAP

Section 10: Motivation for Response to an Emergency

Section 11: Declaration by the EAP

Bibliography & Annexures

2. PROJECT DESCRIPTION

2.1 GENERAL

The following section contains a detailed description of the overall components of the Booysendal South Expansion Project (the Project). It provides an indication of the activities currently undertaken on site specifically associated with BS1/2, BS4, the two Merensky adits and various linear and supporting infrastructure components. It further provides a linkage of the activities with listed activities as described in terms of NEMA and NEMWA and included in Section 3. The status of the various activities provided in this section is based on the last site visit undertaken on 19 May 2017. Project development is ongoing and as a result, changes and alterations are inevitable. Therefore, some of the assessments and descriptions of the activities may be outdated.

2.2 ACTIVITY DESCRIPTION

2.2.1 General

The Booysendal South Expansion Project covers the expansion of the existing infrastructure and mining development to increase the current BN production from 220,000ktpm to 450,000ktpm. The Booysendal South Expansion Project specifically focuses on three development areas (BS1/2, BS4 and two Merensky adits) with linear and supporting infrastructure between the development areas. The development components are included in Figure 2-1. The motivation for the activities are included in Section 10.

2.2.2 BS1/2 Portal and Supporting Infrastructure

The bulk of the mining related infrastructure development associated with the Booysendal South Expansion Project is currently being undertaken at BS1/2. BS1/2 is located on a central section of the Farm Buttonshope 51JT, which lies west of the Groot Dwars River valley. The layout and infrastructure associated with the portal complex is depicted in Table 2-1.

Construction Phase

<u>Portal development</u>:
A portal complex is being developed at BS1/2 which includes the construction of a single on-reef boxcut at the western side of the portal complex (development of which is ongoing). Thereafter, two underground shafts will be constructed and developed to access ore in a northerly and southerly direction. Seven adit declines will be developed from these underground shafts which will optimize mining of the UG2 reef. Waste rock from the portal excavation is being temporarily stored on the northern part of the portal terrace and is used in the construction and development of the associated infrastructure.

<u>Terrace</u>
A terrace measuring approximately 6 hectares in extent, is being developed and constructed as part of the portal development. The construction of the terrace includes site clearance, infilling and compaction. Sections of the vegetation cleared for development of the portal and terrace was previously disturbed by agricultural

activities, while sections located to the west were demarcated and noted as critical biodiversity areas (CBA) in the Mpumalanga Biodiversity Sector Plan.

The development and construction of the terrace required more than 10 cubic metres of fill material and took place within 100 m of the Groot Dwars River (located east of the terrace) and within the 100yr floodline of an unnamed tributary of the Groot Dwars River (located south of the terrace). The infilling volumes associated with the terrace are totalled to be approximately 16,025.75m^3. The concrete required for the development of the infrastructure components associated with the portal complex on the terrace were calculated to be approximately 2,762.02m^3.

According to the DRA Infrastructure Environmental Impact Report JZASM0413-PM-REP-001 July 2015, the size of the Portal complex development is 12 hectares in extent.

Stormwater Management:
A pollution control dam (PCD) measuring 14,000m^3 is in the process of being constructed at the eastern end of the terrace. The PCD will be lined with a High-density Polyethylene (HDPE) liner. A section of the PCD is located within 100m of the Groot Dwars River.

The stormwater management infrastructure located upstream of the portal has been finalised. This infrastructure consists of a trapezoidal (overlapping) cut-off trench which diverts two non-perennial streams around the terrace development. The drainage lines now report into the cut-off trench and discharge into the southern unnamed tributary of the Groot Dwars River and into an open area to the north. Rock gabions were packed to reduce erosion where the streams flow into the cut-off trench, while rocks serve as energy dissipaters at the outflow of the cut-off trenches. The trenches are concrete lined with a 150mm thick concrete lining and mesh. The southern section of the trench (trench 1) is 157.85m long, and the northern section (trench 2) is 284.42m long. According to the DRA general arrangement drawing, the average horizontal disturbance along the length of the cut-off trench is approximately 6m wide. This relates to an approximate disturbance footprint of 2,653.6m^2 (2.6ha) The design of the cut-off trench is included in Annexure A1.

Co-disposal Stockpile:
A stockpile has been developed and constructed south of the portal complex within 100m of the unnamed tributary of the Groot Dwars River and consists of a mixture of overburden and topsoil. In addition, access to this stockpile is obtained by way of a crossing which was constructed by infilling the drainage line and two pipe culverts have been placed at the bottom end. The extent and size of the stockpile has not been provided.

A waste rock stockpile has been temporarily developed on the terrace and will be used for construction purposes.

Other Infrastructure:
Infrastructure associated with the BS1/2 portal and terrace complex for which construction is still to commence as part of the Section 24G activities are listed in Table 2-1. It must be noted that no topsoil stockpiles have been provided.

Table 2-1 Infrastructure associated with the Portal Complex – Construction Phase

Components	Description
Offices	The development and construction of office buildings will consist of a combination of pre-fabricated containerised and brick buildings, including a brick security building next to the office complex. (This will be constructed on the terrace)
Workshops	The workshop will be a permanent building constructed with bricks, with a roof and necessary impermeable slab, cut-off trench, oil separator and silt trap. Provision has also been made for a washbay. The design of the washbay will be in accordance with best practice and will be bunded with a cut-off trench on the open side and will link to the oil separator and silt trap. The dirty water from the silt trap and oil separator will be directed to the PCD. Depending of the characteristics of the fines, they will either be disposed of at the BN TSF or processed as part of the ore. The extent to which the surface workshop will decrease will only be known once the underground workshop has been constructed. The same best practice will be implemented for the underground workshop. In addition to the main maintenance workshop, separate boiler, mechanical and electrical workshops will be constructed. An oil separator system will be constructed to ensure that all water containing hydrocarbons reports to the oil separator.
Change house	The change house will be a brick building which will make provision for male and female facilities suitable for 24,00 people.
Raw water storage tank	8,500m³
Process water storage tank	812m³
Potable water treatment plant	A modular package type potable water treatment plant will be installed to treat water to SANS 241:2011 drinking water standards. The treatment process will consist of a chemical dosing pre-treatment, followed by a clarification phase in settlers, followed by filtration through pressure filters and final disinfection by chlorine dosing from where the water will be stored in the potable water storage tank with a throughput capacity of 15m³/h.
Sewage treatment plant	A package type sewage treatment plant with a 30m³/h capacity will be installed on the terrace.
Diesel, chemical and material storage facilities	Diesel and chemical storage facilities will be constructed. These facilities are located in CBAs and are above the NEMA listed activity threshold of 30m³. A separate bunded fuel storage area will be constructed to accommodate two 80,000l diesel storage tanks above ground. Refuelling will take place in a specially prepared area close to the diesel storage area. Used oils will be stored in a specially prepared storage area. One storage compartment of 20,000l for engine oil and one hydraulic oil 20,000l storage area will be constructed. A hazardous waste storage facility will be constructed. The facility will have an impervious bund and will be roofed with a capacity to store 6 x 6m³ lidded skips. A tyre bay will be constructed close to the workshop covering an area of 107m². A cable and salvage yard will be provided on the terrace.
Light	A lighting plan has been prepared for BS1/2. The configuration and type of lights to be used is still to be finalised

Conveyor	Ore will be transported (using a conveyor) from the underground operations to a surface crusher and thereafter to a silo on the northern side of the terrace which will report to the Aerial Rope Conveyor (ARC).
Crusher	A Metso C3054 crusher will be installed on-surface consisting of two-vibrating feeder feedrates, and a jaw crusher. The crusher has a design throughput of 750t/h. The crushing size ranges between 25mm to 300mm. It is indicated that provision will be made for dust suppression, however, the areas where the sprays will be installed has not been determined.
Explosive storage	An emulsion storage area will be constructed in accordance with SASOL Standards and licensed with SASOL. Two storage tank container areas will be constructed. A tanker offload and spill containment area will be constructed on the one side of the container area and a charging unit loading and containment area on the other side. Detonators will come in from the BN explosives magazine. An underground magazine will be constucted. The destruction bay at BN will be used.
Communication Mast	A communication mast less than 15m high will be constructed next to the BN communication mast. The HD400 antenna provides unity gain in the 380 – 470 MHz frequency range. These antennas can be stacked and fed with a matching phasing harness for increased gain. All metal parts will be DC grounded.
Feedbin and ARC Silo	A ROM Mill feed bin will be constructed as part of the crusher and one a 4,000t silo will be constructed at the ARC loading station.
Stormwater Management	Clearance for the clean and dirty water separation equated to approximately 18ha (Source: DRA Report JZASM0413 Booysendal South). The stormwater management infrastructure has been designed to accommodate at least a 1:50yr storm event.
Vent Shafts	Two vent shafts will be developed against the western slope from the portal complex. This will require additional clearance of 18ha (Source: DRA Report JZASM0413 Booysendal South). Powerlines will run from the main sub-station to the vent fans. For every two vent fans a 2000kVA transformer station will be installed. Transformers will be constructed with a 110% impervious bunds with drain valves in event of spillages. Emergency generators will be installed at each of the vent shafts for emergency energy in case of power outages. It was indicted that each vent fan will require an area of 36m². Each vent end will be equipped with a 1,016-mm duct and a 75 kW fan. The report indicates that the ducting will extend approximately 30m on surface to avoid any recirculation of contaminated outflow.

Design capacities for all stormwater and dirty water containment infrastructure at BS1/2 are presented in Table 2-2.

Table 2-2 Stormwater, Infrastructure at BS1/2 (Source: DRA Booysendal North, South & Central Integrated Water Balance Report, GBP-ENG-REP-001, 26 May 2017)

Description	Capacity m³	Surface Area m²	Catchment Area m²
Mine Service Water Silt Trap	1 000	500	500
Central PCD Silt Trap	1 000	500	500
Central PCD	14 000	4 667	87 000

An IWULA is being compiled for submission to DWS to permit the operation of the above water uses as well as the water uses contemplated for the Booysendal South Expansion Project. These applications and submission are in the process of being prepared as part of a separate process to the Section 24G EIA.

The infrastructure associated with BS1/2 is set out in Table 2-1. All the infrastructure included in this table forms part of the Section 24G Application. Figure 2-1 provides an illustration of the footprint area before construction commenced and some time after development started. This has not been included in a separate photo template, as generally recommended, to avoid confusion as there are various areas of development.

Operational Phase

The mining operations under the Booysendal South Expansion Project, as is the case at BN, will be a 24-hour operation. The Prefeasibility Study (PFS) conducted by DRA, 2016, indicated that there will be two 10-hour shifts during the operational phase. Mining operations will be conducted using the conventional mechanised bord and pillar mining methods. The pillars will have 8m by 8m room and 6m by 6m pillar configuration. Mining operations will take place at a depth of 30m below surface (mbs) to a depth of 900mbs. A blasting agent containing nitrates will be used to progress mining operations. The ore extracted will be transported from underground using a conveyor system. The mining production rate at BS1/2 will be approximately 240,000ktpm (119,479tpm from BS1 and 118,613tmp from BS2) and 75,000ktpm at each of the Merensky portals. The total BS reserve is estimated to be 105.88Mt.

The process flow diagram for the operational phase is depicted in Annexure A. During the operational phase, ore from underground will be transported to a primary crusher. The crushed ore will thereafter be transferred onto a conveyor from where it will be taken to the silos for transportation on the ARC to BS4.

Table 2-3 Infrastructure associated with the Portal Complex – Operational Phase

Components	Description
Offices	Normal day to day mining operations will be carried out. Waste generated by the office will be managed as per the policy and procedure currently in place at BN. This involves separation of waste streams, storage of waste as per best practice. Water will be reticulated to the waste water treatment works and recycled into the process. The waste management policy and procedure is included in Annexure D.
Workshops	Oils originating from the oil separator and used oils, diesel and other hydrocarbons will be stored in a specially prepared waste management area from where the waste will be transported to BN for disposal under the current waste management license during operations. It is assumed that dry cleaning practices will be undertaken at the workshops.
Change house	Solar technology will be installed to supplement water heating and heat pumps will ensure that energy is conserved during the operational phase. Water will be provided from the potable water tank and effluent treated at the waste water treatment plant from where it will be recycled in the process through the PCD.
Raw water storage tank	The tank will be operated with capacity for a two-day supply.
Process water storage tank	Process water will be recirculated in the process from the PCD at BS1/2

Potable water treatment plant	The potable water treatment plant at BS1/2 will receive a maximum of 2,748m^3/month (7.33m^3/h) raw water from the TKO Dam. This will be treated for potable water use at the complex. Sludges will be disposed on the TSF at BN in accordance with the Waste Management License (WML) held by BN.
Sewage treatment plant	Effluent will be gravity fed to the sewage treatment plant through a 200mm HDPE pipe at a rate of 30m^3/h. Output of treated effluent will be into the PCD through a 150mm pipe at a rate of 30m^3/h.
Diesel and chemical storage facilities	Preliminary Prefeasibility Study (PFS) calculations indicate 212,084l diesel will be used per month for the BS1/2 complex. An estimated 90,664l/m hydraulic oils 24,609l/m engine oil will be required at BS1/2. The current procedures and schedules applicable at BN will be implemented at BS for bund maintenance and inspections.
Two vent shafts	Ventilation shafts will be commissioned to circulate and supply air to the underground workings. The noise to be generated by the shafts will be frequencies between 63Hz to 8kHz. Ventilations shafts will be in operation 24 hours a day, 7 days a week.
Conveyor	The conveyor system will run from the underground workings at BS1/2 to the feed silo and from there to the ARC silo on the northern side of the terrace. Average tonnage from BS1/2 to the silo will be 663tph with a maximum tonnage of 1,977tph. Bi-weekly conveyor maintenance will be conducted, in accordance with the maintenance procedures implemented at BN.
Crusher	ROM will be conveyed from underground to surface into a surface ROM feedbin. ROM will automatically feed onto a vibrating feeder and grizzly feeder. Undersize ore will report directly to the silo via a conveyor, while the oversize will report to the jaw crusher. From the jaw crusher, the ore will report to the silo and from there will be conveyed to the ARC silo for transportation to the plant at BS4. Allowance is made for dust suppression.
Explosive and explosives storage	The emulsion contains nitrates and may therefore have impacts on surface-and groundwater quality. As with BN, SASOL will pick up spills and waste.
Communication Mast	Maintenance will be carried out as required.
ARC Silo	Crushed ore will be fed into the 4,000t silo at the BS1/2 ARC loading station.
PCD	Water will be reused in the process. The PCD will be operated as empty not to overflow during a 1:100yr storm event. A freeboard of 0.8m will be maintained at all times. Silt will be captured in the downstream silt trap. Maintenance and cleaning of the silt traps and inspections of the dam will be done in accordance with a maintenance plan which will be compiled by Booysendal.
Stormwater management	All stormwater management infrastructure will be inspected and cleaned in accordance with a maintenance plan which will be compiled by Booysendal.
Waste management	Booysendal has an Operating Procedure and a Code of Practice in place for the handling, management and removal of waste in place; NOR-BSD-ENV-PRC-005 and BD-COP-17 respectively. The measures contained in these two documents as well as any other measures required will be included in the environmental management plan.

Ore will be transported from underground operations and will report to the grizzly that separates oversized material whereafter the rest of the ore will be fed into the primary jaw crusher through a feed bin. The oversized material will then be crushed and fed back onto the grizzly into the jaw crusher. From the jaw crusher, the ore will be transported by conveyor to a silo at the start of the aerial ropeway. The ore will be loaded onto the ARC through two silo feeder bins.

The fines will be transported by the conveyor from the ARC to a silo. The silo will link into the ARC system from where the ore can be either transported to BN or to BS4.

The conveyor system will be enclosed thereby limiting spillages off the belt whilst the ore moisture contents of 8% will assist in limiting dust generation. A spray system will also be installed at the end of the conveyor system where it enters the jaw crusher to limit an additional dust generation.

The DRA Mine Design Criteria for Booysendal Central Complex (JZASM0413-Min-DC-002) reports that the total labour requirement for BS1/2 is 1,798.

Stockpiles: The waste rock stockpile will be totally removed as all rock will be required for the construction phase. The co-disposal stockpile will be used for post-construction phase rehabilitation and the non-perennial drainage line will be rehabilitated through the removal of all material and reinstatement of natural flows.

Decommissioning, Closure and Rehabilitation Phase

Closure and rehabilitation will be phased to reduce exposure and enhance rehabilitation.

During closure, all surface infrastructure at BS1/2 should be removed. Potential contaminated liners including that of the PCD, cut-off trench at the workshops, oil separator, bunded areas for hazardous chemical and hydrocarbon storage, sewage lines, sewage treatment plant etc. will be decontaminated and removed to a licensed landfill site in accordance with the hazardous rating of the material. Uncontaminated material and rubble can be placed in the PCD as fill material.

The necessary stormwater management measures will be put in place to avoid and mitigate against erosion and siltation during rehabilitation. All linear infrastructure, i.e pipelines, communication lines, trenches, powerlines etc., will be removed. All fill and infrastructure within drainage lines, including culverts will be removed to ensure that the natural flow of streams and the Groot Dwars River is restored.

The boxcut and adits must be plugged to avoid any decanting into the natural environment. The total area of disturbance must be ripped. Grading should be done to avoid any ponding of water and to enhance natural run-off without causing erosion. All graded areas must be provided with a 300mm topsoil layer and revegetation must be done in consultation with the relevant authorities at that period of time.

Detail around closure and rehabilitation will be provided in the SRK Consulting Closure and Rehabilitation report for Booysendal (Annexure U).

Figure 2-1 Booysendal South Section 24G Expansion Project Components

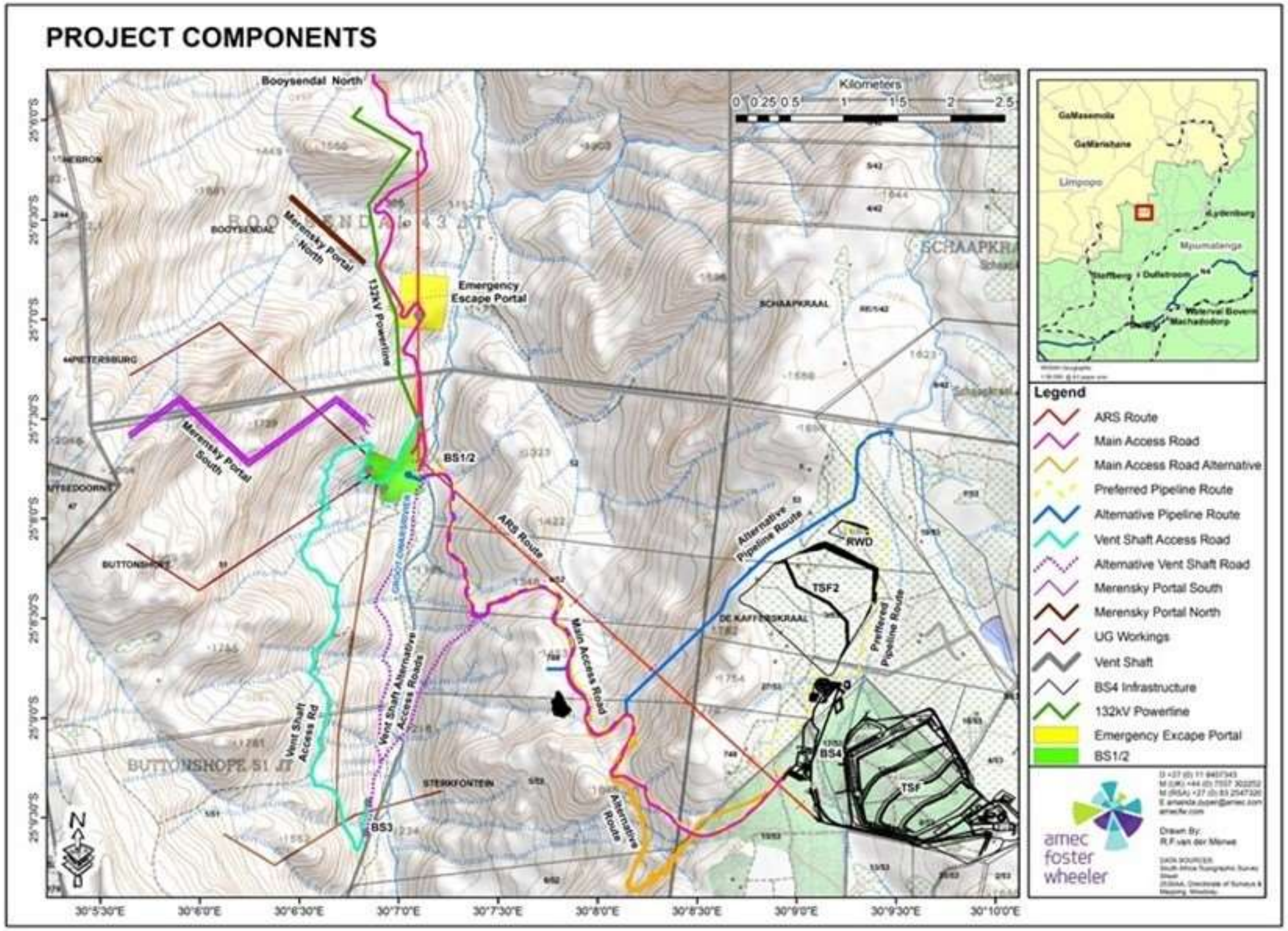


Figure 2-2 BS1/2 Terrace, Portal and Infrastructure Development

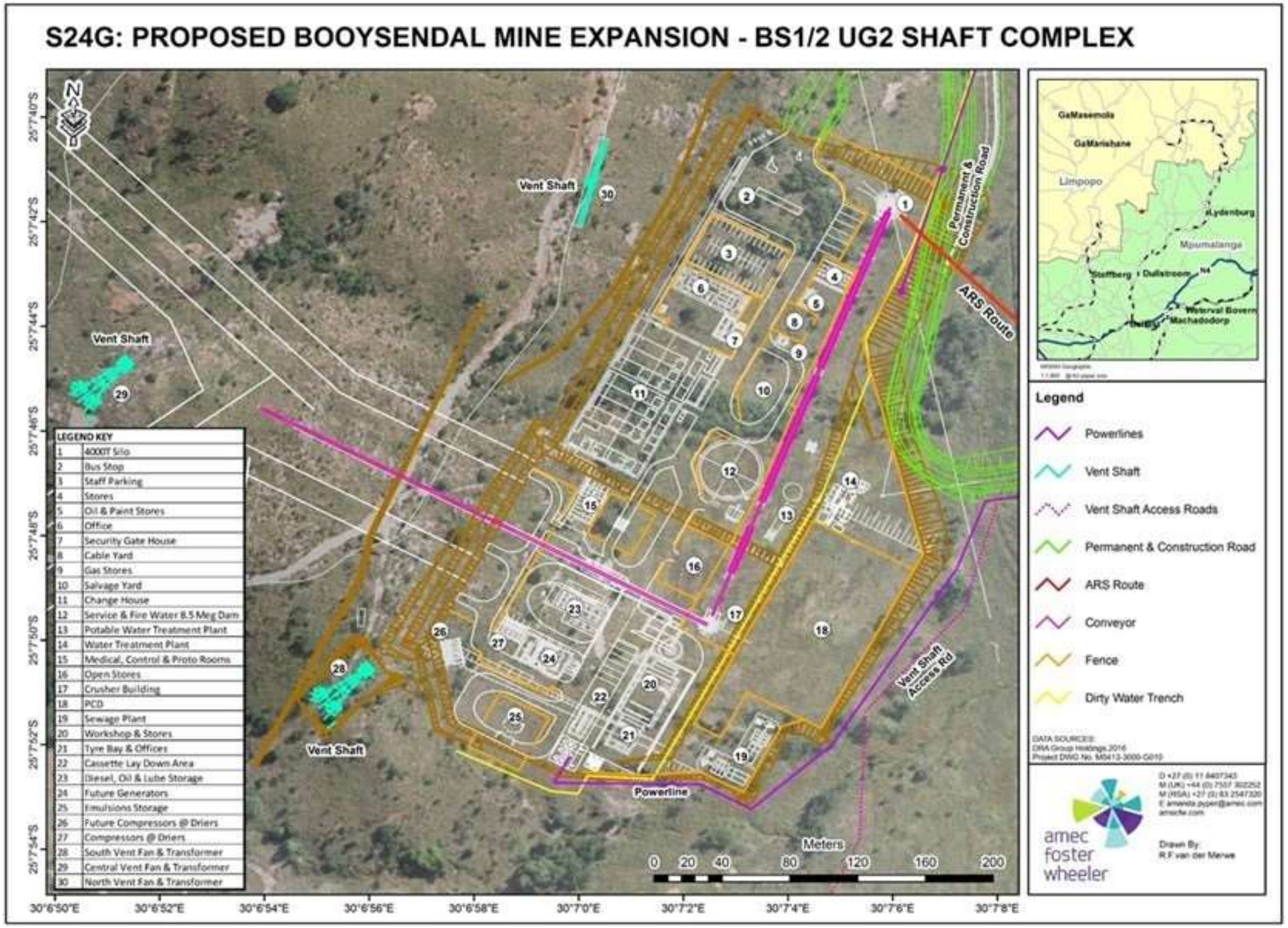


Figure 2-3 BS1/2 Clearance and Construction Activities

2-3a) BS1/2 Prior to Construction as seen from BS4 (east)

2-3b) BS1/2 Construction Activities on 11 Nov 2016 as seen from BS4 (east)

2-3c) Infilling, Terracing and Infrastructure Development at BS1/2 19 May 2017 from the west	**2-3d) Stockpile and Crossing within a Non-Perennial Drainage Line directly south of BS1/2**

2-3e) Upstream Stream Diversion and Cut-off Trench

2-3f) En Route to BS1/2 Terrace on the Southern Right

2.3 UPGRADES AND EXPANSIONS AT BS4 (EVEREST)

Construction Phase

Booysendal is planning to recommission BS4 specifically for the treatment of ore extracted from BS1/2; reworking the existing TSF1 at BS4 and for potential toll treatment of orefrom other sources. It is for this reason, that the expansion and upgrade of the existing infrastructure has commenced and is anticipated to continue. The following BS4 activities have been included in this Section 24G Application:

- Upgrade of the storm water management system at BS4 using the Storm Water Management Plan (SWMP) developed by SLR in 2011, as a basis for the upgrades. (Refer to Table 2-4 for capacities and footprint.) The following upgrades are in the process or will be done:
  - Upgrade of the storm water drainage at, and downstream of, the main portal -. *commenced and still ongoing*;
  - Upgrade of the clean and dirty water separation system upstream of the existing TSF and to the east of the existing portal and workshop complex – *commenced and still ongoing*;
  - Upgrade of the plant pollution control dam (PCD). The dam is not currently lined. As part of the upgrade the dam capacity will be increased and the dam will be provided with a liner and silt trap – *construction commenced*;
  - Decommissioning and rehabilitation of the workshop PCD. This will involve the infill of the basin, contouring and rehabilitation. Ponding of stormwater will be avoided through proper design and rehabilitation – *planned but not commenced yet*;
  - Upgrade of the Mine PCD. The dam capacity is being increased to 30,258m³ and the dam will be provided with a liner – *commenced and still ongoing;*
  - Upgrade of the sewage treatment plant at the workshop. The capacity will be increased to a 20m³/day plant. Water will be discharged into the Return Water Dam (RWD) at Tailings Storage Facility 1 (TSF1) – *planned but not commenced yet*; and
  - Construction of a PCD at the valley boxcut. At the time of the site visit, vegetation has been cleared for the PCD and for a section of the main access road to the south and excavation for the PCD was completed. Earthworks to the access road were also near completion. No stockpiling of topsoil was visible. - *ongoing nearly completed*
- Increase in the size of the run of mine ore stockpile (ROM) to a capacity of 500,000t – *planned but has not commenced yet*;
- Silt trap at the upstream point of the conveyor system – *planned but has not commenced yet*;
- Reworking of tailings on the existing Tailings Storage Facility (TSF 1) through hydro-mining –*indicated as having commenced and ongoing;*
- Replacement of tailings on the existing TSF1 at BS4. It was indicated that no lining will be installed on the TSF. Future activities are planned for TSF1 which does not form part of the Section 24G application – *indicated as having commenced and still ongoing*; and
- Backfilling of the underground workings with tailings – *planned but has not commenced yet*.

The plan of the stormwater upgrades is listed in **Error! Reference source not found.**.

Table 2-4 Stormwater Management Upgrades at BS4 (Source: DRA Booysendal North, South & Central Integrated Water Balance Report, GBP-ENG-REP-001, 26 May 2017)

Description	Capacity m^3	Surface Area m^2	Catchment Area m^2
Mine Storm Water Dam	30,258	10,086	393,235
Plant Storm Water Dam	9,215	3,072	118,607
Valley Box-cut Dirty Water Dam	35,000	10,000	10,000
Old Return Water Dam	90,000	26,354	26,354
Old TSF	-	678,496	678,496
Cut-off Trench	**Work**	**Length**	
Western Cut-off Trench	Rehabilitate and upgrade	2,018m	

Retreatment and Disposal of Tailings

The following is applicable to the construction and operational phases of the reworking, re-deposition and backfilling of tailings into the underground workings. The TSF has a capacity of 29Mt and a RWD with a capacity of 90,000m³, both of which are unlined. The TSF has four compartments with a current estimated *in-situ* 8.7Mt of tailings. The current distribution of tailings is recorded in Table 2-5.

Table 2-5 Current *In-situ* Tailings Volumes at TSF1 (DRA, 2016)

Compartment	In-situ Volume (Tons)
Compartment 1	870,000
Compartment 2	2,350,000
Compartment 3	2,200,000
Compartment 4	3,300,000
Total Volume	8,720,000

The hydro-mining process typically involves the use of high pressure water cannons to mobilise tailings with the water being sourced from the RWD. This water is used to mobilise the tailings and will be captured in lined sumps. The tailings will be mined at a rate of 300ktpm. Once mined, slurry will be pumped to the spiral feed tank and, from there, to the spiral plant at the process plant within BS4. The plant availability is planned to be 7,800 h/a.

Tailings will be redeposited on Compartments 3 and 4 once Compartments 1 and 2 are mined. The tailings deposition will be by way of spigot deposition. It is anticipated that tailings will be mined at 300ktpm and tailings produced at a rate of 255ktpm at 39% solids. Once Compartment 1 and 2 has been re-mined, the tailings originating from processing ore from BS1/2 will be placed on the empty compartments which, as indicated, will not be lined.

The backfill will take place at a rate of 120 ktpm and the additional tailings deposited back onto TSF1. It is anticipated that the amount of water to be contained in the backfill material will be in the order of 740,644 m^3/annum (127m^3/h over a 5,832-operational hour period). The backfill will be designed to ensure that the water draining out of the backfilled material will drain into the bottom barricade, through an underground drainage system which will form part of the backfill process. The water will thereafter be pumped from the bottom barricade back to surface, using the existing underground pump system. Water originating from the backfill process and underground fissure water will be pumped out through the same system. Some separation of the two streams will be possible. Water will be pumped back to the existing RWD at BS4 and reused in the hydro-mining process. The reason for the backfilling is twofold:

- To reduce the need for a second TSF facility at BS4; and
- To stabilise the underground workings which have collapsed and resulted in BS4 being placed under care and maintenance. Stabilisation through backfilling could potentially make the mine safe for re-commencement of mine operations.

These activities form part of the Section 24G for the WML.

The layout of activities associated with the Section 24G EIA is included and depicted in Figure 2-4, while Figure 2-5 is a photo template of activities taking place at BS4 on or before 19 May 2017. The backfilling plan is provided in Figure 2-6 and the reworking process in Figure 2-7.

Figure 2-4 Layout of Infrastructure Development at BS4 including Existing Infrastructure

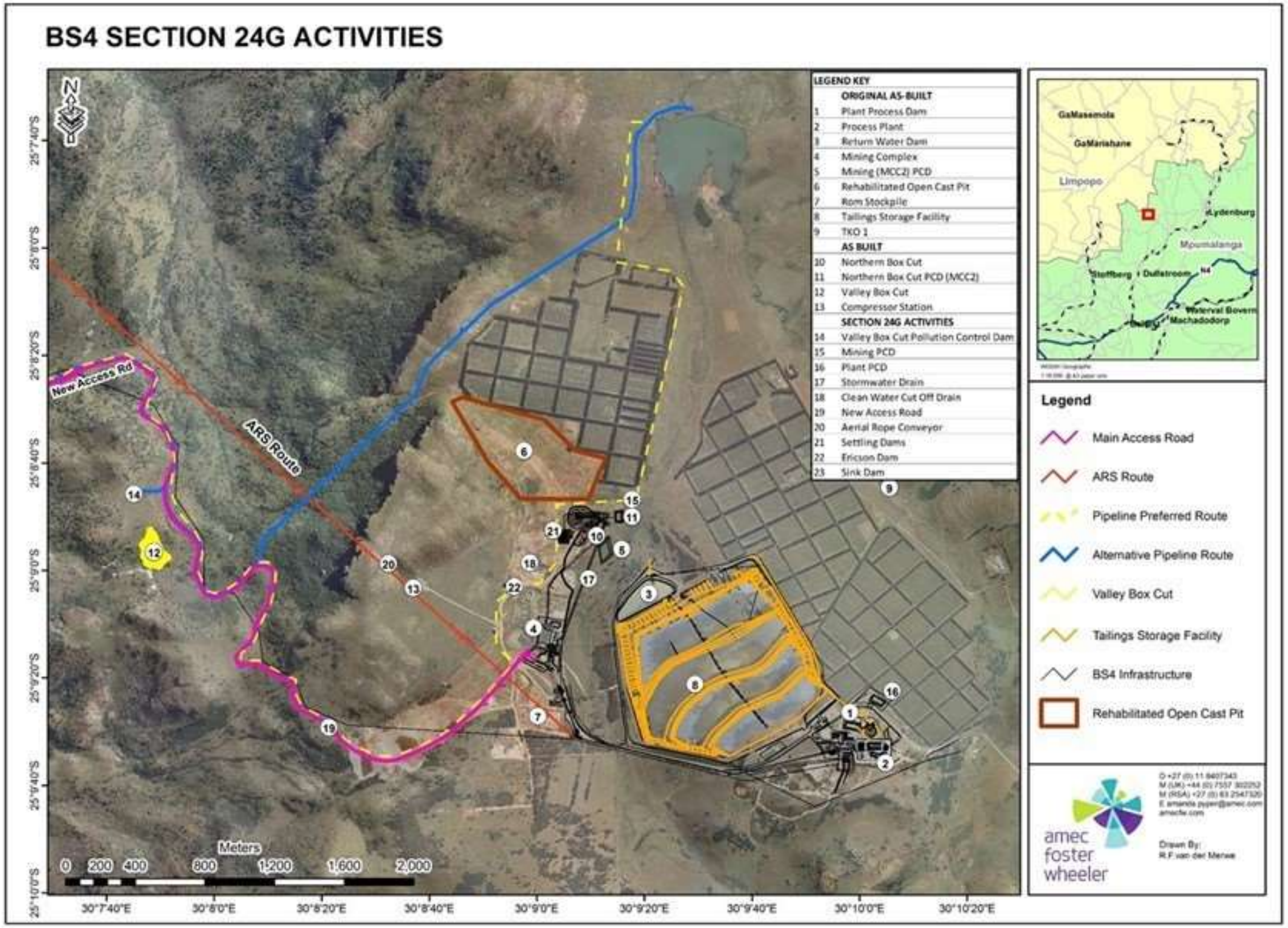


Figure 2-5 BS4 Section 24G Activities

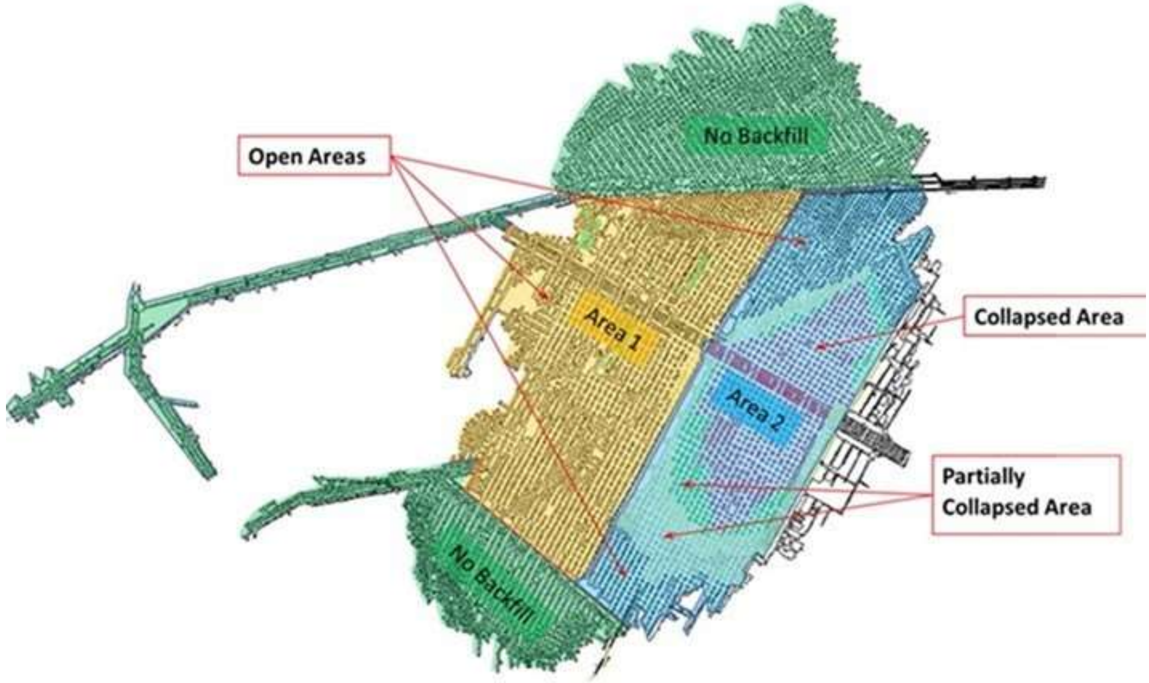
2-5a) New Pollution Control dam at the Valley Boxcut

2-5b) Upgrade of Mine Pollution Control Dam 1 (MCC1) at BS4

2-5c) Existing Tailings Storage Facility at BS4 to be reworked

2-5d) Underground Workings at BS4 to be Backfilled with Tailings

Figure 2-6 Tailings Backfilling Plan for BS4 (Source: DRA, 2017)



Operational Phase

All dirty water dams will be operated as empty. Therefore, all water will be recycled and reused in the mining operations and for the processing of ore. The Plant PCD, Mine PCD and RWD1 water will be used for processes at BS4. Water from the valley boxcut PCD will be used in the mining process at BS1/2. Maintenance of all stormwater management and dirty water containment infrastructure will be managed in accordance with current BN procedures.

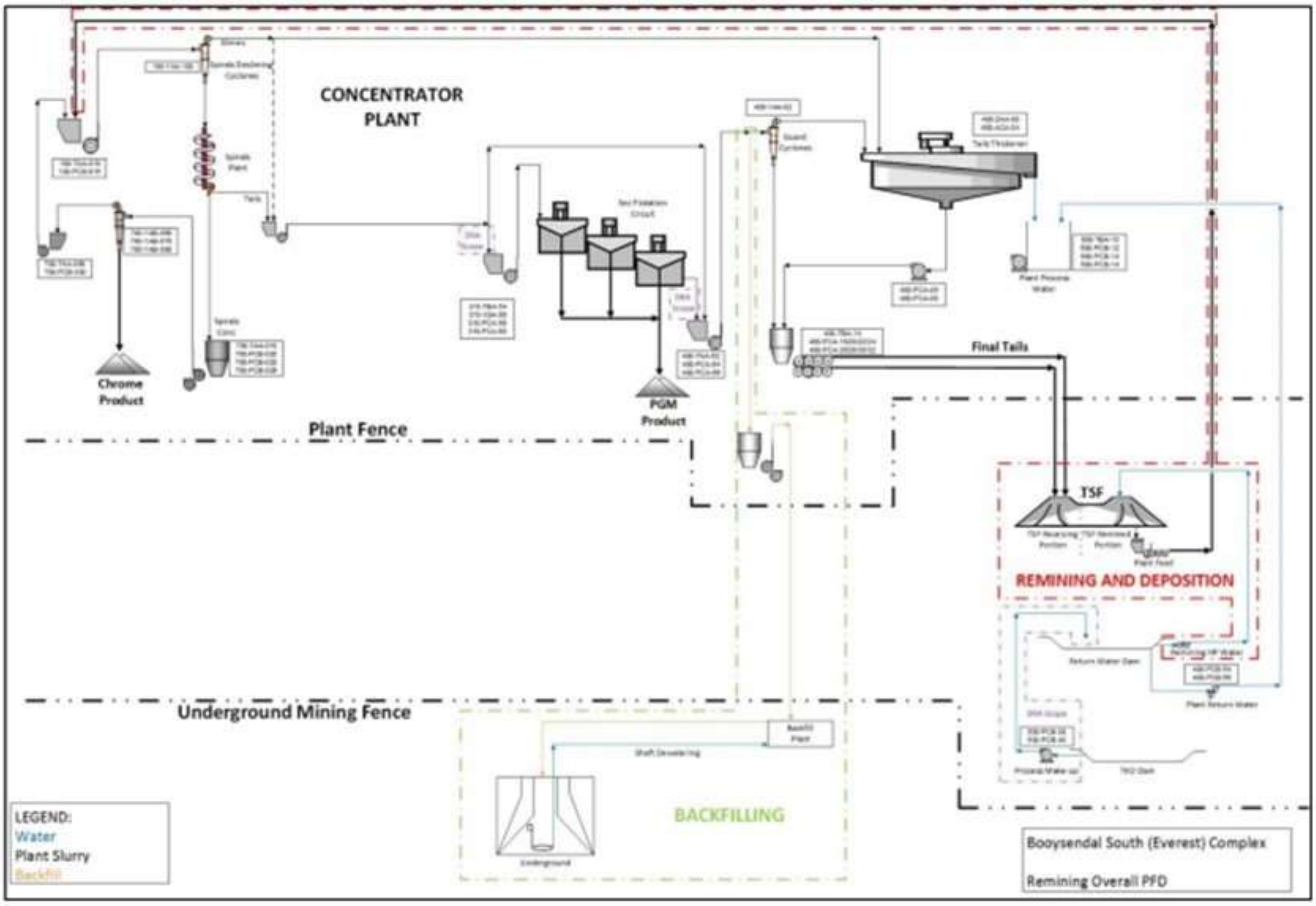
For the reworking of the tailings at TSF1 and tailings deposition, please refer to the construction phase. The engineering department of Booysendal will be responsible for the day-to-day operations and maintenance of the sewage treatment plant as is currently the case at BN.

Decommissioning, Closure and Rehabilitation

Details of decommissioning of BS4 is contained in the Closure Report drafted and compiled by SRK Consulting (Annexure U).

All the Section 24G surface infrastructure will be removed during the decommissioning phase. Concrete and unnatural surfaces will be deconstructed, broken up and removed and all pipelines associated with the sewage treatment plant will be decontaminated and removed for safe disposal according to regulated requirements in place at that time. The concurrent rehabilitation of TSF1 and RWD1 must commence during the operational phase and final rehabilitation should be conducted in accordance with the final rehabilitation and closure plan.

Figure 2-7 Hydro-mining, Backfilling and Re-deposition of Tailings Process



2.4 MERENSKY ADITS

Construction Phase

As part of the Section 24G Application, the development and construction of two Merensky adits has been planned in order to increase the accessibility to the PGM mineral deposits. At the time of the site visit on 19 May 2017, no construction activities had commenced. The location of the portals and the overall Booysendal South Expansion Project components are included and depicted in Figure 2-1.

- Merensky adit central north; and
- Merensky adit central south (as per overall layout map)

The development and construction of the Merensky adits will be preceded by the development of Merensky trenches for the bulk sampling of ore. The trench development will cover an area of 20m x 20m each (400m²).

The trench footprints will form the basis for the development of the Merensky adits for which additional clearance of approximate 300m² each will be required. It was indicated that no vent shaft will be required for the Merensky adits. Other than the portals, no additional surface infrastructure will be constructed. The portals will be accessed from the main access road. The conceptual designs indicate that the combined access roads leading to the Merensky adits measure approximately 1.8km long with a width of 4m in extent and require the clearance of approximately 1.1hectares. The total clearance footprint for both Merensky adits will be approximately 4.5 ha in extent. Large sections of these areas fall within CBAs. Detailed designs of these portal areas are not yet available.

Operational Phase

Ore extracted from the Merensky adits will be transported to the crusher at BS1/2 by truck. From the crusher, the ore will be transported using the conveyor to the ARC silo for ARC transportation to BS4. Information provided indicate that mining operations will be on-reef, at a rate of 45,000tpm from each Merensky adit.

Decommissioning, Closure and Rehabilitation Phase

During the Decommissioning, Closure and Rehabilitation phase, the Merensky adits will be sealed to avoid any decanting after closure. Unnatural surfaces around the Merensky adits will be removed and the adits will be stabilised. Areas around the adits will be rehabilitated, ripped and graded to blend with the natural landscape and to avoid any ponding or channelling of water. Erosion control measures will be put in place.

2.5 LINEAR INFRASTRUCTURE DEVELOPMENT

Various linear infrastructure and linear services are required as part of the Booysendal South Expansion Project. The construction and development of most of the infrastructure has already commenced and is ongoing as part of the Section 24G activities, with the exception of the development and construction of the potable water pipeline from BS4 to BS1/2 which is a planned activity.

2.5.1 Main Access Road

Construction Phase

General:
The current access to the Booysendal South Expansion Project is from a northern access road through the Rustenburg Platinum (Pty) Ltd Der Brochen property. With the southern expansion, the need arose for a southern access road to transport the workforce from the south to the project area. The road which is currently under construction is constructed according to provincial standards and will have an asphalt wearing surface. The average width of the road will be 13.5m with a reserve of 30m which will run from BN to BS1/2 and from there to BS4. The total length of the road is 13.94km. The new access road from BN to BS1/2 runs along the alignment of a 4m wide old prospecting road (additional clearance along this road was required). The road continues to run from BS1/2 to BS4 (this section of the road follows greenfields sections before it ties into the alignment of an existing road, which will be widened). From BS4 the access road ties into the butimen surfaced provincial road D874 which ties into the provincial Mashishing-Roossenekal R577 (P170). The DRA Report

JZASM0413, 2015 indicated that the required clearance for the road construction is 278 ha, of which large sections fall within CBA vegetation units.

Figure 2-8 presents an overview of the main access road alignment from BN to BS1/2 and Figure 2-9 presents the alignment from BS1/2 to BS4.

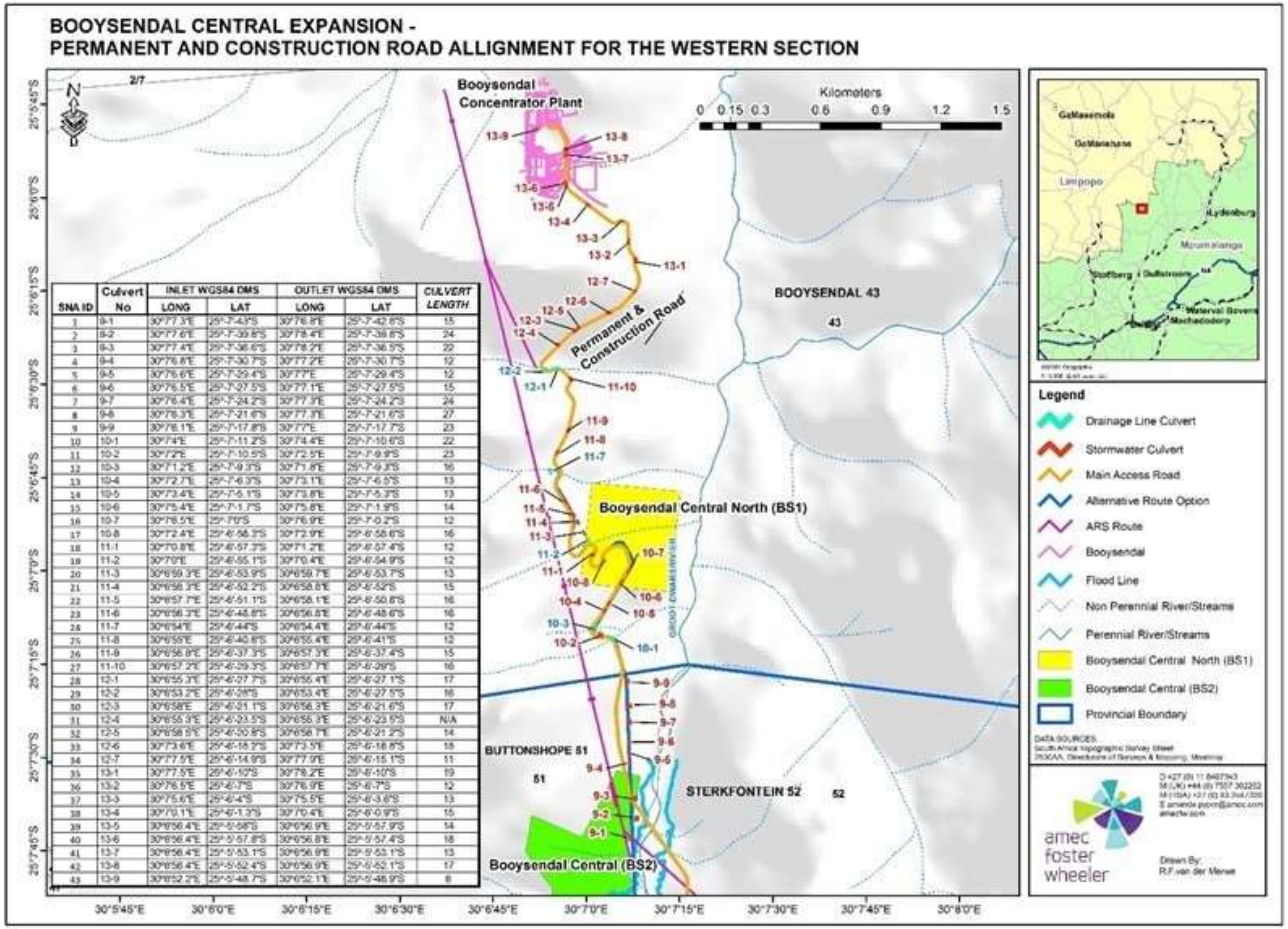
Drainage line and river crossings:
There are 13 drainage line crossings for which culverts are being installed as part of the road construction. In addition, there is also a major river crossing associated with the Groot Dwars River near BS1/2 (see Figure 2-10). The drainage line crossings are constructed using box culverts. Construction work on the bridge has temporarily ceased pending the finalisation of new designs which will allow for the migration of fish species, specifically the IUCN red listed *Enteromius cf. motebensis (Barbus motebensis).* The final revised design was not available at the time that the report was compiled and finalised. The road construction is also associated with more than 10m³ of infilling in a drainage line. The following method statement for the construction of the main river crossing has been provided by WBHO:

- Setting out of the culvert crossing from CH8+910 to CH9+020, including earthwork fill and clearing and grubbing;
- Diversion of the river flow to the western side of the crossing;
- Construction of a 1m fill layer with crushed rock from the west to the edge of the culvert foundation;
- Excavatation of the undercut under the culvert base and construction of a 1m rock layer as a foundation blinding layer;
- Level rock fill layer of concrete for the culvert base;
- Construction of a concrete base;
- Installation of culverts and construction of head and wing walls; and
- Close river diversion.

The development and construction of the draining line crossings require a water use license (WUL) for the Section 21(c) and (i) water uses under the NWA.

As part of the design and, from what could be seen during the site visit, the side headwalls are to be constructed on both sides of the culverts. On the downstream side, the outlet is treated with rock riprap energy breakers. SNA design engineers indicated that aprons will be fitted with energy dissipater blocks and loose rock riprap energy breakers. Apart from erosion protection, the stone pitching will function as sediment traps. Most of the sediment will be deposited at the upstream end but the portion that comes through during heavy storm events will be dealt with by the gabions and riprap. The mechanism of sediment deposit in the mattresses results in the growth of vegetation in the baskets which retain more silt and so the cycle repeats itself and is in a way self-sustaining.

Figure 2-8 Main Access Road Alignment between BN and BS1/2



SNA ID	Culvert No	INLET WGS84 DMS LONG	INLET WGS84 DMS LAT	OUTLET WGS84 DMS LONG	OUTLET WGS84 DMS LAT	CULVERT LENGTH
1	9-1	30°7'7.3"E	25°7'43"S	30°7'6.8"E	25°7'42.6"S	15
2	9-2	30°7'7.6"E	25°7'39.8"S	30°7'8.4"E	25°7'39.8"S	24
3	9-3	30°7'7.4"E	25°7'36.6"S	30°7'8.2"E	25°7'36.5"S	22
4	9-4	30°7'6.8"E	25°7'30.7"S	30°7'7.2"E	25°7'30.7"S	12
5	9-5	30°7'6.6"E	25°7'29.4"S	30°7'7"E	25°7'29.4"S	12
6	9-6	30°7'6.5"E	25°7'27.5"S	30°7'7.1"E	25°7'27.5"S	15
7	9-7	30°7'6.4"E	25°7'24.2"S	30°7'7.3"E	25°7'24.2"S	24
8	9-8	30°7'6.3"E	25°7'21.6"S	30°7'7.3"E	25°7'21.6"S	27
9	9-9	30°7'6.1"E	25°7'17.8"S	30°7'7"E	25°7'17.7"S	23
10	10-1	30°7'4"E	25°7'11.2"S	30°7'4.4"E	25°7'10.6"S	22
11	10-2	30°7'2"E	25°7'10.5"S	30°7'2.5"E	25°7'9.9"S	23
12	10-3	30°7'1.2"E	25°7'9.3"S	30°7'1.8"E	25°7'9.3"S	16
13	10-4	30°7'2.7"E	25°7'6.3"S	30°7'3.1"E	25°7'6.5"S	13
14	10-5	30°7'3.4"E	25°7'5.1"S	30°7'3.8"E	25°7'5.3"S	13
15	10-6	30°7'5.4"E	25°7'1.7"S	30°7'5.8"E	25°7'1.9"S	14
16	10-7	30°7'6.5"E	25°7'0"S	30°7'6.9"E	25°7'0.2"S	12
17	10-8	30°7'2.4"E	25°6'58.3"S	30°7'2.9"E	25°6'58.6"S	16
18	11-1	30°7'0.8"E	25°6'57.3"S	30°7'1.2"E	25°6'57.4"S	12
19	11-2	30°7'0"E	25°6'55.1"S	30°7'0.4"E	25°6'54.9"S	12
20	11-3	30°6'59.3"E	25°6'53.9"S	30°6'59.7"E	25°6'53.7"S	13
21	11-4	30°6'58.3"E	25°6'52.2"S	30°6'58.8"E	25°6'52"S	15
22	11-5	30°6'57.7"E	25°6'51.1"S	30°6'58.1"E	25°6'50.8"S	16
23	11-6	30°6'56.3"E	25°6'48.8"S	30°6'56.8"E	25°6'48.6"S	16
24	11-7	30°6'54"E	25°6'44"S	30°6'54.4"E	25°6'44"S	12
25	11-8	30°6'55"E	25°6'40.8"S	30°6'55.4"E	25°6'41"S	12
26	11-9	30°6'56.8"E	25°6'37.3"S	30°6'57.3"E	25°6'37.4"S	15
27	11-10	30°6'57.2"E	25°6'29.3"S	30°6'57.7"E	25°6'29"S	16
28	12-1	30°6'55.3"E	25°6'27.7"S	30°6'55.4"E	25°6'27.1"S	17
29	12-2	30°6'53.2"E	25°6'28"S	30°6'53.4"E	25°6'27.5"S	16
30	12-3	30°6'58"E	25°6'21.1"S	30°6'56.3"E	25°6'21.6"S	17
31	12-4	30°6'55.3"E	25°6'23.5"S	30°6'55.3"E	25°6'23.5"S	N/A
32	12-5	30°6'58.5"E	25°6'20.8"S	30°6'58.7"E	25°6'21.2"S	14
33	12-6	30°7'3.6"E	25°6'18.2"S	30°7'3.5"E	25°6'18.8"S	18
34	12-7	30°7'7.5"E	25°6'14.9"S	30°7'7.9"E	25°6'15.1"S	11
35	13-1	30°7'7.5"E	25°6'10"S	30°7'8.2"E	25°6'10"S	19
36	13-2	30°7'6.5"E	25°6'7"S	30°7'6.9"E	25°6'7"S	12
37	13-3	30°7'5.6"E	25°6'4"S	30°7'5.5"E	25°6'3.6"S	13
38	13-4	30°7'0.1"E	25°6'1.3"S	30°7'0.4"E	25°6'0.9"S	15
39	13-5	30°6'56.4"E	25°5'58"S	30°6'56.9"E	25°5'57.9"S	14
40	13-6	30°6'56.4"E	25°5'57.8"S	30°6'56.8"E	25°5'57.4"S	18
41	13-7	30°6'56.4"E	25°5'53.1"S	30°6'56.9"E	25°5'53.1"S	13
42	13-8	30°6'56.4"E	25°5'52.4"S	30°6'56.9"E	25°5'52.1"S	17
43	13-9	30°6'52.2"E	25°5'48.7"S	30°6'52.1"E	25°5'48.9"S	8

Note: Culvert numbers indicated in blue are associated with drainage lines

Figure 2-9 Main Access Road Alignment between BS1/2 and BS4 (SNA, 2017)

<u>Stormwater management</u>:
The road is being constructed using concrete lined side drains to prevent longitudinal erosion along the road. Cross drainage is provided at regular intervals to manage the longitudinal run-off. This is done through the construction of concrete pipe and box culverts. For purposes of efficient and effective maintenance in compliance with South African National Road Agency (SANRAL) standards, pipes with a minimum diameter of 600mm were selected. Due to the steep topography and associated high run-off volumes, more than 100 cross drains will be installed.

There are various points where the road lies in a cutting where cut-face intercepts a natural stream. As a result, SNA proposed to install stepped cascades to prevent cut-face erosion and also serve the purpose of energy dissipation.

<u>Cuts</u>
There are certain sections along the road where significant cuts were made. To stabilise the faces and avoid erosion, cement cladding has been applied.

Figure 2-11 is a photo template which provides an indication of current road construction activities. The road is currently being used to access Booysendal from Mashishing and for general construction purposes.

Operational Phase

During operational phase, the main access road will be used to gain access from the south to the Booysendal operational areas and for general worker transportation purposes. The volume of vehicles anticipated to use the road has been estimated by the design engineers, SNA, and is included in Table 2-6. A speed limit of 40km/h has been proposed in order to manage the volume of vehicles traversing the main access road.

Table 2-6 Anticipated 24-hour Traffic Volumes

	Vehicle Type	BS1/2 to BS4	BN to BS4
Concentrate transportation	Trucks	32	32
Personnel carriers	57 Seat Busses	42	0
Mine supply deliveries	Trucks (10 – 18t)	60	30
Light vehicles	LDV's	150 - 200	75 - 100

Other activities to be undertaken during the operational phase are likely to include:

- Routine maintenance including crack sealing, limited surface repair and drainage reinstatement;
- At year 12 – 14 after construction a suitable asphaltic overlay needs to be applied; and
- After year 26 – 30 the asphaltic overlays need to be milled and replaced with a suitable asphaltic overlay after suitable pre-treatment.

Decommissioning, Closure and Rehabilitation

The road surface in totality will be removed and the entire area ripped and rehabilitated. A 300mm topsoil layer will be applied to the length of the road to enhance rehabilitation. The entire footprint will be revegetated.

2.5.2 Access and Temporary Roads

Construction Phase

The clearance for the construction and development of various temporary roads and access roads has commenced. The extent of this clearance is unknown; however it is likely significant.

Operational Phase

The temporary roads that will be constructed and developed will be rehabilitated after the construction phase whereafter, only necessary access roads will remain and be utilised.

Decommissioning, Closure and Rehabilitation

Rehabilitation work at BN is currently being undertaken by a rehabilitation specialist. It was indicated that the same practice will be carried out on BS. This practice contemplates the loosening of compacted soil, the grading of areas to be rehabilitated, the installation of erosion control measures and the seeding of prepared areas for revegetation.

Figure 2-10 Groot wars River Bridge Design

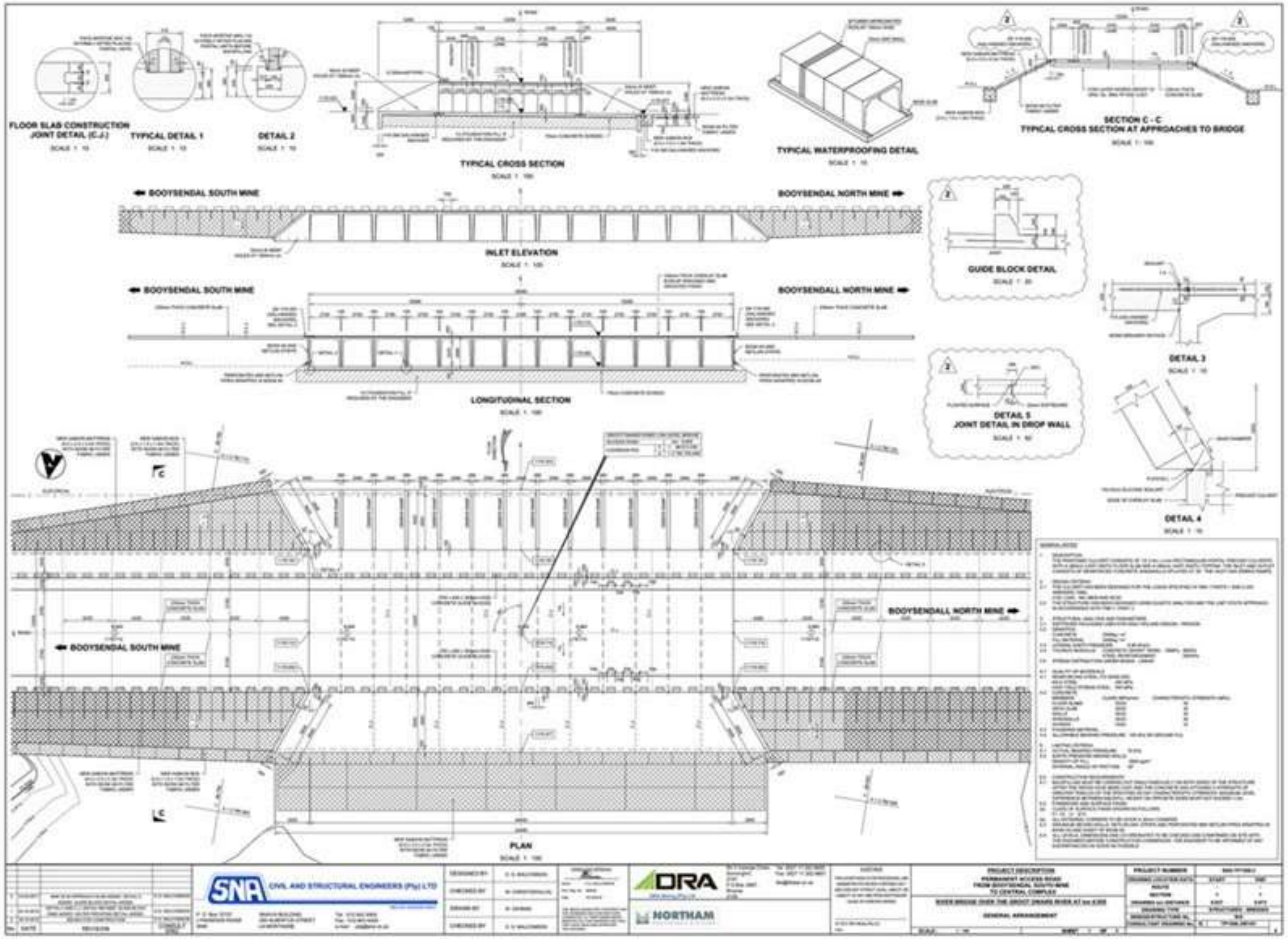


Figure 2-11 Current Road Construction Activities

2-11a) Pre-construction Environment

2-11b) Construction from BN to BS1/2 and to the Eastern Section of BS4

2-11c) Stabilisation of Steeper Section between BN and BS1/2

2-11d) Road Clearance through a Seep Wetland at BS4

2-11e) Main Dwars River Crossing Prior to Construction Commencing

2-11f) Construction of the Groot Dwars River Crossing

2-11g) Construction within the Waterfall River Crossing (upstream)

2-11h) Construction within the Waterfall River Crossing (downstream)

2.5.3 Aerial Rope Conveyor (ARC)

Construction Phase

An aerial rope conveyor (ARC) system is in the process of being constructed which will span from BS1/2 to BS4 and be used for the transportation of the crushed ore mined at BS1/2 to the plant at BS4. The construction of the ARC constitutes clearance of vegetation greater than the NEMA listed activity threshold (300m²), as well as infilling of more than 10m³ in drainage lines including a wetland area. Certain sectors run over CBAs. A total of 12 towers are required. In addition, access/ service road clearance to the towers is necessary, some of these roads will be retained to access the towers whilst the remaining ones will be rehabilitated. The DRA Report JZASM0413, 2015, indicated that the required clearance for the BS1/2 to BS4 ARC corridor is 118 ha. The clearance for the construction of the towers itself will be approximately 16,025.75m² (1.6 ha). Partial clearance has already commenced, and includes that relating to the access roads. The clearance requirements for the permanent and temporary access roads are 25,745.6m² (2.57 ha). Total clearance requirements for the ARC is 89,585.35m² (8.96 ha). In addition, a 100m corridor also needs to be cleared. The breakdown of the clearance requirements is included and set out in Table 2-7.

Table 2-7 ARC Clearance Requirements

Tower	Clearance requirement (m²) Completed	Access Road Clearance (m²)	Any other clearance required	
			Type (e.g. laydown area)	Area of clearance
1	752.10			
2	978.67	Service road 1: 6,177.6 Service road 1A: 516		
3	818.98		Laydown Area	12,040
4	1,069.46		Vulcanisation Area	14,307
5	2,503.95	Service road 2: 1,805		
6	2,009.48	Service road 3: 4,140		
7	506.72	Service road 13,107		
8	1,012.77			
9	602.20			
10	1,532.74			
11	1,536.39			
12	741.20		Laydown Area	10,457
Rope Anchor	672.00			
Drive station	1,289.09			
			Laydown Area behind workshop (BS4)	11,010

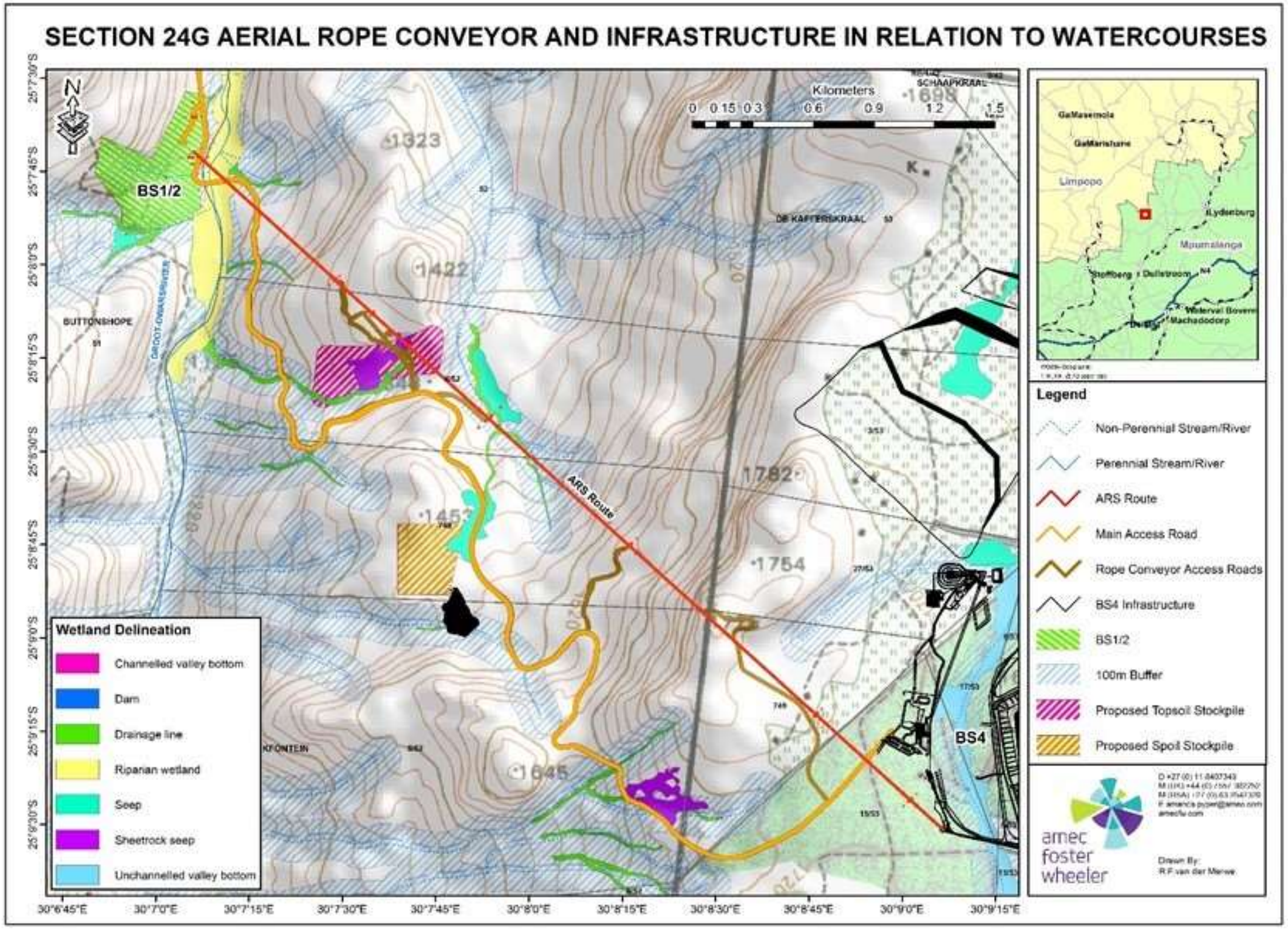
Infilling and excavation within drainage lines will take place with the ARC Towers 1, 4 and 5 construction. Tower 1 is located within the floodline and riparian wetland of the Groot Dwars River, Tower 4 is situated within a wetland, while Tower 5 is located immediately at the edge of a wetland. The infill volumes for these towers is included and set out in Table 2-8. The location of the pillars in relation to watercourses, including wetlands is indicated in the Google image in **Error! Reference source not found.**. The depth of excavation will be on a verage 2.0m which may vary depending on the underlying geology. The highest tower will be 60m high. Laydown areas and 200 tonne cranes will be required for the assembling and installation of the towers respectively. Once excavations for the towers are completed, tower foundations will be laid.

Access road footprints for the ARC will amount to 25,745m^2 and the laydown areas an area of 47,814m^2 of which 21,467m^2 is on disturbed areas at BS4.

Table 2-8 Infill Requirements for ARC Towers Associated with Watercourses

Aerial Rope Conveyor Earth Work Volumes							
	Excavation Volume		Total Backfill Volume			Fill from Stockpile	G6
Tower	Cut	Fill	Additional Cut (total)	Fill (total)	G6/G7 Backfill Under Base	G8/9	Capping Fill
Tower 1	585.32	0	0	3,855.01	428.48	2,950.49	338.44
Tower 4	1,116.96	0	0	1,908.50	0	1,333.64	481.26
Tower 5	2,246.55	0	1,442.53	5,597.71	1,058.00	3,266.69	1,126.78

Figure 2-12 Aerial Rope Conveyor Tower Locations in relation to Watercourses



Operational Phase

Ore will be loaded from the silo at BS1/2 onto the ARC by way of a controlled shute. A light spray will be installed at the tail of the ARC to bind the top layer when transported to BS4. It is foreseen that the light spray together with the 8% moisture content of the ore should be sufficient to contain the potential dust.

The ARC will be powered by two 2,000kVA transformers. It is indicated that the ARC will be operational for 17.1h per day and that ore will be transported to BS4 at a rate of 1,150tph. The monthly capacity of the ARC only from BS1/2 and the two Merensky portals has been simulated at 464,225tpm. Ore will be tipped onto the stockpile at BS4. It is anticipated that bi-weekly conveyor maintenance procedures will be carried out during the operational phase.

Decommissioning, Closure and Rehabilitation Phase

The entire ARC system will be removed and all disturbed areas rehabilitated.

2.5.4 Potable Water Route

Potable water for BS1/2 will be abstracted from the TKO Dam at BS4 (see Figure 2-4) and will report to two gravity tanks (2×137m³). From there, the water will flow to BS1/2 through an 80m³/h galvanised pipeline. A Warman 75NC-DWU, 37kW pump will be installed. The proposed pipeline route alternatives are still being investigated and assessed. An alternative assessment for the routing is included in Section 7.

The abstraction volume of water will be within the existing approved water use license abstraction volume applicable at BS4. The pipeline will be a 225 HDPE PN10 PE100 type pipeline with diameter of 197mm with a throughput capacity of 110m³/h. The proposed pipeline route is 3,800m long. The construction and development of the pipeline has not yet commenced, however is set to commence soon.

2.5.5 Service Water Pipeline Route

Service make-up will be obtained from dewatering at the valley boxcut at BS4 and from dewatering at BS1/2. The pipeline running from BS4 to BS1/2 will be a MS waterline with a throughput of 80m³/h, welded to below pressure ratings. The pipeline must still be constructed and will lie within the main access road reserve, thereby avoiding any new disturbance footprints.

Operational Phase

The volume of make-up required on an annual basis, indicated in the water balance (PZASM0413 Booysendal Integrated Water Balance Analysis_Rev A), will be 280,803m³. The total abstraction volume per month will be 2,748m³ with a maximum hourly throughput 7.33m³/h.

Decommissioning, Closure and Rehabilitation Phase

Post-construction rehabilitation of the road and pipeline corridor must start as soon as sections of the corridor have been completed. During the closure phase, the water pipeline will be removed, and the corridor area will be rehabilitated through ripping, grading, reinstatement of natural flow paths, erosion control measures and revegetation. Management options to manage valley boxcut decant must be investigated closer to closure. It will be important that decant qualities do not exceed the qualities stipulated in the Reserve.

2.5.6 Power Supply Lines

Construction Phase

Power supply during the construction phase at BS1/2 is obtained from a temporary 11kVA power line which has been constructed from the BN boreholes up to BS1/2. The powerline runs for 3.5km along the Groot Dwars River. The powerline will be removed once the permanent powerline and supply is in place.

Permanent power supply to BS1/2 will also be provided by installing a 132kVA power line from the BN sub-station. The powerline will be 3.4km long. The route for the powerline is included and depicted in Figure 2-6. Watercourses and wetlands will be avoided during the construction phase and for the installation of the pylons. The powerline will impact an area of 107 hectares. It has been recommended that existing service roads be used to access the powerline pylons so as to avoid and mitigate against any additional vegetation clearance.

Operational Phase

Maintenance of the powerline will be conducted in accordance with a maintenance plan which will be developed for BS. This will include clearing of vegetation within the powerline servitude to avoid fire damage to the powerline. It is anticipated that the total power requirement for the Booysendal South Expansion Project will be 16.5MVA.

Decommissioning, Closure and Rehabilitation Phase

The construction powerline will be removed once the permanent powerline is commissioned. The permanent powerline will be removed at the end of life of mine (LoM).

2.6 POST-CONSTRUCTION PHASE ACTIVITIES

Rehabilitation of disturbed areas will be completed once construction is finalised. This will involve rehabilitation of surface areas, such as unused access roads, laydown areas, turning circles, encroachment areas etc. Natural flow in streams and drainage lines will be reinstated, cuts will also be stabilised to mitigate against erosion and revegetation of disturbed areas will be finalised. It is important that rehabilitation is undertaken in consultation with a biodiversity specialist.

3. LEGISLATION, POLICIES AND GUIDELINES

The policies, legislation and guidelines specifically applicable to activities which commenced without the necessary environmental authorisation are detailed in the following sections. In order to ensure that Environmental Best Practice Principles are adhered to, all guidelines which are relevant to the commenced activities have also been taken into consideration during the preparation of this EIR and listed below.

3.1 MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 28 OF 2002

The Mineral and Petroleum Resources Development Act, 28 of 2002 (MPRDA) is aimed at the equitable access and the sustainable development of the country's mineral resources. It provides mechanisms that will ensure the protection of the environment throughout the life of mine (LoM).

Social and environmental sustainability is enhanced through the requirement to submit a Social and Labour Plan which indicates a company's commitment to sustainable social development. This includes commitment to training and social investment also with the goal on transferable skills that can be used after mine closure.

Section 5A of the MPRDA indicates that: *"No person may prospect for or remove, mine, conduct technical co-operations, reconnaissance operations, explore for and produce any mineral or petroleum or commence with any work incidental thereto on any area without – (a) an environmental authorisation;"*

Section 37 of the MPRDA places the responsibility on all mining and prospecting operations and related activities to be carried out in terms of section 2 of NEMA.

Section 102(1) of the MPRDA states that: *"A reconnaissance permission, prospecting right, mining right, mining permit, retention permit, technical corporation permit, reconnaissance permit, exploration right, prospecting works programme, exploration work programme, production work programme, mining work programme, environmental management programme or an environmental authorisation issued in terms of the National Environmental Management Act, 1998, as the case may be, may not be amended or varied (including the extension of the area covered by it or the additional of minerals or a share or seam, mineralised bodies or strata, which are not at the time the subject thereof) without the consent of the Minister.*"

For the Section 24G activities, the DMR Regional Office in Limpopo instructed Booysendal in a letter dated 8 May 2017 to undertake an EIA and EMP process in terms of the 2014 NEMA Regulations. The letter further stated that the EIA and EMP must be submitted to the DMR within 106 days from the letter.

3.2 THE CONSTITUTION OF SOUTH AFRICA, 1996 (CONSTITUTION)

Environmental legislation is shaped by the Bill of Rights of the Constitution of the Republic of South Africa. Section 24 of the Constitution, known as the 'environmental right,' guarantees every person the right to an environment that is not harmful to their health or well-being and provides for the protection of the environment against pollution and degradation. This right is binding on the state and people, both natural and juristic; sustainable development is the cornerstone of South Africa's environmental law regime.

In fulfilment of its constitutional mandate to take reasonable legislative measures that gives effect to s24 of the Constitution, the government has promulgated several environmental laws since 1994. These laws provide a legal framework that embodies internationally recognised legal principles.

The principal act governing activities that affect the environment is the National Environmental Management Act, No 107 of 1998 (NEMA).

3.3 NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 107 OF 1998 (NEMA)

Section 24D of NEMA provides for activities listed (Listed Activities) in terms of Regulations GNR 983, GNR 984 and 985 of 4 December 2014 as amended (EIA Regulations) The Listed Activities may not commence without the necessary environmental approval.

Section 24F of NEMA contains the prohibitions related to commencement or continuation of listed activities, specifically Section 24F(1)(a) which states that: *"no person may commence a listed activity or specified in terms of section 24(2)(a) or (b) unless the competent authority of the Minister responsible for mineral resources, as the case may be, has granted an environmental authorization for the activity";* or

24F(1)(b) *"commence and continue an activity in terms of section 24(2)(d) unless it is done in terms of an applicable norm or standard."*

Consideration also needs to be given to those listed activities under the auspices of the Waste Act (NEMWA) for which a waste management licence (WML) is required (GN 921 of 29 November 2013). An integrated process covering NEMA and NEMWA activities is undertaken. A discussion of the purpose and requirements in this respect is provided in Section 3.4 of this EIA.

Where a Listed Activity commenced unlawfully i.e. without an environmental authorisation, an application for its rectification may be brought under s24G of NEMA. An administrative fine of up to R5 million is payable for the granting (or refusing) of such an application.

The DMR has directed Booysendal to compile a report in terms of Section 24G(vii) of NEMA (Section 24G Report). The NEMA activities applicable to the Booysendal South Expansion Project and associated impact assessment are given in Table 3.1.

In terms of NEMA Section 24C (2A) the Minister of Mineral Resources (Minister) is the competent authority to issue environmental authorisations (EAs) under the NEMA and waste management licences (WML) under the National Environmental Management Waste Act 59 of 2008 (NEMWA) for activities which are directly related to mining. It is the competent authority to analyse this Section 24G Report.

Financial provision regulations pertaining to mining was published under NEMA on 20 November 2015 (GN R. 1147). The purpose of these regulations is to provide guidelines for the determination and making of financial provision for the costs associated with the undertaking of management, rehabilitation and remediation of environmental impacts through the lifespan of such operations and latent or residual environmental impacts that may become known in the future. These regulations replace section 41 of the MPRDA and regulations 53 and 54 of the Mineral and Petroleum Resources Development Regulations, GN R527, GG 26275 of 23 April 2004.

Under Regulation 5, financial provision must be made for:

"(a) rehabilitation and remediation;

(b) decommissioning and closure activities at the end of prospecting, exploration, mining or production operations; and

(c) remediation and manaf0unta1gement of latent or residual environmental impacts which may become known in future, including the pumping and treatment of polluted or extraneous water."

Table 3-1 Booysendal South Expansion project NEMA and NEMWA Listed Activities

NEMA Listed Activities **NEMA EIA Contraventions: On or after 8 December 2014** Activities unlawfully commenced with in terms of the EIA Regulations promulgated in terms of the NEMA, Act No 107 of 1998, as amended on or after 8 December 2014	
Government Notice No. R983 Listing Notice 1 **As Amended in GNR327 of 7 April 2017 Activity No(s):**	**Details of Activity(ies) requiring Basic Assessment**
11	The development of facilities or infrastructure for the transmission and distribution of electricity – (i) outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts. *Applicable activity – Construction of a 132 kVA power line between BN and BS1/2*
12	The development of – (i) dams or weirs, where the dam or weir, including the infrastructure and water surface area, exceeds 100 square metres; or (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs- (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse

	<u>Applicable activities</u> –Construction of the BS1/2 terrace within 32m of the southern drainage line; *Placement of a stockpile at BS1/2, BS1/2 UG2 within 32m of a watercourse* *Shaft complex (BS1/2) and cut-off trench upstream of BS1/2 within a water course or 32m form a watercourse;* *Construction of aerial rope conveyor pillars within 32m of a drainage line;* *Water pipeline from TKO dam to BS1/2 within 32m of the Everest stream, including several drainage line crossings,* *Roads (BN to BS1/2, Valley Boxcut to BS4, internal haul roads at BS1/2) – several drainage line crossings* *132 kV Electricity Supply Line watercourse crossing;* *BS4 proposed water infrastructure expansions (pipeline, PCDs, silt trap, increased stockpile area, storm water management drains);* *PCD's exceeding 100 square metres in size;* *Construction of a bridge across the Groot Dwars River at BS1/2.*
13	The development of facilities of infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50 000 cubic metres or more *Applicable activity – combined capacity of the PCDs exceed 50 000 cubic metres*
14	The development and related operation 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 cubic metres or more but not exceeding 500 cubic metres; *Applicable activity – BS1/2 UG2 Shaft Complex: Diesel Storage Bay; Chemical Storage Area; Emulsion Stores; Oil and Paint Stores; engine and Hydraulic Oil Storage area; Dangerous Gas Storage*
19	The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse *<u>Applicable activities</u> – BS1/2 terrace area;* *Bridge across the Groot Dwars River;* *Aerial ropeway conveyor pillars;* *132kV electricity transmission line river crossing – total required excavation over the length of the transmission line will be approximately 120m³;* *Roads (BS1/2 to BN and Valley Boxcut to BS4);* *Stormwaterwater infrastructure at BS4.*
24	The development of a road (ii) with a reserve wider than 13,5 metres, or if no reserve exists where the road is wider than 8 metres *Applicable activity - Access road between BS4 and Valley Boxcut and access road between BN and BS1/2 (13,5 meter wide roads with a reserve of 30 meters).*
31	The decommissioning of existing facilities, structures or infrastructure for- (i) any development and related operation activity or activities listed in this Notice, Listing

	Notice 2 of 2014 or Listing Notice 3 of 2014; *Applicable activity: decommissioning of a PCD at BS4.*
34	The expansion of existing facilities or infrastructure for any process or activity where such expansion will result in the need for a permit or license or an amendmend or license in terms of national or provincial legislation governing the release or emissions, effluent or pollution *Applicable activity - reworking and replacing of the existing BS4 TSF constitutes a waste activity and upgrade of some of the PCDs at BS4 will require water use authorisation*
Government Notice No. R984 Listing Notice 2 as Amended by GNR 325 of 7 April 2017 **Activity No(s):**	**Details of Activity(ies) requiring a Scoping / EIA Report**
6	The development of facilities or infrastructure for any process or activity which requires a permit or licence or an amended permit or license in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent, excluding: activities which are identified in Listing Notice 1 of 2014 EIA Regulations; activities which are included in the list of waste management activities published in terms of section 19 of the Waste Act in which case the Waste Act applies; or the development of facilities or infrastructure for the treatment of effluent, wastewater or sewage where such facilities have a daily throughput capacity of 2, 000 cubic metres or less, as contained in 2014 Listing Notice. *Applicable activity* – *Various activities requiring Section 21f and 21g water use licences under the NWA (to be detailed under the WULA);* *Proposed water infrastructure expansion activities at BS4 requiring water use licences under the NWA.*
15	The clearance of an area of 20 hectares or more of indigenous vegetation *Applicable activity – cumulative clearance of areas for the Booysendal South Expansion Project's activities at BS1/2, BS4 and linear corridors.*
19	The removal and disposal of minerals in terms of Section 20 of the Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002), including – (b) the primary processing of mineral resources including winning, extraction, classifying, concentrating, crushing, screening or washing. *Applicable activity – mining of ore at BS2 and BS4 crushing of ore at BS1/2 and concentrating of BS1/2 ore at BS4.*
Government Notice No. R985 Listing Notice 3 as Amended by GNR 324	**Details of Activity(ies) requiring Basic Assessment Report**

of 7 April 2017 **Activity No(s):**	
4	The development of a road wider than 4 metres with a reserve less than 13,5 metres f) Mpumalanga Outside urban areas: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (ee) Critical biodiversity areas ("**CBAs**") as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans. *Applicable Activity: Internal haul roads at BS1/2*
8	The development and related operation of above ground cableways and funiculars f. Mpumalanga i. All areas outside urban areas; *Applicable activity – Aerial ropeway conveyor from BS1/2 to BS4 and conveyor from the underground workings at BS1/2 via conveyor*
10	The development and related operation 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 30 but not exceeding 80 cubic metres. (e) In Limpopo: i. All areas. (f) Mpumalanga: i. Outside urban areas, in: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (ee) Critical Biodiversity Areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; *Applicable activity – BS1/2 dangerous goods storage (see Listing Notice 1 Activity 14)*
12	The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan. e. Limpopo i. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; ii. Within critical biodiversity areas identified in bioregional plans;

	f. In Mpumalanga i. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; ii. Within critical biodiversity areas identified in bioregional plans; *Applicable activity – Portions of BS1/2, Merensky portals and linear infrastructure is in the Sekhukhune Centre of Plant Endemism. Areas in excess of 20ha will be cleared*
14	The development of- (i) Dams or weirs, where the dam or weir, including infrastructure and water surface area exceeds 10 square metres; or (ii) Infrastructure or structures with a physical footprint of 10 square metres or more; Where such development occurs - (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse e. Limpopo i. Outside urban areas, in: (aa) A protected area identified in terms of NEMPAA, excluding conservancies (ee) Sites or areas identified in terms of an international convention; (ff) Critical biodiversity areas or ecosystem service areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; f. Mpumalanga i. Outside urban areas, in: (aa) A protected area identified in terms of NEMPAA, excluding conservancies (ee) Sites or areas identified in terms of an international convention; (ff) Critical biodiversity areas or ecosystem service areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; *Applicable activity* *Some development footprints within watercourses or within 32 metres of a watercourse also fall within Critical Biodiversity Areas as identified in the Mpumalanga Biodiversity Sector Plan, including the Merensky portals, BS1/2, sections of the main access road, the ARS route, the powerline from BN to BS1/2*

	In addition, South Africa has ratified the RAMSAR convention aimed at the protection of wetlands. Some of the stormwater infrastructure at BS4, portal infrastructure at BS1/2, the main access road crossing at BS1/2 are all located within wetland areas.
18	The widening of a road by more than 4 meters or the lengthening of a road by more than 1 kilometre. e. Limpopo i. Outside urban areas: (ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans (hh) Areas within a watercourse, or within 100 metres from the edge of a watercourse f. Mpumalanga i. Outside urban areas: (ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans *Applicable activity* *A section of the existing BS4 access road to the Valley boxcut will be widened to 13.5m. Sections falls within CBAs. There are several road crossings associated with the widening of the access road between BS1/2 to BN. Large sections exploration road which are widened to form the main access road between BN and BS4 pass BS1/2*

In terms of section 24N(1A) of NEMA, where an environmental impact assessment is being undertaken for the application for an environmental authorisation, the Minister, the Minister responsible for mineral resources or an MEC must require the submission of an environmental management programme (EMP) before deciding an application for an environmental authorisation. An EMP for the Booysendal Expansion Project has been prepared.

3.4 NATIONAL ENVIRONMENTAL MANAGEMENT: WASTE ACT, 59 OF 2008 (NEMWA)

The purpose of NEMWA is to assist in regulating waste management, to ensure the protection of human health and to prevent pollution and environmental degradation through sound waste management principles and guidelines. It furthermore provides for:

- National norms and standards for regulating the management of waste by all spheres of government;
- Licensing and control of waste management activities;
- Remediation of contaminated land;
- A national waste information system; and
- Provision for compliance and enforcement.

NEMWA defines waste broadly as "any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered" and includes all wastes defined in Schedule 3 of NEMWA. NEMWA regulates mining residue deposits or stockpiles.

NEMWA imposes a general duty upon waste holders to take reasonable measures to avoid waste generation and, where this is impossible, to: minimise the toxicity and quantities of waste generated; re-use, reduce, recycle and recover waste; and ensure that it is treated and disposed of in an environmentally-sound way. Failure to do so is a criminal offence, with a maximum fine of R10 million or imprisonment of up to 10 years, or both.

It is necessary to hold a WML for defined waste management activities. The Department of Environmental Affairs (DEA) promulgated a list of activities for which a waste management licence is required on 29 November 2013 (Government Notice 921) in terms of Section 20(b) of NEMWA (Waste Listed Activities). The Waste Listed Activities are separated into three categories i.e. Category A, Category B or Category C.

An application for a WML must be supported by an EIA that complies with the EIA Regulations.

An integrated process covering NEMA and NEMWA activities is undertaken. The procedures for licensing waste management activities are stipulated in Chapter 5 of NEMWA and will have to be considered in the overall EA process.

Category C activities do not require a waste management licence, but must comply with the Norms and Standards for Storage of Waste (DEA, 2013). Such facilities need to be registered with the DEA 90 days before construction commences. Certain waste management activities were promulgated under Section 20(b) of NEMWA in Regulation GN 921 of 29 November 2013 which may not proceed without a Waste Management licence.

Classification of waste streams are required in terms of GNR 634 of 21 August 2013 to ensure that the correct waste management standards and disposal methods are implemented.

GNR 635 of 23 August 2013 provides the norms and standards for disposal of waste to landfill. This includes liner requirements and design specifications.

In 2014 the National Environmental Management: Waste Amendment Act (Act 26 of 2014) was promulgated to include residue deposits and residue stockpiles from:

- Mineral excavation;
- Physical and chemical processing of metalliferous minerals;
- Physical and chemical processing of non-metalliferous minerals;
- Drilling operations

as hazardous waste under NEMWA.

Residue deposits are defined as "any residue stockpile remaining at the termination, cancellation or expiry of a prospecting right, mining right, mining permit, exploration right or production right".

Residue stockpiles are any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, mineral processing plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated within the mining area for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or, production right or an old order right, including historic mines and dumps.

Regulations regarding the Planning and Management of Residue Stockpiles and Residue Deposits, 2015 (GNR 632 of 24 July 2015) was published in the *Government Gazette* 36020 (Residue Regulations).

The Residue Regulations provide for the planning, management and reporting of residue stockpiles and residue deposits, which obligations include:

- The assessment of impacts and analyses of risks relating to the management of residue stockpiles and residue deposits;
- Characterisation of residue stockpiles and residue deposits;
- Classification of residue stockpiles and residue deposits;
- Investigation and the selection of site for residue stockpiling;
- Design of the residue stockpiles and residue deposits;
- Impact Management;
- Duties of the holder of right or permit;
- Monitoring and reporting system for residue stockpiles and residue deposits; • Dust management and control; and
- Decommissioning, closure and post closure management of residue stockpiles and residue deposit.

The regulations provide the tools for and corresponds to the statutory provision relating to managing residue stockpiles and residue deposits in the manner prescribed in Section 43A of the NEMWA (as amended by the National Environmental Management Laws Amendment Act 25 of 2014).

Booysendal South Expansion Project operates tailings storage facilities. Tailings fall within the definition residue stockpiles and is considered waste under NEMWA. WMLs are required for the construction and expansion of residue stockpiles from 2 September 2014 and reprocessing of residue stockpiles from 24 July 2015.

WMLs are also required by the Booysendal Project for the storage, disposal and recycling of waste (including shredding and sorting), where the volumes of waste exceed certain thresholds set in Waste Listed Activities. The Booysendal South Expansion Project triggers activities under Category B of the NEMWA Listed Activities.

A section 24G application is required for waste management activiites that commenced without a WML and that the Booysendal South Expansion Project includes waste management activiites requiring a WML.; thus an application for this licence will be made.

Activities associated with the Booysendal South Expansion Project which will require a WML are listed in **Error! Reference source not found.**. Additional waste management activities, such as backfilling the mine with tailings at BS4, were included in the Section 24G Application for the Booysendal South Expansion Project.

Table 3-2 NEMWA Listed Activities Applicable to Section 24G

Waste Management Activities Contraventions: On or after 29 November 2013

Activities unlawfully commenced with in terms of GNR 921 of 29 November 2013 published under the National Environmental Management Waste Act 59 of 2008 (R921 29 Nov 2013)	
LISTED ACTIVITY(IES)	Details of Activity(ies)
CATEGORY B 4	A person who wishes to commence, undertake or conduct a waste management activity listed under this category must conduct a scoping and environmental impact reporting process set out in the Environmental Impact Assessment Regulations made under Section 24(5) of the National Environmental Management Act 1998 (Act 107 of 1998) as part of a waste management licence application contemplated in Section 45 read with section 20(b) of this Act. (3) The recovery of waste including the refining, utilisation or co-processing of the waste at a facility that processes in excess of a 100 tons of general waste per day or in excess of 1 ton of hazardous waste per day Applicable activity – recovery and re-processing of old tailings at BS4 (9) The disposal of inert waste to land in excess of 25 000 tons. Applicable activity – disposal of tailings at BS4's existing tailings storage facility; backfilling of tailings in mine workings (15) The establishment or reclamation of a residue stockpile or residue deposit resulting from activities which require a prospecting right or mining permit, in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002). Applicable activity – re-processing of tailings at the TSF at BS4

3.5 NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 10 OF 2004 (NEMBA)

The purpose of NEMBA is to ensure the sustainable management and conservation of biodiversity in South Africa. It also provides for the protection of species and ecosystems and sustainable use of indigenous biological resources. Certain portions of the Booysendal South Expansion Project fall within the Sekhukhune Centre of Plant Endemism and Critical Biodiversity Areas as identified in the Mpumalanga Biodiversity Sector Plan. The impact assessment therefore took consideration of the following regulations promulgated in terms of NEMBA:

- GN 1002 of 9 December 2012 containing the National List of Ecosystems that are threatened and in need of protection, promulgated in terms of section 52(1)(a) of NEMBA;
- GN R152 of 23 February 2007 which are the regulations regarding threatened or protected species.
- The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction. This includes preventing further degradation and loss of structure, function and composition

of threatened ecosystems and preserving witness sites of exceptionally high conservation value. GN 276 of 31 March 2017 containing the Draft National Biodiversity Offset Policy which is important to consider where residual impacts are applicable.

- The aim of the National Biodiversity Offset Policy is to ensure that significant residual impacts of developments are remedied, as required by NEMA.
- GNR151 of 23 February 2007 containing the list of critically endangered, endangered, vulnerable and protected species; and
- GN 598 of 12 February 2014 which contains regulations regarding alien and invasive species (AIS Regulations) read with GN 864 of 29 July 2016 which contains the lists of alien and invasive species. NEMBA Section 70 to 77 specifically also deals with the control of species which could pose a threat to biodiversity. The AIS Regulations, which separate alien and invasive species into different categories makes requires the:
    - Immediate eradication of Category 1a listed invasive species;
    - Control of Category 1b listed species;
    - Category 2 listed species which need to be managed in the same manner as Category 1b species except where a permit was granted to allow for these species, in which case the spreading of the species have to be controlled; and
    - Category 3 listed species, where species within riparian zones must be controlled as per Category 1b.

An alien and invasive management programme must be put in place for all categories of AIS. The relevant AIS found in the Booysendal Expansion area will managed in accordance with the AIS Regulations.

South Africa has ratified the Convention on International Trade in Endangered Species (CITES) and has published regulations regarding compliance with CITES in GN R173 of 5 March 2010 and regulates the import and export of endangered species.

Comprehensive reference to international conventions and legislation applicable specifically to ecology related to the Booysendal South Expansion Project is included in the Terrestrial Ecology Report done by NSS.

3.6 NATIONAL ENVIRONMENTAL MANAGEMENT PROTECTED AREAS ACT, 57 OF 2003 (NEMPAA)

Certain areas are protected from development under the NEMPAA, including those declared national parks, nature reserves and world heritage sites.

NEMPAA provides that, despite other legislation, no person may conduct prospecting or mining activities in special nature reserves or protected areas without the prior consent of the Ministers of Mineral Resources and Environmental Affairs. NEMPAA binds all state organs and trumps other legislation, including the MPRDA in the event of a conflict concerning the development of protected areas.

The Booysendal South Expansion Project, though situated in a critical biodiversity area, will not traverse any area protected under NEMPAA and consent is therefore not required.

3.7 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT, 39 OF 2004 (NEMAQA)

NEMAQA was promulgated to ensure the protection and regulation of air quality and to provide measures that will prevent pollution and sustainability. Under NEMAQA, the Minister of Environmental Affairs must identify substances in ambient air which present a threat to health, well-being or the environment and establish national standards for ambient air quality, including the permissible quantity or concentration of each substance in ambient air. Under NEMAQA the following regulations were promulgated which have specific bearing on the project:

- Regulation GN 893 of 22 November 2013 listing activities which could result in atmospheric emissions and which requires an Atmospheric Emissions Licence (AEL) before being undertaken. Examples of such activities include the use of combustion installations, storage of petroleum products, slag processes, carbonisation and coal gasification, mineral processing and disposal of hazardous and general waste by way of incineration. An Air Quality Impact Assessment (AQIA) was undertaken to determine if the Booysendal South Expansion Project undertakes any listed activities under NEMAQA and if any of its emissions exceed the allowable thresholds and therefore whether it required an AEL. The AQIA indicates that an AEL under NEMAQA is not required.
- The National Dust Control Regulations were promulgated on 1 November 2013 in GNR 827 providing dust standards and measures for dust control. **Error! Reference source not found.** presents a cceptable dust fall rates issued in terms of the Regulations.

Table 3-3 Acceptable Dust Fall Rates

Restriction Area	Dust fall rate (D) (mg/m²/day, 30-day average)	Permitted frequency of exceeding dust fall rate
Residential area	D < 600	Two within a year, not sequential months
Non-residential area	600 <D <1200	Two within a year, not sequential months

Of further importance is to note that the project site does not fall within an air quality priority area in terms of Section 18(1) of NEMAQA. Further detail around air quality is in included in the AQIA.

3.8 NATIONAL WATER ACT, 36 OF 1998 (NWA)

The purpose of the NWA is to ensure that the country's water resources are allocated, protected, used and managed to the benefit of current and future generations taking consideration of the growing demand, the human and ecological reserve needs whilst promoting economic development to the benefit of all. The DWS and relevant delegated Regional Managers and Water Management Agencies (WMA) have been appointed as the National trustees to oversee the governance of the country's water resources.

In terms of Section 21 of the NWA certain consumptive and non-consumptive water uses were identified which can only commence once authorised. Where a water use cannot be authorised as a Scheduled 1 Use (permissible use without an authorisation requirement), a permissible water use in terms of Section 22 of the NWA or as a General Authorisation, a Water Use Licence must be obtained and an application in terms of Section 40 and 42 of the NWA must be submitted. Eleven consumptive and non-consumptive water uses have been identified under Section 21 of the NWA. These water uses include:

- taking water from a water resource ("Section 21(a) water use");
- storing water ("Section 21(b) water use");
- impeding or diverting water flow in a watercourse ("Section 21(c) water use");
- engaging in a controlled activity ("Section 21(e) water use");
- discharging waste or water containing waste into a water resource, through a pipe, canal, sewer, sea outfall or other conduit ("Section 21(f) water use");
- disposing of waste in a manner which may detrimentally impact on a water resource ("Section 21(g) water use");
- altering a watercourse's bed, banks, course or characteristics ("Section 21(i) water use"); and
- removing, discharging or disposing of water found underground if necessary for the efficient continuation of an activity or for the safety of people ("Section 21(j) water use").

The water uses applicable to the Section 24G Application are included in **Error! Reference source not found.**.

Booysendal is in the process of applying for a water use licence in a separate process, in accordance with section 40 and 41 of the NWA, to this Section 24G process.

Table 3-4 Water Uses Associated with the Section 24G Activities

Section 21 Water Use	Description of the Water Uses
Section 21 (a) taking water from a water resource	• Water from the TKO dam to BS1/2. • Taking water from two boreholes for potable use at BS4 • Dewatering of the underground works at the valley boxcut at BS4
Section 21 (b) storing water	• Potable water storage tank at
Section 21 (c) impeding or diverting the flow of water in a watercourses **Section 21 (i) altering the beds, banks, course or characteristics of a water resource**	Please note that in the case of the Project all the water uses below involves both Section 21 (c) and (i) uses. • Three of the ARC towers are located on the edge of water courses and one in a wetland where excavations will be made for the base on the towers. • 18 drainage line crossings associated with the main access road for main access road. Culverts will be installed • Diversion of two streams upstream of the BS1/2 portal complex • TKO pipeline crossing the Everest stream
Section 21 (g) disposing of waste in a manner which may detrimentally impact on a water course	• 14,000m^3 PCD at BS1/2 • Mine PCD at BS4 • Process water tank at BS1/2 • Valley boxcut dirty water dam • Ore stockpile at BS4 • ROM stockpile at BS1/2 • Reworking of Tailings at BS4 • Backfilling of tailings into the underground workings at BS4 • Return water dam at BS4 • Plant PCD at BS4

	• Erickson dam at the north decline (343 m^3) • Four settling ponds at the north decline (350 m^3 each) • Sink dam at the north decline (286 m^3)
Section 21 (j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity of for the safety of people	• Removing of underground water from the underground workings at BS1/2
Detail around the water uses will included in the Water Use Licence Application to be submitted to the DWS **Volumes applicable to the water uses are included in Section 2**	

In addition to the water uses, GN 704 of 4 June 1999, promulgated in terms of Section 26(1) of the NWA regulations were promulgated specifically aimed at the protection of water resources associated with mining related activities. The regulations state some minimum requirements which needs to be adhered to in aid of the protection of the water resources on a mine. It regulates the use of water, management of dirty and clean water infrastructure and related activities at mines. This includes minimum requirements for infrastructure that holds dirty water. A mine can apply for exemptions of these requirements and could be granted approval should sufficient management measures be put in place to ensure the protection of the environment.

Article 4 of the Regulation places some restrictions in terms of the locality of certain infrastructure which could have an impact on water resources:

(a) *"locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year flloodline or within a horizontal distance of 100 metres 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) *Place or dispose of any residue 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, prospecting diggings, pit or any other excavation;"*

The following activities are applicable to the application for exemption from Article 4(a) activities:

- A section of the BS1/2 terrace falls within 100m of the Groot Dwars River and within 100m from and within the 1:100 year floodline of a non-perennial drainage line of the Groot Dwars River;
- The co-disposal overburden/topsoil stockpile falls within 100m of the non-perennial drainage line of the Groot Dwars River; and
- The mining PCD at BS4 is located within 100m of the wetland downstream.

The following activities are applicable to the application for exemption from Article 4(b) activities:

- Backfilling a section of the underground workings at BS4 with tailings (Please see Section 2 for details).

3.9 NATIONAL FORESTS ACT, 84 OF 1998 (NFA)

Section 12 of the NFA gives power to the Minister of Agriculture, Forestry and Fisheries to declare certain trees as protected species. The latest list has been promulgated under GN R908 of 21 November 2014. There are several known protected tree species in the Booysendal South Expansion area which have been or must be as part of the development. For this purpose, it will be necessary to submit an "Application for a Licence Regarding Protected Trees" to the Department of Agriculture, Forestry and Fisheries (DAFF).

Section 15 of NFA indicates that no protected species may be cut, disturbed, damaged or destroyed without a licence granted by the DAFF. The Section 24G application includes reference to the protected species applicable to the development.

3.10 NATIONAL HERITAGE RESOURCES ACT, 25 OF 1999 (NHRA)

The purpose of NHRA is to ensure that the heritage resources which are of cultural significance, as described in Section 3 of the Act, will be protected. The protection of heritage resources is nationally overseen by the South African Heritage Resources Agency (SAHRA) with delegated powers to provincial heritage resources authorities.

Section 38 of the NHRA requires that the any proposed development that exceeds 5000m^2 must inform SAHRA prior to undertaking the development. SAHRA may then require a heritage impact assessment to be conducted before it consents to the development.

The NHRA states that human remains older than 60 years and younger than 100 years are protected by the NHRA with reference to Section 36 and the Human Tissues Act (Act 65 of 1983). Procedures for the removal of graves are clearly stated in Section 36 including procedures for Consultation Regarding Burial Grounds and Graves (Section 36[5]) where such graves are situated outside a formal cemetery administrated by a local authority. If the grave is not situated inside a formal cemetery, but is to be relocated to one, permission from the local authority is required and all regulations, laws and by-laws, set by the cemetery authority, must be adhered to.

Human remains that are younger than 60 years are protected under Section 2(1) of the Removal of Graves and Dead Bodies Ordinance, No 7 of 1925, and the Human Tissues Act, 65 of 1983, and are under the jurisdiction of the National and Provincial Department of Health. Final approval for removal of human remains must be submitted to the office of the relevant Provincial Premier. This function is generally delegated to the Provincial MEC for Local Government and Planning; or in some cases, the MEC for Housing and Welfare.
Authorisation for exhumation and reinternment must also be obtained from the relevant local or regional council where the grave is situated, as well as the relevant local or regional council to where the grave is being

relocated. To handle and transport human remains, the institution conducting the relocation must be authorised under Section 24 of Act 65 of 1983 (Human Tissues Act).

Booysendal was granted authorisation to move graves which were associated with the BS1/2 portal. This was process was conducted in consultation with the relevant families as required under the NHRA.

Under section 34 of the NHRA structures which are older than 60 years may not be demolished without a permit issued by the relevant provincial heritage resources authority. No structures older than 60 years were recorded in the Booysendal South Expansion area and the Heritage Impact Assessment.

Section 35 of the NHRA deals with archaeological, paleontological and meteorite heritage resources and requires that any archaeological or paleontological objects that are found site must be reported to the provincial heritage resources authorities. The discovered archaeological or paleontological objects may not be removed, damaged or destroyed without obtaining a permit from the heritage resources authority.

3.11 CONSERVATION OF AGRICULTURAL RESOURCES ACT, 43 OF 1998 (CARA)

In terms of CARA, landowners are legally responsible for the control of weeds and alien vegetation. The Act makes provision for three categories of alien and invasive species:

- Category 1a invasives must immediately be removed and destroyed;
- Category 1b invasives need to be immediately be removed and contained;
- Category 2 invasives require a permit to retain the species on site and must ensure that it does not spread. All category 2 plants in riparian zones need to be removed; and
- Category 3 a permit is required to retain these species. All category 3 plants in the riparian zone need to be removed,

CARA is also clear in terms of the conservation of soil and states that degradation of the agricultural potential is illegal. It furthermore requires the protection of land against soil erosion and the prevention of water logging and associated salinization.

3.12 SPATIAL DEVELOPMENT POLICIES

3.12.1 The National Development Plan 2030 (NDP)

The NDP is a long-term development framework and plan for South Africa, and was released in August 2012. All major development policies and strategies of district and local municipalities find expression in the NDP and the NDP must be referred to when determining the socio-economic impacts of a development or project on the surrounding area. This was taken into account in the Social Impact Assessment (SIA) for Booysendal Expansion Project.

3.12.2 Mpumalanga Economic Growth and Development Plan (MEGDP)

The primary objective of the MEGDP is to foster economic growth that creates jobs, reduce poverty and inequality in the Province. The objectives of the MEGDP were considered in the SIA.

3.12.3 Municipal Integrated Development Plans (IDP) and Spatial Development Frameworks (SDF)

The SDF serves as a guideline for the following: land-use management systems, infrastructure investment directive, address socio-economic inequalities, effective and efficient land use and land use integration. The SDF is a road map for all infrastructural development and the SDF must inform all infrastructure projects. Three town planning schemes regulate the Booysenal Expansion Project:

- Lydenburg Town Planning Scheme, 1995;
- Sabie Town Planning Scheme, 1984; and
- Graskop Town Planning Scheme, 1992.

These town planning schemes were taken into account in the SIA.

Local Economic Development (LED) is central to the IDP of a municipality. The aim of the LED process is to create employment, alleviate poverty, redistribute resources and most importantly keep money generating in the Local Municipality. Mines are expected to take into consideration the LED strategies of the local municipalities when developing programmes for their SLPs.

3.13 OTHER ACTS, GUIDELINES AND PLANS CONSIDERED

Provincial legislation considered by the specialists include amongst others:

- Mpumalanga Nature Conservation Act, 10 of 1998 – provides for the protection of the environment;
- Mpumalanga Biodiversity Sector Plan (MBSP) - allows for a spatial plan for the biodiversity conservation;
- Limpopo Environmental Act, 7 of 2003 – makes provision of the protection of terrestrial and aquatic biodiversity;
- The Limpopo Conservation Plan of 2013 was designed to support integrated development planning;
- Limpopo Environmental Implementation Plan 2015-2020 (published under PN 64 in PG 2715 of 10 June 2016) - describes policies, plans and programs of the department that performs functions that may impact on the environment and how this department's plans will comply with the NEMA principles and national environmental norms and standards;
- Mpumalanga Environmental Implementation Plan 2015-2020 (published under PN 15 in PG 2657 of 29 February 2016) - identifies the policies, plans and programmes within each of the provincial and relevant national departments in the province that could have significant impacts on the environment, and indicates measures that these departments' are, putting into place or planning to put in place, to improve their environmental performance and co-operative environmental governance; and
- Various Municipal by-laws.

3.14 NOISE CONTROL REGULATIONS GOVERNMENT GAZETTE NO. 15423, 14 JANUARY 1994

These noise control regulations provide the limit of exceedance at which noise levels becomes a disturbance. According to the regulations an exceedance of 7.0dBA above the prevailing ambient noise levels are allowed before a noise disturbance is created.

3.15 STANDARDS AND GUIDELINES

3.15.1 South African National Standards – SANS 10103 of 2008

SANS 10103 provides the requirements for noise measurement and rating of environmental noise with respect to annoyance and to speech communication.

3.15.2 South African National Standards – SANS 10210 of 2004

This national standard is used when calculating or predicting increased road traffic noise during new developments.

3.15.3 International Finance Corporation Environmental, Health and Safety Guidelines for Mining

The IFS guidelines recommended noise levels for noise sensitive areas is 55.0dBA during the day and 45.0dBA during the night.

3.15.4 United States Bureau of Mines – USBM (1980). Structure response and damage produced by ground vibration from surface mine blasting.

USBM 1980, provides limits for ground vibration levels resulting from blasting. Ground vibration levels as a result of blasting should not exceed 10,0m/s for clay huts and 25.0mm/s for brick or formally constructed buildings.

3.15.5 NEMA Implementation Guidelines: Sector Guidelines for Environmental Impact Assessment Regulation (published in GN 654 of 2010 in *Government Gazette* 3333, dated 29 June 2010).

This guideline provides guidance on how to compile EIAs containing information and analysis of a high quality and which is sufficiently comprehensive to enable the decision-maker to make a well-informed decision. It explains the requirements in the EIA Regulations and provides practical guidance and tools for the EIA process.

3.15.6 Minimum Requirement for the Handling, Classification and Disposal of Hazardous Waste, 1998 (Minimum Requirements)

The Minimum Requirements provide the applicable waste management standards or specifications that must be met when dealing with Hazardous Waste. It also provides a point of departure against which environmentally acceptable waste disposal practices can be distinguished from environmentally unacceptable waste disposal practices.

3.15.7 Department of Environmental Affairs and Tourism (2004); Cumulative Effects Assessment, Integrated Environmental Management, Information Series 7, Department of Environmental Affairs and Tourism (DEAT), Pretoria.

This guideline provides information on cumulative effect assessments, integrated environmental management, and highlights the potential approaches for incorporating cumulative effects into EIAs.

3.15.8 Department of Environmental Affairs (2011); A user friendly guide to the National Environmental Management: Waste Act, 2008. South Africa, Pretoria.

This guide gives a simplified overview of the contents and application of the Waste Act. It also covers processes or directions on how to manage polluted land and develop industry waste management plans. It provides guidance and information on the licensing of waste management activities, waste information, compliance and the consequences for non-compliance NEMWA.

3.15.9 DEAT (2004): Criteria for determining Alternatives in EIA, Integrated Environmental Management, Information Series 11.

This document provides an overview of the key criteria for determining project alternatives, in the Environmental Impact Assessment (EIA) Process.

3.15.10 Guideline for Implementation: Public Participation in the EIA Process (published in GN 807 of 2012 in Government Gazette 35769 of 10 October 2012).

Assists applicants, interested and affected parties and environmental assessment practitioners to under their roles in the Public Participation Process (PPP). It provides information on the benefits of the PPP and guidance on conducting the PPP.

3.15.11 International Finance Corporation (IFC) Standards, Guidelines and Requirements

During the SIA, IFC Performance Standards (PS) were taken into consideration. These standards articulate a company's strategic commitment to sustainable development, and are an integral part of the IFC’s approach to risk management.

4. DESCRIPTION OF THE RECEIVING ENVIRONMENT

4.1 GENERAL

The initial specialist studies were undertaken for BS1/2, BS3 and the linear infrastructure components. These studies were undertaken between the period November 2015 and March 2016. Due to changes and revisions in the project definition and the commencement with the development and construction activities, a second set of studies were undertaken to cover baseline conditions associated with BS4 and to assess the impacts associated with the Section 24G activities. Where possible, the studies were integrated if they were undertaken by the same specialists. Terrestrial and aquatic studies were not undertaken by the same specialists and, as such, the first set of studies provide an indication of the original baseline conditions.

4.2 CLIMATE

For this report, available data from Mesoscale Model version 5 (MM5), and Mashishing (W0554816), Buffelskloof (B4E003) and Roossenekal (B4E004) weather station data for the period 1971 to 2016 as used. Where more than one dataset was available, data for all stations were included to provide a greater reliability. Although there is a weather station on site the data is not available for a long enough period to be reliable for the calculation of climate and seasonal averages. The project area has a typical Highveld character with warm summers and moderate winters. It is a summer rainfall area with highest rainfall between October to March.

4.2.1 Temperature

The temperature of the project area is moderate with the average maximum temperature for January reaching 30°C and the average minimum of 17°C. Average maximum temperature for July is 21°C and the average minimum 3°C. The temperature extremes for Mashishing are 34.5°C and -5.9°C in winter, however frost is not common at Booysenda. Average minimum and maximum temperatures are set out in Table 4-1.

Table 4-1 Average Temperatures as obtained from Mashishing Weather Station (W0554816) and MM5

Month	Jan	Feb	March	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Mashishing Weather Station (W0554816) for the period 1961 - 1990												
Minimum °C	14.7	14.2	12.9	10.0	6.0	2.8	2.7	4.8	8.1	10.8	12.7	14.1
Maximum °C	25.9	25.5	24.8	22.6	20.8	18.3	18.8	20.9	23.6	24.0	24.2	25.2
Mesoscale Version 5 (MM5) for the period January 2013 to December 2015												
Minimum °C	10.8	9.9	8.5	5.6	2.9	1.1	0.4	1.8	3.9	3.1	5.0	9.8
Maximum °C	27.1	26.8	25.0	23.2	21.1	18.5	18.6	22.6	23.8	26.4	25.8	26.6
Average	17.7	17.7	16.3	14.0	12.6	10.2	9.5	11.4	14.2	14.9	16.4	17.7

4.2.2 Rainfall and Evaporation

Average rainfall for the project area as measured at the closest rainfall station (Buffelskloof) is 730mm. The wettest months are from October to March. Rainfall is mainly in the form of intense thunderstorms. In this valley environment, the rainfall leads to high run-off over a short period. Average rainfall during winter months is low only being 5mm.

The average evaporation for the project is 1,756.5mm per annum exceeds rainfall, thereby resulting in a water deficit. The evaporation and rainfall data for Buffelskloof and Roossenekal weather stations are included in Table 4-2.

Table 4-2 Average Monthly Rainfall and Evaporation as Measured at Roossenekal ad Buffelskloof

Station	**Buffelskloof B4E003**		**Roossenekal B4E004**		**Average or B4E003/4**	
Elevation (mamslL*)	1280		1440		1200 – 1700	
Distance to Site (km)	24		22		0	
Data Start Year	1971		1971		1971	
Data End Year	2016		2016		2016	
Month	Rainfall (mm)	S-Pan Evaporation (mm)	Rainfall (mm)	S-Pan Evaporation (mm)	Rainfall (mm)	S-Pan Evaporation (mm)
January	105.1	180.7	125.9	169.8	115.5	175.2
February	91.5	159.7	94.9	165.8	93.2	162.8
March	76.1	149.1	77.6	174.8	76.8	161.9
April	47.7	122.0	40.2	169.2	44.0	145.6
May	12.8	109.1	12.7	153.4	12.8	131.3
June	4.2	91.9	6.6	144.1	5.4	118.0
July	4.2	99.0	2.9	115.9	3.6	107.5
August	8.5	122.2	7.1	100.6	7.8	111.4
September	19.1	153.5	19.9	85.0	19.5	119.3
October	66.1	173.8	68.0	90.7	67.0	132.3
November	121.9	165.9	119.1	118.3	120.5	142.1
December	121.6	172.7	124.4	150.0	123.0	161.4
Total	*678.9*	*1,699.7*	*699.1*	*1,937.7*	*689.0*	*1,668.7*

*mamsl = meters above mean sea level

Maximum rainfall over a six-month period from 1971 to 2016 for the wettest 10 periods are included in Table 4-3. During these wet periods evaporation, except for one event, still exceeded rainfall. In terms of the data presented, it does not appear that rainfall within the area is significantly influenced by climate change.

Table 4-3 Extreme Rainfall Periods (Source: Surface Water Study for BS4: SLR, 2017)

Ten Wettest Periods	Buffelspoort (B4E003)			Roossenekal (B4E004)		
	Period Start	**Total 6 Month Rainfall**	**Total A-pan 6 Month Evaporation**	**Period Start**	**Total 6 Month rainfall**	**Total A-pan 6 Month Evaporation**
1st	Nov 1995	885.8	861.4	Oct 1990	865.9	975.9
2nd	Oct 1980	832.6	927.7	Oct 1980	856.6	923.1
3rd	Oct 1999	765.5	879.8	Oct 1995	840.7	970.9
4th	Oct 1979	755.1	1005.4	Oct 2007	806.5	937.6
5th	Oct 1977	751.3	1032.6	Oct 1999	773.8	896.1
6th	Oct 1984	689.2	1015.3	Oct 1971	743.9	1031.7
7th	Oct 1998	657.0	893.4	Oct 2008	724.9	935.5
8th	Oct 1996	656.0	879.8	Sep 2011	717.8	981.7
9th	Sep 1972	623.3	1157.9	Oct 1983	713.3	974.3
10th	Oct 1987	614.3	991.2	Oct 1973	667.2	904.2

Storm intensities are included in the SLR Hydrological assessment for various storm scenarios. Refer to Annexure F2.

4.2.3 Wind

The main wind direction in the project area is from the south-east. Seasonal differences and changes in wind speed and direction occur. Other than normal pressure systems influencing wind speed and direction, the steep valleys also lead to micro-climates with upward flow of air against the valley slopes during the day (anabatic) and downward flow of air during the night (katabatic). The seasonal wind roses for the project as derived from MM5 data is included in Figure 4-1.

4.2.4 Extreme Weather Conditions

Extreme weather conditions as obtained from the 2010 GCS Environmental Impact Assessment for the Booysendal Mine is include in **Error! Reference source not found.**.

Table 4-4 Booysendal Extreme Weather Conditions

No of Days with:	Jan	Feb	March	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	p/a
Thunder	6.2	4.4	3.7	2.7	0.9	0.5	0.4	1.1	1.4	4.1	7.1	5.1	37.6
Hail	0.3	0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.5	0.2	1.9
Fog	1.9	1.3	1.1	0.9	0.4	1.1	0.8	1.1	0.8	2.6	1.6	1.6	15.2
Snow	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.6

4.3 TOPOGRAPHY

The bulk of the Booysendal South Expansion project (BS1/2, BS4, the Merensky Portals and most of the linear infrastructure) is in the Groot Dwars River Valley. The Groot Dwars River Valley is surrounded by the Steenkampsberg mountains to the west, south and east. The project is associated with steep, rugged valley slopes which varies in height from approximately 1,050 mamsl in the valley bottom to 2,328 mamsl at the top of the Steenkampsberg. BS4 is mainly situated on the eastern plateau (refer to Figure 4-2 and Figure 4-3).

Water is the main erosive force which alters the landscape and topography in the area. The process is naturally slow, but is significantly increased when disturbance of vegetation takes place. Due to the steep slopes and the underlying norites, the area is highly sensitive to erosion.

The topography in the project area until recently, prior to the commencement of the Section 24G activities, was mainly natural.

Figure 4-1 Seasonal Wind Direction and Speed (Air Quality Impact Assessment for Booysendal Mine, Airshed, 2017)

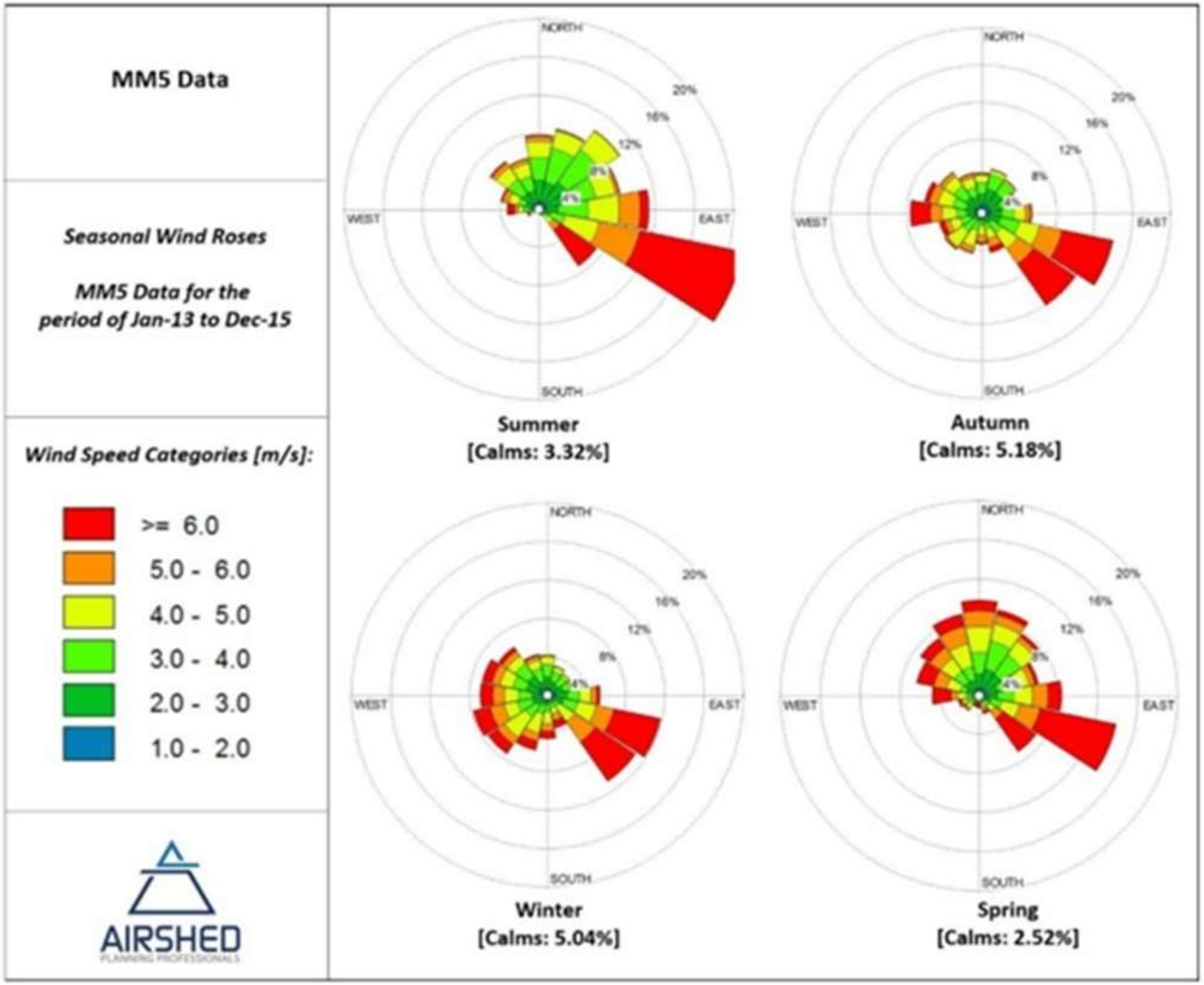


Figure 4-2 Booysendal Project Topography

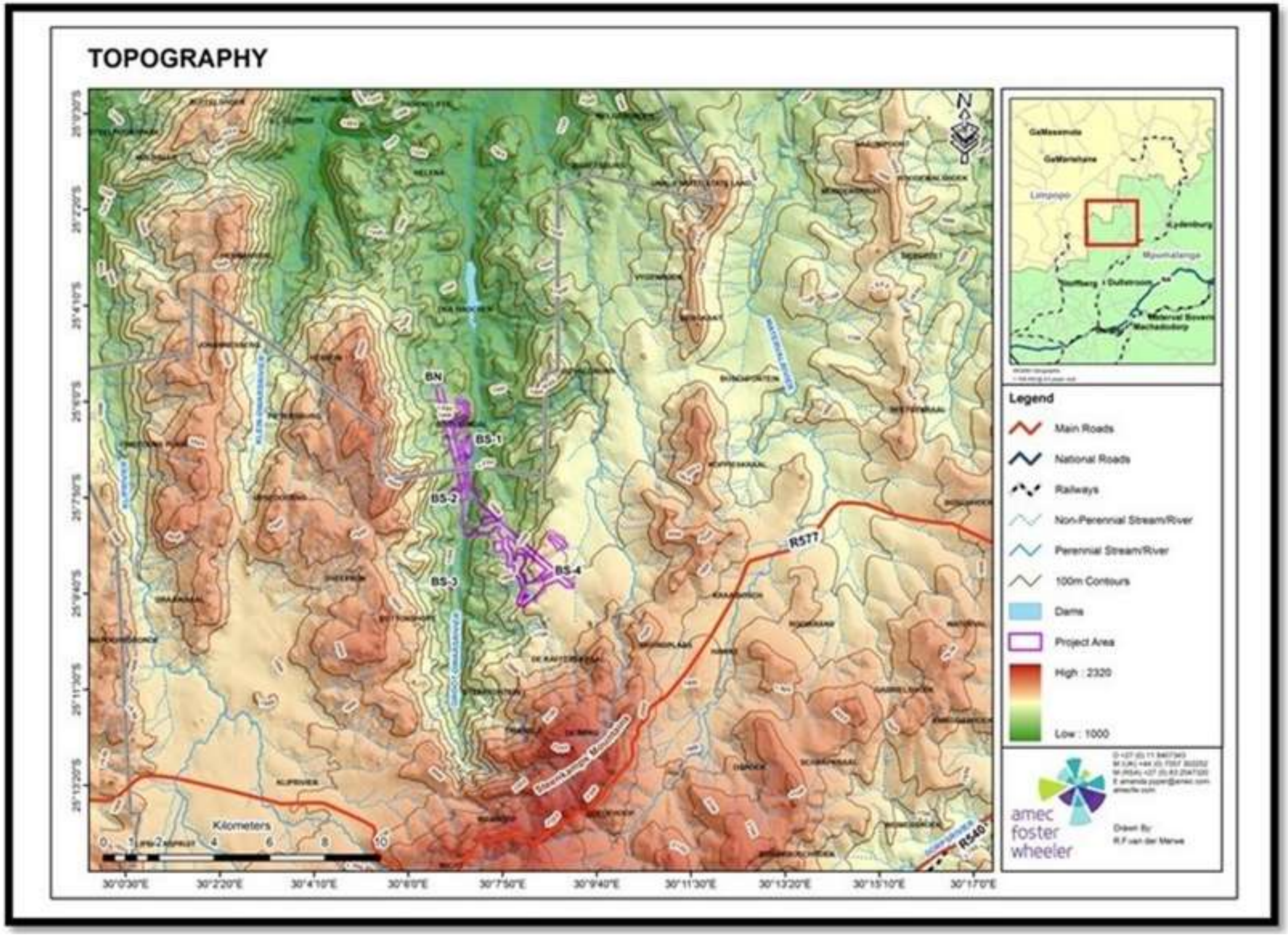


Figure 4-3 Booysendal South Expansion Project Topography seen from the North

4.4 SOIL, LAND USE AND LAND CAPABILITY

4.4.1 General

The soil, land use and land capability assessment (soil study) for the Booysendal South Expansion Project (including the future underground mine at BS3 and TSF2 complex at BS4) was undertaken by TerraAfrica. The soil study provides an indication of baseline conditions before the Section 24G activities commenced and an assessment of the impacts associated with the Section 24G activities. The Soil, Land Use and Land Capability Assessment Report is included in Annexure C and contains more detail than the summary provided in the following sub-sections.

4.4.2 Methodology

The methodology followed to undertake the soil study was as follows:

<u>Desktop Review</u>
All available past and historical soil studies for Booysendal and Everest Mine (prior to the acquisition of the Everest Mining Right) were reviewed. In addition, land type data from the Agricultural Research Council and the Environmental Potential Atlas was also consulted for purposes of compiling the assessment report.

<u>Field Survey</u>
Investigations of the soil profile (texture, structure, colour and depth) up to a depth of 1.5m was conducted using a hand auger. Sampling points were located between 100m and 250m apart depending on the accessibility and desktop delineation of the soil forms. A hydrochloric acid was used to assess and identify the presence of carbonates in the soil, specifically associated with the Section 24G activities. Field investigations were conducted during 26 to 30 January 2016 to cover BS1/2, BS3, the ARC, main access road, initial pipeline route and powerline route. This was followed by additional field investigations in November 2016 to cover BS4 and to assess the impacts of Section 24G activities.

<u>Laboratory Analysis</u>
Eleven representative soils samples were taken to the Nvirotek Labs for analysis and identification of the presence of pH, phosphorous, exchangeable cations (calcium, magnesium, potassium and sodium), organic carbon and texture classes (sand, silt, clay fractions).

<u>Reporting</u>
The reporting process included a description of the baseline soils, using the S.A. Soil Classification Taxonomic System (Soil Classification Working Group, 1991) published as memoirs on the Agricultural Natural Resources of South Africa No. 15. Land capability classes were determined using the guidelines outlined in Section 7 of “The Chamber of Mines Handbook of Guidelines for Environmental Protection (Volume 3, 1981)”. Impacts on soils were assessed and management, mitigating and motoring measures proposed.

4.4.3 Area of Influence

The direct area of influence (AoI) for the soil study has been delineated as the areas where disturbance will take place and the areas directly adjacent to that which may also be subject to disturbance. This included an area measuring 1,451 hectares in extent. Potential impacts where also assessed for the indirect AoI which stretches up to the Der Brochen Dam (which will act as a sediment sink) in the north and a buffer around the Booysendal South Expansion Project. This buffer was determined by waterways and preferential flow paths which could be affected by the development and which could lead to a change to the overall soil characteristics as a result of the direct impacts.

4.4.4 Baseline Soil Forms and Soil Characteristics

Soil forms the basis of any ecosystem since the inherent soil properties such as salinity, texture, water-holding capacity and soil profile depth will naturally favour vegetation best adapted to these conditions. Soil properties also indicate current pedogenic processes. Therefore, any impacts on the soil properties will also affect these aspects and have an impact on the larger landscape and the ecosystems it supports.

Eighteen soil forms were identified on the project area. Due to the topography within the area, the soil forms are highly variable. In the flatter areas, soil forms are dominated by clay-loams with a weak to moderate structure. These soils are suitable for agricultural production. The hill slopes contain young soils characterised by shallow, rocky lithic soils. The characteristics of the various soil forms are included in Table 4-5 and the distribution of soil forms is depicted in Figure 4-4.

Table 4-5 Soil Forms and Characteristics in the Project Area of Influence

Soil Form	Extent		Characteristics
	Ha	%	
Arcadia	23.6	1.6	The Arcadia soils are mainly associated with the Merensky North Portal, which is high in clay content with shrinking-swelling properties, typical of vertic soils with a depth of approximately 80cm. Land capability: high grazing potential.
Bainsvlei	59.8 ha	4.1	The Bainsvlei soils consist of a orthic A horizon up to a depth of 35cm and a red apedal B horizon up to depths of 120cm. The oxides in the soil provide a macro-aggregating effect which reduces the soil erosion potential. The soil as a result, is highly suitable for rehabilitation purposes. Bainsvlei soils are located next to the Everest tributary and areas directly alongside it. The activities which have commenced within this area are mainly stormwater management infrastructure upgrades. Land capability: arable land.
Bonheim	12.6	0.66%	The Bonheim soil form is limited to an upper slope of the road going down to the Everest valley. The soil form consists of a 15cm melanic A horizon and a B-horizon with a higher clay content. The soil structure is strong and less susceptible to erosion. Land capability: grazing land capability

Soil Form	**Extent**		**Characteristics**
	Ha	%	
Clovelly	3.2	0.17	Clovelly soils are restricted to a small section east of the valley boxcut. The soils are associated with the main road which extends from BS4. The soils consist of a sandy-loam orthic A-horizon and a well-drained apedal B-horizon and are 100cm deep. The soils are highly susceptible to erosion. Land capability: Suitable for arable crop production and for use as topsoil.
Griffin	17.5	0.92	Griffin soils are located on the even gradient area southwest from the BS4 workshops. The soils are fairly well developed soils with an orthic A-horizon of 20-45cm depth and a apedal yellow-brown to red B-horizon. The soils have a loamy texture, well drained, usually acidic, low phosphate status and moderate organic matter. These soils will be mainly impacted by infrastructure associated with the development of the last and second last ARC towers and access roads. This soil form is less prone to erosion. Land capability: arable land capability but will required fertilizer.
Hutton	273.5	14.36	The Hutton soil form occurs in the BS4 development area and the northern portion of it has previously been planted with kiwifruit orchards, of which, some the kiwi trees are still present. Small sections of the main access road which runs up the slope to BS4 also consist of Hutton soil. The soils have a range of red colours and a well-developed orthic A-and B-Horizon of between 130cm - 150cm. The soil form is less sensitive and susceptible to erosion as a result of the relative high clay content of between 10% and 25%. Land capability: This soil form has high arable land capability.
Hydromorphic Soils	71.8	3.77	The Hydromorphic soil is located in sections of the kiwifruit orchards at BS4 and further downstream. The soils are indicative of temporary and permanent periods of water saturation. The soils have a blue-greyish colour and consist of a vertic, melanic or orthic A-horizon followed by a G-horizon. The soils are highly sensitive to development. Sections of the ARC and towers, PCD and stormwater management upgrades on the northern side of BS4 and sections of the road to BS4 are associated with this soil form. Land capability: Wetland (no-go areas).
Inhoek	174.7	9.17	The Inhoek soil form is associated with areas along the Groot Dwars River, pockets along the road alignment, areas around the valley boxcut and in the BS1/2 vent shafts. Inhoek are younger soils with 35cm-45cm depth overlying unconsolidated sediments in which soil formation has not progressed sufficiently to form diagnostic horizons. The soil form is sensitive to erosion mainly as a result of the topography and young nature of the soil. Land capability: Grazing
Lithic Soils	616.4	32.36	Lithic soils (Glenrosa and Mispah) are associated with the steeper valley areas and consists of rock and weathered rocky sections. This soil form is easily visible as rocky areas with very little soil formation. Sections of the road crosses through the lithic soils and the upper sections of BS1/2 and vent shafts. Large sections of the main access road from BN to BS1/2 and up to BS4 traverses Lithic soils. Very little

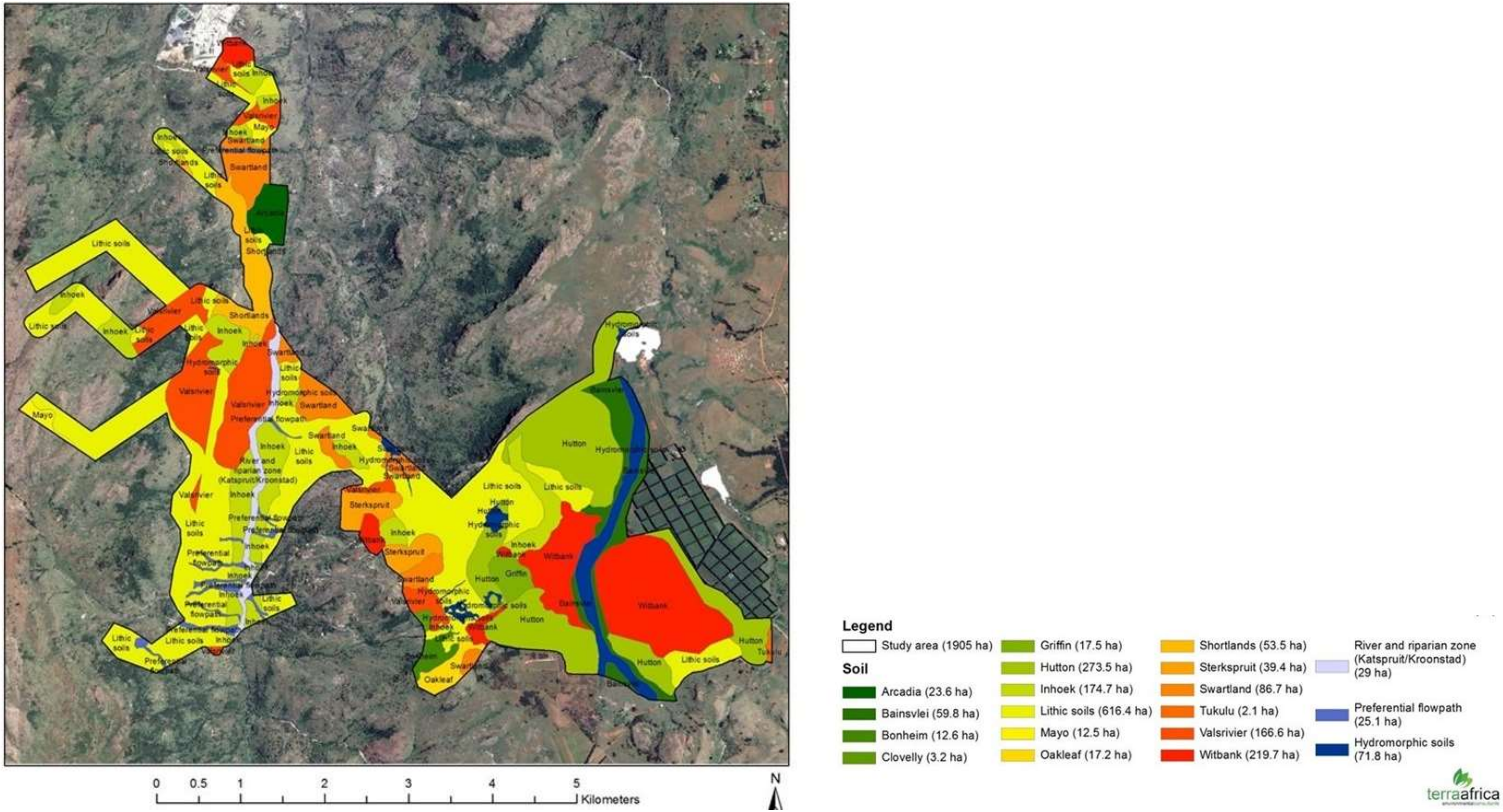
Soil Form	**Extent** Ha	%	**Characteristics**
			topsoil is associated with this soil form, as a result the soil form is susceptible to erosion. Land capability: Wilderness.
Katspruit/Kroonstad	29	1.52	The riparian zone of the Groot Dwars River Valley is associated with dark grey, saturated Katspruit and Kroonstad soils. These soil forms are enriched with a clay layer of 15cm. All infrastructure within the 1:100 floodlines are associated with these soil forms. These soil forms are highly sensitive. Land capability: Wetland.
Mayo	12.5	0.66	The Mayo soil forms contains strong structured Melanic A horizon of between 15cm to 25cm deep, on top of a hard bedrock B-horizon. A short section of the road and powerline alignment close to BN traverses this soil form. Land capability: Grazing or wildlife conservation.
Oakleaf	17.2	0.9	The Oakleaf soil form contains well developed (80cm) orthic A-horizon. The high sandy-loam contents of the soils make it susceptible to wind and water erosion. The section of the main access road which is no longer applicable, previously crossed Oakleaf soil forms. Land capability: High agricultural production and grazing capability.
Shortlands	53.5	2.81	The Shortlands soil forms contain well developed A-horizon and are susceptible to erosion. The second section of the powerline from BN, sections of the main access road and a small northern section of the terrace are associated with the Shortlands soil forms. Land capability: Grazing.
Sterkspruit	39.4	2.07	The Sterkspruit soil form contains well-developed orthic A-horizon overlaying a B-horizon with relatively high clay content. Clay dispersion in the A-horizon makes the soil highly susceptible to erosion. The soil is associated with areas along the main access road between BS4 to BS1/2. Land capability: grazing land capability.
Swartland	86.7	4.55	The Swartland soil has a 20cm orthic A-horizon. The B-horizons consist of blocky, structured pedocutanic B-horizon. The shallow soil depth and composition make the soil form significantly susceptible to erosion. The Swartland soil form is associated with the second section of the powerline and road from BN, a section of the ARC, sections on of the main access road on the eastern slope of BS4. Land capability: grazing land capability.
Tukulu	2.1	0.11	The Tukulu soil consists of a well-drained orthic A-horizon of approximately 35cm. The soil has a pedocutanic B-horizon portray, although it portrays signs of wetness, making it a deep, fertile soil. A small section on the south-eastern edge of BS4 contains Tukulu soil forms. This soil form will likely not be impacted by the Section 24G activities. Land capability: arable land.

Soil Form	Extent		Characteristics
	Ha	%	
Valsrivier	166.6	8.75	The Valsrivier soils are a duplex soil with a well-developed A-and B-horizon. The soil has a depth of between 50 to 70cm. The B-horizon is clay enriched containing characteristics of wetness. Therefore, the soil from is susceptible to erosion, therefore, topsoil stockpiling should take these erosion sensitivities into consideration. BS1/2 is mainly located on Valsrivier soils together with the last section of the powerline and small sections of the main access road and ARC. Land capability: grazing land capability.
Witbank	219.7	11.53	The Witbank soil form is associated with areas previously impacted by mining related activities, including roads, drill pads etc and has been disturbed with associated erosion eminent in most areas. The majority of BS4 and the valley boxcut contains Witbank soil forms. Land use: Due to the disturbed nature, this soil form is classified as wilderness.

4.4.5 Land Capability

Land capability is the inherent capacity of land to be productive under sustained use and specific management methods. The land capability of an area is the combination of the inherent soil properties and the climatic conditions and landscape properties such as slope and drainage patterns that may have resulted in the development of wetlands as an example. Even though land use is intrinsically linked to soil and land capability of an area, it is also largely a function of the economic climate and availability of resources additional to productive land. Land capability has strong influence on socio-economic aspects of human settlements. Baseline land capabilities are used as a benchmark for rehabilitation of land in the case of project decommissioning. The proper management of topsoil in many instances is overlooked and can add significantly to closure and rehabilitation cost. Land capability classes were determined in terms of the Section 7 of The Chamber of Mines Handbook of Guidelines for Environmental Protection (Volume 3, 1981), included in Table 4-6.

Figure 4-4 Soil Forms associated with the Section 24G Activities



A baseline land capability assessment is important to guide final closure and rehabilitation closure objectives and plans. The land capabilities of the Section 24G activities are included in Table 4-5 and Figure 4-5. The land capability associated with the Section 24G activities is mainly grazing land on the western side of the Groot Dwars River with pockets of wetland land capability and grazing land. On the eastern side of the Groot Dwars River, land capability has approximately equal grazing and wilderness capability with sensitive wetland sections in some of the footprints with the largest portion having a wilderness land capability (610.7 hectares). The soil and land capability report states:

- "The wilderness land capability consists of the very shallow soil forms such as Mispah and Glenrosa on steep slopes. These areas have little topsoil available for stripping and the soil regeneration potential is low. Land with this land capability is most suited for low density grazing or game farming.
- A slightly smaller section of land has grazing land capability (569.6 hectares). This land is suitable for game farming and/or cattle grazing although the area is traditionally a conservation area as a result of the high biodiversity and the uniqueness of the ecosystem present. The eastern portion of the site (BS4) is dominated by land with arable land capability (350.6 hectares) that is suitable for both dryland and irrigated crop production. The hydromorphic soils, areas in the valley bottoms as well as the small section of Katspruit/Kroonstad have wetland land capability (125.6 hectares). Land with wetland capability serves as a water purification and storage system in the landscape and should be conserved."

Table 4-6 Booysendal South Expansion Project Land Capability

Criteria for Wetland	➢ Land with organic soils or ➢ A horizon that is gleyed throughout more than 50% of its volume and is significantly thick, occurring within 750mm of the surface.
Criteria for Arable Land	➢ Land, which does not qualify as a wetland, ➢ The soil is readily permeable to the roots of common cultivated plants to a depth of 750mm, ➢ The soil has a pH value of between 4,0 and 8.4, ➢ The soil has a low salinity and SAR (Sodicity Ratio), ➢ The soil has a permeability of at least 1.5-mm per hour in the upper 500-mm of soil ➢ The soil has less than 10% (by volume) rocks or pedocrete fragments larger than 10-mm in diameter in the upper 750mm, ➢ Has a slope (in %) and erodbility factor (K) such that their product is <2.0, ➢ Occurs under a climatic regime, which facilitates crop yields that are at least equal to the current national average for these crops, or is currently being irrigated successfully.
Criteria for Grazing Land	➢ Land, which does not qualify as wetland or arable land, ➢ Has soil, or soil-like material, permeable to roots of native plants, that is more than 250mm thick and contains less than 50% by volume of rocks or pedocrete fragments larger than 100mm, ➢ Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants, utilizable by domesticated livestock or game animals on a commercial basis.
Criteria for Wilderness Land	➢ Land, which does not qualify as wetland, arable land or grazing land.

4.4.6 Land Use

All the Section 24G activities fall within mining rights areas, therefore the main land uses are mining related, including exploration. Other land uses include:

- The southern section of the Farm Buttonshope which is being managed as a conservation trust area;
- Grazing taking place in the northern section of BS4;
- Kiwi orchards are located in the northern and north-eastern section of BS4 (the orchards are neglected and not currently being managed); and
- The collection of the narcotic CAT by local communities throughout the project area.

4.4.7 Ecosystem Services

For this assessment, Ecosystem Services (ES) provided by the soil in the larger landscape was considered. This included taking into consideration (quoted directly from the report):

- "The likely distance at which the proposed mine including infrastructure will impact the availability and functionality of ecosystem services;
- The likely distance that people are willing to travel to utilise natural resources on a regular basis if existing ES are disturbed or removed due to the mine; and
- Water catchment areas likely to be affected by the mine."

The ecosystem services provided by the soil in the study area is summarised in Table 4-7 below.

4.4.8 Soil Sensitivities

Soils located in the study area are very sensitive due to a combination contributing elements which includes the topography, the composition of soils, and the location of certain soil types.

<u>Soil Forms with High Sensitivity (125.6 hectares)</u>
The high sensitivity soils were recommended by the soil study to be treated as no-go areas, this therefore includes all soils which have wetland characteristics.

<u>Soil Forms with Medium-High Sensitivity (1180.3 hectares)</u>
Soils demarcated as having a medium-high sensitivity are based on the sediment delivery potential an erosion index of the soils. According to this data, large portions of the site where construction activities are taking place have a high sedimentation and erosion sensitivity. Other medium-high sensitive areas are associated with shallow soils on hard rock or hard pedocretes (e.g. Mispah soil form) and shallow soils on weathered rock, relatively soft geological sediments, clays or soft pedocretes (other soils ≤ 400 mm deep).

The sensitive soils in relation to construction activities are included and depicted in Figure 4-8. No-go areas which need to be avoided are clearly indicated.

4.4.9 Soil Investigation Gap Analysis

The following gaps and limitations were identified in the soil and land-use assessment report:

- The preferred potable water pipeline route was only provided after the field investigations were conducted, as such, the soil study did not cover this area;
- The changes made to the main access road realignment section on the BS4 side were not available at the time that the soil surveys were conducted;
- No soil management reports detailing soil management practices on site were available;
- A soil contamination assessment did not form part of the scope of work. This may be required for areas that are being rehabilitation, i.e the MCC2 PCD at BS4; and
- The soil assessment is based on the last site visit undertaken in November 2016. Changes resulting from continued construction have not been assessed.

Figure 4-5 Land Use Categories of the Project Area

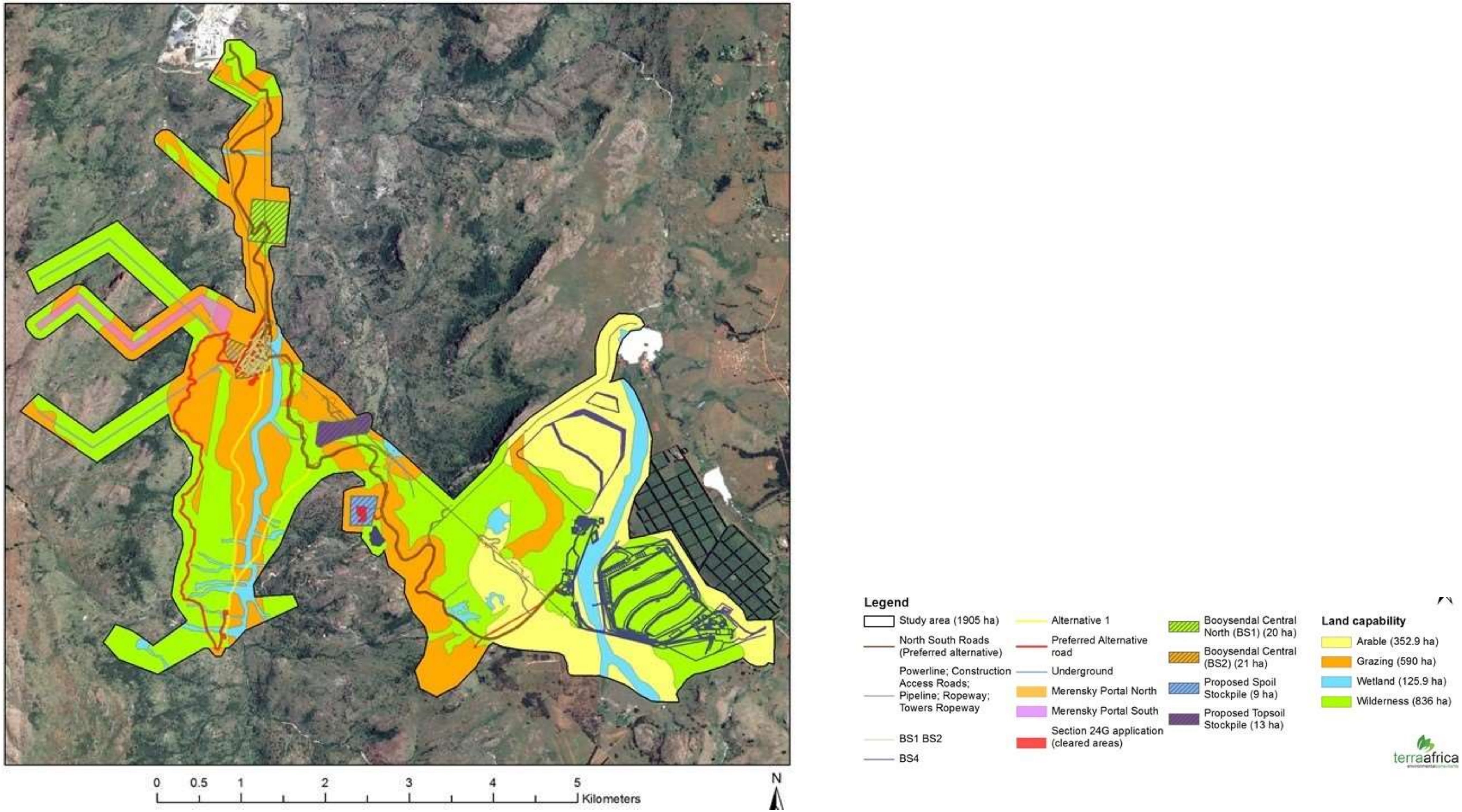
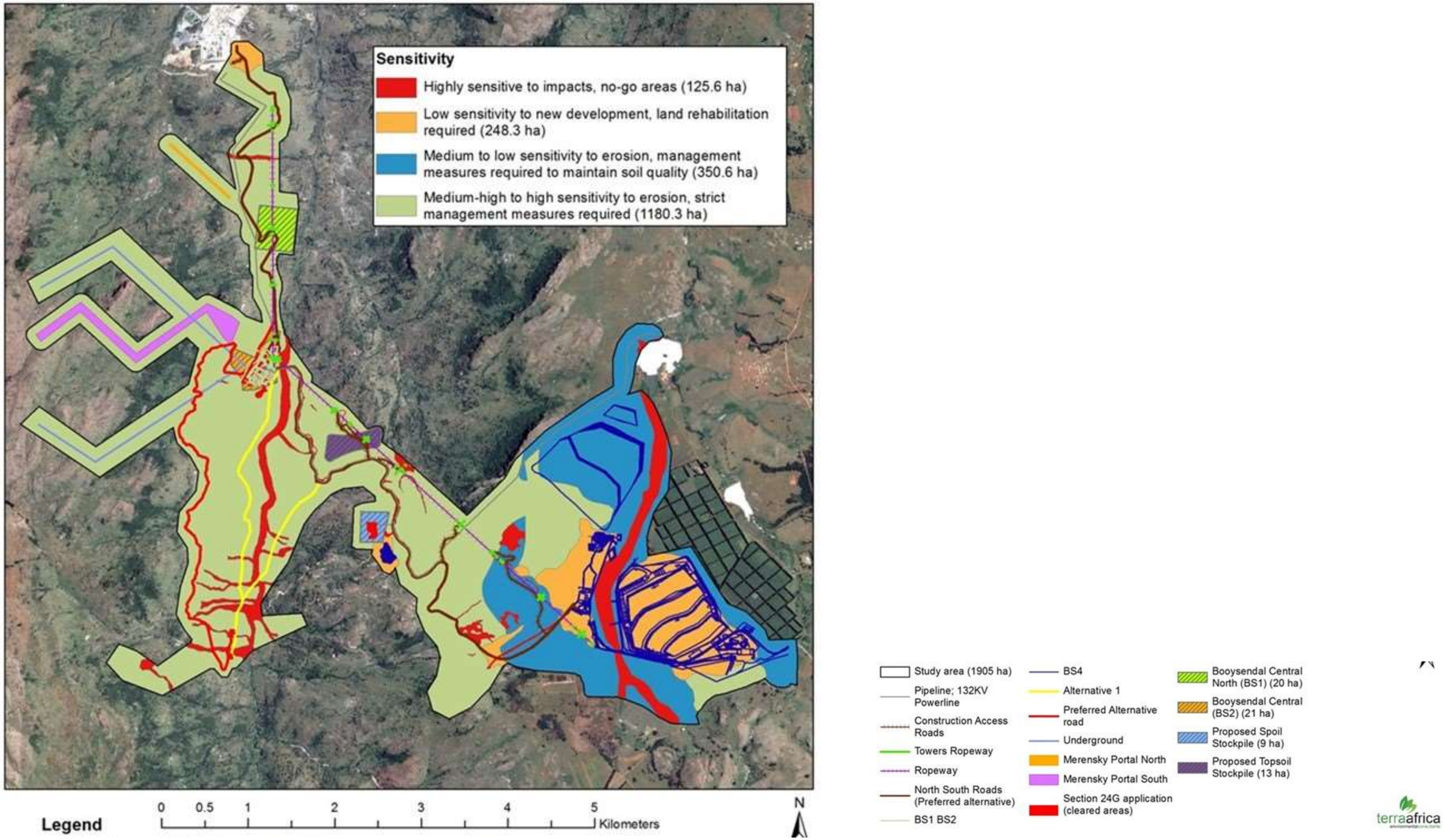


Table 4-7 Soil Ecosystem Services

Ecosystem Service	Service Category	Threats/ Availability	Relevant Environment of ES	Importance of ES	Replicability
Hydromorphic soils provide flood mitigating and water storage services	Regulating	Hydromorphic soils in the larger AoI is coming increasingly under threat.	Steep slopes and valley bottoms.	High – there is a definite correlation between habitat types and soil types. Flood attenuation and water storage in this environment is essential.	Low – At best of times it is difficult to restore the water storage function of soils. The lack of topsoil storage associated with the activities which commenced makes the destruction permanent.
Soil contribute to the nutrient cycle which supports the flora	Regulating	The project is located in the sensitive Sekhukhune Centre of Endemism. Soil in this area has a unique mineral and metal content to which the surrounding vegetation has adapted.	All areas where construction activities are taking place.	High – disturbance in the nutrient cycle will lead to a change in the natural habitats.	Low – removal of soil and natural vegetation led to loss of nutrients, this is further enhanced by the lack of topsoil storage.
Soil serves as habitat to macro-organisms and smaller fauna species. Macro-organism further assist in decomposition and maintaining the nutrient cycle	Provisioning	Macro-organisms and smaller fauna will be impacted in all areas where construction activities are taking place.	All areas where construction activities are taking place.	High – vulnerable fauna species associated with the project area. Loss of soil-organisms influence nutrient cycles.	Low – the nature of the development will lead to permanent mortality in disturbance footprints. Rehabilitation of unused access roads could to some extent serve as off-set.

Figure 4-6 Soil Sensitivity Classification



4.5 GEOLOGY

The Booysendal South Expansion Project falls within the eastern limb of the Bushveld Igneous Complex, consisting of an igneous layer measuring approximately 7km to 9km. The complex is understood to date back 2,052 Ma and comprises four successive igneous events. The Merensky, UG and PGM reefs are contained in the upper critical zone of this complex. These reefs are hosted within the Booysendal South Expansion Project from the northern Booysendal section to the southern sections of the project dipping to the west at an angle of between 8° and 12°. The Merensky reef overlays the UG2 reef by approximately 40m (Geotechnical Mine Design Final, 28-04-2016). The reefs become thinner in the southerly direction.

The UG2 is contained in chromitite seams which are between 5m and 8m thick. These seams consist of various layers underlain by norite and anorthosite layers and capped by a chromitite layer. It is within this 1.0 to 1.5m thick chromitite layer that the PGM mineralisation is hosted.

4.5.1 Geological Structures

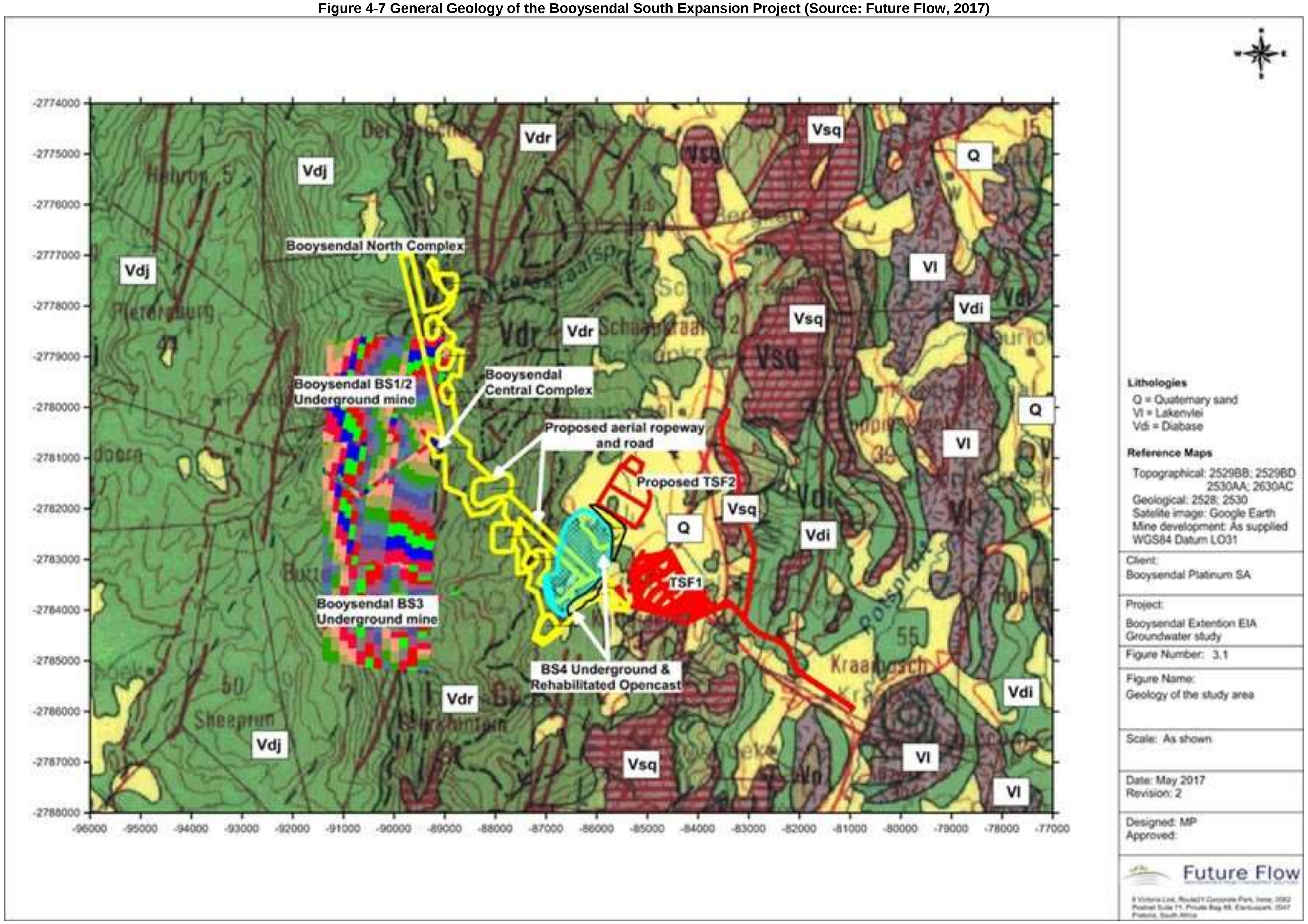
The Geotechnical Mine Design Final, 28-04-2016 ,undertaken by Middindi Consulting (Pty) Ltd, indicates that there are approximately 165 structures (faults and dykes) associated with the wider Booysendal Project area. The dykes and faults trend mainly in a north-easterly, north-westerly and east-to-west direction. The major fault in the region is the northeast trending Steelpoort fault. The geotechnical study furthermore indicates that there is no seismic activity associated with the fault zones.

The geological structures present at Booysendal include potholes, dykes, faults and joints, with three major faults in the target mining area. The report indicates that these features are generally not associated with groundwater in this area, however, the Hydrogeological Report compiled by Future Flow, 2017, indicates that there are a number of geological structures that may act as preferential flow paths. Packer testing in the valley further confirmed high hydraulic conductivity of the structures.

The first major fault is the St. George's fault, which has a down-throw of an unknown quantity towards the east and the second, is a graben structure with a down-throw of 100m. Towards the south of the proposed BS3 area, the geological structure is extremely complex with the development of several synforms and antiforms.

In addition to this, the ground geophysical survey performed during the 2011 Future Flow Fairway study in the Groot Dwars River valley indicates the presence of a number of geological structures that could act as preferential groundwater flow paths. Packer testing performed on exploration boreholes in the valley also confirmed the presence of zones of high hydraulic conductivity associated with these structures.

Figure 4-7 General Geology of the Booysendal South Expansion Project (Source: Future Flow, 2017)



4.5.2 Project Specific Geology

The specific geology of the project area has to be taken into consideration as part of the development process. The two main areas of development are the BS1/2, associated Merensky Portals and the BS4 development. The geology for the Booysendal South Expansion Project is depicted in **Figure 4-7**.

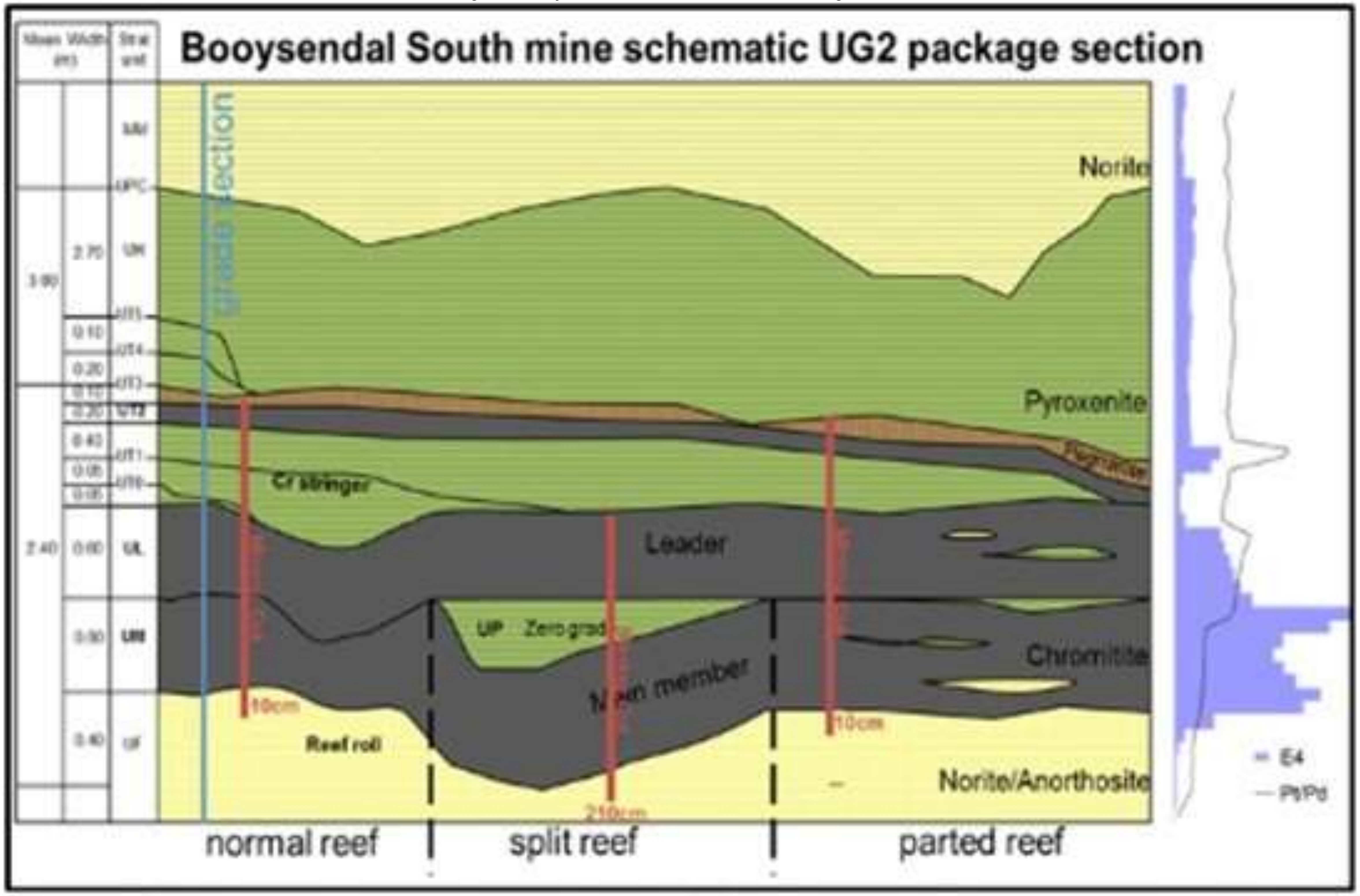
<u>BS1/2 and Merensky Portals</u>
With reference to **Figure 4-7** there are two major faults associated with this area, the first major fault, namely the St. George's fault, has a down-throw of an unknown quantity towards the east and the second is a graben structure with a down-throw of 100m. Towards the south of the proposed BS3 area, the geological structure is extremely complex with development of several synforms and antiforms.

In addition to this, the ground geophysical survey performed during the 2011 Future Flow Fairway study in the Groot Dwars River valley shows the presence of a number of geological structures that could act as preferential groundwater flow paths. Packer testing performed on exploration boreholes in the valley also confirmed the presence of zones of high hydraulic conductivity associated with these structures.

<u>BS4</u>
According to the Future Flow report, the structural geology of the historical BS4 underground area was partly defined through the ERM Booysendal geophysical investigation, and the GCS EMP study of 2009. Results from these two studies show the presence of several significant regional structures that could act as groundwater flow paths. Several dolerite, diabase, and syenite intrusions form the dykes that intersect the area.

GCS (2009) states that the faults are represented by two prominent strike directions e.g. north-northwest and north-northeast. From experience and previous investigations in this area is it known that the north-northeast faults are normally associated with open fractures and brittle deformation, indicating that they are of a much younger age.

Figure 4-8 Booysendal South Mine Schematic UG2 Package Section



4.6 HYDROGEOLOGY

The baseline hydrological assessment and the Section 24G Hydrogeological Impact Assessment was compiled and drafted by Future Flow Groundwater and Project Management Solutions. The Hydrogeological Report and Management Plan is included in Annexure E.

4.6.1 Methodology

The hydrogeological study was carried out in phases as follows:

Groundwater Baseline Characterisation
A groundwater baseline characterisation was carried out. This included:

- Desktop reviews of existing groundwater and geological studies and data previously compiled for the Booysendal and previously named Everest operations respectively;
- Undertaking a hydro-census of privately owned surrounding boreholes and selected monitoring boreholes to determine regional groundwater levels, flow directions and gradients, with the aim to assess if groundwater users would be impacted by the mining activities;
- Groundwater chemical analysis - Water samples were taken at selected privately owned boreholes to determine background groundwater conditions to serve as reference once mining commences. The analysis was done by WATERLAB (Pty) Ltd, SANS accredited laboratory; and
- Geochemical analysis - Rock samples were taken from the roof, ore seam, and floor material, and existing TSF at BN for geochemical characterisation to inform potential leachate from TSF1 at BS4, the stockpiles and backfill material. As samples were from the same seam and ore body it is representative. Another geochemical analysis on the tailings at TSF 1 at BS4 was conducted to determine Acid Base Accounting (ABA) and Acid Mine Drainage (AMD) potential. The results are important input into the numerical modelling and contamination transports model.

Numerical modelling
A three-dimensional numerical groundwater flow and contaminant transport model was constructed. The model was constructed using MODFLOW, which is internationally developed and recognised. MODFLOW is widely used to simulate the impacts of mining activities on the groundwater environment, including groundwater inflow volumes into the underground mine, groundwater level drawdown in the aquifers due to mine dewatering and the associated changes in groundwater flow patterns. The MT3DMS add-on package was used to simulate the contaminant migration through the study area. Parameters that were quantified include:

- Mine inflow volumes into the various mining areas over the LoM;
- Impacts on the surrounding groundwater levels, flow patterns, and groundwater users due to mine dewatering and seepage from the various surface infrastructure;
- Impact of backfilling of the underground area with tailings material on groundwater and pollution migration patterns;
- Impacts on the Groot Dwars River due to mine dewatering and the associated reduced baseflow contribution;

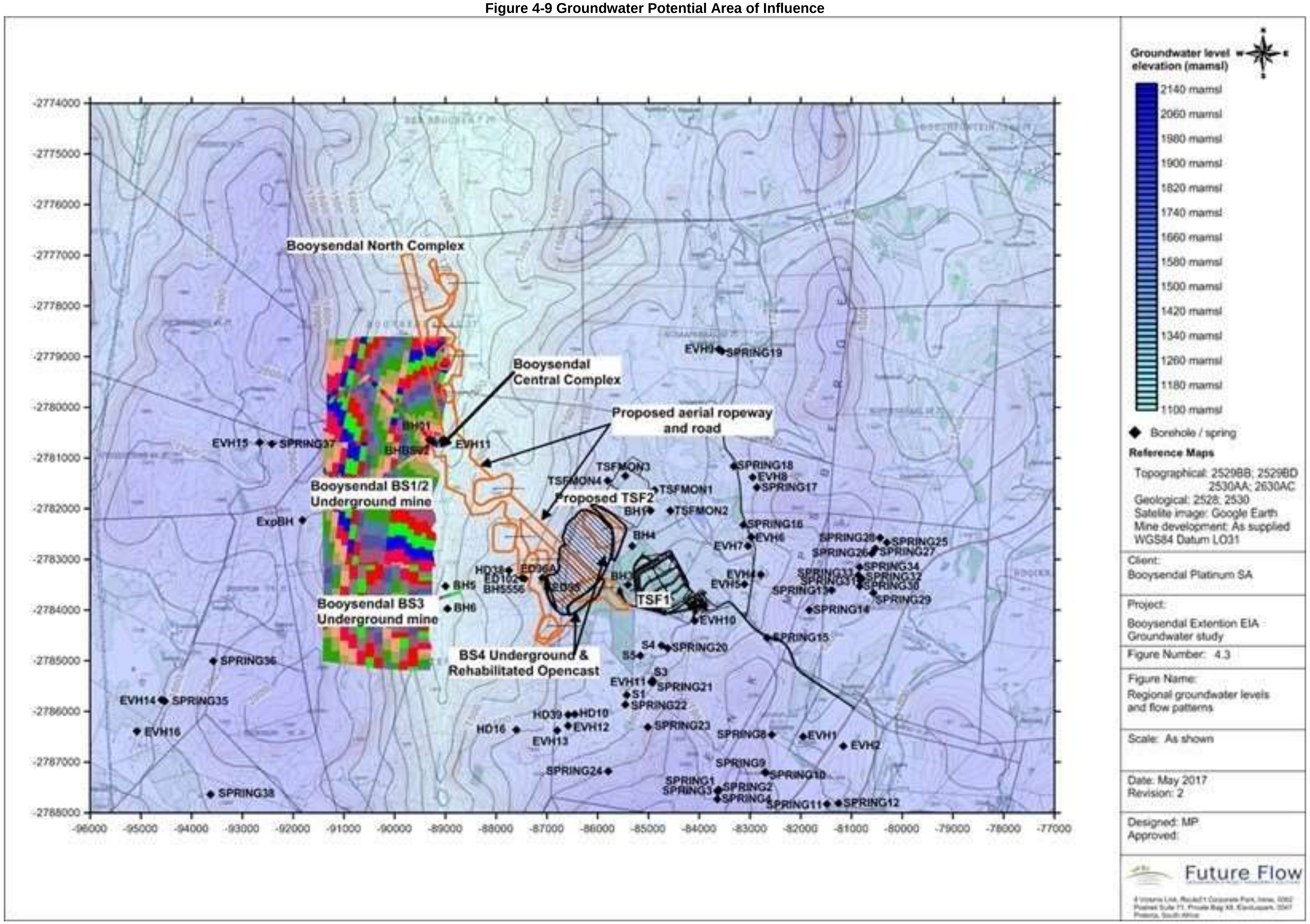
- Groundwater level recovery after mine closure;
- Contaminant migration away from the mining areas and surface infrastructure, and the associated impacts on the surrounding groundwater quality; and
- Impacts on the surface water bodies due to contaminant migration.

Reporting
A detailed report capturing the findings of the baseline study, impact model, impact assessment and a groundwater management plan (see Annexure E).

4.6.2 Hydrogeology Area of Influence (AoI) and Sensitive Receptors

The potential groundwater AoI includes springs and borehole users to the east, west and south of the Booysendal Mine operations. The groundwater users outside of the mining area up to a distance of 2km from the delineated mining area are, by definition, the sensitive receptors of the groundwater environment (refer to Figure 4-9 and Section 4.5.3).

Figure 4-9 Groundwater Potential Area of Influence



4.6.3 Baseline Hydrogeology

Aquifer Classification

There are two types of aquifers in the project area namely the Weathered Zone Aquifer and Fracture Rock Aquifer.

Weathered Zone Aquifer

The upper aquifer forms as a result of the vertical infiltration of recharging rainfall through the weathered material being retarded by the underlying lower permeability material. Groundwater collecting above the contact migrates down gradient along the contact to lower lying areas. In places where the contact is near surface the groundwater can daylight on surface as one of the many springs that occur in the area, or seep as baseflow into the surface water bodies. This aquifer, therefore plays an important role in water provision to communities within 2km from the site; it furthermore contributes to recharge of surface water resources. The shallower weathered zones are associated with the steep valley sides. As a result of the steep valley, the sides recharge of the aquifer is low. The depth to groundwater/ water table ranges between surface and 12m below ground level (mbgl), while the groundwater is contained at levels up to depths of 35m. The current Section 24G activities and developments which could impact on the lower aquifer include:

- The upper portions of the BS1/2 complex where weathering is expected at 5 to 20m below surface (mbs). Borehole data indicates that groundwater levels occurring within this weathered zone is encountered at levels < 5mbgl;
- The extrapolation of available borehole data at BS4 indicates that the weathered zone associated with TSF1 should be at levels of 11 to 15m. Borehole data indicates that groundwater in this aquifer is encountered at depths between 1.4 to 14mbgl. It is a concern that the groundwater levels are rising which is indicative of seepage from TSF1 and RWD1; and
- The weathering of material at the BS4 underground works is expected to be between 25 to 35mbs.

Fractured Rock Aquifer

The Fractured Rock Aquifer is an underlying competent and fractured rock aquifer. Groundwater flows in the lower aquifer are associated with the secondary fracturing in the competent rock and, as such, will be along discrete pathways associated with the fractures (refer to Figure 4-6 for potential pathways). The depth of the water table/ groundwater level in the fractured aquifer ranges between 22 and 42 mbgl. Most groundwater flows in this aquifer are expected to be along the upper 40 to 50m. It is expected that groundwater will not be encountered below 80m. The fractured aquifers are mainly associated with flat and valley areas. The current Section 24G activities and developments which could impact the fractured rock aquifer include:

- The lower lying areas at BS1/2 including the ARC towers, silo, and main access road across the Groot Dwars River. Borehole data indicated that groundwater is encountered at levels between 5 and 10mbgl;
- The extrapolation of TSF2 information at BS4 indicated that dykes and lower levels of weathering can be expected with TSF1. Transmissivity in this aquifer ranges between 0.001 and 4.3; and
- Previous studies undertaken at BS4 indicate that the underground workings are associated with a prominent shear zone. The flows which continue along the shear zones could result in underground

subsidence and collapse of the underground workings. Water levels in the underground workings are rising and at times lead to natural decanting in the area of the valley boxcut.

Groundwater Flow
There is a strong correlation between groundwater flow and the topography as groundwater flow is directed from higher laying areas to valleys.

Hydraulic Conductivity and Classification
The hydraulic conductivity for the aquifers in the area ranges between 0.001 and 4.3 m/day. This main recharge is in the order of a three magnitude around BS4.

Groundwater recharge
Various groundwater studies of the project area have been undertaken. These studies indicate a recharge value percentage of up to 5 % of mean annual rainfall (MAR) using an average annual rainfall value of 709 mm (0.709 m). According to these values, aquifer recharge has been calculated at 28.754 Mm^3/a in the local sub-catchments. The estimated annual groundwater use per household has been calculated at 8, 760 m^3/a. In terms of these figures, it has been calculated that groundwater abstraction and use is less than 1% of the average annual recharge.

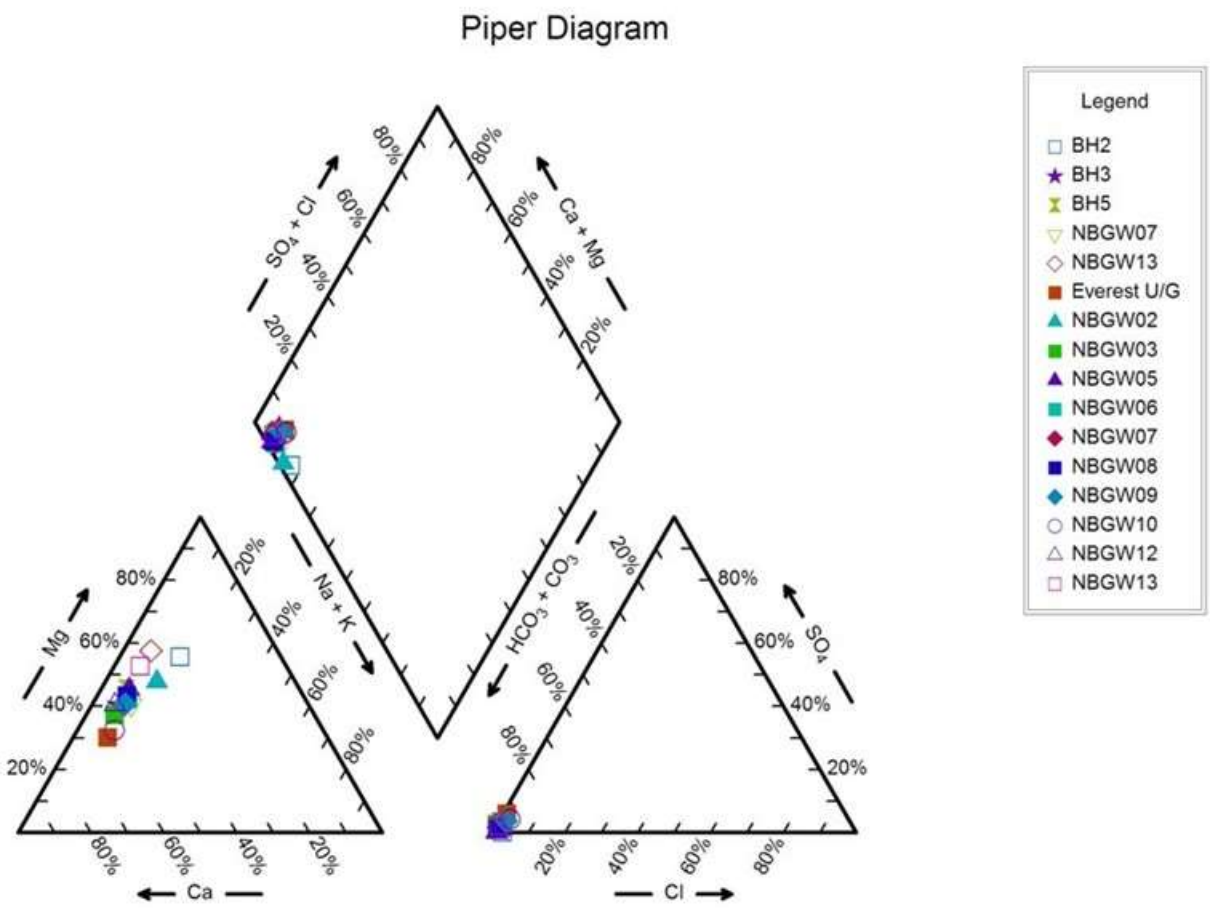
Hydro-census
There are several groundwater users within a 2km radius of the various development areas (BS1/2, BS4 and linear components) dependant on groundwater for potable use and cattle watering. Water users within a 2km radius (refer to Figure 4-7) include:

- EVH11 – this borehole belongs to Ria Groenewald and collapsed prior to the 2011 Fairway EIA study already. The borehole is currently not in use;
- EVH15 – the borehole belongs to the government and is leased to a community group for use. In 2011 it was reported that this borehole is used during the dry season (June to August);
- Spring 37 – this spring belongs to the government and is leased to a community group for use. The spring flows perennially and is a main source of water to the farm;
- Borehole EVH6 – this borehole belongs to the Kiwi Farm community. The borehole is not currently in use;
- Borehole EVH7 – this borehole belongs to BS and is used to supply the Cotlands nursery school;
- Spring 16 – the spring is used by the Kiwi Farm community;
- Spring 18 – the spring is used by the Khotsong community for domestic use (washing of clothes and drinking water);
- Spring 20 – the spring belongs to Ria Groenewald and is used for domestic use;
- Spring 21 – the spring belongs to Ria Groenewald and is used for domestic use;
- Spring 22 – this spring belongs to Danie Nel and was not used during 2011;

Water Quality

An overall assessment of the water quality using Piper diagrams indicates that the groundwater samples represent recently recharged water where little to no ion exchange associated with contamination from external sources has taken place. The water quality is homogenous and very good. Most of the chemical parameters fall within the SANS:241 of 2011 drinking water standards. Nitrate levels of the water associated with the underground workings at BS4 at times exceed the SANS:241 limits. This can be attributed to the blasting agents used as part of the previous mining activities. Iron levels in one borehole exceeded SANS:241 limits. As there is no obvious link to contaminants, it is derived that the borehole casing might be the reason for this elevated levels. A more detailed discussion of water quality is included in Section 4.12. The background groundwater qualities are typical of recently recharge water with little ion exchange and no contamination influence. Refer to Figure 4-10.

Figure 4-10 Booysendal Background Water Qualities



4.6.4 Hydrogeology Ecosystem Services

Table 4-8 presents a summary of the services to the ecosystem provided by groundwater recharge.

Table 4-8 Groundwater Ecosystem Services

Ecosystem Service	Service Category	Threats/ Availability	Relevant Environment of ES	Importance of ES	Replicability
Recharge of surface water resources	Regulating	Excavations on seep zones. Covering seep zones with unnatural surfaces e.g. main access road, ARC pillars, BS1/2 terrace.	Seep zones against steeper slopes.	High – river systems.	Low to Medium – where construction changes are short term or shallow rehabilitation could assist in restoring seep zones, however, where excavations are deep or longer term, it will not be possible to restore seep zones leading to permanent loss of run-off and recharge.
Drinking and livestock water and used for agricultural purposes by surrounding communities	Provisioning	Dewatering of the aquifers due to mine dewatering, or contamination due to contaminant migration away from pollution sources (underground mining areas, TSF, PCD, stockpiles, workshops, etc.) pose a risk to the sustainability of utilising the groundwater resource.	Areas within a 2km radius from the mining right boundary.	High – groundwater and surface water are the only sources of clean water for domestic and agricultural supply in the AoI.	Low – the impact assessment indicates that it will take approximately 115 years after mine closure for groundwater to recover to current levels. Once contamination has entered the aquifers, it will be almost impossible to remediate the impacts through mechanical, chemical, or engineering processes. Natural attenuation will take many, possibly hundreds, of years.
Shallow seep zones support unique flora species	Supporting	Excavations on seep zones. Covering seep zones with unnatural surfaces i.e. main access road, ARC pillars, BS1/2 and the terrace.	Seep zones against steeper slopes.	High – unique flora species are associated with the seep zones.	Low to Medium – where construction changes are short term or shallow rehabilitation could assist in restoring seep zones, however, where excavations are deep or longer term, it will not be possible to restore seep zones leading to permanent run-off and flora loss.

4.6.5 Hydrogeology Sensitivities

Refer to Section 4.6.2.

4.6.6 Gap Analysis

The following gaps and limitations have been identified in the hydrogeological assessment:

- Packer tests conducted in the past were limited as the tests did not exceed depths of 100m. Mining operations at BS1/2 will exceed depths of 200m to 900m therefore, limited information and data is available on deeper aquifers where mining operations will take place;
- It is expected that most of the rock fractures will be closed at depths of mining due to the weight of the overlaying rocks however, this does not assess nor rule out the possibility that individual high yielding fractures may be intersected;
- There is no groundwater information available on the Merensky Reef. The provision of additional information may result in the groundwater model changes; and
- There is no information available on whether additional settling material (i.e. cement) will be co-disposed in the underground mine. This could impact the volume of water freely decanting from the material, and also impact the leach quality. For purposes of the assessment it was assumed that no additional material will be deposited.

The numerical model is included under the impact assessment discussion in Section 8.

4.7 GEOCHEMICAL AND WASTE CHARACTERISATION

Two waste characterisation studies were carried out as part of the Booysendal South Expansion Project. The original hydrogeological assessment, undertaken by Future Flow (2017), included an assessment of rock samples from Booysendal North (BN) and samples from the current tailings from the TSF at the BN location. The Future Flow study also includes the results of previous studies performed on samples from four exploration boreholes from BN and the BS4 site. The objective of this testwork was to gain an understanding of the net leachate potential of stockpiles, waste rock and tailings which will originate from future ore to be mined at BS1/2 and the Merensky Reefs and considered to be comprised of similar material.

A second set of geochemical testwork was undertaken by Jones and Wagner (2016) on the tailings of TSF1 at the location of BS4 to gain an understanding of potential leachate impacts associated with the reworking of the tailings and backfilling of the tailings into the underground workings at BS4.

4.7.1 Methodology

The geochemical study by Future Flow (2017) and the separate study undertaken by Jones and Wagener (2016) include the following analyses and testwork:

- Sulphur content, as Total Sulphur % and also Sulphur Speciation %, to determine the extent of Acid Generating Potential from sulphides present;
- Neutralisation tests to determine Neutralisation Potential (NP);

- Acid Base Accounting (ABA) assessment combining the above results to determine Net Neutralisation Potential (NNP) and Neutralisation Potential Ratio (NPR);
- Paste pH to examine the acidity or alkalinity of the samples;
- XRD analyse to determine the mineralogical composition of the materials and assist in interpretation;
- Elemental analysis by aqua regia digestion of samples and analysis for metals and anions listed by the DEA (“National Norms and Standards for the Assessment of Waste for Landfill Disposal” (GNR 635) to determine Total Concentrations (mg/kg); and
- Distilled water leach testing of samples followed by the analysis of the resulting leach solution for all metals and anions listed by the DEA (as above) to determine Leachate Concentrations (mg/l).

ABA results are compared with international standards to define net acid generation potential.

Elemental analysis and leach testing results are compared with DEA waste classification guidelines based on the various Total Concentration Thresholds (TCT) for key elements in mg/kg and Leachable Concentration Thresholds (LCT) for key elements in mg/l to determine Waste Type and Class of disposal requirements.

4.7.2 Waste Characterisation Results

Future Flow - Rock samples from Booysendal North (BN)

Results are reported from the following sets of samples from BN:

- Ore and overlaying material samples from four exploration boreholes drilled around the Northern Pit from the Hoogland ore body (BH1-4) from previous testwork (GCS 2011); and
- Six rock samples taken from roof (2), ore (2), inert waste and floor from the current BN operations and two tailings samples from the BN-TSF.

Sulphur analyses are reported for the four samples, BH1-4, with all data at the detection limit of 0.01% total sulphur. Based on these low sulphur values alone, these samples are defined as Non-Acid Forming, although no Neutralisation Potential testwork data was available.

Leach testing performed on the samples BH1-4 showed exceedances in LCT0 values only for chromium, antimony and vanadium, with detection limits for arsenic, nickel, lead and selenium above the LCT0 values but below LCT1 values.

Elemental analysis using aqua regia digestion and leach testing based on a 20:1 liquid to solid ratio was performed on the six rock samples and two tailings samples, following the GN 635 guidelines to include metals, anions and key organics relevant to the operation. From the results of this testwork, the elemental concentration of cadmium, cobalt, copper, manganese, nickel, lead, antimony, vanadium and fluoride exceeds the TCT0 guidelines in most of the samples but all samples comply with TCT1 guidelines.

From the leachate testwork, total chromium exceeds the LCT0 guideline concentration of 0.1 mg/l for one of the two ore samples and both of the tailings samples by a factor of 3, with the other ore sample showing a chromium concentration of <0.025 mg/l. All leachates were below the LCT1 guideline concentration.

Based on these results, from the set of samples from BN, these materials are classified as Type 3 Waste following the GN 635 classification requiring disposal at a site complying with Class C landfill regulations.

These samples are considered to be representative of ore stockpiles, waste rock and tailings which will originate from future mining operations at BS1/2 and the Merensky Reefs and hence require disposal in accordance with Type 3 Waste as outlined above.

Future Flow - Rock samples from BS4 exploration boreholes

Data was also available from previous studies on rock samples from exploration boreholes at the BS4 site, comprised of hanging wall pyroxenite, UG2 chromite and footwall norite/anorthosite. Acid Rock Drainage characterisation testwork was performed on this set of samples. Based on the total sulphur content of less than 0.003 %, all of these samples can be classified as Non-Acid Forming. Furthermore, the Neutralisation Potential of the samples ranged from 17.8 to 46.5 kg CaCO3 per tonne, indicating the presence of significant alkaline-generating minerals.

Leachate testwork on these three samples provided leachate concentrations for 12 of the 16 DEA listed elements with chromium exceeding LCT0 guideline concentrations but below the corresponding LCT1 concentrations in all three samples. Vanadium also exceeded LCT0 concentrations in the UG2 chromite sample.

Although Total Concentration values from sample elemental analyses are not reported, the above leachate results would indicate that tailings material from BS4, and also that remaining in underground voids following mining at BS4, would correspond to a Type 3 waste.

Jones and Wagener (2016) - Tailings from TSF 1 at Location BS4

A total of 17 tailings samples were obtained from the four separate areas within the tailings facility TSF1 located at BS4. These samples were used to generate one composite sample for waste characterisation testwork. From the results obtained from sulphur speciation, being Acid Base Accounting (ABA) and Paste pH, the tailings composite sample TSF1 can be clearly assessed as being Non-Acid Forming:

- Sulphide sulphur by LECO method for Total Sulphur was found to be below detection limits (<0.01%(m/m)).
- ABA results demonstrated a Neutralization Potential (NP) of 5.96 kg $CaCO_3$ per tonne resulting in a Neutralisation Potential Ratio (NPR) of 19. This can be compared with a ratio of 4 used in International Standards as a threshold for Non-Acid Forming material.
- A paste pH of 8.7 confirming the low alkalinity indicated by the NP result.

Elemental analyses were compared with Alloway Earth's Crustal Abundance concentrations, with arsenic and cadmium both 44 times and chromium 480 times the concentration of Crustal Abundance. In the case of chromium, this is consistent with the XRD results showing a chromite mineral content of 15.5% (m/m). Elemental analyses were also compared with their respective Total Concentration Threshold (TCT). In terms of TCT's, the concentrations of arsenic, cobalt, chromium, nickel, vanadium and fluoride exceed their respective TCT0 values, such that on this basis the tailings are classified as a Type 3 (low hazardous) waste which must be disposed of on a Class C landfill.

The results obtained from leachate testwork, however, demonstrate that none of the constituents exceed the lowest Leach Concentration Threshold, LCT0, such that only the Total Concentration values have resulted in the tailings being assessed as a Type 3 waste.

The Department of Water and Sanitation has recently circulated a memorandum stating that use can be made of source–pathway–receptor modelling to motivate for an alternative (less stringent barrier system) than the Class C default system based on the waste assessment results (DWS,2016). In view of this approach that the DWS has adopted, and based on the favourable leach results and non-acid forming nature of these tailings, it should also be possible to discuss with the authorities the development of a TSF depository for this material without a formal barrier system, provided that the long-term impact on the receiving environment will remain insignificant.

Furthermore, in view of the consideration of underground disposal of this material as backfill at BS4, it should be noted that the leachate concentrations for chromium and vanadium from BS4 samples are at least an order of magnitude greater than leachate concentrations from this TSF1 composite, thereby providing support to this approach.

4.7.3 Gap Analysis

It is assumed that the ore and tailings samples taken at BN will be representative of the ore and resulting tailings which will be generated at BS1/2 given that it has the same ore body.

The potential impacts of the waste streams on specifically on surface- and groundwater is included in Section 8. The test results and detailed discussions around the waste characterisation are included in Annexure E and Annexure O.

4.8 HYDROLOGY

Various hydrological studies were carried out as part of the Booysendal South Expansion Project.

SNA conducted an initial hydrological assessment of the main access road to delineate catchment, and determined flood calculations and to size the culverts, which was updated in 2016. DRA 2017 updated the integrated water balance for all areas of the Booysendal Mine. SLR (June, 2016) conducted a hydrological assessment specifically for BS4 and Letsolo Water and Environmental Services conducted a comprehensive hydrological assessment which incorporated all the various hydrological assessments into one report and expanded on the hydrological assessment for areas which were not covered and addressed in the other specialist studies. The Letsolo study further included a water and salt balance and a stormwater management plan. The Letsolo study is included as Annexure F1 and the Hydrological assessment for BS4 is included in Annexure F2.

4.8.1 Methodology

The purpose of the hydrological assessment is to provide an analysis of the various catchments associated with the project development areas, and to inform the design requirements which must be taken into consideration to ensure the protection of the environment, and assess the various impacts through the LoM so as to provide effective management and mitigating measures for use of the surface water environment.

Desktop Review
During the desktop investigation, weather data was sourced from the weather stations at Beetgekraal (004516), Roossenekal (0553762), Maartenshoop (0593419) and Tonteldoos (0553859). Although there is a weather station at BN, the dataset was not in operation long enough to provide reliable long term data.

The average distance weighted mean annual precipitation (MAR) was calculated as 728mm, while the arrhythmic mean was calculated at 730mm. The latter was used for run-off computations.

Site Investigation
Two separate site visits were undertaken: the first visit was conducted from 7 to 8 December 2015. The purposes of the site visit was to gain an understanding of the proposed development of BS1/2, the main access road and the ARC at the time. A second site visit was conducted from 8 to 9 February 2016. The purpose of the visit was to:

- Identify the streams which were relevant to the proposed development and proposed affected areas;
- Collect water samples to obtain an indication of background water quality;
- Log the areas of interest which had to be included in the hydrological assessment; and
- Characterise the tributaries in terms of their flow characteristics.

Field investigations were also undertaken by SLR on 13 October 2016 to gain an understanding of the baseline hydrology of the study area around BS4 and again on 16 January 2017 in order to assess the impacts around the BS1/2 portal and road development and to provide a management review with recommendations for the improvement of stormwater management.

Analysis of Hydrological Data

<u>Water sampling</u>
Water sampling and the preservation of water samples was performed in accordance with the relevant SANS guidelines (SABS ISO 5667-2: 1991 and SABS ISO 5667-3: 1994). The water samples were analysed at the SANS accredited AquaStrata Laboratory. Water quality and water quality trends are discussed in detail in Section 4.11.

Catchment delineation
Catchments were delineated for all areas where development had commenced or intended to commence, using topographical contour and river data.

Flood calculations:
Flood calculations were determined for the various sub-catchments to ensure that clean-and dirty water and stormwater management infrastructure was sized correctly. The Rational Method was used by the various responsible specialists. The method requires as input, the size of the catchment, rainfall intensity, the runoff coefficient which is dependent on slope, vegetation cover and permeability. The slope is calculated using the difference in elevation height between 10% and 85% of the length of the watercourse, divided by the length of the watercourse.

For the main access road, a 1:10yr flood was calculated and used to size the various culverts. This is in line with the South African Road Agency (SANRAL) requirements for minor arterial roads. The calculations for the PCDs were based on run-off calculations for the catchments.

Floodline delineation
Floodline delineations for the Groot Dwars River, the southern stream located next to BS1/2 and the Everest stream were conducted by DRA and SNA Civil and Structural Engineers. The methodology used was assessed, however the floodlines were not remodelled. The HEC-RAS software package was used to delineate the floodlines. The model requires catchment analysis, flood peak analysis and flood peak assessment.

The applicable Groot Dwars River catchment delineated stretches approximately 13km downstream covering an area of 70km². The catchment characteristics were assessed to determine run-off. An analysis of the catchment characteristics which could influence run-off are required as part of the model input. This includes slope, vegetation cover, infiltration capacity and unnatural surfaces. River analysis is furthermore required to determine the floodlines, which includes flood peak, river characteristics such as streambed roughness values, overbank conditions and stream profile. The HEC-RAS methodology followed was deemed to be acceptable.

Water-and salt Balance Calculations:
The purpose of the water and salt balance was to calculate potential changes in salt loads taking consideration of predicted salt concentrations x annual flow m³. The water and salt balance is a basis from where the environmental managers can monitor changes in water quality.

4.8.2 Area of Influence

The Booysendal South Expansion Project falls within the Olifants River Water Management Area (WMA 4) which covers an area of approximately 54,570km². The Olifants River runs through the Kruger National Park, and into Mozambique joining the Limpopo River. The river system is therefore cross-boundary system of international importance.

The Booysendal South Expansion Project further falls within quaternary catchment B41G of the Olifants River WMA. The upper reaches up to the inlet of the Der Brochen Dam and associated catchments are considered the AoI for the hydrological assessment. This includes a stretch of 28km of the Groot Dwars River and 27 associated smaller catchments (refer to Figure 4-12 **Error! Reference source not found.**).

4.8.3 Baseline Hydrology Findings

The Booysendal South Expansion Project falls within quaternary catchment B41G. The Groot Dwars River in the location of BS1/2 and the river crossing and the Everest Tributary which runs between TSF1 and the mine-workshop area at BS4, are the major water resources in the study area. There are several perennial and non-perennial drainage lines which dissect the whole of the development footprint. The drainage lines at BS4 are mainly associated with infrastructure and are therefore susceptible to contamination. As a result, Booysendal has commenced with the upgrade of the stormwater management system at BS4.

Main Access Road Flood Calculations

The 1:10yr flood volumes for each of the culvert crossings were calculated to determine the required culvert sizing.

Floodline Delineation

A floodline delineation for BS1/2 and BS4 were done. The location of the 1:100 year floodlines in relation to the project components are included in Figure 4-12 for BS1/2 and Figure 4-14 for BS4.

Figure 4-11 Hydrological Area of Influence and Catchment Delineations

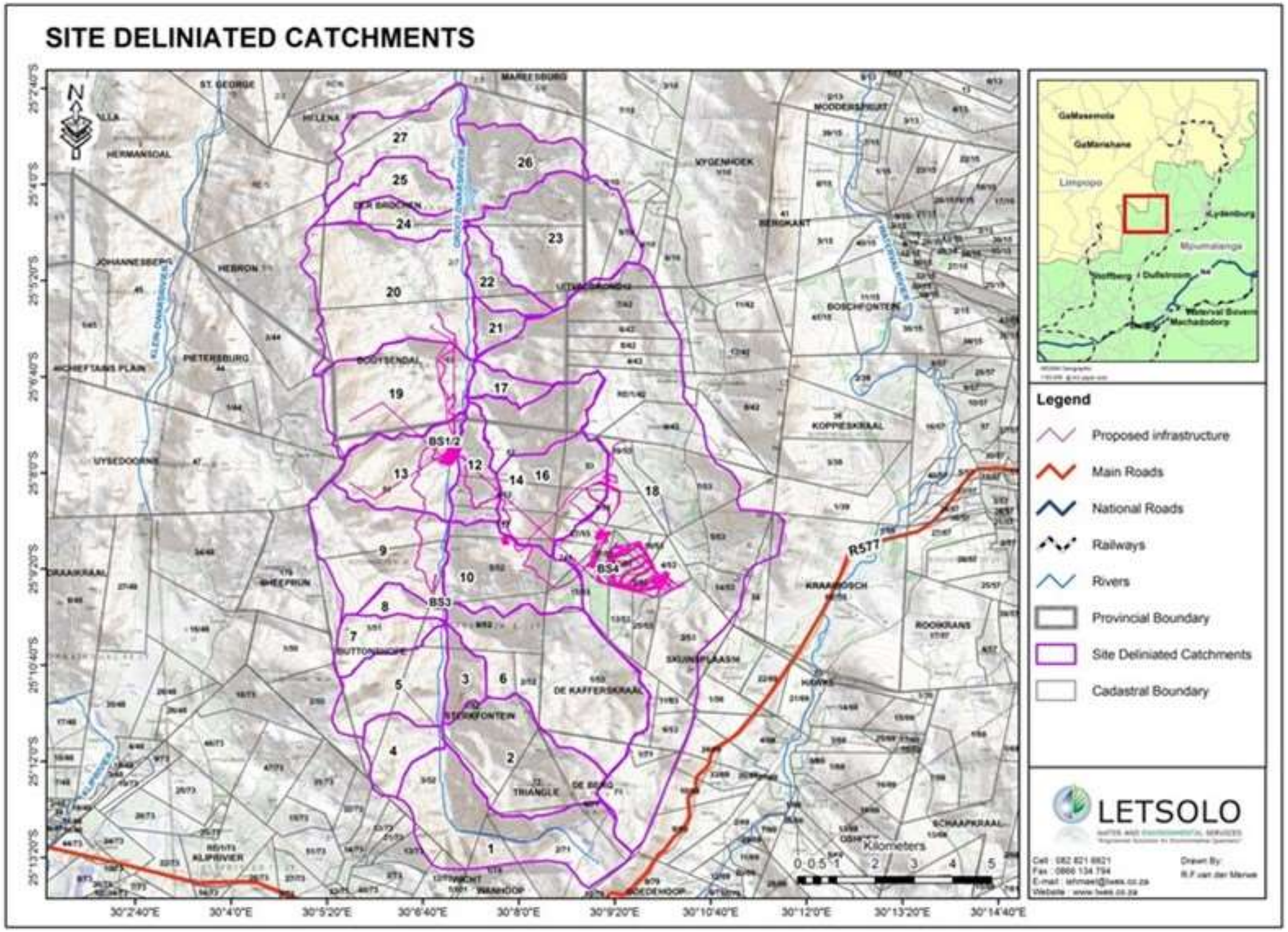


Figure 4-12 BS1/2 1:100yr Floodline Delineation

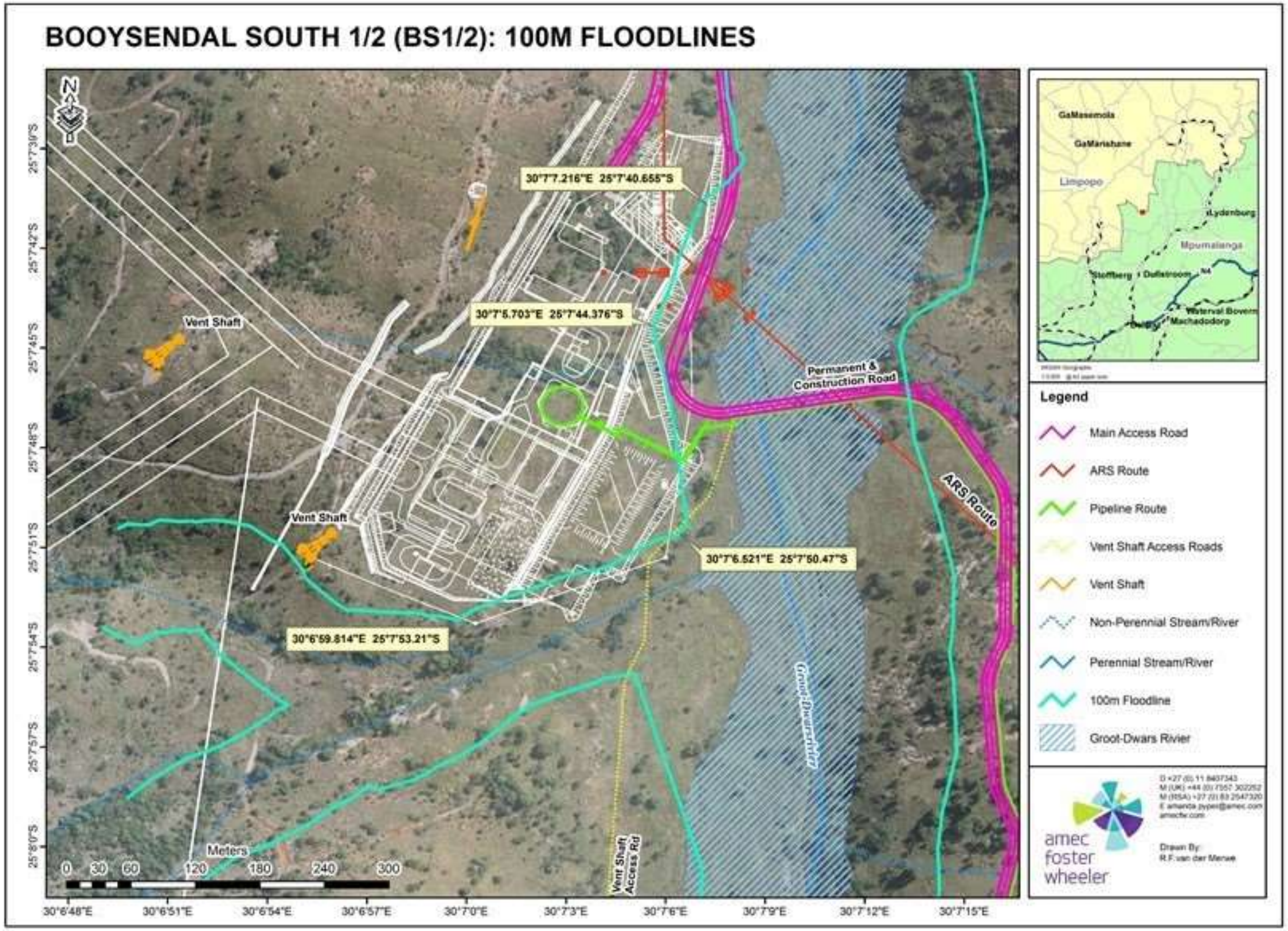
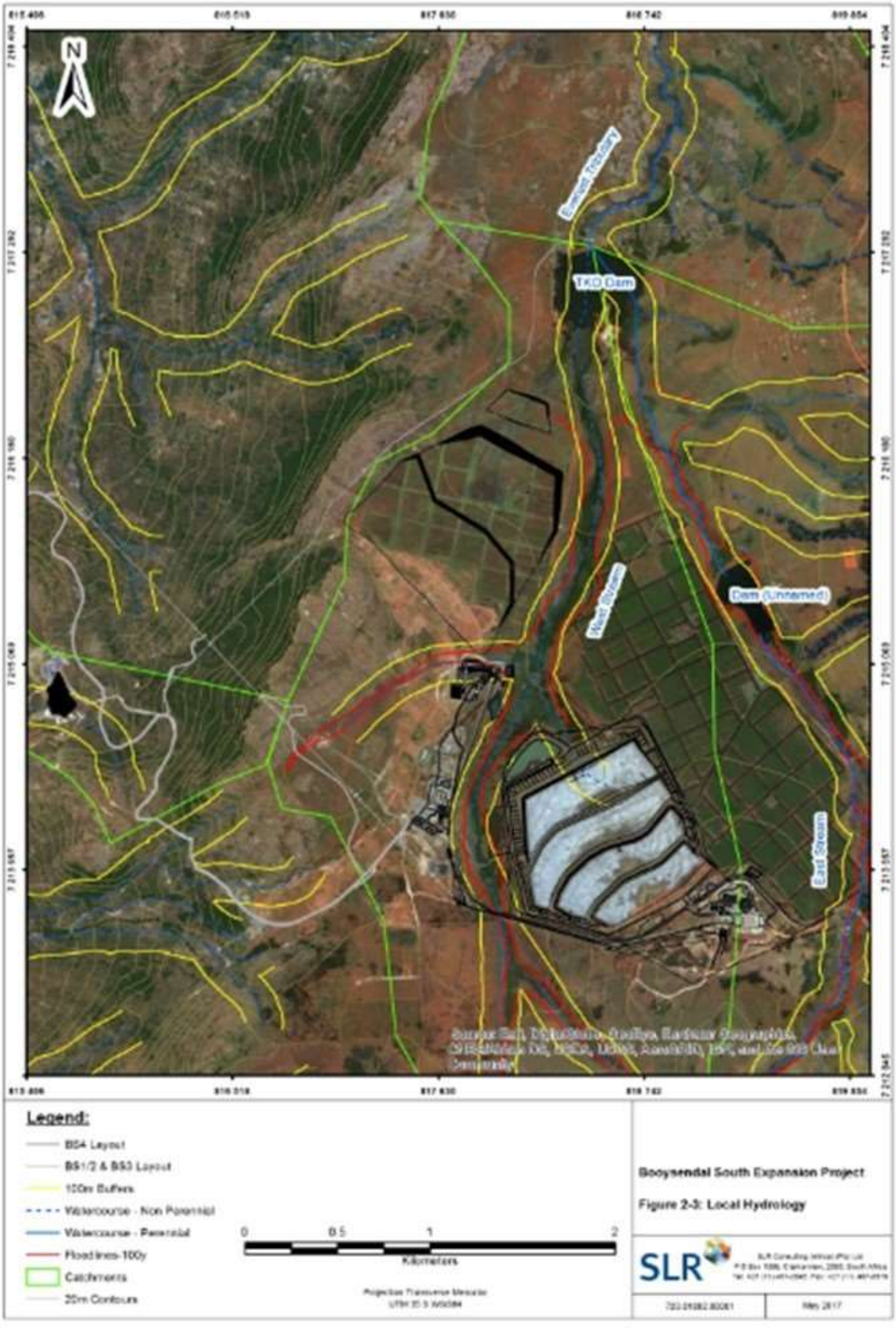


Figure 4-13 BS4 100yr Floodline and 100m Buffer (Source: SLR, June 2017)



<u>Water Balance</u>

The integrated water balance for the mine operation indicates that there will be a positive water balance even though the mean annual evaporation exceeds the MAR. This can be attributed to the dewatering which is required at the valley boxcut and underground water at BS1/2.

The total allocation that the Booysendal Mine will have from the Lebalelo pipeline, boreholes at BN and BS4 and the allocation from the TKO Dam by far exceed the project water requirements. Please refer to Section 7. Even if climate change should become apparent, the current allocation will far outweigh the requirements. The findings of the hydrological assessment are stated as follows:

- "The maximum make-up water supplied to BYC (BS1/2 and BS3) from the Box Cut DWD is 12,821m3/month.
- Excess dirty water from the valley boxcut DWD will need to be treated before discharge to the environment, typical rates vary between 43.8m³/hr and 152m³/hr (16,420 - 57,020 m³/month).
- The demand of raw water from TKO Dame is typically 2,482 – 2,748m³/month.

Comparing the discharge rates against the makeup water rates, it is concluded that the Booysendal Mine will be a net producer of water i.e. water positive."

Please refer to Annexure F for a full description of the water balance.

<u>Water-and Salt Balance</u>

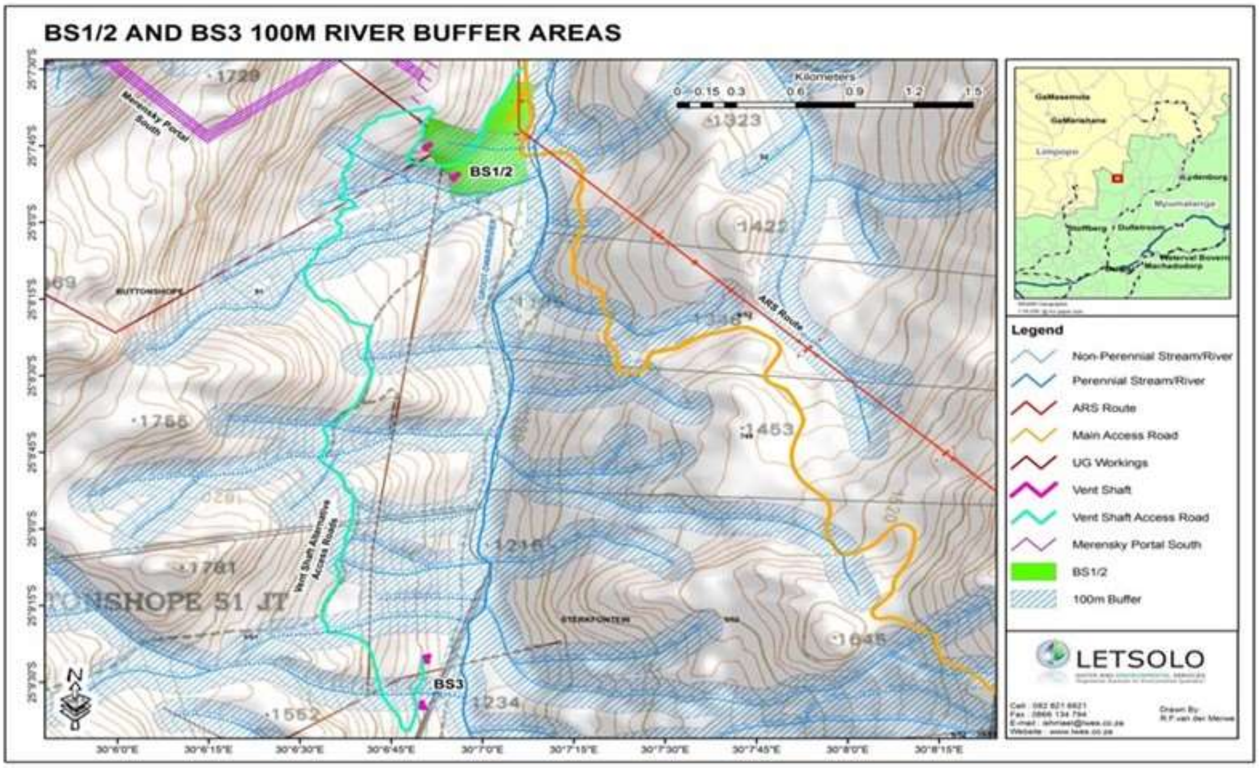
The water-and salt balance was conducted for selected variables, including Total Dissolved Solids (TDS), sulphate and nitrates. The salt load calculations of the study concluded that there is an increase in salt loads downstream in the Groot Dwars River where the stream coming from Everest ties into it. The study indicated that this can be attributed to discharge from the valley boxcut underground water.

4.8.4 Hydrology Sensitivities

The provisions of the NWA require that no development may take place within the 1:100yr floodline or 100m from the edge or drainage line and further prescribes that a a water use needs to be applied for within a 500m buffer between wetland areas and areas of where development is set to commence. These buffers are therefore deemed sensitive areas from a hydrological perspective. The BS1/2 buffers are depicted in Figure 4-12, the BS4 buffers are depicted Figure 4-13 and the 100m buffer for the smaller drainage lines is depicted in Figure 4-14. The wetland sensitivities are described in more detail in Section 4.11.

The upstream catchment of the Groot Dwars River is also considered as a sensitive environment due to the pristine nature of the surface water resource.

Figure 4-14 Smaller Drainage Line 100m Buffer Zones



4.8.5 Gap Analysis

The Hydrological assessment identified certain gaps and limitations in its assessment. The location and flood calculations for the drainage line crossings associated with the realigned section of the main access road at BS4 were not available and therefore limited the reports and findings in respect thereof.

Deterioration of water quality increases downstream in the Groot Dwares River indicating cumulative contaminat loads are attributed by the various mines along the river. The significance of the deterioration is a gap in this study as it is uncertain if the overall impact of mining on the Groot Dwars River was modelled. Some descreptancies exist between the Aquatico coordinates and locations for surface water quality monitoring points exists which needs to be resolved.

4.9 TERRESTRIAL ECOLOGY

Two terrestrial ecology assessments were conducted as part of the Booysendal South Expansion Project. The first study by Ecofin Consulting Ecologists provided a baseline for BS1/2, the main access road to BN, pipeline and powerline route, the ARC route from BN, and the limited surface infrastructure at BS3. The study is included in Annexure G2. The study was conducted against the original EA project description as Ecofin Consulting Ecologists were involved in the initial Booysendal EMP terrestrial ecology studies in 2009.

The second study was conducted by Natural Scientific Services CC (NSS) which covered specifically the expansion of BS4 and assessing the impacts of the Section 24G activities. NSS was previously involved in terrestrial ecology studies at BS4, including projects Fairway and Hoogeland. NSS used baseline findings included in the Ecofin report to assess the impacts caused by the Section 24G activities. This was aided by additional studies undertaken by NSS to fully understand the impacts and to cover all affected or proposed affected areas, but excluded areas for which the designs have changed after field investigations were undertaken. These gaps and limitations in information will be detailed in the gap analysis section. For this Section 24G EIA, reference will specifically be made to the NSS report as it dealt with the S24G activities. The report is included in Annexure G1. The terrestrial ecology assessment covered flora, mammals, birds, reptiles, frogs, butterflies, odonate, scorpions and baboon spiders.

4.9.1 Flora Study Methodology

The purpose of the flora survey was to determine the structure, dominant species composition and condition of local floral communities situated within the project area. The assessment was conducted using the following methods:

a) Desktop Assessment

The desktop assessment included an investigation into the regional vegetation and the conservation importance of the site. For this purpose, various national sources were consulted, including amongst others, the Mpumalanga Biodiversity Section Plan, 2013 (MBSP), species of Conservation Importance (CI) from records sourced from the Plants of Southern Africa website, the online South African National Botanical Institute's (SANBI) Threatened Species Programme list and species lists supplied from the Mpumalanga Parks and Tourism Agency for farms in the QDS 2530AA. Various specialist studies conducted over time for BS4 and Booysendal Mine operations were also consulted in support of the baseline assessment.

b) Field Surveys

NSS performed field fauna and flora surveys for BS4 during the periods 9 to13 January 2017 and 23 to26 January 2017 for the Section 24G activities outside of BS4 and during 22 to25 May (fauna) and 24 to28 May 2017 (flora) for additional infrastructure associated with BS3. In addition to this, NSS also drew on previous field survey data undertaken by them for the BS4 Hooogland Project which was carried out during 23to 25 April 2014, 25 to 27 August 2014 and 18 to 23 November 2014. The field survey information was further supplemented by the findings from the Ecofin study for which surveys were carried out from 8 to 11 February 2016 (Flora), and 4 to 8 March 2016 (fauna).

The following methodologies were used in carrying out the flora field surveys as noted in the NSS report:

- "Sampling of vegetation plots to determine the spatial extent, structure, condition and dominant species composition of different floral communities in the Booysendal study area. Sampling plot size was standardised at 100m^2. Whilst a plot was sampled, a list of plant taxa was compiled and each taxon was assigned a cover-abundance estimate using the Braun-Blanquet approach" which also provided as output of common or dominant species.
- "Walking random transects to detect localised and CI (i.e. Red Listed, endemic, Protected and medicinal) plant species. Transects were also conducted along the road route alternatives for BS3.
- Recording any observed alien and invasive plant species on site for incorporation into a management plan."

- Opportunistic counting, and GPS logging of *Vitex obovate wilmsii* which are associated with the endemic *Pycna Sylvia.*

The flora sampling plots are depicted in Figure 4-15.

c) Flora Data Analysis

For the analysis of flora survey data, the Juice software program was used to conduct a TWINSPAN detrended correspondence analysis and a Braun-Blanquet analysis to assess cover abundance. For detail please refer to Annexure G.

d) Reporting

The reporting process included the regional and local floral communities, floral species, species of Conservation Importance, impacts on floral species and communities, management and monitoring requirements, and residual impacts.

4.9.2 Fauna Study Methodology

The fauna assessment was carried out concurrently with the flora assessment by NSS and as a result adopted the same methodologies used in the flora assessment.

a) Desktop Assessment

Same as the flora assessment.

b) Field Surveys

- Identification of fauna based on visual observations of fauna, spoor, droppings, burrows and any other evidence. Birds were identified based on their calls, direct sightings and flight behaviour. Hepetofauna and scorpions were searched for by inspecting rock crevices and overturning or rocks and logs.
- Sweep-netting was carried out to catch butterflies, damselflies and dragonflies;
- Live trapping was done at four sites using array traps with pitfall traps at the centre, specifically aimed at reptiles, amphibians, and terrestrial macro-invertebrates. Fourteen metal mammal traps consisting of multi-entry and Sherman traps were also placed in the areas of the array traps aimed tat rodents;
- Grab samples;
- Camera-trapping through motion sensitive cameras installed at 13 locations at BS used to identify vertebrates and specifically nocturnal carnivores; and
- Mist netting and acoustic bat trapping: Mist nets were erected at two areas for two survey days. An ulta-sonic Echo Meter 3 detector was used to record caught bat’s echolocating calls. Calls were also recorded while driving at slow speed.

c) Fauna data Analysis

Bat calls were analysed through the conversion of the calls to wave and zero crossing files which then allowed for further examination of peak frequencies duration and band width to assist in the identification of bats.

d) Reporting

The NSS report contains the findings of the fauna and flora assessments in the project area, including a description of sensitive species, assessment of impacts which resulted from the Section 24G activities and recommendations pertaining to mitigation, management and monitoring.

For details on methodology, please refer to Annexure G1.

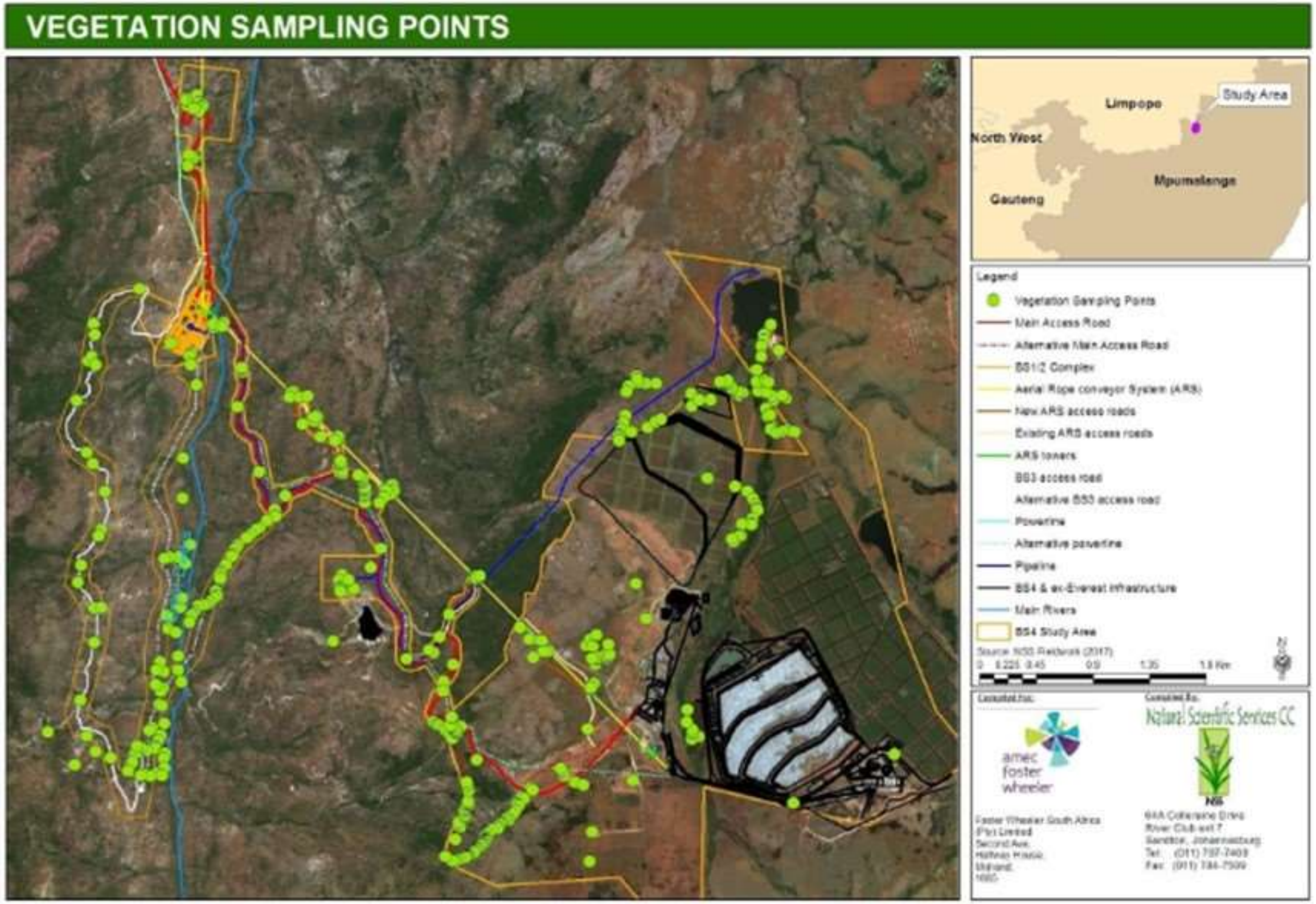
4.9.3 Area of Influence

The AoI applicable to the flora assessment covers both the Sekhukhune Montane Grassland and the Sekhukhune Mountain Bushveld Biomes in which it is located due to the sensitivity of the biomes.

4.9.4 Baseline General

The unique characteristics of vegetation in the study area is a direct result of specific environmental conditions. The variations in topography (refer to Section 4.2) have contributed to specific micro-climatic conditions with greater moisture and higher temperatures in the valleys generally giving rise to bushveld vegetation and drier and cooler conditions on the plateaus with grassland vegetation. This in turn results in the development of habitats to which specific fauna species have adapted. The grassland ecosystem is associated with high biodiversity, of which a very small portion is currently formally protected. The underlying geology and associated soil layers originating from it’s geology, specifically the ultramafic rock, has contributed to the plant endemism.

Figure 4-15 Flora Survey Sampling Plots (Source: NSS, June 2017)



4.9.5 Flora Baseline

a) Regional Flora

The project is located in the Sekhukhune Centre of Plant Endemism (SCPE). The Section 24G activity falls within the Sekhukhune Mountain Bushveld while BS4 falls in the Sekhukhune Montane Grassland Biomes of the SCPE. Due to BS4's closeness to the Mashishing Montane Grassland it has ecotone characteristics. The characteristics of the two vegetation types are given in Table 4-9.

Table 4-9 Regional Flora Types (Source: NSS, 2017)

Vegetation Type	Structure	Topography	Endemic Species	Status	Threats
Sekhukhune Montane Grassland	Dense grassland on rocky slopes and boulder fields, with scattered dense thickets on sheltered rocky outcrops	Steep hillsides and deep river valleys, with occasional level plains and plateaus (altitudinal range: 1,300 – 1,960m a.s.l.)	High proportion to the SCPE and four endemics to vegetation type.	Vulnerable and Endemic to Mpumalanga Conservation target of 24%.	Mining operations.
Sekhukhune Mountain Bushveld	Open to closed microphyllous and broad-leaved savanna, often with a well-developed herb layer.	Steep hillsides and mountain slopes, as well as gentle foot slopes.	High proportion to the SCPE and three endemics to vegetation type	Least Threatened	Increasing pressure from mining developments.

b) Regional Flora Diversity

The SANBI PRECIS list indicates that there are 450 plant species in the quadrant where the project is located. The dominant families include: *Asteraceae, Poaceae*, *Fabaceae* and various herb species. The vegetation is a result of the unique combination of topography, geology and resulting soil forms and climate.

c) Local Habitats and Flora Communities

The NSS study found that, with the exception of the Groot Dwars River system and BS4, the majority of the floral communities within the valley occurred largely in a natural to pristine state. Most floral communities that remain in a natural state extend beyond the current perimeter fence around BS4.

Four main habitats and 16 floral communities were identified in the study area. All the communities within the area already developed by project activities have been significantly impacted.

More than 100 Conservation Important (CI) floral taxa occur in the region, of which, NSS recorded more than 80 located within and/or near BS, including almost 30 locally endemic, two Vulnerable (VU), several Near Threatened (NT), numerous Declining and 60 Protected Species (PS). The information obtained from the 78 vegetation sampling points were comprehensive enough to allow for a floral community and habitat analysis. Table 4-11 contains a list of CI floral taxa found in the wider study area, whilst the species highlighted indicate the CIs found on site. A complete list of species which could be found in the study area is included on Annexure G(A).

Table 4-10 contains a summary of the habitat types and flora communities while

Figure 4-16 provides an indication of the distribution of the floral communities in relation to the development. For detail, refer to Appendix G(A).

Table 4-10 Habitat Types Associated with the Booysendal South Expansion Project (NSS, June 2017)

Flora Community	National Importance	Species Diversity	Condition [1]
Rocky Outcrop, Sheet Rock and Boulder Habitat Type			
***Aloe-Myrothamnus* Shrub Sheetrock Community** **>90% Rock Cover** **Six conservation important (CI) species or areas**	Mpumalanga -Critical Biodiversity Area Sekhukhune Mountainlands Threatened Ecosystem Mpumalanga Mesic Grasslands Focal Area North Eastern Escarpment Priority Area.	Diverse species composition. Large succulent component Irreplaceable.	No transformation was evident during the surveys. Weedy species are rare. The flora community is stable and has a strong association with Sheet Rock Seeps – resulting in a unique species assemblage.
Searsia- Diospyros - Rhoicssus **70 – 80% Rocky outcrops** **Five CI or CI-areas**	Within De Berg Conservancy (DPNR) Buffer Highest Biodiversity Importance (MBGs) Sekhukhune Mountainlands Threatened Ecosystem North Eastern Escarpment Priority Area.	Sensitive to change High floral diversity Irreplaceable.	Surrounding agricultural activities and grazing pressure. Limited alien and invasive species present. Relative intact community.
Brachiaria - Tristachya **70 – 80% Exposed Rock** **Transition between Sekhukhune Montane Grassland and- Mountain Bushveld** **Four CI or CI-areas**	Within De Berg Conservancy (DPNR) Buffer Highest Biodiversity Importance (MBGs) Sekhukhune Mountainlands Threatened Ecosystem North Eastern Escarpment Priority Area.	Proportionately high species diversity and irreplaceable community.	Transformation limited to road construction for the ARC Weedy species are scarce and community is considered stable. Surrounding grazing pressures on these systems. Limited Alien species present.
Woodland and Thicket Habitat Type **Located at the base of Cliff and Kloof valley**			
Mashishingia - Vitex - Kirkia **Rocky Thicket Community** **25-30% vegetation cover** **Six CI or CI-areas**	Within De Berg Conservancy (DPNR) Buffer Highest Biodiversity Importance (MBGs) Mpumalanga - Critical Biodiversity Area	Moderate to high species diversity. Sensitive to change Difficult to rehabilitate, therefore deemed irreplaceable.	General fragmentation associated with valley activities. Clearance for road network and tower/ pylon footprints was taking place

[1] Condition based on latest site survey information.

Flora Community	National Importance	Species Diversity	Condition [1]
	Sekhukhune Mountainlands Threatened Ecosystem Mpumalanga Mesic Grasslands Focal Area North Eastern Escarpment Priority Area.		Dumping of topsoil on adjacent vegetation Some weedy species Non-impacted areas stable.
Acacia - Euclea- Hippobromus **Scolopia Thicket Community** **30-40% land cover** **Four CI or CI-areas**	Within De Berg Conservancy (DPNR) Buffer Highest Biodiversity Importance (MBGs) Mpumalanga - Critical Biodiversity Area Sekhukhune Mountainlands Threatened Ecosystem Mpumalanga Mesic Grasslands Focal Area North Eastern Escarpment Priority Area.	Moderate species diversity Still sensitive to change Long term invested rehabilitation for damaged areas.	Limited transformation associated with clearance of access roads for the ARC. Some weedy species are present. Community considered stable.
Protea - Themeda **Slope Open Woodland** **40-50% under canopy** **Five CI or CI-areas**	Sekhukhune Mountainlands Threatened Ecosystem Mpumalanga Mesic Grasslands Focal Area Highest Biodiversity Importance (MBGs) Within De Berg Conservancy (DPNR) Buffer North Eastern Escarpment Priority Area.	Moderate to high species diversity Sensitive to change Long term invested rehabilitation for damaged areas.	Almost Intact, although road clearance and construction is planned. Erosion because of prospecting roads – rehabilitation is required Community still stable.
Cliff Face and Kloof Habitat	Could not be surveyed for safety reasons and poor accessibility. It is not expected that this habitat will be impacted		
	Rocky Grassland		
Loudetia - Themeda* and *Acacia caffra - Ozoroa - Tristachya **Slope Grassland Communities** **40-50% flora cover with rock** **Four CI or CI-areas**	Sekhukhune Mountainlands Threatened Ecosystem Mpumalanga Mesic Grasslands Focal Area Highest Biodiversity Importance (MBGs) Within De Berg Conservancy (DPNR) Buffer North Eastern Escarpment Priority Area	Moderate to high Sensitive to change. Difficult to rehabilitate due to soil, rock and slope. Requires long term invested rehabilitation on damaged areas.	Fragmented in the valley due to road construction and past exploration roads Erosion associated with the latter. Community still stable

Flora Community	National Importance	Species Diversity	Condition [1]
	Mpumalanga -Critical Biodiversity Area.		
Heteropogon - Eragrostis **Semi-natural grassland** **40-50% vegetation cover with exposed soil** **Eight CI species**	Sekhukhune Mountainlands Threatened Ecosystem Highest Biodiversity Importance (MBGs) Within De Berg Conservancy (DPNR) Buffer North Eastern Escarpment Priority Area.	Moderate to high diversity Diversity of disturbed areas are lower than that of undisturbed areas.	Where historic grazing and farming took place disturbance is evident. Alien vegetation infestation apparent at BS4.
Riparian and Wetland			
Tulbaghia – Eleocharis **Sheetrock Wetland** **Mainly seep over rock – 10-15% cover** **Three CI classifications**	FEPA River Catchment Endangered Wetland Vegetation Group - Mesic Highveld Grassland Group 7 (MHGG7) Nationally Protected (NWA) Sekhukhune Mountainlands Threatened Ecosystem Mpumalanga Mesic Grasslands Focal Area Highest Biodiversity Importance (MBGs) Within De Berg Conservancy (DPNR) Buffer North Eastern Escarpment Priority Area Mpumalanga - Critical Biodiversity Area.	Unique species assemblage due to the close association and links with the sheetrock community.	Structure intact little disturbance Little to no weeds.
Fuirena - Agrostis **Seep Zones** **60-70% vegetation cover** **Three CI classifications**	FEPA River Catchment Endangered Wetland Vegetation Group - Mesic Highveld Grassland Group 7 (MHGG7) Nationally Protected (NWA); Sekhukhune Mountainlands Threatened Ecosystem Mpumalanga Mesic Grasslands Focal Area Highest Biodiversity Importance (MBGs)	Moderate diversity	Seep community at BS4 undcer pressure because of grazing Valley seep community limited impact.

Flora Community	National Importance	Species Diversity	Condition [1]
	Within De Berg Conservancy (DPNR) Buffer North Eastern Escarpment Priority Area Mpumalanga -Critical Biodiversity Area.		
***Phragmites - Schoenoplectus* and *Fuirena - Leersia - Phragmites* Vlei systems** **80+% coverage** **Three CI classifications**	FEPA River Catchment Endangered Wetland Vegetation Group - Mesic Highveld Grassland Group 7 (MHGG7) Nationally Protected (NWA) Sekhukhune Mountainlands Threatened Ecosystem Mpumalanga Mesic Grasslands Focal Area Highest Biodiversity Importance (MBGs). Within De Berg Conservancy (DPNR) Buffer. North Eastern Escarpment Priority Area Mpumalanga - Critical Biodiversity Area.	Less diverse than the surrounding rocky grassland.	Disturbance due to the main access road and bridge construction. Agricultural disturbance and damming at BS4. Due to the impacts the status of the community has been altered to monospecific cultures.
***Faurea - Combretum - Halleria* Riparian vegetation** **Mainly rock with scattered undergrowth** **Three CI classifications**	FEPA River Catchment Endangered Wetland Vegetation Group - Mesic Highveld Grassland Group 7 (MHGG7) Nationally Protected (NWA); Sekhukhune Mountainlands Threatened Ecosystem Mpumalanga Mesic Grasslands Focal Area Highest Biodiversity Importance (MBGs) Within De Berg Conservancy (DPNR) Buffer North Eastern Escarpment Priority Area Mpumalanga -Critical Biodiversity Area.	Moderate to high species diversity.	Some road construction which lead to sedimentation of channels and displacement of boulders otherwise largely intact with limited alien species.

Flora Community	National Importance	Species Diversity	Condition [1]
***Acacia-Hyperthelia* Lower Floodplain Grassland** **Approximately 80% coverage** **One CI species**	FEPA River Catchment Endangered Wetland Vegetation Group - Mesic Highveld Grassland Group 7 (MHGG7) Nationally Protected (NWA) Sekhukhune Mountainlands Threatened Ecosystem Mpumalanga Mesic Grasslands Focal Area Highest Biodiversity Importance (MBGs) Within De Berg Conservancy (DPNR) Buffer North Eastern Escarpment Priority Area, Mpumalanga -Critical Biodiversity Area.	Moderate to low species diversity.	Historic activities in the valley and at BS4 contributed to some transformation of the community.
Transformed Areas			
Transformation of natural flora communities are associated with the Kiwi farms at BS4, current agricultural practices (grazing) at BS4, alien infestation at BS4 and along current disturbance footprints, and past agricultural practices along the Groot Dwars River. Some transformation of vlei areas at BS4 also occurred.			

The distribution of the various habitat types and flora communities are depicted in Figure 4-16.
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Figure 4-16 Distribution of Flora Communities

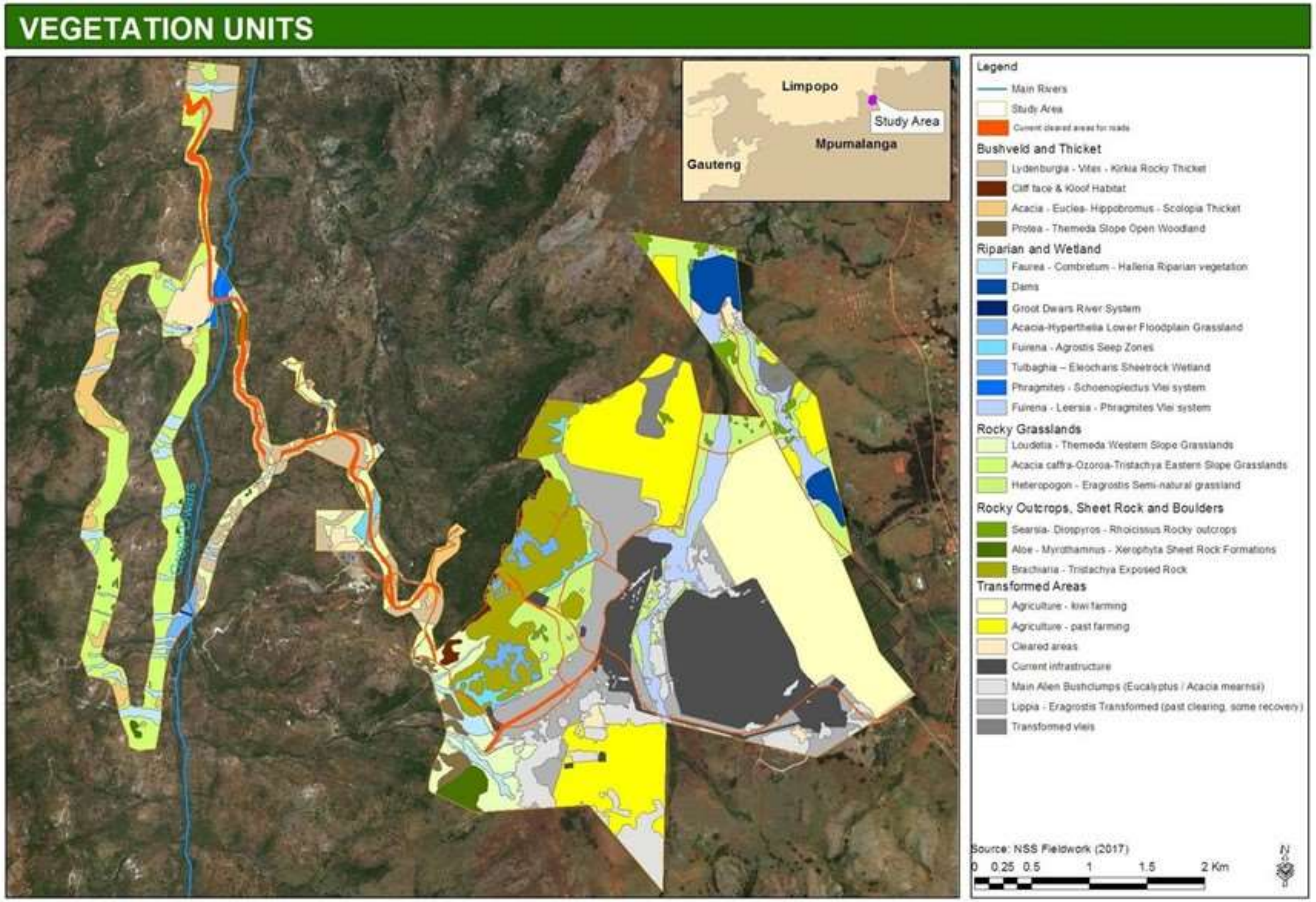


Table 4-11 Conservation Important Species (Source: NSS, June 2017)

Species	Family	Red Data	Endemic	Protected
Asclepias schlechteri (WM754)	Apocynaceae	EN		
Myrothamnus flabellifolius Welw.	Myrothamnaceae	DDT		
Ledebouria (Resnova) megaphylla	Hyacinthaceae	VU (Mp)	SCPE	
Zantedeschia pentlandii	Araceae	VU	SCPE (N)	MNCA
Eucomis vandermerwei	Hyacinthaceae	VU	LCPE /SCPE (N)	MNCA
Watsonia occulta	Iridaceae	Rare	LCPE	MNCA
Curtisia dentata	Cornaceae	NT		NFA
Habenaria barbertoni	Orchidaceae	NT		MNCA
Merwilla plumbea (Lindl.) Speta	Hyacinthaceae	NT		MNCA
Jamesbrittenia macrantha (Codd) Hilliard	Scrophulariaceae	NT		
Callilepis leptophylla	Asteraceae	Declining		
Aloe cooperi	Asphodelaceae	Declining		MNCA
Eucomis autumnalis subsp. clavata	Hyacinthaceae	Declining (MP)		MNCA
Eucomis montana	Hyacinthaceae	Declining		MNCA
Ilex mitis	Aquifoliaceae	Declining		
Aloe pretoriensis	Asphodelaceae		SCPE (N)	MNCA
Huernia zebrina subsp. insigniflora (Sekhukhuneland form)	Apocynaceae		SCPE (N)	MNCA
Cyphia transvaalensis	Lobeliaceae		SCPE (N)	
Gnidia caffra (Meisn.) Gilg (Form)	Thymelaeaceae		SCPE	
Kleinia longiflora DC. (Form)	Asteraceae		SCPE	
Aloe barbara-jeppeae	Asphodelaceae	NT	SCPE (N)	MNCA
Vitex obovata E.Mey. subsp. wilmsii (Gurke) C.L.Bredenkamp & D.J.Botha	Lamiaceae		SCPE (N)	
Berkheya insignis (Sekhukhune form)	Asteraceae		SCPE	
Brachycorythis ovata Lindl. subsp. ovata	Orchidaceae			MNCA
Cyphostemma sp.nov.aff.humile	Vitaceae		SCPE	
Gymnosporia species A	Celastraceae		SCPE	
Ipomoea bathycolpos subsp. sinuatodentata	Convolvulaceae		SCPE	
Melhania cf randii (form)	Malvaceae		SCPE	
Agapanthus inapertus	Agapanthaceae		Mp	MNCA
Streptocarpus dunnii Hook.f.	Gesneriaceae		Mp	
Hermannia brachymalla	Malvaceae		LCPE	
Searsia tumulicola var. meeuseana forma pumila	Anacardiaceae		LCPE	
Searsia wilmsii (Diels) Moffett	Anacardiaceae		LCPE	
Catha edulis	Celastraceae			NFA
Pittosporum viridiflorum	Pittosporaceae			NFA
Aloe arborescens	Asphodelaceae			MNCA

Species	Family	Red Data	Endemic	Protected
Aloe greatheadii var. davyana ("longibracteata" form)	Asphodelaceae			MNCA
Aloe modesta (possibly-unconfirmed)	Asphodelaceae	VU		MNCA
Aloe minima (possibly-unconfirmed)	Asphodelaceae			MNCA
Brachystelma coddii	Apocynaceae			MNCA
Brunsvigia radulosa Herb.	Amaranthaceae			MNCA
Corycium nigrescens	Orchidaceae			MNCA
Dioscorea cotinifolia	Dioscoreaceae			MNCA
Disa aconitoides	Orchidaceae			MNCA
Disa cf. saxicola	Orchidaceae			MNCA
Disa patula var. transvaalensis	Orchidaceae			MNCA
Erica drakensbergensis Guthrie & Bolus	Ericaceae			MNCA
Eulophia ovalis var bainesii	Orchidaceae			MNCA
Eulophia ovalis var ovalis	Orchidaceae			MNCA
Eulophia hians var nutans	Orchidaceae			MNCA
Eulophia sp. (no flower)	Orchidaceae			MNCA
Gladiolus papilio	Iridaceae			MNCA
Gladiolus crassifolius	Iridaceae			MNCA
Gladiolus densiflorus	Iridaceae			MNCA
Gladiolus cf ecklonis	Iridaceae			MNCA
Gladiolus woodii	Iridaceae			MNCA
Habenaria caffra	Orchidaceae			MNCA
Habenaria clavata	Orchidaceae			MNCA
Habenaria pseudociliosa	Orchidaceae			MNCA
Haemanthus humilis	Amaranthaceae			MNCA
Kniphofia fluviatilis	Asphodelaceae			MNCA
Kniphofia linearifolia	Asphodelaceae			MNCA
Neobolusia tysonii	Orchidaceae			MNCA
Olea capensis subsp. enervis	Oleaceae			MNCA
Olea europaea subsp. africana	Oleaceae			MNCA
Orthochilus foliosa (Lindl.) Bolus	Orchidaceae			MNCA
Protea gaguedi	Proteaceae			MNCA
Protea roupelliae Meisn. subsp. roupelliae	Proteaceae			MNCA
Protea welwitschii	Proteaceae			MNCA
Satyrium ocellatum subsp. hallackii	Orchidaceae			MNCA
Satyrium cristatum var. longilabiatum	Orchidaceae			MNCA
Satyrium parviflorum	Orchidaceae			MNCA
Scadoxus multiflorus	Amaranthaceae			MNCA
Scadoxus puniceus (L.) Friis & Nordal	Amaranthaceae			MNCA

Species	Family	Red Data	Endemic	Protected
Schizocarphus nervosus	Hyacinthaceae			MNCA
Triaspis glaucophylla Engl.	Malpighiacaeae		SCPE (N)	
Protea caffra Meisn. subsp. caffra	Proteaceae		SCPE	MNCA
Euclea crispa (Thunb.) Gurke subsp. Crispa (Sekhukhune)	Ebenaceae		SCPE	
Aloe spp	Asphodelaceae		SCPE (N)	
Aloe cryptopoda Baker	Asphodelaceae		SCPE (N)	
Aloe cf parvibracteata Schonland	Asphodelaceae			MNCA
Brunsvigia radulosa Herb.	Amaranthaceae			MNCA
Total	**82**	**17**	**27**	**59**

LC = Least Concern; VU = Vulnerable; NT = Near Threatened; EN = Endangered; DDT: Data Deficient
MNCA: Mpumalanga Nature Conservation Act (No.10 of 1998); NFA: National Forest Act; SCPE: Sekhukhuneland Centre of Plant Endemism; LCPE: Mashishing Centre of Plant Endemism

d) Alien and Invasive Species

There are a limited amount of alien and invasive species associated with BS1/2 and the linear infrastructure component, although some settlement has commenced in disturbed footprint areas. There are many alien and invasive species which have been identified at BS4. Category 1 species which require removal include:

- *Xanthium spinosum L;*
- *Opuntia ficus-indica (L.) Mill;*
- *Datura stramonium L; and*
- *Verbena brasiliensis and V bonariensis Vell.*

4.9.6 Baseline Fauna

This section provides a summary of the baseline fauna survey for the Section 24G activities. The detailed report and species lists are included in Annexure G1 and G2 respectively. The areas where pitfall traps, mist nets and cameras were placed are illustrated in Figure 4-17.

The overall findings from the study indicate that a large number (20) of CI species are associated with the wetland habitats. Approximately thirteen CI and geographically restricted species are associated with the rocky, grassy hillslopes and ridges. These habitats are, therefore, very sensitive. Additionally, the cliff face habitat to the west of BS4 is an important habitat for various CI bird species, including the NT Natal Long-fingered Bat, Geoffroy's Horseshoe Bat, the VU Cohen's Horseshoe, Vereaux's Eagle, the Southern Bald Ibis, Lanner Falcon and the EN Cape Vulture.

The sheet rock is critical habitat for the NT locally endemic Sekhukhune Flat Lizard, the NT FitzSimon's Flat Lizard, the VU *Hadogenes polytrichobothrius* scorpion and the PS Southern African Python.

The valley bushveld habitat has also been identified as important for the VU recorded Leopard, the NT Brown Hyena and locally endemic *Pycna sylvia* cicada. It is also anticipated that the VU Crowned Eagle and Wolkberg Dwarf Chameleon could also be found within this area.

The location of the recorded CI species within the project area is included in Figure 4-18.

a) Mammals

A total of 46 mammal species were recorded by NSS and other specialists (previous studies). Overall 88 mammal species are expected to occur within the study area. Species which commonly occur throughout the study area include: the Black-backed Jackal, Bush Duiker, Four-striped Grass Mouse, Cape Porcupine, Scrub Hare, Slender Mongoose and Steenbok.

A commonly occurring species associated with wetlands throughout BS4 is the Marsh/Water Mongoose. The TKO Dam provided sightings of the NT African/Clawless Otter and Serval species. The NT African Hedgehog is reported to also commonly occur within the area.

Species recorded in the Groot Dwars River Valley included the Charcma Baboon, Eastern Rock Elephant Shrew, Namaqua Rock Mouse, Klipspringer, Red Rock Hares, and Rock Hyrax. In the valley, south of BS1/2 the VU Leopard, NT Brown Hyena, Kudu, Waterbuck, Bushbuck, Bushpig and Cane Rats were detected. Vervet Monkeys were also found within the alien vegetation areas at BS4. Cattle were recorded at BS4 and in the valley between BS1/2 and BS3.

Through the mist netting and acoustic recordings, the Cape Serotine, Dusky and Rusty pipistrelles and the Schlieffen's Twilight Bats were found in the riparian-woodland areas while the NT cave-roosting Long Fingered Bat, the NT Geoffroy Horseshoe Bat were found in the cave areas close to Hoogland.

All CI mammal species found and which could be found on site are included in Table 4-12. All species in blue coloured rows were found in the study area. The fauna assessment concluded that the fauna species located in the area are moving away from the operational and construction areas.

Table 4-12 Conservation Important Fauna Species

Threatened and/or Protected Fauna Taxa**		
Scientific Name	**Common Name**	**Conservation Status**
Mammals		
Aonyx capensis	African / Cape Clawless Otter	NT
Atelerix frontalis (frontalis)	Southern African Hedgehog	NT
Crocidura mariquensis	Swamp Musk Shrew	NT
Dasymys robertsii	Roberts' Marsh / Water Rat	VU
Hyaena brunnea	Brown Hyena	NT
Hydrictis maculicollis	Spotted-necked Otter	VU

Threatened and/or Protected Fauna Taxa**		
Scientific Name	**Common Name**	**Conservation Status**
Leptailurus serval	Serval	NT
Miniopterus natalensis	Natal Long-fingered Bat	NT
Myosorex cafer	Dark-footed Mouse / Forest Shrew	VU
Orycteropus afer	Aardvark	PS
Panthera pardus	Leopard	VU
Pelea capreolus	Vaal / Grey Rhebok	NT
Poecilogale albinucha	African Striped Weasel	NT
Redunca fulvorufula	Mountain Reedbuck	EN
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	NT
Rhinolophus cohenae	Cohen's Horseshoe Bat	VU
Birds		
Anthropoides paradiseus	Blue Crane	NT
Alcedo semitorquata	Half-collared Kingfisher	NT
Anthus brachyurus	Short-tailed Pipit	VU
Aquila verreauxii	Verreaux's Eagle	VU
Balearica regulorum	Grey Crowned Crane	EN
Bugeranus carunculatus	Wattled Crane	CR
Buphagus erythrorhynchus	Red-billed Oxpecker	NT
Circus maurus	Black Harrier	EN
Circus ranivorus	African Marsh Harrier	EN
Eupodotis senegalensis	White-bellied Korhaan	VU
Falco biarmicus	Lanner Falcon	VU
Geronticus calvus	Southern Bald Ibis	VU
Gyps coprotheres	Cape Vulture	EN
Nettapus auritus	African Pygmy Goose	VU
Polemaetus bellicosus	Martial Eagle	EN
Sagittarius serpentarius	Secretarybird	VU
Stephanoaetus coronatus	Crowned Eagle	VU
Tyto capensis	African Grass Owl	VU
Reptiles		

Threatened and/or Protected Fauna Taxa**		
Scientific Name	**Common Name**	**Conservation Status**
Acontias breviceps	Short-headed Legless Skink	VU
Chamaesaura aenea	Coppery Grass Lizard	NT
Homoroselaps dorsalis	Striped Harlequin Snake	NT
Platysaurus orientalis fitzsimonsi	FitzSimons' Flat Lizard	NT
Platysaurus orientalis orientalis	Sekhukhune Flat Lizard	NT
Python natalensis	Southern African Python	PS
Tetradactylus breyeri	Breyer's Long-tailed Seps	VU
Frogs		
Hadromophryne natalensis	Natal Ghost Frog	VU
Butterflies		
Aloeides rossouwi	Rossouw's Copper	EN
Dingana fraternal	Stoffberg Widow	CR
Lepidochrysops rossouwi	Rossouw's Blue	VU
Metisella meninx	Marsh Sylph	NT
Platylesches dolomitica	Hilltop Hopper	VU
Dragonflies and damselflies		
Aeshna ellioti	Elliot's Hawker	VU
Proischnura rotundipennis	Round-winged Bluet	VU
Pseudagrion celeste	Catshead Sprite	VU
Pseudagrion newtoni	Harlequin Sprite	VU
Scorpions		
Hadogenes polytrichobothrius	Flat Rock Scorpion	VU
Blue rows - Species found in the study region during surveys		

b) Birds

A total of 321 bird species could occur within the study area. Between the findings made by NSS and Ecofin respectively, a total of 219 species were recorded during the 2016 and 2017 surveys. 35 species which were not previously recorded have been observed, including the Ashy Flycatcher, Knysna Turaco, Lesser Spotted Eagle, Red-billed Oxpecker, Red-chested Flufftail and Scaly-throated Honeyguide.

The complete species list is included in Annexure G1 and G2 respectively. The list of species of conservation concern, including those found in the study area (blue rows), are included in Table 4-12. The habitat diversity supports a diverse bird assemblage ranging from water birds, typical Highveld grassland birds and Bushveld and Lowveld birds. The Booysendal South Expansion Project and particularly the development of the ARC poses a risk to various bird species in the area.

c) Reptiles

A total of 82 reptile species are expected to occur in the BS study area (refer to Annexure G). Of these 82 reptile species, 24 species were confirmed to be present on site. Table 4-13 provides a list of the habitat types and the species found on site associated with each habitat type.

Table 4-13 Reptile Species per Habitat Type

Habitat	Species (Common Name)
BS4 Rocky grassland	Cape Skink, Montane Dwarf Burrowing Skink, Spotted Grass Snake, Holub's Sandveld Lizard and Wahlberg's Snake-eyed Skink
Valley bushveld	Common Flap-neck Chameleon, Black Mamba, Eastern Tiger Snake, Mozambique Spitting Cobra and Southern Tree Agama
Wetland	Brown Water Snake, Red-lipped Snake, South African Marsh Terrapin
Boulders and sheet rock	Common Crag Lizard, Rainbow Skink, Sekhukhune Flat Lizard (**NT**), Van Dam's Dragon Lizard and Van Son’s Gecko
Common to BS	Common Dwarf Gecko, Southern Rock Agama, Variable Skink and Yellow-throated Plated Lizard

The CI species which could occur in the study area and which have been spotted (indicated on blue) are included in Table 4-12.

d) Frogs

The desktop study indicated that there are 14 frog species which could potentially occur within the project area. At least 7 species were identified on site either through their calls or through sightings throughout BS, including the Guttural Toads, Raucous Toads and Red Toads, often at a significant distance away from the nearest wetland. Mozambique Rain Frogs, Bubbling Kassinas and Boettger’s Cacos were heard calling in the grassland areas in and around BS4. Juvenile and adult specimens of potentially the Bushveld Rain Frog were found on slopes and at the bottom of the valley. During the May 2017 site visit, Queckett’s River Frogs were heard calling from the Groot-Dwars River. River frog tadpoles and adult frogs were also recorded in small, perennial, mountain streams that were feeding into the River.

Only one CI could potentially occur in the area, namely the VU Natal Cascade/ Ghost Frog. The Ghost Frog species are extremely vulnerable to destruction or degradation of habitats and especially sedimentation.

Figure 4-17 Pitfall Traps, Camera Traps and Mist Net Survey Areas

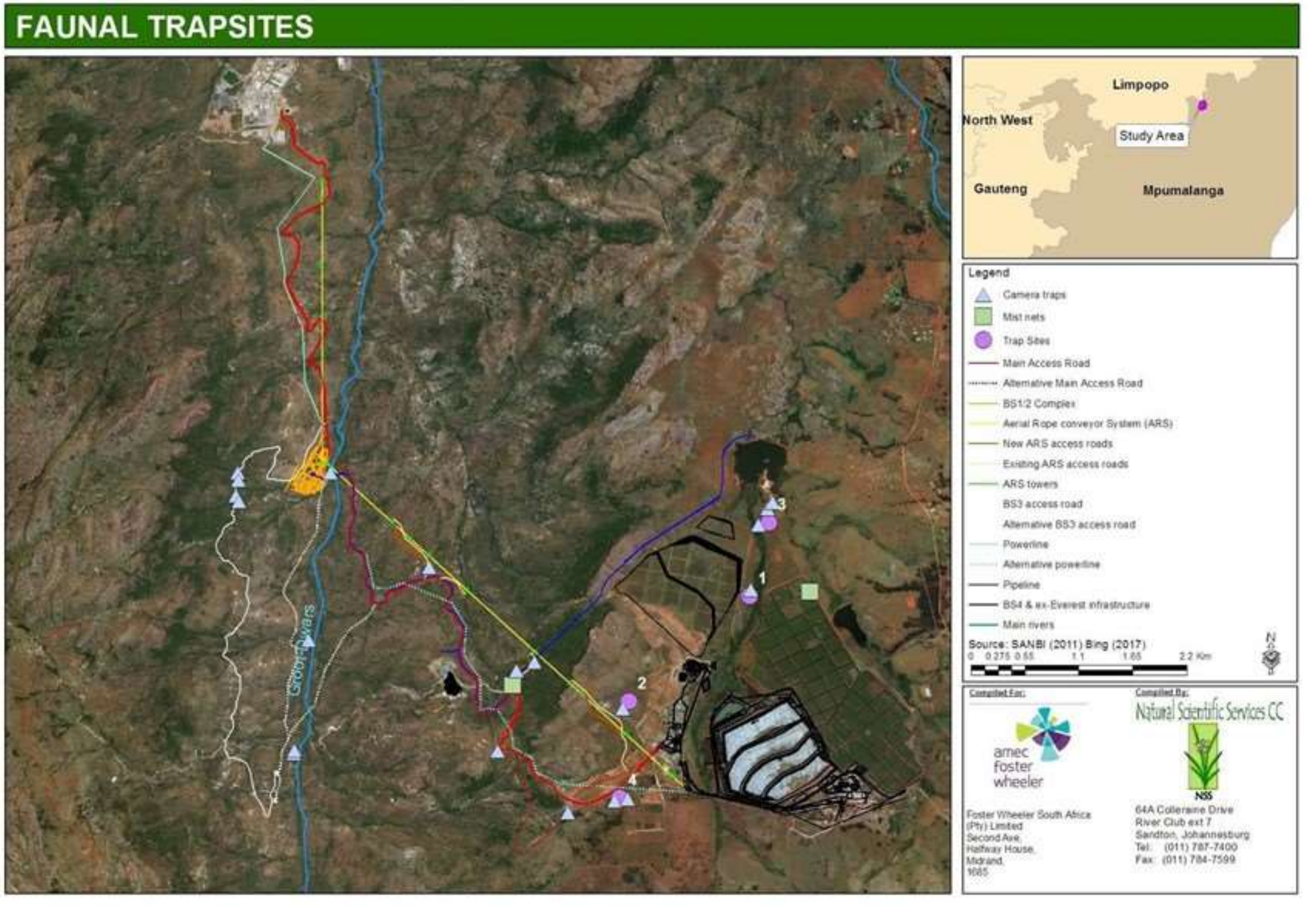
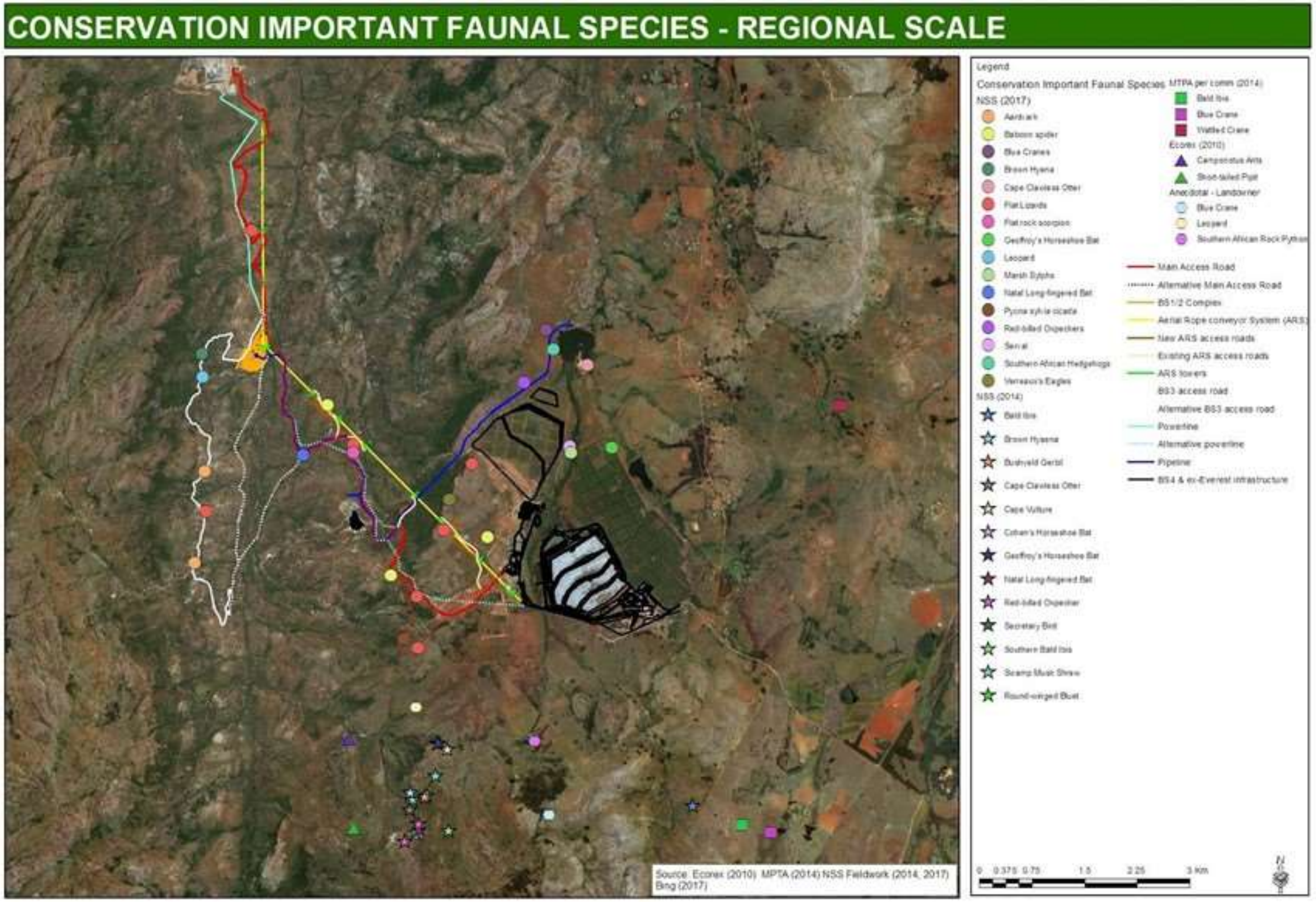


Figure 4-18 Recordings of CI Fauna Species within the Project Area in Relation to the Development Footprints



e) Butterflies

The BS project area contains an especially rich diversity of butterflies. Between NSS and Ecofin, a total of 64 butterfly species were recorded during the survey periods. This is approximately two and a half times more than the amount of species which has been recorded in quadrant 2530AA to date.

The CI species which could occur and which were sighted are included in Table 4-12. The NT Marsh Sylph (*Metisella meninx*) were seen in the wetland areas at BS4.

The most typical species associated with the various habitats are included in Table 4-15 while the full species list is included in Annexure G.

The specialist teams have also identified endemic and geographically restricted species, including the endemic:

- Long Tom Widow – found between Mbabane in Swaziland to Steelpoort, generally on steep, grassy south and east facing slopes at height between 1,200m and 2,000masl.
- Tite's Cooper – distribution is limited to high mountain peaks and ridges in Mpumalanga and KwaZulu Natal.
- Mashishing Opal – distribution from Vryheid in the south to Graskop in the north on high-lying rocky outcrops and hillsides.
- Steelpoort Spotted-eyed Brown – restricted distribution in Limpopo and Mpumalanga, limited to grassland and savanna rocky hillsides.

Table 4-14 Butterflies and Habitat Preferences

Habitat	Species (Common Name)
Species occurring across habitats	African Migrant, African Monarch, Broad-bordered Grass Yellow, Brown-veined White, Common Diadem and Painted Lady and Yellow Pansy
BS4 Grassland	Lycaenids, jokers and pansies
Valley Bushveld	Charaxes, Guineafowl, leopard and swallowtail butterflies

f) Odonata (Dragonflies and Damselflies)

76 dragon-and damselfly species could potentially occur within the BS study area of which, 27 species were identified through sweep netting and observations. This is a high diversity. Although four CI species could potentially occur only one, the Round-winged Bluet (*Proischnura rotundipennis*) were identified at Hoogland but is also expected to occur elsewhere in BS.

The list of species, is included in Annexure G.

g) Scorpions and Baboon Spiders

Through active searching and pitfall trapping six scorpion and four baboon spider species were recorded by NSS and Ecofin. Another four scorpion species could potentially occur in the study area. The 6 scorpion species include *Opistophthalmus glabrifrons, Opistacanthus validus* and *Uroplectes triangulifer* regularly found under rocks in BS. Ecofin (2016) also recorded *Chelectonus intermedius* and *Pseudolychas pegleri* in BS. Additional scorpion species, which have marginal distribution ranges, include the medically important *Parabuthus mossambicensis and Parabuthus transvaalicus*, the widespread bark scorpion *Uroplectes vittatus*, and the

Pugnacious Burrowing Scorpion Opistophthalmus pugnax. None of the species is listed are listed as threatened or protected. One endemic species, the *Hadogenes polytrichobothrius* was only observed in sheet rock areas.

Potential habitats and areas of occurrence of CI species are fully described in the NSS Report in Annexure G.

4 baboon spider species were identified by Ecofin in the BS area. None of the species are listed as threatened or protected. The 4 identified species include: Starbust Horned Baboon Spider (*Ceratogyrus bechuanicus*), the Transvaal Banded Baboon Spider (*Harpactira gigas*), the Malelane Golden-brown Baboon Spider (*Pterinochilus breyeri*), and the Transvaal Golden Baboon Spider (*Pterinochilus nigrofulvus*).

h) Pycna sylvia

The *Pycna sylvia* is a cicada species which were thought to have been extinct, but were rediscovered in 2004 in the Groot Dwars River Valley. Data on the cicada is deficient but research indicates that there is a strong association of the cicada with the tree *Vitex obovate. Wilmsii.* The tree is endemic to the south-eastern Limpopo, northern Mpumalanga, Gauteng and Swaziland.

Malherbe et.al (2004), sighted in the NSS report, indicated that the adult life stage is between 6 and 8 weeks during the period of mid-November to the end of December. The life cycle of the larva is not known but it can be anything from 1 to 7 years. During the field survey in January 2017, the *Pycna sylvia* were found around the ARC, southerly and south-western slopes of the main access road.

The NSS report indicates that the density of the Vitex was calculated as 326m² or 18m in the valley. These numbers may assist in determining offset for the *Pycna sylvia* and its associated Vitex host.

4.9.7 Terrestrial Ecology Ecosystem Services

NSS conducted a full analysis of the ecosystem services of the BS project area as well as an assessment of the potential impacts on the various ecosystem services as a result of the developments. The findings are contained in Table 4-16.

4.9.8 Terrestrial Ecology Sensitivities

This section is a short summary of the sensitivities included in the NSS Terrestrial Biodiversity Report (Please refer to Annexure G1) and specifically focuses on the regional and immediate sensitivities.

The Sekhukhune Mountainlands is listed as an Endangered ecosystem under GN 1002 of 9 December 2011 containing the National List of Ecosystems that are threatened and in need of protection, promulgated in terms of section 52(1)(a) of NEMBA. The biome is also listed as a Priority Zone for conservation initiatives by SANBI.

The project is located approximately 4km north of the De Berg Conservancy (Davel Nature Reserve) and approximately 10km north from the Veloren Valei Nature Reserve. Increased pressure and impacts in the project area may also lead to increased pressures on the conservation areas. There are several threatened and protected species declared in terms of Section 56(1) of NEMBA as listed in terms of Regulation GG 587 of 31 March 2015.

The Groot Dwars River system is classified as a Freshwater Ecosystem Priority Area (FREPA). Therefore, any mining activities should accordingly be restricted to 1km from of a wetland or any riverine habitats.
In terms of the Mpumalanga Biodiversity Sector Plan, Critical Biodiversity Areas (CBA) were identified where development should be restricted due to the sensitivity of the existing biodiversity. The CBA area in terms of the development is included in Figure 4-19. Similarly, a sector plan has been developed for the Limpopo Province which plan set out in Figure 4-18.

NSS has furthermore done a sensitivity analysis of each habitat where development is taking place based on the conservation importance. Due to the extent of this analysis you are referred to Annexure G1.

Table 4 15 Terrestrial Ecology Ecosystem Services

	Service Category	Threats/ Availability	Relevant Environment of ES	Importance of ES	Replicability
Production of O_2	Supporting	Clearing of vegetation, disturbance of wetlands and dust outfall on vegetation.	All areas containing vegetation.	High CI - Fundamental ecosystem process.	Moderate
Provision of habitats for fauna	Supporting	Will be impacted throughout the BS footprint and beyond, wherever terrestrial and wetland habitats are cleared or degraded by dust, erosion, sedimentation, contamination, invasive alien flora, noise, light, etc.	All vegetated areas.	High CI - Unique local floral communities provide critical habitat for local endemic fauna.	Irreplaceable
Sense of Place and eco-tourism	Cultural	The potential impacts from BS such as dust, noise, light and invasive alien flora, on the nearby Davel Private Nature Reserve and the Verloren Vallei Nature Reserve and Ramsar Wetland are of significant concern.	Groot Dwars River Valley.	High CI - The aesthetic value of the region is important for regional ecotourism and protected areas.	Irreplaceable
Flora with medicinal and other cultural uses	Cultural	E.g. Catha edulis is harvested in the BS area by people who reportedly travel long distances to obtain and harvest the plant matter.	Mainly in the Groot Dwars River Valley.	High CI - Harvested products can have high economic value.	Low
Research opportunity and scientific knowledge	Cultural	A number of recently discovered and un-described or recently described, and many data deficient floral and faunal taxa occur in the region.	Especially in undisturbed areas.	High CI - Locally endemic species are highly threatened by expanding mining activities.	Low

Vegetation bind soil and assist in controlling erosion	Regulating	Removal of vegetation for construction and settlement of alien and invasive species.	All areas where vegetation growth is taking place.	High CI - Vegetation is critical in controlling erosion due to the local soil's high susceptibility to erosion and the steep slopes, and heavy regional thundershowers which contribute to and advance erosion.	Low
Pollination of CI and other native flora	Regulating	Removal of habitat and mining activities could impact on pollinators and plant production.	All except for build-up areas	High CI - Pollination is critical for the Sekhukhuneland Centre of Plant Endemism.	Irreplaceable
Run-off regulation including flood control, retention and dissipation	Regulating	Run-off velocities will increase over areas where vegetation has been removed or where areas are compacted and provided with hardened surfaces.	All areas containing vegetation	High CI - Water regulation is essential for people and biodiversity.	Low
Water purification	Regulating	Will impact on wetlands, in particular the Groot Dwars River and main BS4 wetland, are subject to significant disturbance.	Especially wetland areas with *Phragmites*	High CI - Clean water regulation is essential for people and biodiversity.	Low
Carbon sequestration		Will be impacted to some degree wherever terrestrial and wetland vegetation is cleared or plant photosynthesis is compromised by dust.	Vegetated areas	High CI - Fundamental eco-system process.	Moderate

Figure 4-19 Project CBA in terms of the Mpumalanga Biodiversity Sector Plan

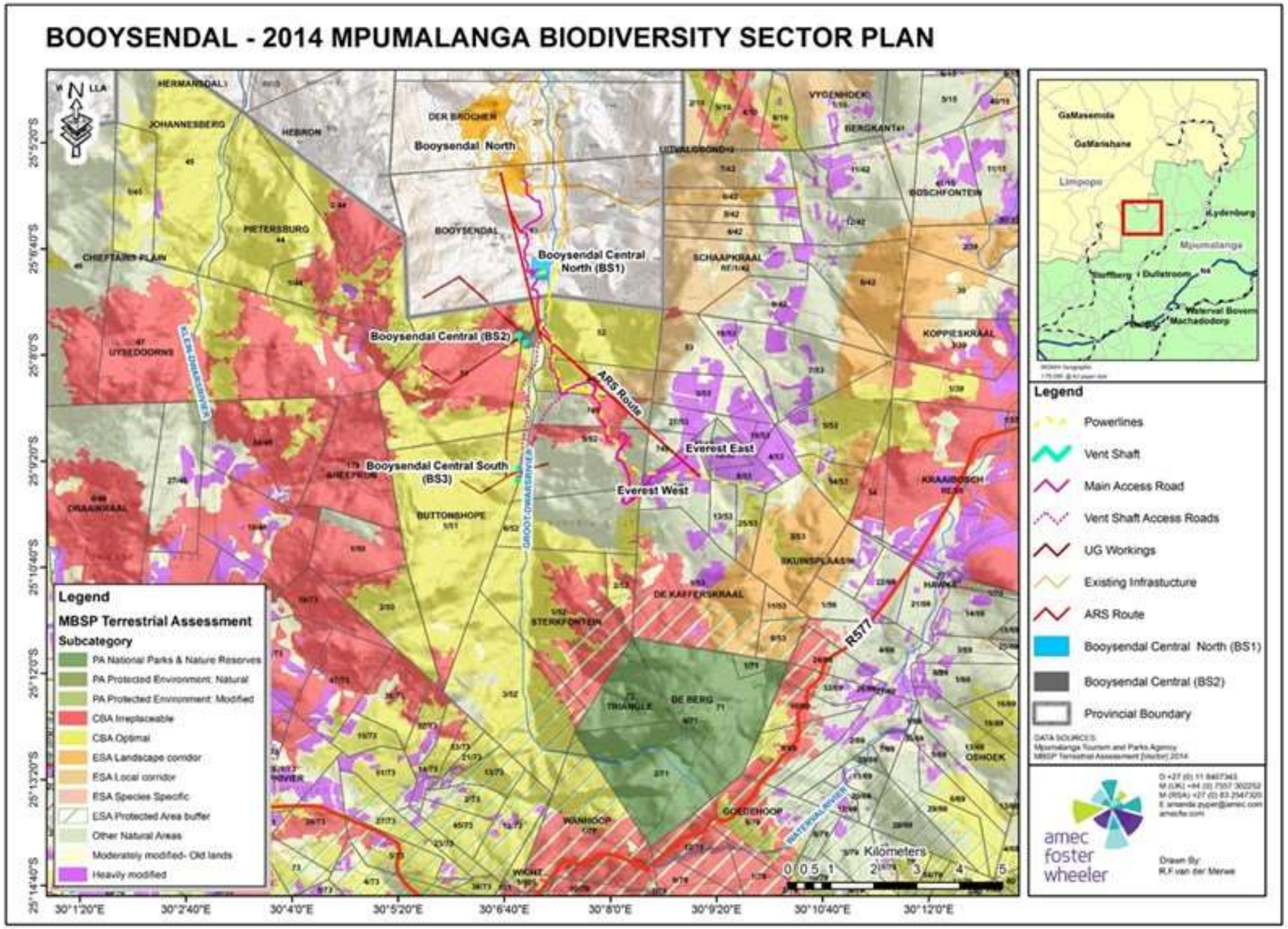
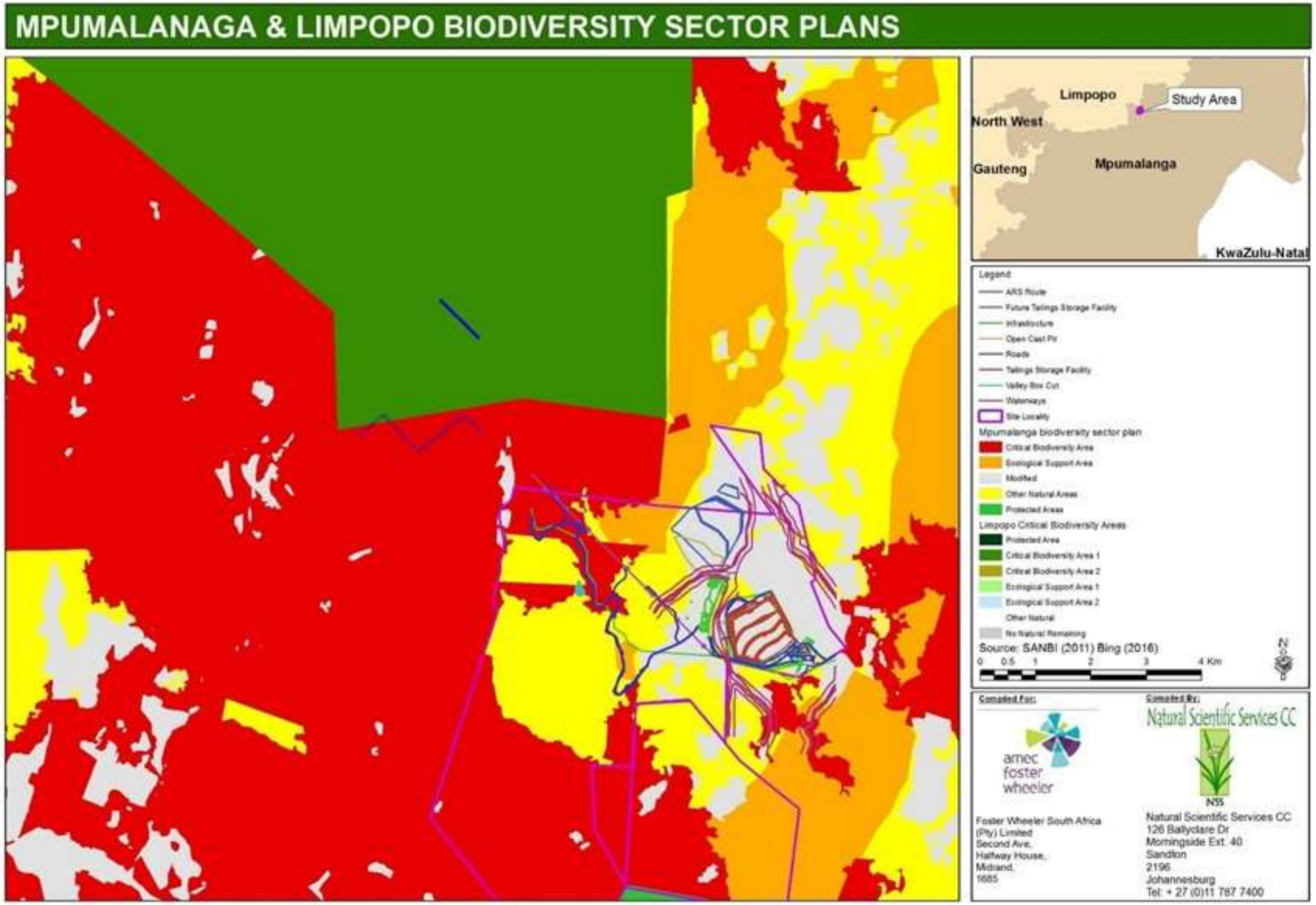


Figure 4-20 Limpopo Sector Plan, 2013



4.9.9 Terrestrial Ecology Gap Analysis

The following gaps and limitations were noted in the terrestrial ecology study:

- Field surveys of BS3 was conducted at the end of the growing season. As a result it may have impacted and limited the detection and identification of all species and potential vulnerable species;
- Due to changes in the project description, various sections of the proposed TKO pipeline option down the western escarp were not surveyed and as a result, not comprehensively assessed;
- Field surveys were conducted over brief survey periods, therefore as a result of the limited timelines, it is possible that not all flora and fauna species were identified;
- Various species may have been overlooked and unidentified as a result of their migratory patterns, small size, secretive or unpredictable behaviours or short activity/ flowering periods; and
- Some areas where inaccessible and as a result, may not have been sufficiently sampled.

4.10 AQUATIC ECOLOGY

Two aquatic biodiversity assessments were undertaken. The first was based on the original project definition involving BS1/2, BS3 and the linear infrastructure components. This study was carried out by The Biodiversity Company (TBC). The study covered wetlands, riparian vegetation and aquatic biodiversity.

The second study specifically focused on BS4 and the Section 24G activities. This study was carried out by Clean Stream Biological Services (Pty) Ltd. Clean Stream took into consideration the results and findings of the TBS report when compiling its assessment report. The two reports are included on Annexure H.

4.10.1 Methodology

The methodology for undertaking the aquatic biodiversity assessment included:

a) Desktop Review

Various aquatic biodiversity reports were reviewed for BS4 (biannual reports from 2007 – 2013) and Booysendal (biannual reports from 2010 to 2016). Other historic biodiversity reports which were reviewed date back to 2001. Water quality reports were reviewed. Vulnerable and Threatened species databases were also consulted, the TBC report was further reviewed for background data assembly purposes.

b) Field Surveys and Assessments

Two surveys were undertaken by Clean Stream, the first during the rainy season from 11 to 13 January 2016 and the second during the winter season 5 to 6 June 2017. The aim of the latter study was to gain better insight into the distribution and presence of the IUCN Listed VU *Enteromius cf. motebensis* species. The overall purpose of the study was to assess the present ecological status (PES), habitat integrity (IHI), macroinvertebrates, fish species and fish response assessment index (FRAI).

The sampling sites where the surveys were conducted are shown in Table 4-17. The sites are representative of all activities and potential impacts which may result from the Section 24G development footprint areas. The survey protocols which were undertaken at each site is also provided.

Table 4-15 Aquatic Biodiversity Sampling Sites

Sub-reach	Sampling Site	Description	Coordinates	Sampling Protocols
Sub-reach GD 1 (Upstream of BS1/2 and the bridge over the Groot Dwars River)	US1	Groot Dwars River upstream of BS3	-25.165194° 30.116842°	Fish sampling
	US2		-25.160783° 30.116132°	
	Trib1	Non-perennial tributary of the Groot-Dwars River overlying proposed mining at BS3	-25.158520° 30.115486°	
	B0	Groot Dwars River upstream of S24G activities and adjacent to proposed mining at BS3	-25.155636° 30.116079°	SASS, fish, on-site water quality
	B0_A	Groot Dwars River upstream of S24G activities but downstream of proposed mining at BS3	-25.152812° 30.117025°	Fish sampling
	B1A		-25.150950° 30.116184°	SASS, fish, on-site water quality
	PS-US		-25.139376° 30.117145°	SASS, fish, on-site water quality
	Bridge-US		-25.136797° 30.118132°	Fish sampling
	GD-RC		-25.129820° 30.119684°	SASS, fish, on-site water quality
	Trib2	Near-perennial tributary of the Groot-Dwars River (may be affected by gravel roads to vent shafts at BS3)	-25.144808° 30.116973°	Fish sampling
Sub-reach GD 2 (Adjacent to and downstream of S24G activities)	Bridge DS	Immediately downstream of the bridge	-25.124790° 30.120071°	Fish sampling
	PS-DS	Downstream of the road crossing and the proposed mining at BS1/2 and the Southern Merensky Portal. This site is located adjacent to present activities at BS1/2.	-25.123105° 30.119828°	SASS, fish, on-site water quality
	PN-US	Downstream of the road crossing and proposed mining at BS1/2 and the Southern Merensky Portal and adjacent to a gravel road within the floodplain. This site is also located downstream of the Southern Tributary but upstream of the Waterfall Tributary and Everest tributary	-25.115644° 30.121357°	SASS, fish, on-site water quality
	GD2	Downstream of most activities except for potential impacts from the northern portal (Waterfall Tributary) and the Tailings complex (via the Everest Tributary)	-25.108626° 30.122360°	SASS5, on-site water quality
Sub-reach	B1-DS	The most downstream site in the study area, downstream of all activities, including potential	-25.104202° 30.123396°	SASS, fish, on-site water quality

Sub-reach	Sampling Site	Description	Coordinates	Sampling Protocols
GD 3 (downstream of activities)		impacts from the tailings complex, via the Everest Tributary.		
Everest Tributary E1	RC1	Everest Tributary upstream of proposed activities associated with the tailings storage facility.	-25.161057° 30.172675°	SASS, fish, on-site water quality
	RC2	Everest Tributary downstream of the haul road bridge	-25.157036° 30.173785°	SASS, fish, on-site water quality
	RC3	Everest Tributary upstream of the TKO Dam	-25.134633° 30.161249°	SASS, fish, on-site water quality
	E1	Everest Tributary downstream of the TKO dam. This site receives impacts from existing infrastructure associated with Everest Mine and is located downstream of the proposed new tailings storage facility at BS4.	-25.123718° 30.160772°	SASS, fish, on-site water quality
	E3	Everest Tributary upstream of the confluence with Groot Dwars River. This site will be used as a biomonitoring site to assess the impact of this tributary on the Groot Dwars River.	-25.107026° 30.127369°	SASS, fish, on-site water quality
Southern Tributary	S-Trib	This non-perennial tributary may be impacted by road construction as well as the ARS connecting BS1/2 and BS4	-25.116726° 30.124818°	On-site water quality
Waterfall Tributary	WF-US1	Waterfall tributary 300m upstream of bridge crossing.	-25.107194° 30.111525°	Fish sampling
	WF-US2	Waterfall tributary directly upstream of bridge crossing.	-25.107581° 30.114049°	
	WF-Trib	Lower reaches of Waterfall tributary (downstream of waterfalls) is impacted by construction of the main access road between BS1/2 and BN as well as by the proposed northern portal. The sampling site is located between Booysendal activities and the confluence with the Groot Dwars River.	-25.107845° 30.119745°	SASS, fish, on-site water quality
Central Trib	C-Trib	Wetland draining immediately south of construction activities at BS1/2.	-25.130958° 30.118368°	water quality (Salinity and Turbidity)

PES and IHI

The methodology used to determine the PES is the River Eco-Classification for Reserve Determination methodology for IHI physical habitat disturbance and PES was used as developed by Kleynhans, considering water abstraction, floe modification, bed modification, channel modification, inundation, water quality, exotic macrophytes, solid waste, indigenous vegetation removal, exotic vegetation presence and bank erosion. The classification categories for PES is included in Table.

Table 4-16 Present Ecological Status Classes (Clean Stream, June 2017 as adapted from Kleynhans, 1999)

CATEGORY	BIOTIC INTEGRITY	DESCRIPTION OF GENERALLY EXPECTED CONDITIONS
A	Excellent	Unmodified, or approximates natural conditions closely. The biotic assemblages compare to that expected under natural, unperturbed conditions.
B	Good	Largely natural with few modifications. A change in community characteristics may have taken place but species richness and presence of intolerant species indicate little modifications. Most aspects of the biotic assemblage as expected under natural unperturbed conditions.
C	Fair	Moderately modified. A lower than expected species richness and presence of most intolerant species. Most of the characteristics of the biotic assemblages have been moderately modified from its naturally expected condition. Some impairment of health may be evident at the lower end of this class.
D	Poor	Largely modified. A clearly lower than expected species richness and absence or much lowered presence of intolerant and moderately intolerant species. Most characteristics of the biotic assemblages have been largely modified from its naturally expected condition. Impairment of health may become evident at the lower end of this class.
E	Very Poor	Seriously modified. A strikingly lower than expected species richness and general absence of intolerant and moderately tolerant species. Most of the characteristics of the biotic assemblages have been seriously modified from its naturally expected condition. Impairment of health may become very evident.
F	Critical	Critically modified. Extremely lowered species richness and an absence of intolerant and moderately tolerant species. Only intolerant species may be present with complete loss of species at the lower end of the class. Most of the characteristics of the biotic assemblages have been critically modified from its naturally expected conditions. Impairment of health generally very evident.

Water Quality

In-situ water quality analysis was conducted on site for electric conductivity (EC), pH, dissolved oxygen concentrations, oxygen saturation and temperature to understand potential ecological responses. This was aided by laboratory analysis of suspended solids and turbidity.

Aquatic Macroinvertebrates

The South African Scoring System (SASS5) methodology was used to assess river health and water quality. Where the relative abundance and diversity of sensitive taxa is indicative of a healthy system with good water quality.

Fish Assessment

The fish assessment was done taking consideration of the habitat composition based on the Habitat Cover Rating method (Kleynhabs, 1996). In which case habitats are assessed according to different attributes to satisfy habitat requirements for various fish species. At each site electrofishing was done to determine the FRAI of classes.

c) Data Analysis and Reporting

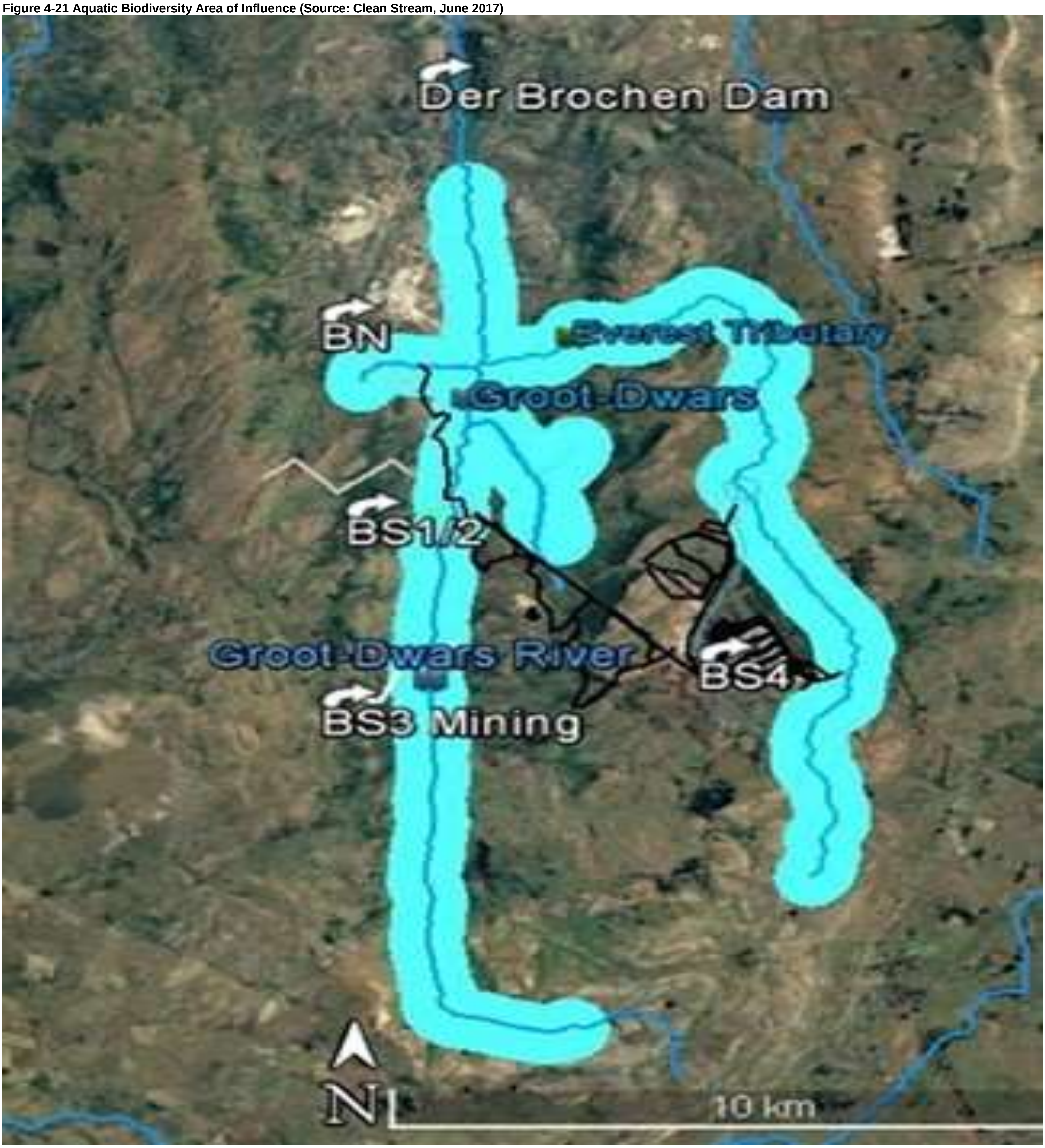
This includes baseline findings, assessment of impacts on the aquatic river system and the development of a management plan.

4.10.2 Area of Influence

The AoI of the project on the aquatic environment can be regarded as all the activities which could impact on watercourses in sub-quaternary catchment B41G. The main drainage lines which receive the impacts, namely the Groot Dwars River and the Everest Tributary, form part of the AoI. As aquatic life is continuously moving up and down, the river reaches and flows are not static, therefore potential impacts could occur up and downstream of the development activities. The downstream Der Brochen Dam is the downstream boundary of the AoI as the dam acts as a sink for impacts, although water quality impacts can impact on aquatic ecosystems downstream of the dam. The AoI is included in Figure 4-21 Aquatic Biodiversity Area of Influence (Source: Clean Stream, June 2017).

There are several wetlands and mountain streams systems within the area of influence with its own unique aquatic biodiversity. There is also a farm dam in the Everest Tributary which influences the biodiversity.

Figure 4-21 Aquatic Biodiversity Area of Influence (Source: Clean Stream, June 2017)



4.10.3 Baseline Aquatic Biodiversity

Quaternary catchment B41G, together with it associated catchments is a National Freshwater Ecosystem Priority Area (NFREPA) system. NFREPA systems are important in maintaining threatened or near-threatened fish species. The Mpumalanga Biodiversity Conservation Plan indicates that the aquatic ecosystems within the sub-quaternary are considered as irreplaceable and the Everest Tributary as highly significant. The Ecological Sensitivity of the system was also assessed as being very high.

a) Water Quality

The findings from the water quality assessment against background water quality results indicated that there is a gradual increase in salinity downstream in the Groot Dwars River. Turbidity was also visibly higher with a measured suspended solid spike from 11 to 210mg/l between August and December 2016 at the bridge construction. Aluminium levels also at times exceeded the guideline limits for aquatic ecosystems in the Everest tributary since the Section 24G activities commenced. Salinity in the Waterfall tributary, where road construction is taking place, the tributary at BS1/2 where portal and terrace development is taking place and in the wetland tributary at BS4 were elevated. These factors could have an impact on aquatic biodiversity, especially as this is a sensitive system.

b) Habitat Integrity

Limited habitat integrity data was available to compare current conditions to, but previous assessments indicated a PEA of A/B. The study found that the PES of the upper reaches of the Groot Dwars River was pristine to largely natural (Category A/B). The riparian habitat was also Largely Natural (Category B). The habitat integrity of the upper reach therefore has experienced limited impacts associated with the Section 24G activities. Future planned mining activities at BS3 could however, impact on the habitat integrity.

The integrity of the habitat in the middle reach of the Groot Dwars River (BS1/2) has been modified by the Section 24G activities and notably by the construction and erection of the bridge and associated impacts on the wetland areas, resulting in a decrease of the habitat integrity and riparian habitat to Category Cs.

The habitat integrity downstream where the Waterfall and Everest tributary runs into the Groot Dwars River has also deteriorated as a result of the Section 24G activities to a category C (moderately modified). The habitat integrity of the Everest tributary has also deteriorated from Category B to Category C. The impact of the habitat integrity of the other streams surveyed were of lesser significance.

c) Aquatic macroinvertebrates

The baseline of Groot Dwars River before commencement of the Section 24G activities directly upstream of the Everest Tributary confluence, indicates a high diversity and the presence of sensitive taxa (sensitive to change in water quality). This stretch is classified as largely natural (Category B). The Average Score Per Taxon (ASPT) was 6.0 – 6.6 and the SASS score 114 to 149. The upper reaches of the Groot Dwars River, has been classified as pristine (ASPT 6.4 and SASS 180). A total of 28 taxa was recorded in 28, many of which are sensitive to water quality change.

Findings from a macroinvertebrate assessment indicate that the Everest Tributary is Largely Natural to Moderately modified, with a PES of B-C. The reaches downstream of the TKO dam is largely or seriously modified with a PES score of D to E. Species diversity is low.

The ASPT and SASS scores in the streams have deteriorated from upstream to downstream since the commencement of the Section 24G activities. The downstream site indicated an absence of sensitive species *(Heptageniidae* and *Athericidae*) which were found prior to the commencement of the Section 24G activities.

Figure 4-22 provides an indication of the sampling points. The SASS score deterioration for monitoring point B0 and B1 since 2015 is indicated in Table 4-17.

Figure 4-22 Aquatic Biodiversity Monitoring Points (Clean Stream, June 2017)

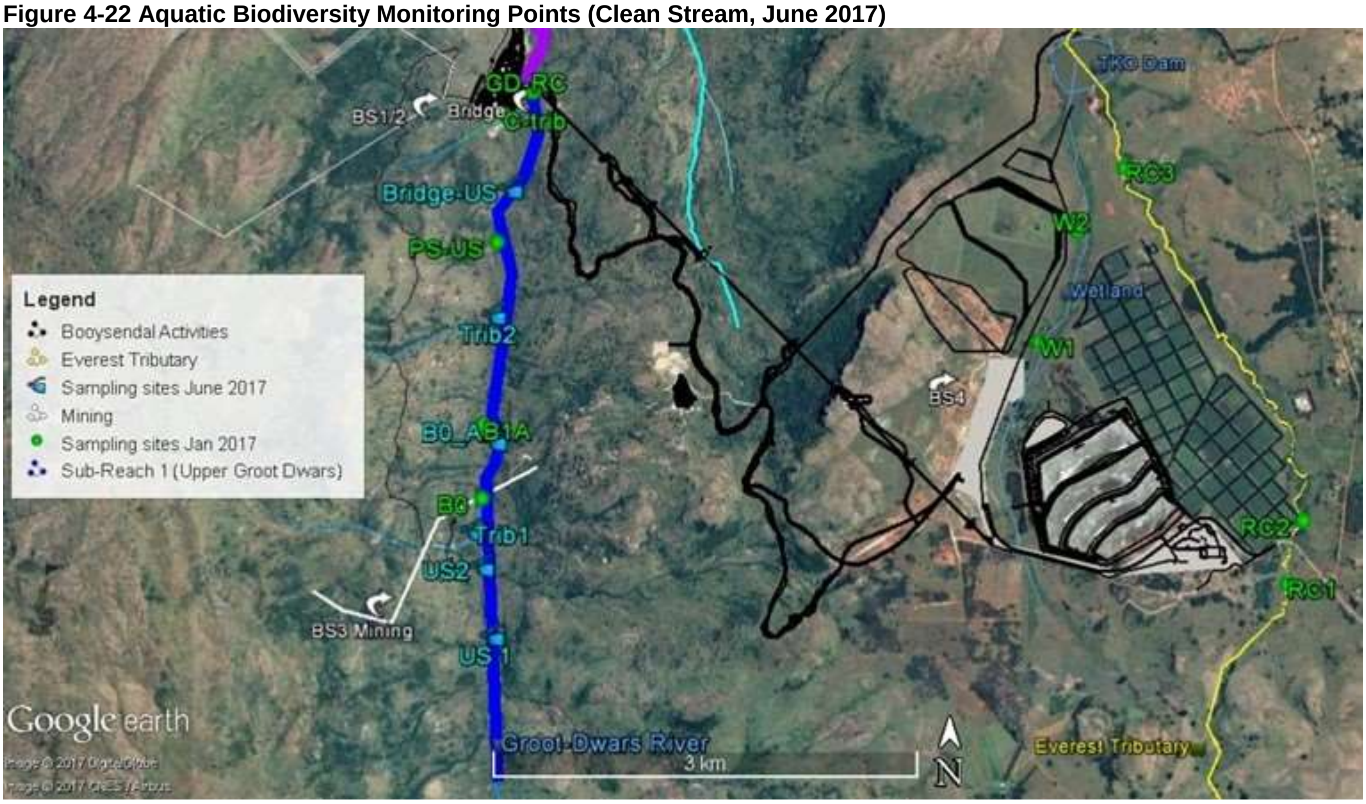


Table 4-17 SASS Scores Over Time

	August 2015	January 2016	January 2017
SASS Score B0	185	150	151
SASS Score B1	152	123	99

Clean Stream also assessed the Macroinvertebrate Response Index (MIRAI), which provides an indication of habitat modification and species diversity. The results of the MIRAI in Table 4-18 confirm the good water quality and habitat suitability within the upstream reach, upstream of the road crossing of the Groot Dwars River. There was a gradual decline in the MIRAI score in a downstream direction with the most downstream reach classified as Category C (Moderately Modified). Habitat and water quality were considered the most important drivers of macroinvertebrate assemblage patterns within these reaches.

Table 4-18 Macroinvertebrate Response Assessment Index

	Groot Dwars River			
	Upstream reach	**Middle reach**	**Downstream reach**	**Everest Tributary**
FLOW MODIFICATION	79.4	80.9	64.0	67.3
HABITAT	73.5	66.4	58.7	86.1
WATER QUALITY	80.2	80.2	63.7	71.4
INVERTEBRATE Ecological Category Score	78.7	77.8	63.9	73.8
INVERTEBRATE ECOLOGICAL CATEGORY	**B/C**	**C**	**C**	**C**

d) Fish

A significant amount of historical studies have been conducted in the Section 24G project area since 2001. The results of the studies indicate that there are at least eleven indigenous species present in the various reaches on the study area (refer to Table 4-19) and one alien species (*Cyprinus carpio*).

Table 4-19 Indigenous Species in the Section 24G Study Area (Clean Stream, 2017)

Period	2001/02	2007	2008	2011/12	2012/13	2016
Source	(RauEcon)	Nepid	CSBS	SAS	SAS	TBC
Zone	GD3	Groot Dwars (Everest mine)	Groot Dwars downstream of study area.	E1 (RC1, TKO Dam)	GD1(B0, B1)	Upper reaches of Groot Dwars
Amphilius uranoscopus	X	X				X
Enteromius anoplus		?				
Enteromius neefi	X	X	X		X	X
Enteromius cf. motebensis						X
Enteromius trimaculatus	X		X			
Labeobarbus marequensis	X	X	X		X	
Chiloglanis pretoriae	X	X	X		X	
Clarias gariepinus	X		X	X		
Labeo cylindricus	X		X			
Labeo molybdinus			X			

Oreochromis mossambicus	X		X			
Tilapia sparrmanii	X		X	X	X	X
*Cyprinus carpio**				X		
Total number of indigenous species	9	5	9	2	4	4
Total number of alien species				1		

*Alien species

The Clean Stream study confirmed some of the species although high flows were restrictive in species identification during the two survey periods.

Clean Stream identified the following activities which impacted on fish habitats and therefore diversity and species presence:

- The bridge over the Groot Dwars River may cause pooling upstream and accelerated flows through culverts into downstream reaches. This change in flow regime may act as a migration barrier to certain fish. The accelerated flows will also cause erosion downstream of the outlet, scouring banks and reducing the availability of marginal vegetation habitats. Erosion will also increase the turbidity of the water, affecting species with a high requirement for clear water. Where sediments settle out, substrates will be altered, affecting those species that prefer clear, cobbled substrates. Pool depth will also be reduced, affecting species that prefer deep pools. The inundation upstream of the bridge may also create favourable habitats for unfavourable species (such as Largemouth bass and Sharptooth catfish) and change the overall fish assemblage of this area.
- Mining will cause a reduction in flows (because of mine dewatering and lowering of the water table), affecting species with a preference for fast flows and deep pools. Water quality impacts will be exacerbated as dilution will be reduced, affecting species that require water of good quality.

4 fish species have been identified which is intolerant to change. These species will therefore react to any change which may result from a deterioration in water quality. The species include: E*. cf. motebensis, E. neefi, L. cylindricus* and *L. molybdinus.*

The *Labeobarbus marequensis, Labeo* species and *Clarias gariepinus* are migratory species that require free movement to complete their life cycle. Migration barriers like the Groot Dwars River crossing or stone pitching in the drainage lines or culverts prohibit the migration of fish.

The biotic integrity base on the Fish Response Assessment Index (FRAI) was used to determine the PES based on fish assemblage. Although the study was based on limited historical data and should therefore be deemed as preliminary, there was a decrease in the FRAI score from the upstream to the downstream point with a low score (61.3) in the Everest Tributary. A decrease in species abundance was also observed. The complete FRAI assessment is included in Annexure H1.

4.10.4 Ecosystem Services

Clean Stream identified the following ecosystem services:

- Provisioning - water mainly for drinking and artisanal mining purposes; timber; harvesting of wood; medicinal plants; hunting; gathering of food; agricultural activities and fishing; and
- Supporting services ‘’are the natural processes that maintain the other services’.

4.10.5 Aquatic Sensitivities

Enteromius motebensis is listed by the International Union for Conservation of Nature (IUCN) as vulnerable. This classification indicates that this species has a very limited geographic range, severely fragmented locations and may be continually declining. Protection of this species is of the utmost importance. As some of the habitat has already been disturbed offset measures will have to be put in place. Booysendal is in the process of developing an offset strategy with the input from MPTA. Specific management measures for the protection of the *Enteromius motebensis* is included in the EMP. The *Oreochromis mossambicus* (Mozambique tilapia) is listed as being near-threatened[2] on the IUCN database and its listing is related to the hybridization of this species with alien *Oreochromis* species (specifically *Oreochromis niloticus*).

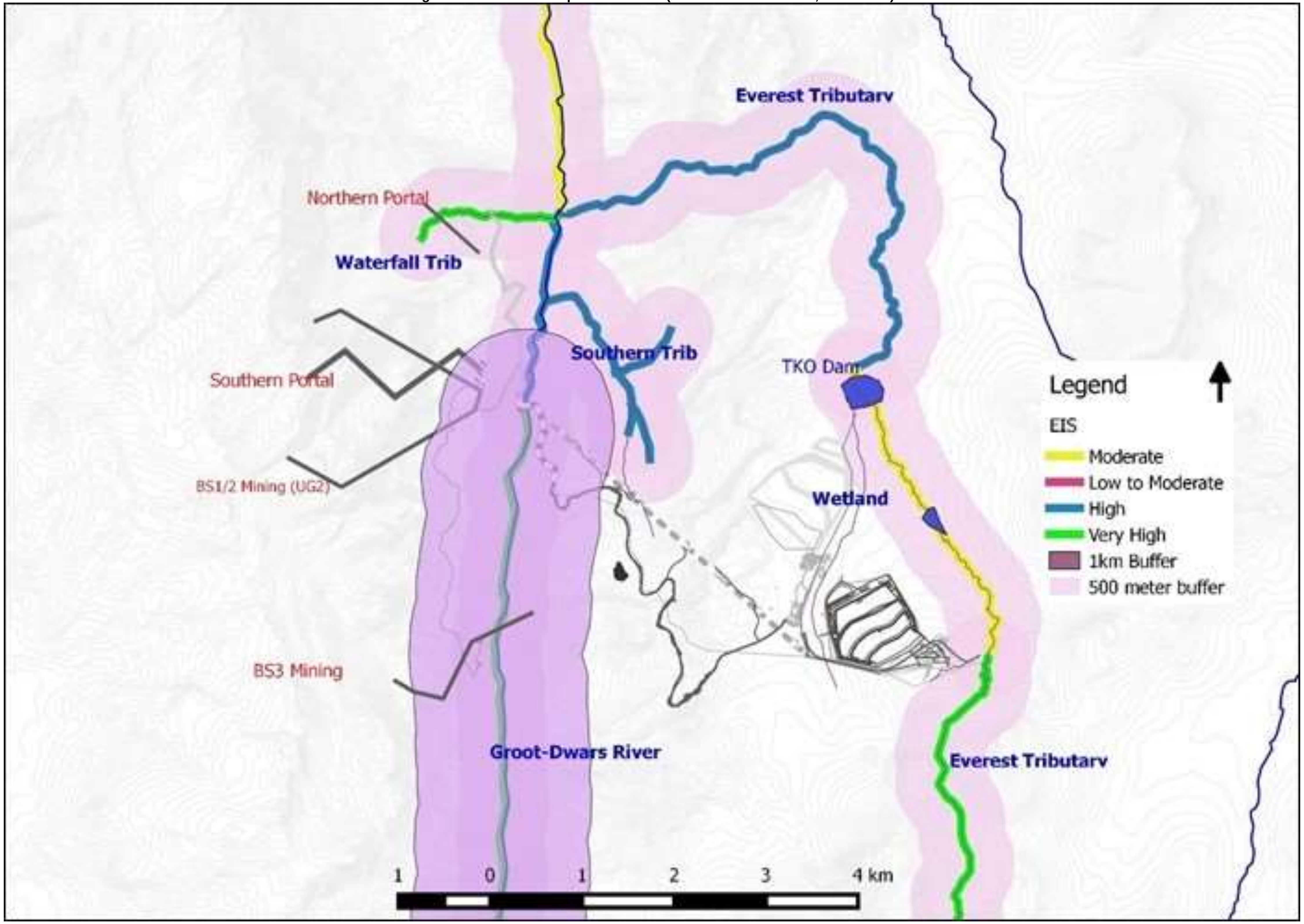
The Groot Dwars River Upstream Reach was assessed as having Very High Ecological Importance and Sensitivity; high availability of habitat for, and the highest observed prevalence of, the Red-Listed *Enteromius cf. motebensis.* The Groot Dwars River Middle Reach (adjacent to BS1/2) was assessed as having a High Ecological Importance and Sensitivity (EIS). This is a Largely Natural river with a high diversity including sensitive aquatic biota. Therefore, based on the aquatic biodiversity findings and identified sensitive systems it is proposed that buffers between 500m and 1km from the resources be maintained (Please refer to Figure 4-22).

4.10.6 Gap Analysis and Limitations

Very little is known about the *Enteromius cf. motebensis* population in the Groot Dwars River and its tributaries. It is recommended that a genetic assessment be conducted to determine how genetically distinct the population is. A more comprehensive study of its exact distribution and abundance, as well as its habitat needs, within the Groot Dwars and its tributaries, and surrounding catchments, is required to determine whether the future survival of this species can be effectively achieved as part of an offset strategy. The question that needs to be answered is whether there will be sufficient suitable habitat remaining in the upper Groot Dwars River to sustain the population in perpetuity. Further studies are also required to determine whether mitigation and management measures (such as translocation to identified refugia) will be effective in conserving this species.

[2] A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Figure 4-23 Sensitive Aquatic Habitats (Source: Clean Stream, June 2017)



The concentrations of chromium that may reach the Groot Dwars River as a result of backfilling of the underground mine with tailings from TSF1 is uncertain. Chromium (especially hexavalent chromium) is toxic to aquatic biota. It is understood that this decant will be contained in a PCD adjacent to the valley box-cut and re-used within the processing plant. The fate of this water post-closure is, however, uncertain. The current prediction is that the chromium concentration in decanting mine water may increase to 0.3 mg/l (Future Flow 2017). If undiluted, this exceeds the guideline limit for aquatic ecosystems (DWAF 1996) of 0.007 mg/l.

The magnitude of the impact of dewatering on habitat for *E. cf. motebensis* and other flow-dependent species, is uncertain. The exact extent and layout of the underground workings was not known at the time of compiling this report. As such, it is uncertain to what extent wetlands and watercourses will be under-mined and therefore unclear and uncertain as to what the nature and extent of the risk of subsidence and/or ingress will be.

It is unknown to what extent dewatering will impact the associated tributaries (particularly the Waterfall Tributary) and specifically in terms of flows and habitat, nor what this effect will be on the receiving Groot Dwars River, particularly during low flow periods. It is our understanding that the bridge over the Groot Dwars River was being re-designed to mitigate against the impacts pertaining to the flow and the movement of fish species. However, the final design of the bridge was not available at the time of finalising this report and it was therefore assumed that the construction of the bridge will take place in consultation with a fish specialist.

4.11 WETLANDS

Two wetland studies were undertaken. The first study was done by TBC 2. This study was conducted only with reference to wetlands associated with the BS1/2, BS3, main access road, aerial rope conveyor and powerline.

The second study was done by Wetlands Consulting Services (Pty) Ltd and specifcally focused on BS4 and the Section 24G activities. The purpose of the study was to:

- Identify the presence and extent of wetlands on site;
- Undertake a wetland type classification;
- Assess the functional importance of wetlands;
- Assess the PES of wetlands on site;
- Assess the ecological importance and sensitivity of the wetlands on site; and
- To assess the impacts on wetland systems with recommendations for mitigation and management.

4.11.1 Methodology

The methodology followed for the wetland study included:

a) Collation of Existing Information

Two previous wetland studies were undertaken; the TBC study in 2016 and another by Scientific Aquatic Services for Project Fairway in 2012. Baseline information was drawn from these studies. The NFEPA national wetland inventory datasets were also consulted to obtain additional information.

b) Wetland Delineation and Typing

Wetlands were initially delineated using topographical maps, orthophotos and Google earth Imagery to delineate wetland areas through the identification of rivers, wetness signatures. Suspected wetland areas were further investigated in the field.

The identification and delineation of wetlands was done through the use of various indicators including, hydrophytes, hydromorphic soils and soil forms, prolonged saturation and terrain.

c) Wetland Functional Assessment

A two-level functionality assessment was done allowing for establishing ecosystem services, which enables one to make relative comparisons of systems based on a logical framework that measures the likelihood that a wetland can perform certain functions.

d) Assessment of the PES, EI and Ecological Sensitivity

The PES and ecological importance and sensitivity (EIS) assessments were undertaken for every HGM unit identified and delineated within the study area. This was done to establish a baseline of the current state of the wetlands and to provide an indication of the conservation value and sensitivity of the wetlands in the study area. The Level 1 PES was carried out as described by the WET-Health manual (Macfarlane *et al*., 2008). The EIS was determined using the methodology detailed by Rountree *et al*. (2013).

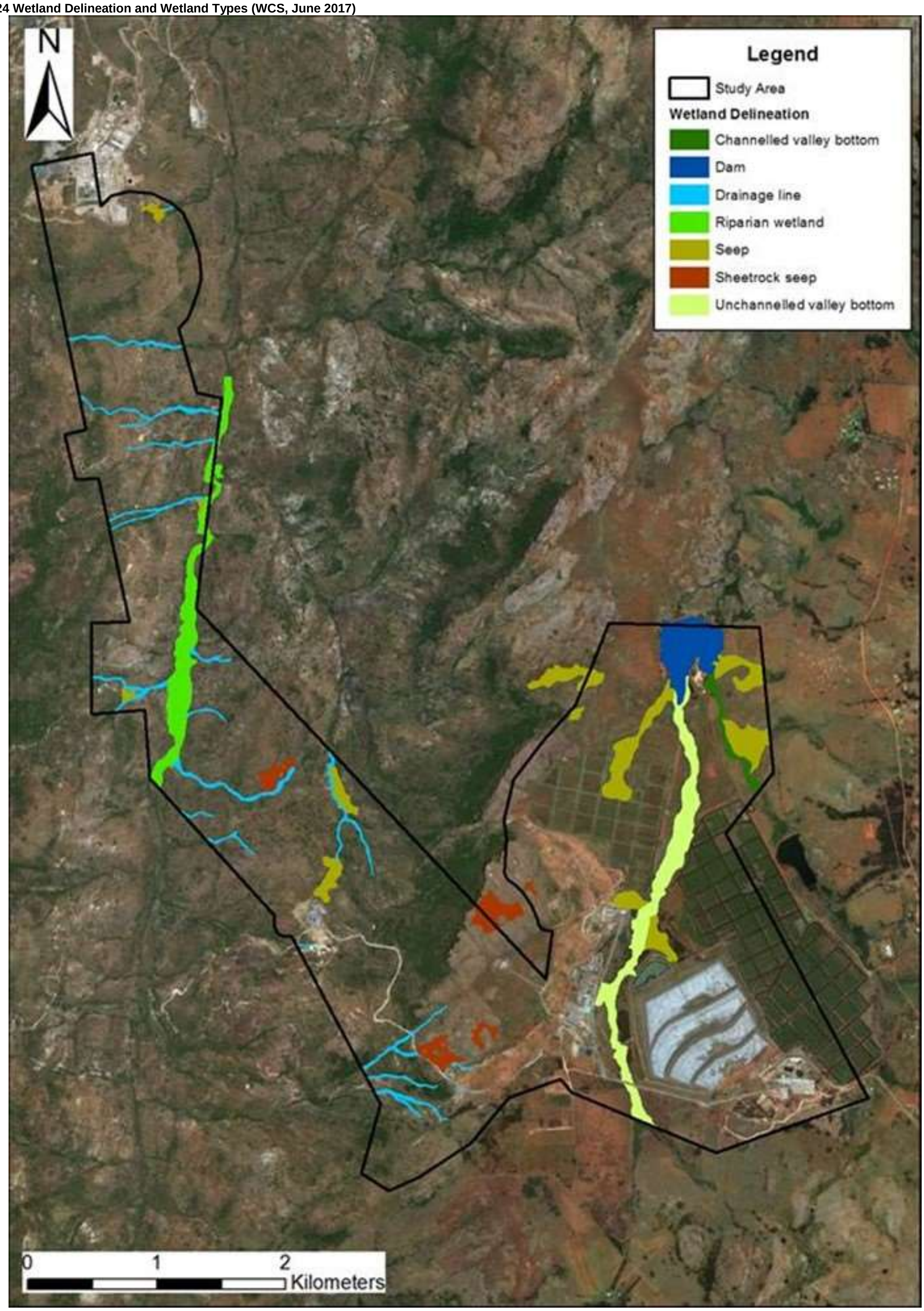
e) Impact Assessment

The impact assessment was carried using the standardised methodology which was provided.

4.11.2 Area of Influence

The area of influence corresponds with the Booysendal South Expansion Project area included in the Wetland Delineation map and depicted in Figure 4-24.

Figure 4-24 Wetland Delineation and Wetland Types (WCS, June 2017)



4.11.3 Baseline Wetland Findings

a) Wetland Delineation and Typing

Five types of wetlands were identified in the study area. The wetlands cover approximately 8.1% (133 hectares) of the studied area of 1,640 hectares. The type of wetlands areas thereof and comparative area within the study area is listed in Table 4-20 Booysendal South Section 24G Wetlands Table 4-20 while the location of the wetlands are depicted in Figure 4-24.

Table 4-20 Booysendal South Section 24G Wetlands (WCS, June 2017)

Wetland Type	Area_(ha)	% of wetland area	% of study area
Channelled valley bottom	4.69	3.52%	0.29%
Un-channelled valley bottom	32.31	24.26%	1.97%
Riparian wetland	24.36	18.29%	1.49%
Seep	40.09	30.10%	2.44%
Sheetrock seep	10.84	8.14%	0.66%
Drainage line	20.90	15.69%	1.27%
Total	**133.19**	**100.00%**	**8.12%**

Areas along the Groot Dwars River has been classified as a **riparian wetland** and shares both wetland and riparian zone characteristics. Most of the reach affected by the Section 24G activities is clearly channelled, with the channel bed made up of cobbles and larger boulders, with occasional pools. The key hydrological driver for this wetland is considered to be upstream surface flow inputs and the subsequent overtopping of the channel banks. The wetland habitat is generally dominated by *Phragmites* reeds. This wetland habitat is most developed immediately upstream and downstream of the road crossing currently under construction. In some sections of the affected reach, the marginal wetland habitat largely disappears and the system becomes more riverine in nature, with a narrow riparian zone found along the edge of the macro-channel bank. A key riparian indicator species is the river bushwillow, *Combretum erythrophyllum*.

Seep wetlands make up the largest extent of wetland habitat on site and occur scattered across the study area, however the majority of hillslope seepage wetland is located in the east of the study area in association with the Everest tributary. The key hydrological driver of these systems is the infiltration and subsequent lateral movement of water through the soil profile, referred to as interflow. Two of the seep wetlands have been significantly impacted by existing mining activities – the seep immediately downslope of the existing TSF and the seep adjacent to a PCD at BN.

Two large **sheetrock seep wetlands** were identified and mapped, and it is likely that a large number of very small, isolated such systems occur scattered throughout the area. Sheetrock seeps have been differentiated from other seeps on the basis of the shallow nature of the soil profile in these wetlands and the presence of extensive exposed bedrock within the wetlands.

b) Functional Assessment

Typical functions of wetlands include nutrient removal, sediment trapping, stream flow augmentation, flood attenuation, erosion control and trapping of pollutants. The functionality assessment was conducted utilising the Wet-EcoService tool.

The wetlands in the study area identified key habitats that differ from the surrounding terrestrial ecosystems and contribute towards the high biodiversity importance of the area. This contributed as captured to the wetlands being classified as critical biodiversity areas and the classification of the wetland vegetation types as Critically Endangered and Endangered. The Groot Dwars River wetland system assists with sediment trapping, while the seep and un-channelled valley bottom wetlands plays an important role in water quality maintenance.

c) Present Ecological Status

The wetland catchments in the study area are considered to be largely intact, also maintaining the flow inputs to the wetlands. Some of the smaller systems have been more heavily impacted where existing mining/construction activities has impacted on flow into wetlands.

Flow distribution and retention within some of the wetlands has also been impacted by linear infrastructure crossings, typically road crossings, which lead to flow concentration and accelerated erosion. Other impacts observed include:

- Alien vegetation, specifically impacting the Everest tributary;
- Flow impoundment, specifically affecting the Everest tributary;
- Increased sedimentation and turbidity associated with ongoing construction work and mining activities. This affects especially wetlands close to Section 24 G activities; and
- Water quality impacts, specifically the Everest tributary and associated seeps, as well as a seepage wetland adjacent to BN.

Notwithstanding the impacts, most of the wetlands, are largely natural to moderately modified with a PES category between B and C. Refer to Annexure I for complete description).

d) Ecological Importance and Sensitivity

“Ecological importance” of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. “Ecological sensitivity” refers to the system’s ability to resist disturbances and its capability to recover from disturbance once it has occurred. Consideration was taken of the location of the wetland within the Oliphant’s River Catchment which is subject to significant water quality issues and the importance of wetland purification and stream flow regulation functions. In addition, contributing factors that informs the EI and ES include:

- The location within the extremely transformed and threatened Sekhukhune Mountainlands which have been classified as Endangered.
- The wetland vegetation types of the area, Mesic Highveld Grassland Group 7 and Central Bushveld Group 1 wetlands, considered to be Endangered and Critically Endangered respectively.
- The fact that virtually the entire study area has been classified in the Limpopo Conservation Plan as a critical biodiversity area, and large portions of the study area (specifically the Groot Dwars River valley) were also classified in the Mpumalanga Biodiversity Sector Plan as critical biodiversity areas.

- The generally largely intact nature of the wetlands and watercourse within the study area, with 85 % of wetland habitat are considered largely natural to moderately modified.

The PES of the wetland systems is included in Table 4-21 and the locations are illustrated in Figure 4-25

Table 4-21 Present Ecological Status of the Booysendal Wetlands

Wetland Type	Importance & Sensitivity			TOTAL
	High	**Moderate**	**Low/Marginal**	
Channelled valley bottom	4.69			4.69
Unchanneled valley bottom	32.31			32.31
Riparian wetland	24.36			24.36
Seep		34.28	3.69	37.97
Sheetrock seep		10.84		10.84
Drainage line		20.90		20.90
TOTAL	61.36	66.02	3.69	131.07
Percentage	46.82%	50.37%	2.81%	100.00%

4.11.4 Ecosystem Services

The ecosystem services identified are included in Table 4-22.

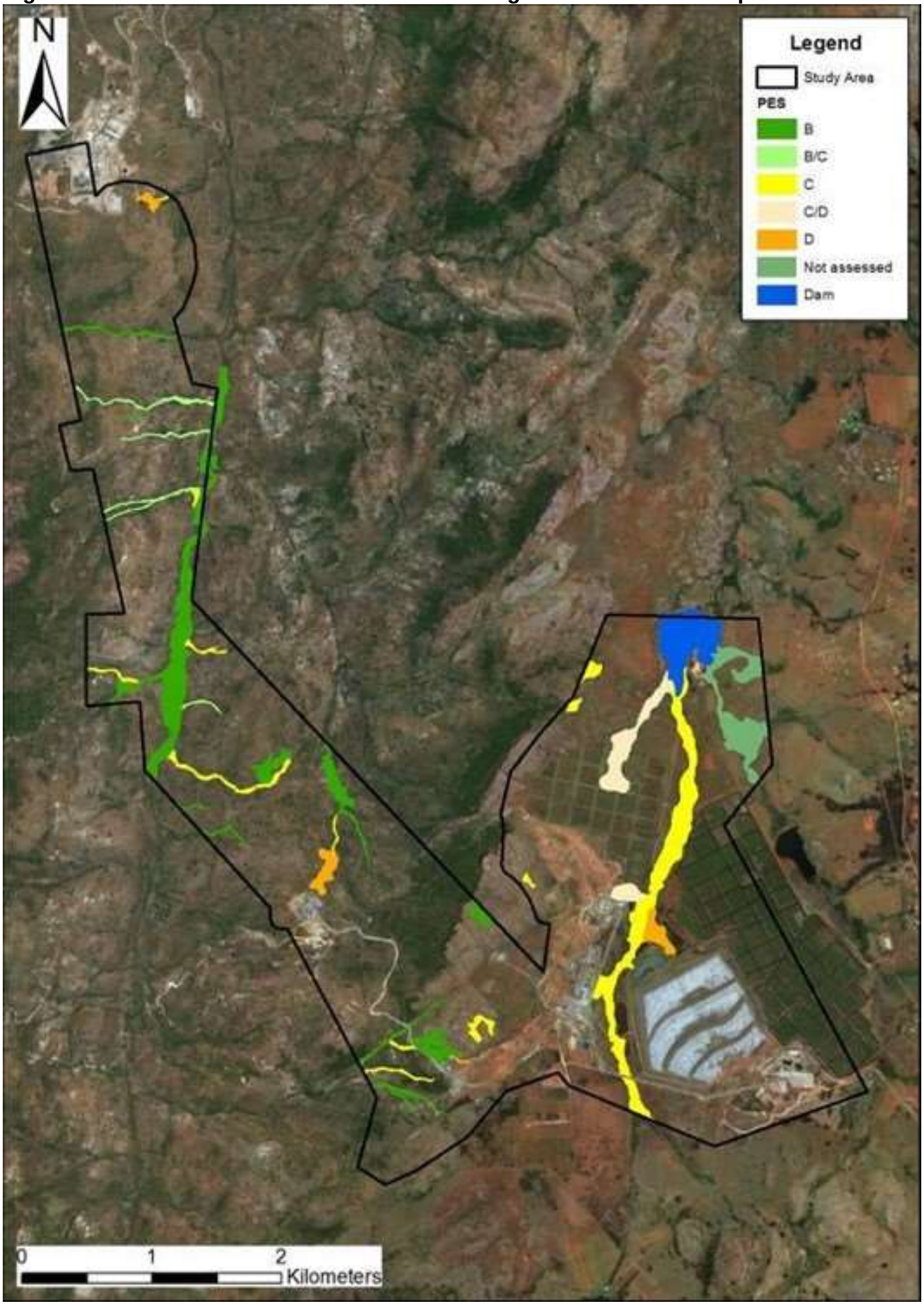
Table 4-22 Identified Ecosystem Services

Ecosystem Service	Service Category	Threats/ Availability	Relevant Environment of ES	Importance of ES	Replicability
Nutrient Removal	Regulating	Destruction of wetlands	All wetlands	Dependant on the type of wetland. mainly high to moderate	Wetlands which have been removed and where infrastructure footprints are cannot be replaced. Wetlands which have been disturbed can be rehabilitated. The input of a wetland rehabilitation specialist is essential.
Sediment Trapping	Regulating	Modification of wetlands and increased silt loads as a result of construction activities.	All wetlands	Dependant on the type of wetland. mainly high to moderate.	Wetlands which have been removed and where infrastructure footprints are cannot be replaced. Wetlands which have been disturbed can be rehabilitated. The input of a wetland rehabilitation specialist is essential.
Flood Attenuation	Supporting	Removal and modification of wetlands as a result of construction activities.	All wetlands	Dependant on the type of wetland. mainly high to moderate.	Wetlands which have been removed and where infrastructure footprints are cannot be replaced. Wetlands which have been disturbed can be rehabilitated. The input of a wetland rehabilitation specialist is essential.
Erosion Control	Regulating	Destruction of modification of wetlands as a result of the construction activities.	All wetlands	Dependant on the type of wetland. mainly high to moderate.	Wetlands which have been removed and where infrastructure footprints are cannot be replaced. Wetlands which have been disturbed can be rehabilitated. The input of a wetland rehabilitation specialist is essential.
Pollutant Trapping	Regulating	Deterioration in the PES as a result of modification or destruction of wetlands.	All wetlands	Dependant on the type of wetland. mainly high to moderate.	Wetlands which have been removed and where infrastructure footprints are cannot be replaced. Wetlands which have been disturbed can be rehabilitated. The input of a wetland rehabilitation specialist is essential.

4.11.5 Wetland Sensitivities

Refer to Section 4.11.3.

Figure 4-25 Location and Classification of Ecological Sensitive and Important Wetlands



4.11.6 Gap Analysis

The following gaps and limitations were identified in the wetland assessment:

- The S24G activities had commenced prior to the field survey and resulted in substantial alterations to the surrounding areas. Therefore the baseline conditions, including the extent of wetland habitat within the development footprints are unknown.
- No hydro-pedological modelling of wetland flow inputs was undertaken.
- No information was available on the likely impact of underground mining on surface flow within the Groot Dwars River or other surface water resources.

4.12 WATER QUALITY

The scope of work for the water quality study was to conduct a trend analysis of the surface-and groundwater monitoring data over time and to interpret the trends to assess if the current Section 24G activities have an impact on water quality. The water quality analysis was undertaken by Aquatico Scientific (Pty) Ltd on behalf of Clean Stream. The overall finding from the study indicated that there has been a slight increase in macro and micro nutrients in the river system, however the same trends can be seen upstream of the mining activities. This indicates that changes occuring in the river system are not limited to the mining boundaries. The Water Quality Report is included in Annexure J.

4.12.1 Methodology

The surface-and groundwater assessment was conducted at desktop level. Aquatico has conducted water quality sampling at all the Booysendal operations since January 2015. All sampling is conducted by a team of trained field technicians. Samples are submitted within 48 hours to a SANS accredited laboratory for analyses. Monthly data is compared to the applicable water use limits. Quarterly and annual assessments of the water quality data is done by water quality specialists.

All fieldwork is conducted based on the protocols and specifications, and code of practice contained in the SABS ISO 5667-1-15. These international standards address all aspects from the program design, sampling methods as well as sample preservation and many other aspects. In addition to analysing the Aquatico data sets, historic data, hydrocensus data and annual surface and groundwater reports were consulted to form a baseline for the specialist water report.

4.12.2 Area of Influence

This study mainly focuses on the surface and groundwater areas around the new expansions. Surface water and aquifer areas include the Dwars Rivers, Everest Tributary, as well as the Waterfall (Central) tributary.

4.12.3 Baseline Surface Water Quality

The location of the surface water monitoring points is depicted in Table 4-24. Although these monitoring points are representative of the activities associated with the larger Booysendal operation, it is more focused on the

Section 24G activities. The limits against which the surface water quality was measured is included in Table 4-24

Table 4-23 Surface Water Monitoring Points

Reference	Description	Locality	
		Latitude	Longitude
	River or stream at Booysendal Central		
NBC SW01	Central Dwars River Downstream	S25.12794	E30.11974
NBC SW02	Central Dwars River Midstream at SW03 Confluence	S25.12970	E30.11949
NBC SW03	Central South Stream Tributary before Confluence with Dwars River	S25.13160	E30.11744
NBC SW04	Central South Stream Tributary Upstream	S25.13065	E30.11535
	Dwars River and Tributaries		
NBS GD1	Groot Dwars River, downstream of East Stream confluence	S25.10419	E30.12360
NBS GD2	Groot Dwars River, upstream of East Stream confluence	S25.11011	E30.12293
NBS GD3	Groot Dwars River, downstream of mining area	S25.14514	E30.11735
NBS GD4	Groot Dwars River, upstream of mining area	S25.15403	E30.11678
NBSW01	Groot Dwars River (G-DRS 1)	S25.09276	E30.12285
NBSW02	Groot Dwars River below the De Brochen Dam	S25.05148	E30.11938
NBSW03	Everest (Eastern) Tributary	S25.10738	E30.12443
NBSW04	Groot Dwars River Upstream B/C	S25.10585	E30.12272
NBS E1	East stream + West stream, after TKO1 dam	S25.12567	E30.16084
NBS E2	East stream (Everest tributary) downstream of mining area, before TKO1 dam	S25.13349	E30.15761
NBS E3	East stream (Everest tributary) upstream of mining area, at main tar road crossing	S25.15875	E30.17309
NBS W1	West stream (Kraalspruit) downstream of mining area, before TKO1 dam	S25.14051	E30.15846
NBS W2	West stream (Kraalspruit) upstream of mining area	S25.15546	E30.15283
	TKO Dams		
NBS TKO1	TKO1 - big TKO (Transvaal Kiwi Orchards)	S25.12693	E30.15691
NBS TKO2	TKO2 - big TKO (Transvaal Kiwi Orchards)	S25.14391	E30.16654
	Return water dam		
NBS M1	Excess water dam - MCC1	S25.14847	E30.15367
NBS M3a	Settler No.1	S25.14808	E30.15114
NBS M5	Erickson Dam	S25.15263	E30.14966
NBS M6	Sink Dam	S25.14816	E30.15190
NBS P3	Tailings Return Water Dam	S25.15132	E30.15679
NBS P4	Inflow to Return Water Dam (Tailings)	S25.15135	E30.15678
	Seepage		
NBS VS01	Valley box cut stream	S25.14731	E30.11709
NBS VS02	Valley box cut	S25.14929	E30.12994
	Process water dam		
NBS P1	Concentrator Plant Process Water Dam	S25.15823	E30.16660
NBPW04	Frog Pollution Control Dam	S25.09335	E30.12238

Table 4-24 Surface Water Quality Limits

VARIABLE	UNITS	Water Resource Protection - Dwars River Instream Water quality; WUL 2006	Special Authorisation Limit, Section 21f and g, 2013	SAWQG Volume 4, Agricultural Use Irrigation TWQGR for Crop Yield; DWAF (1996)	SAWQG Volume 5, Agricultural Use, Livestock Watering, Cattle; DWAF (1996)	SAWQG Volume 7, Aquatic Ecosystems; DWAF (1996)
pH @ 25°C	pH	-	5.5/7.5	6.5/8.4	-	-
Electrical conductivity (EC) @ 25°C	mS/m	-	100	40	-	-
Total dissolved solids (TDS)	mg/l	520	-	-	2000	-
Calcium (Ca)	mg/l	25	-	-	1000	-
Magnesium (Mg)	mg/l	25	-	-	500	-
Sodium (Na)	mg/l	9	-	70	2000	-
Potassium (K)	mg/l	46	-	-	-	-
Chloride (Cl)	mg/l	62	-	100	3000	-
Sulphate (SO_4)	mg/l	70	-	-	1000	-
Nitrate (NO_3) as N	mg/l	6	1.5	-	45	-
Ammonium (NH_4) as N	mg/l	-	2	-	-	-
Orthophosphate (PO_4) as P	mg/l	-	2.5	-	-	-
Fluoride (F)	mg/l	-	1	2	4	0.75
Aluminium (Al)	mg/l	-	-	5	5	0.005
Boron (B)	mg/l	-	0.5	0.5	5	-
Cadmium (Cd)	mg/l	-	0.001	0.01	0.01	0.00015
Hexavalent chromium (Cr^{6+})	mg/l	0.014	0.02	0.1	1	0.0007
Chromium (Cr)	mg/l	-	-	-	-	0.007
Copper (Cu)	mg/l	-	0.002	0.2	0.5	0.0003
Iron (Fe)	mg/l	-	0.3	5	10	-
Manganese (Mn)	mg/l	-	0.1	0.02	10	0.18
Lead (Pb)	mg/l	-	0.006	-	0.1	0.0002
Vanadium (V)	mg/l	-	-	0.1	1	-
Zinc (Zn)	mg/l	-	0.04	1	20	0.002
Total suspended solids (TSS)	mg/l	-	10	50	-	-
Chemical oxygen demand (COD)	mg/l	-	30	-	-	-
Oil and grease (SOG)	mg/l	-	0	-	-	-
Sodium Adsorption Ratio	SAR	-	-	2	-	-
Dissolved Oxygen	mg/l	-	-	-	-	-

a) Process Water Dam Qualities

The water quality results are included on Annexure A of the Water Quality Report attached as Annexure J. Due to the extensive nature of the dataset. The baseline section contains a summary of results. For more detailed information, please refer to Annexure J.

There are various process water dams at BS4. As a result of the mine operations at BS4 having been placed under care and maintenance since 2012, the water qualities of Frog PCD at BN were used as reference process water qualities. The process water dams at BS4 include: NBS M1 (Excess water dam – MCC1), NBS M3a (Settler No.1), NBS M5 (Erickson Dam), NBS M6 (Sink Dam), NBS P1 (Concentrator Plant Process Water Dam), NBS P2 (Concentrator Process Storm water Dam), NBS P3 (Tailings Return Water Dam) and NBS P4 (Inflow to Return Water Dam Tailings) will be discussed under process water at BS4 and the NBPW04, Frog PCD as a process water locality from BN.

The trend analysis found that the process water quality at the BS4 is fairly good, as these areas mainly contain storm run-off due to the mine being under care and maintenance for several years. The process water dam qualities are summarised as follows:

- The process water qualities are neutral to alkaline with pH results variating between 7 and 10. The ideal water quality ranges for process water to be re-used in industrial process are between 7 and 8 as the higher the alkalinity of the water the higher the possibility of scaling or deposits to occur in equipment and processes (DWAF;1996).
- The EC-values for the BS4 process water dams were below 100 mS/m, which is within the acceptable range as listed in the Special Limit for waste water discharge, whereas the process water at the Frog PCD at BN fluctuate between 100 mS/m and 400 mS/m. A decrease in water quality of the process water dams at BS4 can be expected once the mine becomes operational again.
- The BS4 process water dams generally complied with the Dwars River limits in terms of Mg, Cl and K with only slight exceedances in terms of Ca and Na. The SO_4 concentrations were stable for the selected period with only NBS P4 and NBPW04 that fluctuated during the same period.
- These concentrations measured at NBS P4 can be remnants from the process water that was discharged into the dam while the mine was still operating. The higher SO_4, NO_3_N and Cl concentrations at the FROG PCD is expected because the water forms part of the closed process water system used by BN.

For details around water qualities please refer to Annexure J.

Although process water dam qualities at BS4 are currently within the range limits for Section 21f limits, it can be expected that the water qualities will change once operations at BS4 commences in the near future.

b) Valley Boxcut Dewatering Qualities

The valley box cut stream (NBS VS01) and valley box cut seepage (NBS VS02) are two valley box-cut decline shafts that decants into the Dwars River Valley. The monitoring at these two localities only commenced in September 2015:

- The water quality at both dewatering areas is monitored on a monthly basis, the data collected between September 2015 and January 2017 will be used in this assessment.
- The pH values were neutral to alkaline during the monitoring period.

- Electrical Conductivity values indicated non-saline water quality with values fluctuating between 10 mS/m and 50 mS/m during the assessment period. These variables had values exceeding the special limit. However, the dilution that occurs between the decant area and the Dwars River is very high, as the Dwars River instream values between the up-and downstream areas does not indicate changes from these two sources.
- Similar trends were observed for Ca, Mg, NO3_N and SO4 with stable trends that decrease slightly in summer months and then start to increase during winter months.
- The K concentrations were more stable compared to the other parameters. The Groot Dwars River guidelines were exceeded in in terms of Ca, Na and NO3_N at locality NBS VS02
- The water quality at NBS VS01 is less likely to cause effects with regards to the discussed variables, whereas slight environmental fluctuations may occur with the water quality from NBS VS02 as this locality tends to have slightly higher concentrations.
- The reason for the higher concentrations at NBS VS02 is unknown.
- Chlorine concentrations fluctuated during the first annual period, thereafter the concentrations stabilised at levels well below the Dwars River guidelines. The Cl concentrations are similar to what would be expected in a natural water system.
- The overall water impact on the natural river is very low, as monitoring localities up-and downstream of the two decant areas does not show increases in water constitutes, indicating that the decant water also dilutes before entering the river system.

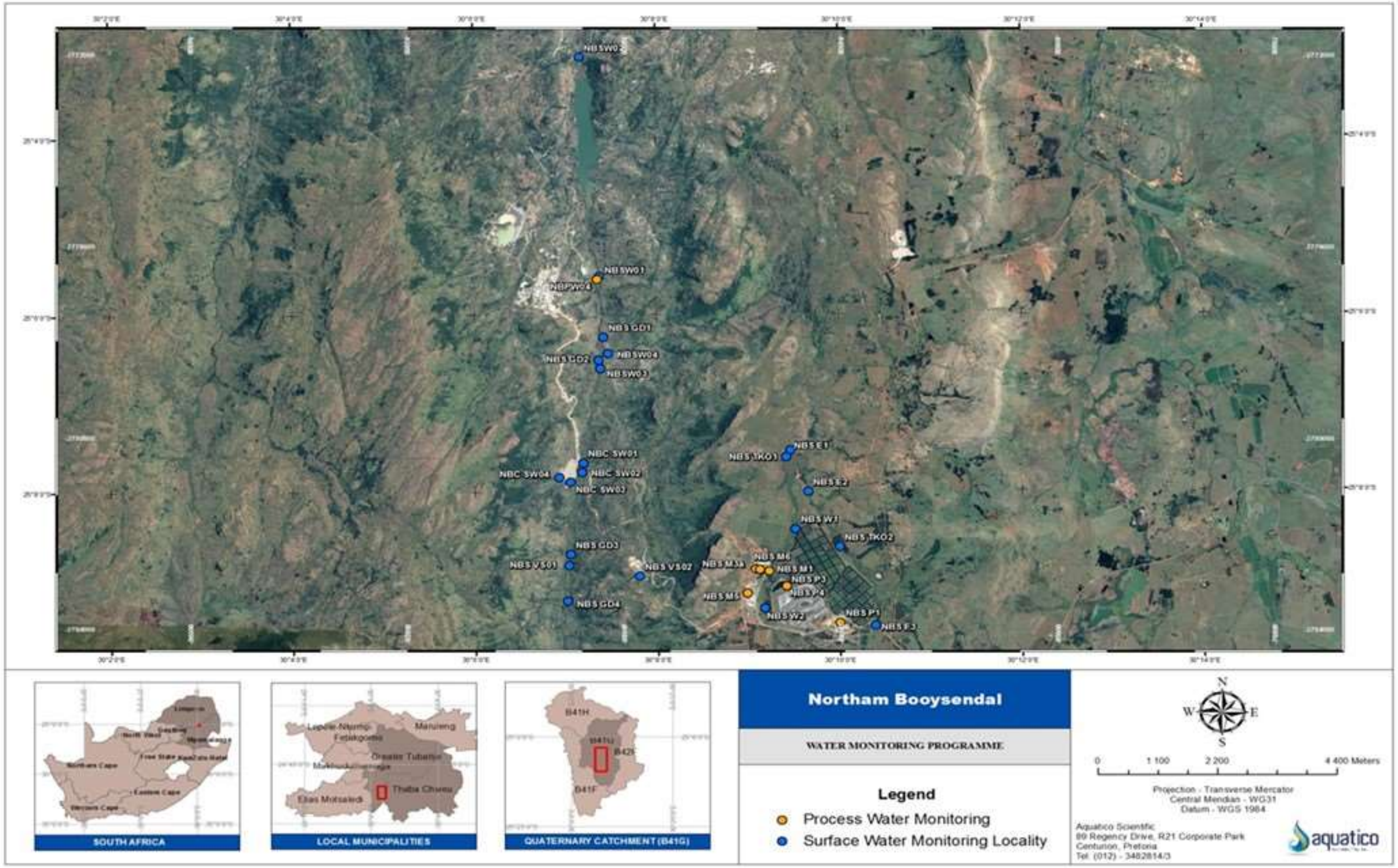
With the exceedance of some of the values it is therefore recommended that no direct discharge be permitted. In the event that discharge becomes necessary, a water treatment plant will be required to treat the water to special limits.

c) Tributaries and Dams

The Western (NBS W1 & NBS W2) and Eastern tributaries (NBS E3, NBS E2 and NBS E1) flow around the BS4 operations, where both flow towards the TKO1 and TKO2 dams downwards to Everest Tributary (NBSW03) into the Groot Dwars River. This locality is vital as any spills or seepage that occurs at BS4 will be picked up at this downstream locality. The map indicating the water monitoring localities is depicted in Figure 4-26.

- The baseline data for the tributaries and dams around the new and old mining activities were added with data from January 2015 to February 2017.
- The receiving environment localities which include the TKO dams, western- and eastern tributaries, indicated neutral pH-values which fluctuate between 7 and 8.5.
- The electrical conductivity had high levels at NBSW03 during January 2015 – March 2015 with concentrations that decreased and remained stable towards the end of 2017.
- All of the selected variables had indicated the same spike in concentrations at NBSW03 with only slight variations recorded towards 2017. The concentrations mainly complied with the Instream Dwars River values for Ca, Mg, K and Na. Locality NBS W1 was recorded as dry October 2016, after which slightly higher SO_4 concentrations were measured during November 2016 and December 2016.
- The Cl concentrations were slightly higher than the baseline at NBS W1 during 2016. Fluctuating Al concentrations were recorded at NBS TK01, NBS E1, NBSW03, NBS W1, NBS TKO02 and NBS E2.
- The water quality measured in the tributaries and dams vary during seasonal changes as the up-and downstream localities has similar trends throughout the assessment period.

Figure 4-26 Surface Water Monitoring Locations



d) Groot Dwars River

The Groot Dwars River valley lies west of the current mining operations. Surface water drainage via the valley areas will directly reach the Groot Dwars River, however any surface drainage at the North Box cut area and processing areas (Plant and TSF) will reach the Groot Dwars River through the Kraalspruit approximately 6km downstream. The localities included in this section are NBS GD1, NBS GD2, NBS GD3, NBS GD4, NBSW01, NBSW02 and NBSW03.

- The pH-values in the Groot Dwars River were neutral to alkaline during the baseline assessment and correlates with the other natural water systems (refer to Appendix A of the Water Quality Report in Annexure J).
- The EC, Ca, Mg, Na, K and NO_3_N recorded very low concentrations even compared to the DWAR River Instream values at all the Groot Dwars River localities.
- During February 2015, the NBSW04 locality has an outlaying value in all the measured concentrations, which can be related to the higher concentrations measured at the Everest Tributary (NBSW03) during the same period (Appendix A of the Water Quality Report in Annexure J).
- This is also an indication of very sensitive limits set as the upstream values also do not comply with the limits.
- The Al concentrations at all of the localities in the Groot Dwars River indicated similar fluctuations during December 2016 to February 2017 as what was observed at the BS4 river localities (Figure 4-15).
- After heavy rainfall in December 2016 and January 2017, the water quality improved in the entire river system, with only NBSW02, the Der Brochen dam downstream area which remained the same. The water quality in the Groot Dwars River catchment varies during seasonal changes as the up-and downstream localities displayed similar trends throughout the assessment period.

e) Central Tributaries

The Central Tributaries currently consist of 4 monitoring localities up-and downstream of the construction areas as well as after confluence with the Groot Dwars River (Figure 4-26). The localities included in this section are NBC SW01, NBC SW02, NBC SW03 and NBC SW04.

- Discussion on the water quality data for BS-1/2 the following variables will be included; pH, EC, Ca, Mg, K, Na, NO3_N, Cl, NH4_N, SO4, Mn and Al. The data for this section was collected from May 2016 until January 2017. Construction started to increase during June 2016 to July 2016.
- The pH-values fluctuated between 8.7 and 8, which is in the alkaline ranges. Compared to other areas, the water pH-values remained within the area values.
- The EC-values were fairly stable from May 2016 to September 2016, with slight increase in October 2016, after which the concentrations decreased to concentrations lower than the initial data measured during the first part of the monitoring period. The same trend was observed from Ca, Mg and Na whereas the K concentrations increased during November 2017 at NBC SW01 and NBC SW02, which is sampled in the Groot Dwars River.
- This could indicate possible influence from the construction operations. The K concentrations did however decrease again during January 2017 to similar concentrations measured before heavy construction started. The Na concentration at the downstream area returned to normal quicker than that of the upstream areas, which can indicate changes in the natural geology with regards to Na.
- The NH4_N measured at NBC SW01 were slightly higher concentrations at July 2016 and December 2017 compared to the upstream localities which remained stable during the same period. Sulphate

(SO4) concentrations at all the monitoring localities increased during July 2016 and January 2017, with locality NBC SW01 that increased during October 2016.

- The Al trends observed at BS1/2 were similar to the trends observed in the Groot Dwars River and Tributary localities.
- The water quality in the Groot Dwars River catchment varies during seasonal changes as the up-and downstream localities displayed similar trends throughout the assessment period.

In summary; the natural water systems within the mining operations indicated water quality with a fairly neutral to alkaline pH-value as well as very low to low anion and cation loads. The natural water quality fluctuates with the changes in seasons as well as rainfall in the area. Slightly higher aluminium concentrations were recorded at several of the natural water systems. However this seems to be a natural occurrence and the measured Al concentrations are most likely to be in a suspended state (due to the neutral pH at all the localities) rather than in solution as would be the case under more acidic pH conditions.

The process water quality at BS4 indicates similar water quality to that measured at the natural water systems, as the process facilities have not been operational as a result of the BS4 mining operations being under care and maintenance. The NBPW03, FROG PCD, is a process water locality situated in the valley and process water from BN is stored for re-use. The water quality at the aforementioned process water locality is an indication of typical process water, with very high to elevated anions and cations, and more alkaline pH-values.

4.12.4 Baseline Groundwater Quality

The groundwater monitoring locations for BN are includedin Figure 4-27 (Please refer to Annexure J for coordinates) and for BS in Figure 4-28. An additional 4 groundwater monitoring boreholes were drilled on recommendation of Future Flow around BS1/2. These boreholes have been incorporated into the monitoring campaign. The limits for groundwater quality are included in Table 4-25. These limits come from the BN and BS4 IWULs and includes SANS241:2011 standards where other limits are not available.

Table 4-25 Groundwater Limits applicable to the Booysendal Operation

VARIABLE	UNITS	SANS 241-1:2015 Drinking Water Standard (SABS, 2015)	WUL;2006 Groundwater Resource – BS-4	WUL;2011 Groundwater Resource – BN
pH @ 25°C	pH	5.0/9.7	-	8.34
Electrical conductivity (EC) @ 25°C	mS/m	170	-	37.51
Total dissolved solids (TDS)	mg/l	1200	246	-
Total hardness	mg CaCO3/l	-	-	-
Total alkalinity	mg CaCO3/l	-	-	-
Calcium (Ca)	mg/l	-	35	20.68
Magnesium (Mg)	mg/l	-	25	5.61
Sodium (Na)	mg/l	200	15	10.45
Potassium (K)	mg/l	-	46	
Chloride (Cl)	mg/l	300	13	8.8

Sulphate (SO_4)	mg/l	500	12	
Nitrate (NO_3) as N	mg/l	11	6	0.48
Nitrite (NO_2) as N	mg/l	0.9	-	
Ammonium (NH_4) as N	mg/l	1.5	-	-
Orthophosphate (PO_4) as P	mg/l	-	-	-
Fluoride (F)	mg/l	1.5	-	-
Aluminium (Al)	mg/l	0.3	-	-
Iron (Fe)	mg/l	0.3	-	-
Manganese (Mn)	mg/l	0.1	-	-
Hexavalent chromium (Cr^{6+})	mg/l	-	-	-
Total suspended solids (TSS)	mg/l	-	-	-
Chromium (Cr)	mg/l	0.05	-	-
Copper (Cu)	mg/l	2	-	-
Zinc (Zn)	mg/l	5	-	-
Boron (B)	mg/l	2.4	-	-
Silicon (Si)	mg/l	-	-	-
Chemical oxygen demand (COD)	mg/l	-	-	-
Oil and grease (SOG)	mg/l	-	-	-
Cadmium (Cd)	mg/l	0.003	-	-
Lead (Pb)	mg/l	0.01	-	-
Arsenic (As)	mg/l	0.01	-	-
Selenium (Se)	mg/l	0.04	-	-
Mercury (Hg)	mg/l	0.006	-	-
Cobalt (Co)	mg/l	-	-	-
Nickel (Ni)	mg/l	0.07	-	-
Vanadium (V)	mg/l	-	-	-

Figure 4-27 Groundwater Monitoring Locations for BN

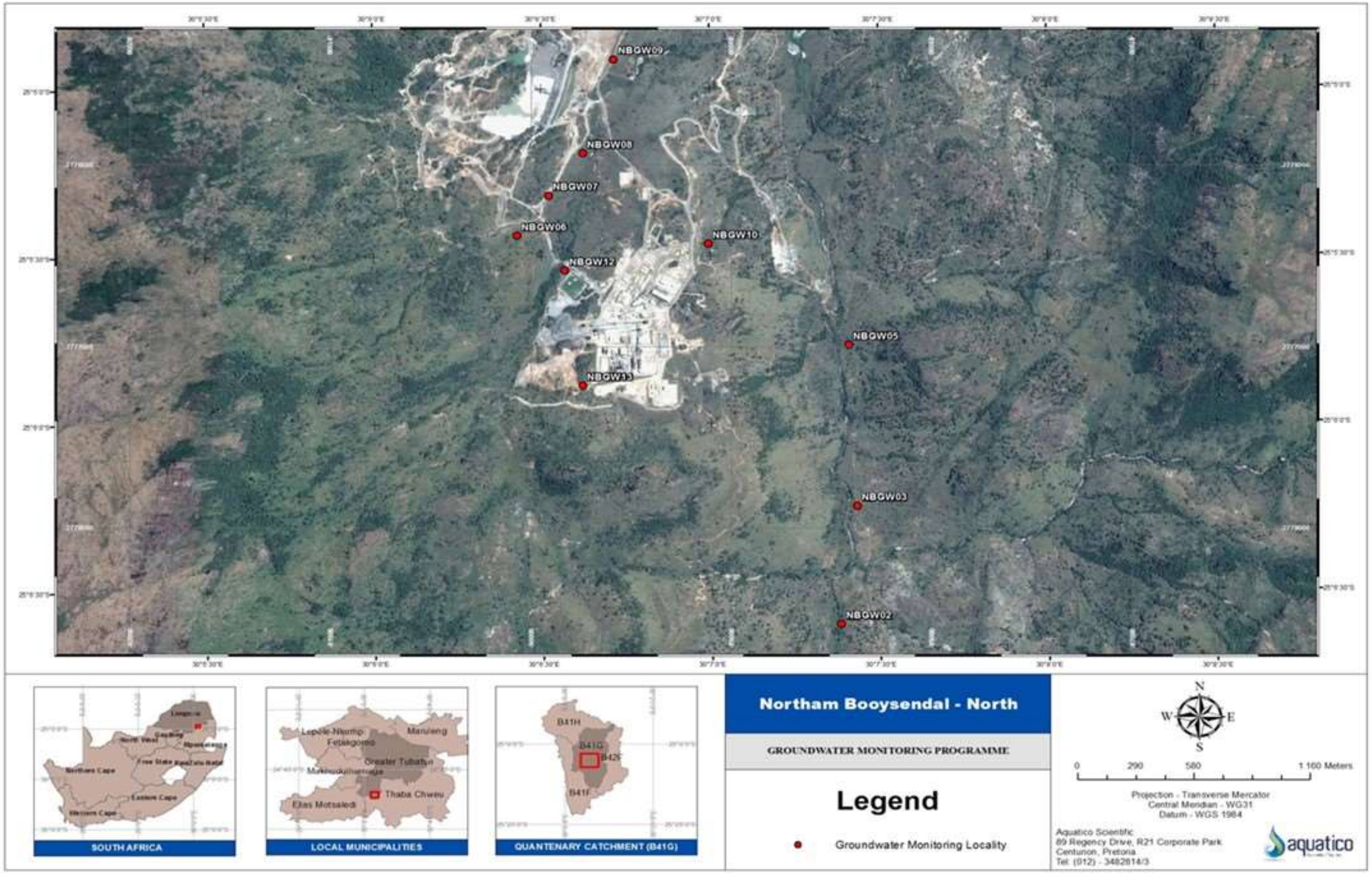
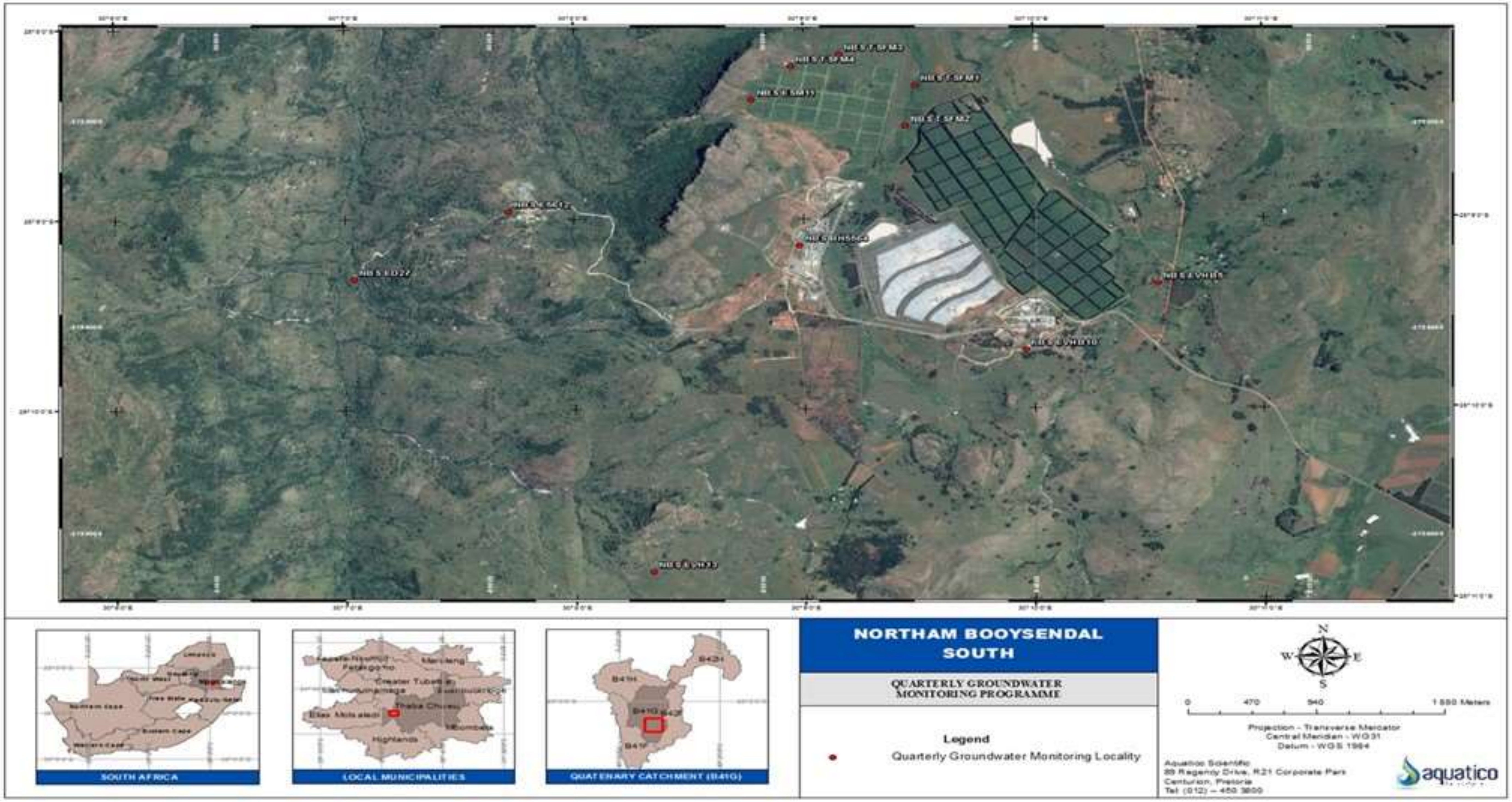


Figure 4-28 Groundwater Monitoring Locations for BS



a) Booysendal North

The site-specific groundwater monitoring results at BN indicate that groundwater quality within the immediate vicinity of the BN mining activities is chemically and physically considered to be of good quality according to the South African National Standards for drinking water *(SANS 241:2015)*. The WUL guideline concentrations were exceeded in the majority of the monitoring boreholes. The long-term trends indicated no signs of any significant increase or decrease in concentrations for the past monitoring year. Long term increases in the calcium and/or magnesium content of groundwater from monitoring boreholes NBGW09, NBGW10, NBGW12 and NBGW13 are however evident when considering the entire data record. We are however of the opinion that these increase trends are not caused by any activities relating to the mine. The following presents a summary of the groundwater qualities at BN: (Please refer to Table for average water qualities and exceedance indications)

- Borehole NBGW09 is located directly down gradient from the slimes dam which, given its relatively large footprint area and "wet source" status, is considered to be one of the more significant sources in the mine lease area. Surface water sampled from the slimes dam's sump is characterised by elevated concentrations of sulphate, sodium, nitrate and chloride. None of these contaminants have yet been detected in monitoring borehole NBGW09.
- Borehole NBGW10 is located down gradient (north-east) from the mine's workshops and administration areas. At this point in time, no single source or specific activity can be linked to the increase in calcium observed in this borehole.
- Borehole NBGW12 is located directly down gradient from pollution control dam 2. Surface water sampled from the dam is characterised by exceptionally high levels of nitrate pollution. Groundwater from NBGW12 has shown no signs of nitrate pollution.
- Borehole NBGW13 is located in the up gradient groundwater flow direction and away from most of the obvious source areas. No reasonable explanation can therefore be provided for the increasing calcium and magnesium trends observed in this borehole.
- The groundwater is dominated by calcium and magnesium cations, while bicarbonate alkalinity dominates the anion content.
- With regards to the organic and bacteriological content of the groundwater, SOG scans found organic compounds in all monitoring boreholes, while *E.coli* was found in boreholes NBGW06 and NBGW10. At this point in time no reasonable explanation can be provided for the occurrence of *E.coli* in the two abovementioned boreholes. Neither one of them are located near any form of a sewage treatment facility, which in a mining environment, is the main potential source of bacteria.

When compared to the South African National Standards for drinking water *(SANS 241:2015)*, groundwater from the three regional monitoring boreholes is chemically and physically considered to be of good quality. The calcium, magnesium and sodium content of groundwater from all three regional monitoring boreholes exceeded the WUL guideline concentrations. No significant change in concentration trends are evident.

With regards to the organic and bacteriological content of the groundwater, SOG scans found organic compounds in all three boreholes, while E.coli was found in boreholes NBGW02 and NBGW3. This cannot be linked to any mining or related activity therefore, the only reasonable explanation for the bacteria in these two boreholes is that it originated from pit latrines or areas where animals congregate (i.e. feedlot or kraal). The groundwater is dominated by calcium and magnesium cations, while bicarbonate alkalinity dominates the anion content.

Table 4-26 Groundwater Chemical Concentrations at BN

Borehole ID	pH	EC mS/m	TDS mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l
NBGW02	8.4	52.5	346.0	46.7	38.9	22.9	0.5	5.5
NBGW03	8.0	49.0	339.5	61.9	27.4	13.0	0.4	2.3
NBGW05	7.7	46.4	319.3	51.1	30.5	10.1	0.4	5.2
NBGW06	7.8	31.1	243.7	34.4	18.2	7.6	0.5	2.9
NBGW07	7.8	39.9	293.7	47.0	22.5	9.9	0.7	3.2
NBGW08	7.7	41.4	304.2	46.7	25.2	10.0	0.5	3.9
NBGW09	8.0	65.1	452.0	78.6	40.4	16.5	0.7	11.3
NBGW10	7.8	53.3	372.2	76.8	21.8	14.3	0.3	13.9
NBGW12	7.4	109.7	718.0	157.4	56.2	20.1	0.5	107.2
NBGW13	8.0	69.9	502.7	70.8	56.3	15.1	0.7	6.4
Borehole ID	**SO_4 mg/l**	**NO_3 mg/l**	**F mg/l**	**Al mg/l**	**Fe mg/l**	**Mn mg/l**	**NH_4 mg/l**	**PO_4 mg/l**
NBGW02	0.9	0.3	<0.466	<0.005	0.002	0.004	0.201	0.034
NBGW03	17.9	0.7	<0.466	0.008	<0.009	<0.001	0.148	0.033
NBGW05	1.8	0.3	0.125	0.110	1.415	0.072	0.145	0.022
NBGW06	1.4	1.4	<0.466	<0.005	<0.009	<0.001	0.084	0.036
NBGW07	4.4	1.5	<0.466	<0.005	<0.009	<0.001	0.070	0.033
NBGW08	3.5	0.4	<0.466	<0.005	<0.009	0.038	0.252	0.028
NBGW09	28.3	1.5	<0.466	<0.005	<0.009	<0.001	0.061	0.029
NBGW10	19.4	2.4	<0.466	<0.005	<0.009	<0.001	0.065	0.028
NBGW12	13.0	0.5	<0.466	0.011	<0.009	**0.610**	0.089	0.031
NBGW13	18.9	1.3	<0.466	<0.005	<0.009	<0.001	0.117	0.027

Parameters in Red indicated exceedance of drinking water standards SANS241:2011

b) Booysendal South

A total of 18 groundwater monitoring boreholes occur throughout the mining rights area and their positions are indicated in Figure 4-28. 6 of these boreholes are currently being sampled at monthly intervals, while the remaining 12 are sampled quarterly. Note that boreholes NBSEVH5, NBSEVH12 and NBSEVH13 are considered to be regional/non-source specific monitoring boreholes and their groundwater qualities are therefore expected to be representative of the ambient/unaffected groundwater quality conditions.

5 chemical and physical parameters (TDS, SO4, pH, NO3 and Mg) were again chosen from the full list of inorganic analyses as indicators of the type of contamination that could potentially occur at the BS operations. Average concentrations of chemical and physical indicator parameters for the past year are provided in Table 4-27. A summary of the groundwater qualities at the various operational areas is as follows:

Process Plant: Groundwater within the immediate vicinity of the plant is of relatively good quality (as some of the parameters do however exceed SANS guideline concentrations) per guidelines stipulated in the Water Use Licence and the South African National Standards for drinking water. The iron content of groundwater down gradient from the plant is however of concern as high concentrations were measured in borehole NBSESM8. The manganese and fluoride content in this borehole also exceeded the maximum permissible SANS concentrations of 0.4 mg/l and 1.5 mg/l respectively. The plant area is mainly dominated by fresh, clean, relatively young groundwater that has started to undergo magnesium ion exchange. The groundwater is consequently dominated by magnesium cations, while bicarbonate alkalinity dominates the anion content.

Table 4-27 Annual Average Groundwater Quality at BS4

Borehole ID	pH	EC mS/m	TDS mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l
NBSE5612	8.2	47.2	318.3	47.7	29.1	14.5	1.4	3.7
NBSED27	8.2	55.7	284.8	18.6	2.4	87.0	3.5	106.3
NBSESM2	7.6	16.5	124.8	11.9	10.9	3.9	0.5	4.0
NBSESM3	8.1	29.3	203.5	19.0	24.6	5.5	1.3	9.3
NBSESM5	8.8	31.7	211.4	8.4	31.9	8.9	1.0	6.3
NBSESM6	7.4	11.8	87.9	8.1	7.4	2.7	1.5	5.3
NBSESM7	7.7	16.6	102.6	9.5	10.5	5.7	0.5	10.9
NBSESM8	6.7	5.8	37.1	3.2	1.6	1.3	0.5	0.8
NBSEVH12	7.9	12.9	80.0	10.6	6.4	5.2	0.8	7.2
NBSEVH13	8.1	21.1	153.5	21.1	10.9	6.5	0.7	11.9
NBSEVHB10	6.5	3.0	19.5	1.4	1.1	0.8	0.2	0.5
NBSEVHB5	7.6	26.3	199.5	26.0	17.7	5.7	0.9	10.8
NBSTSFM1	7.8	20.0	148.8	15.9	13.9	6.9	0.4	1.4
NBSTSFM2	8.1	23.0	151.0	18.0	14.1	10.3	0.5	3.5
NBSTSFM3	7.6	16.2	124.5	12.6	10.5	3.6	0.2	3.4
NBSTSFM4	7.6	26.8	174.0	37.9	9.3	5.5	2.6	11.2
Borehole ID	SO_4 mg/l	NO_3 mg/l	F mg/l	Al mg/l	Fe mg/l	Mn mg/l	NH_4 mg/l	PO_4 mg/l
NBSE5612	20.8	2.7	<0.472	<0.005	<0.009	<0.001	0.568	0.018
NBSED27	1.7	0.2	<0.472	<0.005	<0.009	0.135	**2.935**	0.016
NBSESM2	0.8	0.8	0.083	<0.005	0.244	**0.484**	0.265	0.025
NBSESM3	5.9	4.1	<0.472	<0.005	<0.009	<0.001	0.427	0.025
NBSESM5	3.1	**19.6**	<0.472	<0.005	<0.009	<0.001	0.525	0.027
NBSESM6	1.6	0.4	0.511	<0.005	1.168	**0.411**	0.254	0.005
NBSESM7	0.8	1.9	<0.472	<0.005	0.017	0.007	0.905	0.023
NBSESM8	0.6	0.4	**1.871**	<0.005	**3.620**	**1.874**	0.110	0.008
NBSEVH12	1.7	0.6	<0.472	<0.005	<0.009	<0.001	0.373	0.017
NBSEVH13	1.7	1.1	<0.472	<0.005	<0.009	<0.001	0.034	0.019
NBSEVHB10	1.5	0.6	<0.472	<0.005	<0.009	<0.001	0.045	0.018
NBSEVHB5	5.2	1.7	<0.472	<0.005	<0.009	<0.001	0.038	0.028
NBSTSFM1	2.7	0.3	<0.472	0.022	<0.009	0.299	0.044	0.019
NBSTSFM2	1.8	3.8	<0.472	<0.005	<0.009	<0.001	0.040	0.016
NBSTSFM3	1.7	0.4	<0.472	<0.005	<0.009	<0.001	0.096	0.019
NBSTSFM4	12.8	0.5	<0.472	<0.005	<0.009	0.009	0.069	0.017

Parameters in Red indicates exceedance of SANS241:2011 drinking water standards

TSF 1: Groundwater within the immediate vicinity of the tailings dam is of good quality according to guidelines stipulated in the Water Use Licence and the South African National Standards for drinking water. The nitrate content of groundwater from monitoring borehole NBSESM3 did at times exceed the WUL guideline value of 6 mg/l, which is believed to be seasonally driven. The tailings dam is the most obvious source of the nitrate contamination, which was originally introduced to the mining environment through the usage of nitrate based explosives. However, the seasonally driven trend observed for NBSESM3 is not shared by the two other down gradient monitoring boreholes (NBSESM2 and NBSESM7), which suggests that the tailings dam may not be the only source contributing to the groundwater nitrate content of monitoring borehole NBSESM3.

The tailings dam area is mainly dominated by fresh, clean, relatively young groundwater that has started to undergo magnesium ion exchange. The groundwater is consequently dominated by magnesium cations, while bicarbonate alkalinity dominates the anion content.

TSF 2: Groundwater within the immediate vicinity of the proposed TSF2 is of good quality according to guidelines stipulated in the Water Use Licence and the South African National Standards for drinking water. The WUL guideline concentration for calcium is 35 mg/l, was exceeded in monitoring borehole NBSTSFM4. Borehole NBSTSFM2 displayed high nitrate content in October 2016, which according to historical monitoring data is not uncommon for this borehole. The overutilisation of nitrate-containing fertilisers by the nearby kiwi orchard is believed to be responsible for this phenomenon. It is also possible that seepage from upstream groundwater could have impacted on the nitrate concentrations.

The tailings dam area is mainly dominated by fresh, clean, relatively young groundwater that has started to undergo magnesium ion exchange. The groundwater is consequently dominated by calcium and magnesium cations, while bicarbonate alkalinity dominates the anion content.

Workshop Area and MCC1 PCD: Borehole NBSBH5564 remained blocked throughout the entire evaluation period and therefore could not be sampled.

The groundwater down gradient from the MCC1 dam (borehole NBSESM5) is affected by nitrate pollution and remedial actions need to be considered to mitigate the impact. On the positive side, the nitrate content in this borehole decreased from 33 mg/l in February 2016 to 9 mg/l in February 2017. This decreasing trend forms part of a much longer trend that began shortly after the May 2012 sampling run and at a time when the groundwater nitrate content was nearly 140 mg/l. It is assumed that this is as a direct result of mining activities which have ceased. These findings are in line with the hydrogeology report which indicated leachate of nitrates from TSF 1 and the RWD.

The groundwater magnesium content in borehole NBSESM5 exceeded the WUL guideline concentration of 25 mg/l. Similar to nitrate, the magnesium content in this borehole has been decreasing during the past five years or so. This also corresponds with the ceasing of mining activities. Management measures in the form of lining and the current upgrade of the stormwater management system could alleviate the seepage issue and associated impacts on groundwater.
The MCC1 dam area is dominated by groundwater that is usually a mix of different types – either clean water from fields 1 and 2 of the Expanded Durov diagram that has undergone sulphate, but especially nitrate mixing/contamination or old stagnant sodium chloride dominated water that has mixed with water richer in magnesium. The groundwater is consequently dominated by magnesium cations, while nitrate dominates the anion content. This can be directly attributed to impacts associated with the past mining activities.

It is important that the downstream wetland be protected as part of the upgrade of this PCD. It is also important that the rehabilitation of the redundant PCD take into consideration this waste stream and that it is managed in accordance with best practice. Waste classification of this waste steam will most likely be required. None of the water in the redundant PCD should be discharged directly into the environment.

Valley Boxcut: Groundwater within the immediate vicinity of the valley box cut is considered to be of good quality and also suitable for human consumption according to the South African National Standards (SANS 241:2015). However, concentrations of most chemical and physical indicator parameters exceeded the guideline values as stated in the Water Use Licence of 2006. Monitoring borehole NBSE5612 is dominated by magnesium cations and bicarbonate alkalinity, which is an indication of fresh, clean, relatively young groundwater. On the other hand, groundwater from NBSED27 is dominated by sodium cations and chloride anions, which is representative of very old stagnant water that has reached the end of the hydrogeological cycle.

Regional Borehole Qualities: Groundwater from regional monitoring boreholes is of good quality and shows no signs of impacts from mining and/or any other activities. Groundwater is dominated by calcium/magnesium cations and bicarbonate alkalinity, which is typical of ambient/unaffected groundwater quality conditions.

4.12.5 Ecosystem Services

The water quality study identified the provisioning service for drinking water as an ecosystem service. (Please refer to Table 4-8 for assessment of this ecosystem service).

4.12.6 Water Sensitivities

The Groot Dwars River drains towards the Olifants River which is considered one of the most polluted rivers in Southern Africa (Myburgh & Botha, 2009), it is therefore important to ensure that the upper catchment of this already stressed river system is monitored closely, and that impacts are mitigated and restricted.

4.12.7 Gap Analysis

Various gaps, limitations and restrictions were noted and identified during the conduction of the hydrogeological assessment. As a result of collapse, the monitoring and assessment of some of the boreholes over time was not possible. The collapsed boreholes will be required to be fixed or alternatively that new boreholes be drilled. During the rainy season, some boreholes become inaccessible, restricting and limiting the data collected and the final assessment and findings made.

4.13 NOISE AND VIBRATION

The noise and vibration assessment was carried out by Barend van der Merwe from dBAcoustics. The purpose of the environmental noise and vibration study was to determine the environmental baseline noise and vibration levels at BS1/2 complex, along the overland main access road between BN and BS4, ARC system as well as at the abutting residential areas (east, south and west) of the Groot Dwars River Valley. The noise baseline information was then used to calculate the possible noise intrusion levels from the mine activities at the noise receptors to the east, west and south of the Groot Dwars River Valley and to determine if vibrations related to blasting will have an impact on potential receptors. The Noise and Vibration Assessment is included in Annexure K.

4.13.1 Methodology

The methodology followed for the noise and vibration assessment consisted of:

a) Desktop Review

The desktop review involved the review of all previous noise and vibrations assessments carried out for Booysendal and BS4 (Everest). Historical studies and the scope of historical studies were limited.

b) Field Surveys

The noise and vibration study was carried out during three periods, namely summer (15 to 16 February 2016), winter time (19 July 2016) and spring (10 October 2016). The different periods were required due to the difference between the prevailing ambient noise levels during summer when the insect activities increased the prevailing ambient noise levels whereas there are no insect activities during the winter, resulting in lower prevailing ambient noise levels. The different field surveys were furthermore required due to the expansion of the project definition. The noise measurements were preceded by an identification of points where noise measurements were required (refer to Annexure K). Daytime (6:00 – 22:00) and night time (22:00 – 6:00) noise measurements were taken with the following instruments:

- Larsen Davis Integrated Sound Level Meter Type 1 – Serial no. S/N 0001072;
- Larsen Davis Pre-amplifier – Serial no. PRM831 0206;
- Larsen Davis ½" free field microphone – Serial no. 377 B02 SN 102184; and
- Larsen Davis Calibrator 200 – Serial no.9855.

The L_{Aeq} was measured over a representative sampling period exceeding 10 minutes at each measuring point. The instruments were calibrated before and after each reading and the calibration certificates for the instruments are also included on the noise report.

c) Reporting

The assessment of noise levels is described using statistical noise calculations based on an average of the projected noise levels of the project. This is compared to the ambient noise level. The outcome of the comparison provides an intrusion level which can vary in dBA. Anything over the allowed threshold level of 7dBA is considered a noise disturbance. The measurement of noise levels is based on an Leq value, which is the constant sound level that would contain the same acoustic energy as the varying sound level during a period.

Noise calculations were done using the equation:
$Lp = Lw – 20\log R – 5dB$
Where:
Lp is the sound level at a distance from the source in dBA,
Lw the sound level at source in dBA and
R the distance to the source.
The noise level inputs used for the various noise sources are included in Table 6-4 of the Noise Impact Assessment Report (Annexure K).

Blasting during the construction phase can cause ground vibration and over-air pressure. The formula used to calculate vibration is: $V = k.\left(\frac{R}{\sqrt{W}}\right)^{b}$ where V is the peak particle velocity in mm/s; R is the distance from the blast to the monitoring point in m; W is the explosive charge weight per delay in kg; k and b are standard weighting factor.

Air Overpressure is generally more apparent than ground vibration and can cause for instance windows to rattle. The formula used to calculate air overpressure is: $P[dBZ]5\% = 165.3 - 24\log 10\left(\frac{D}{\sqrt[3]{W}}\right)$ where P is the 95th percentile of the peak pressure on dBZ; D is the distance to the blast in and W is the charge per mass delay in kg.

4.13.2 Area of Influence

The AoI applicable to the noise investigation includes an area around the operation where noise abatement levels will be within legal limits. This includes all residential areas within a 4km radius from the mining operations. The AoI as included in the noise study is included in Figure 4-29.

Figure 4-29 Noise Assessment Area of Influence (Noise Impact Assessment, 2017 as taken from Google Earth, 2016)

4.13.3 Baseline Noise and Vibration Findings

Existing noise sources in the study area include; the processing plant at BN (which can be heard near the communities at BS4), heavy duty vehicle noise, distant traffic from the feeder roads, construction activities at BS1/2, sounds associated with farming activities, birds and insects.

It is important to note that the Groot Dwars River valley is encompassed with mountains which acts as natural noise barriers. Furthermore, sound levels decrease by 6dB with a doubling in distance for point source noise 3dB uniform linear sounds. Other natural factors which influences noise and which were taken into consideration in the study, include wind, climate conditions. Standards for noise levels for different areas have been developed in SANS10103:2008 and are included in Table 4-28.

Table 4-28 SANS 10103:2008 Noise Standards

Type of District	Equivalent Continuous Rating ($L_{Req.T}$) for ambient noise - dBA					
	Outdoors			Indoors, with Open Windows		
	Day-Night L_{Rdn}	Day L_{Reqd}	Night L_{Reqn}	Day-Night $L_{R.dn}$	Day $L_{Req.d}$	Night $L_{Req.n}$
Rural Districts	45	45	35	35	35	25
Suburban with little road traffic	50	50	40	40	40	30
Urban Districts	55	55	45	45	45	35
Urban with some workshops, business premises and main roads	60	60	50	50	50	40
Central Business District	65	65	55	55	55	45
Industrial District	70	70	60	60	60	50

Baseline noise measurements were undertaken at representative points illustrated in Figure 4-30. A description of each measuring point is included in Annexure K. The baseline noise levels measured during the two survey periods are included in Table 4-29.

Figure 4-30 Background Noise Measurement Locations (Source: dBAcoustics, June 2017)

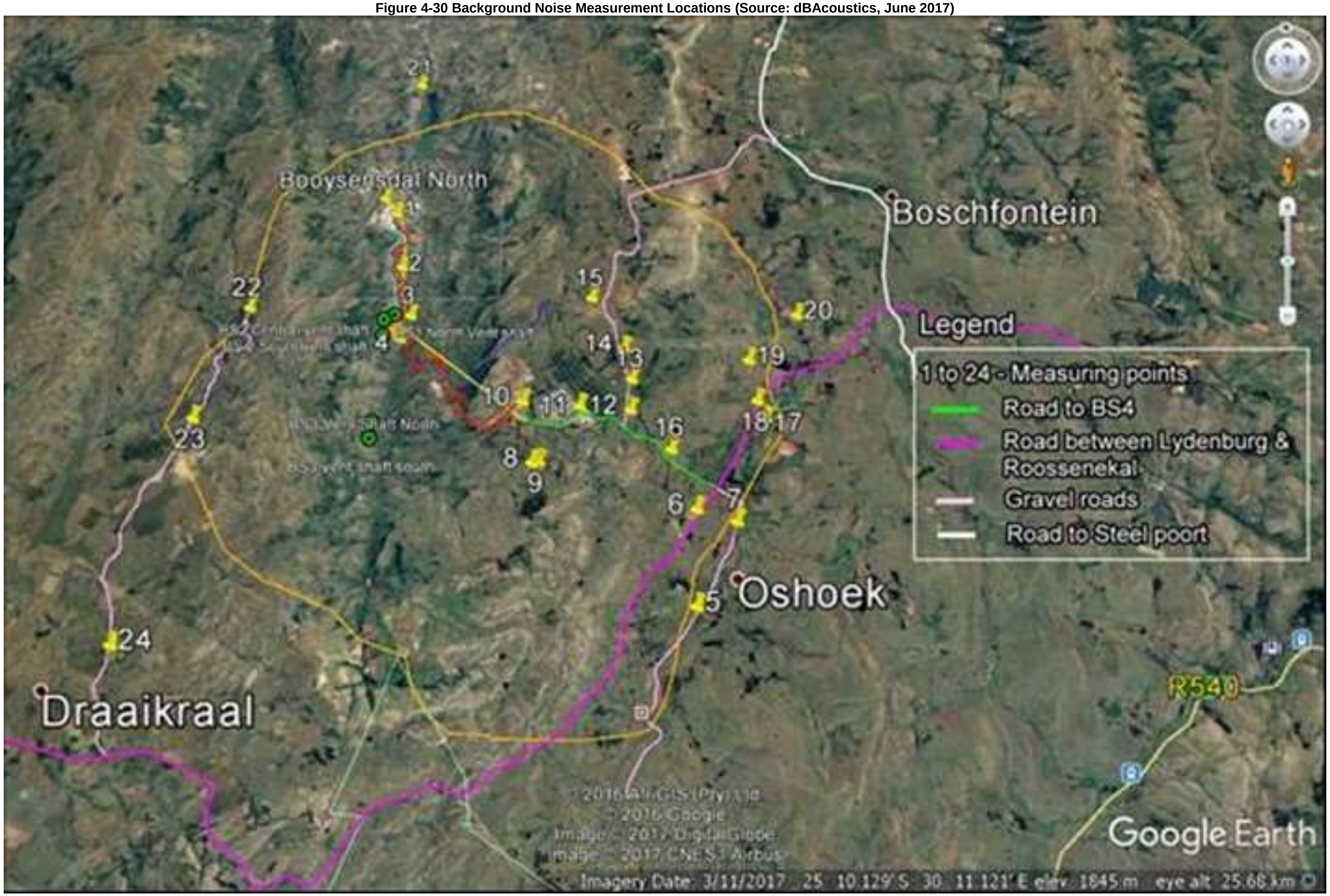


Table 4-29 Baseline Noise Levels

Position	Day Time				Night Time			
	Leq dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA	Remarks	Leq dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA	Remarks
1	62.1	72.8	52.8	Crushing at a mobile crusher	No night time noise readings taken			
1a	76.5	82.6	71.7	Opposite the 2nd crusher				
1b	62.9	73.6	60.1	Opposite the concentrator				
1c	63.3	69.6	61.2	Opposite the concentrator				
1d	49.7	62.2	42.6	400m from the plant				
2	34.0	64.7	20.6	Natural noise	32.0	50.5	24.4	Distant insects
3	41.4	67.5	25.5	Excavator activities 300m from site	30.0	58.2	21.7	Distant insects
4	35.4	63.6	23.8	Far distance excavator	28.8	48.4	24.7	Distant insects
5	32.3	49.5	20.0	Distant R577 traffic & domestic noise	29.8	49.1	19.4	Distant insect noise
6	34.4	60.0	22.1	Distant R577 traffic & domestic noise	28.2	44.8	22.2	Distant insect noise
7	36.0	49.5	18.4	Distant R577 traffic & domestic noise	31.2	48.1	19.1	Distant insect noise
8	33.7	47.2	19.9	Farm animals 50.3dBA aircraft	36.5	47.5	33.3	Distant insect noise
9	27.4	45.6	18.0	Distant animal noise	36.0	57.7	32.0	Distant insect noise
10	35.1	60.7	20.8	No mine activities	34.8	54.3	28.9	Distant insect noise
11	30.7	45.2	21.1	Distant security point noise	37.8	53.6	34.6	Distant insect noise
12	38.6	56.6	20.9	Distant domestic noise	38.4	60.7	35.0	Distant insect noise
13	34.6	65.4	22.5	Distant domestic noise	37.4	60.7	29.6	Distant insect noise42.7
14	37.9	61.0	25.1	Distant domestic noise	33.6	63.7	29.6	Distant insect noise
15	42.7	58.5	26.5	Distant domestic noise	33.7	57.9	28.9	Distant insect noise
16	50.1	76.9	23.1	Distant traffic noise from R 577 and the access road to mine intermittent traffic	34.5	60.7	35.0	No traffic – distant insect noise
17	39.8	55.7	23.8	Traffic noise from the R577	28.6	47.8	17.0	Distant insect noise
18	54.7	79.8	24.7	Traffic noise from the R577	53.0	60.4	42.7	Fewer vehicles at night

19	36.4	61.1	21.2	Traffic noise from the R577	32.7	52.8	19.8	Distant insect noise
20	39.1	56.8	21.3	Farm activities	32.1	49.6	19.2	Distant insect noise
21	52.5	71.8	27.8	Traffic noise	50.2	68.2	40.1	Natural noise - no mine activities
22	27.0	45.1	16.9	Distant noise	25.3	59.8	15.4	Natural noise - no mine activities
23	26.9	47.5	17.2	Natural noise. No mine activities	24.0	41.4	15.2	Natural noise - no mine activities
24	28.5	62.8	16.5	Natural noise. No mine activities	26.7	58.6	15.3	Natural noise No mine activities

The findings from the baseline noise assessment indicated that the arithmetic prevailing ambient noise levels near the residential areas (eastern and southern sides) were 34.0dBA during the day and 34.7dBA during the night time periods for the summer period and 31.0dBA during the day and 26.7dBA (east, south and west) during the night for the winter period. These areas are some distance from the roads and there were no mine activities at BS4 however the BN mine was fully operational. The ambient noise levels are therefore, within the rural parameters. No vibration or over-air pressure levels was measured during the survey periods as there was no blasting undertaken during these periods. Section 8 contains an assessment of the noise and vibration during the life of mine.

4.13.4 Ecosystem Services

No ecosystem services are associated with the noise levels.

4.13.5 Noise Sensitive Receptors

Sensitive receptors are people or natural living organisms which could be affected by an increase in noise levels. The location of potential sensitive receptors is depicted in Figure 4-29.

4.13.6 Gap Analysis

- There were no baseline noise and/or vibration data available except for the initial noise studies conducted for BN in 2002;
- The noise calculations were based on information from similar studies carried out by the author on different projects in combination with information provided by DRA Projects;
- The blasting sites were not available along the road at the time of the study. As a result, the nearest point to each residential property was used in the formulas based on 500kg and 1 000kg explosives per blast; and
- There were no traffic volumes available at the time of the study for the new road and the calculations were based on 90 vehicles per hour.

4.14 AIR QUALITY

The air quality impact assessment (AQIA) was drafted and compiled by Airshed Planning Professionals. The scope of the study was to determine the impacts associated with the Booysendal South Expansion Project and specifically impacts of the Section 24G activities on the air quality and specifically dust fallout.

4.14.1 Methodology

a) **Desktop Review and Emissions Inventory**

Dust monitoring at Booysendal Mine commenced in 2010. The baseline study included the analysis of meteorological data. Local meteorological data (including wind speed, wind direction and temperature) was obtained from MM 5 data for the period 2013 to 2015. The data was set up for use in the air dispersion model. Metrological data plays an important factor in determining pollutant dispersions (refer to Section 4.1 for climatic data). Factors which are taken into consideration in the model include wind speed, wind direction and influence of temperature on air movement.

Another important input factor in the dispersion model is emissions which could result from the mine operations. The mechanical equipment lists, fleet lists and parameter of other potential sources of emissions i.e. the crusher was analysed and an emissions inventory as source developed for input into the air dispersion model.

b) Impact Prediction

The United States Environmental Protection Agency approved AERMET/AERMOD dispersion modelling suit was used to model particulate concentrations and dust outfall. Ambient concentrations were simulated to determine the highest hourly, daily and annual averaging levels. The dispersion of pollutants was modelled for an area covering 15.3km (north-south) by 14.4km (east-west). These areas were divided into a grid with a resolution of 102m (north-south) by 96m (east-west). AERMOD simulates ground-level concentrations for each of the receptor grid points.

The impacts were assessed against the South African National Ambient Air Quality Standards issued by the Department of Environmental Affairs (2009 and 2012). The limits of the tow pollutants of concern is included in Table 4-30.

Table 4-30 South African National Ambient Air Quality Standards for PM_{10} and $PM_{2.5}$ (DEA 2009 and 2012)

Substance	Molecular Formula / notation	Averaging Period	Concentration Limit (μg/m³)	Frequency of Exceedance	Compliance Date
Particulate matter	PM_{10}	24 hour	75	4	Immediate
		1 year	40	-	Immediate
Fine particulate matter	$PM_{2.5}$	24 hour	40	4	Immediate
			25	4	1 January 2030
		1 year	20	-	Immediate
			15	-	1 January 2030

4.14.2 Area of Influence

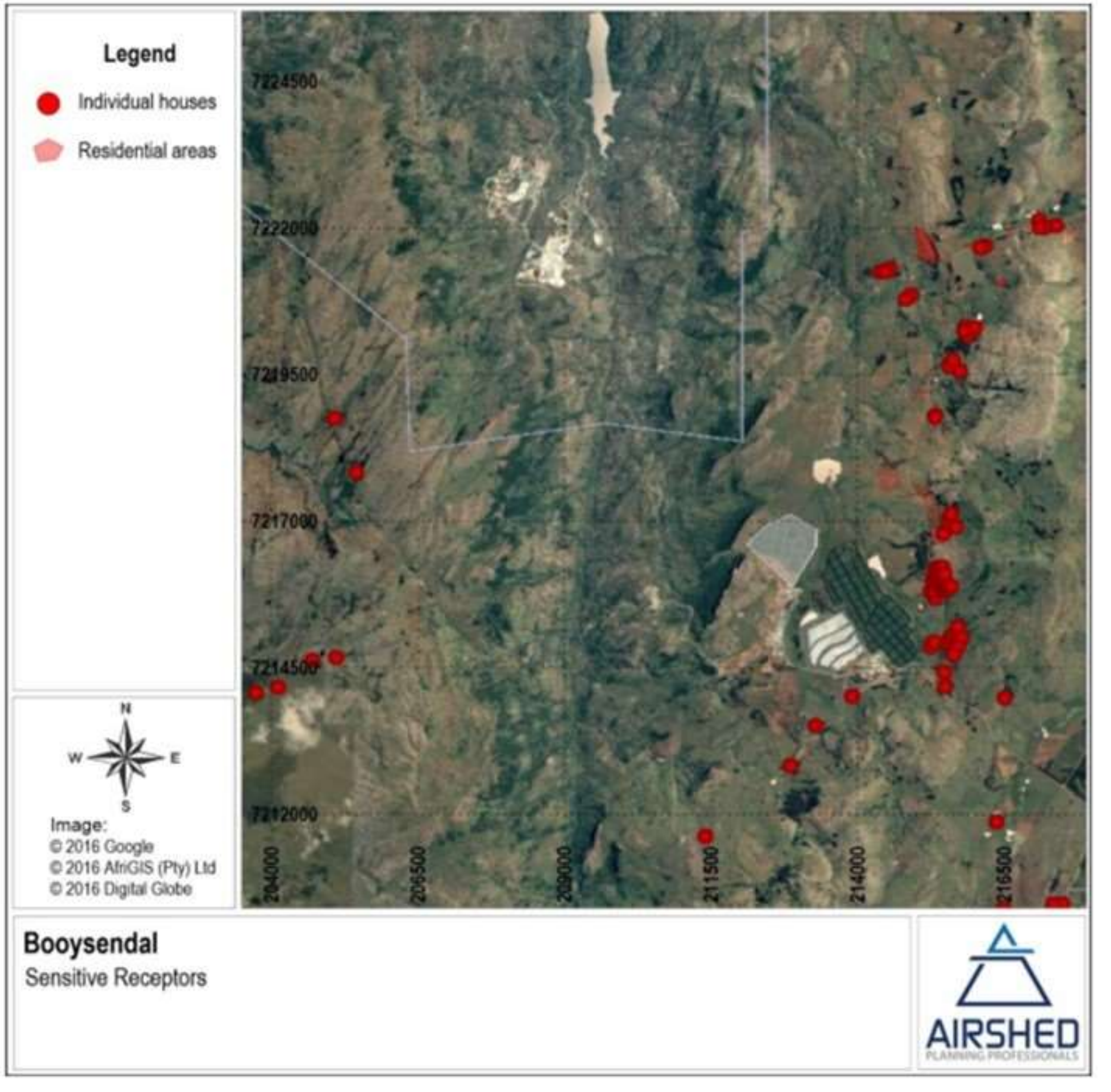
The area of influence was determined to be the surrounding sensitive receptors indicated in Figure 4-31

4.14.3 Baseline Air Quality Findings

a) Local Wind Field

The flow field is dominated by south-easterly winds with a >14% frequency of occurrence. Thermo-topographical induced flow is anticipated to represent an important component in the airflow over the study area with significant differences evident between day-time and night-time wind field characteristics. The slope of the terrain accounts for the increased frequency of occurrence of northerly and north-westerly wind during the day-time and increased south-easterly winds during the night-time. The differential heating and cooling of the air along a slope typically results in down-slope (katabatic) flow at night, with low-level up-slope (anabatic) airflow occurring during the day. Seasonal flows follow the larger synoptic circulation patterns of the country with increased easterly flows observed during summer months and an increase in westerly flows during the winter period.

Figure 4-31 Potential Sensitive Receptors and Air Quality Impact Study Area of Influence



b) Ambient Temperature and Atmospheric Stability and Mixing Depth

Temperature is an important factor in air buoyancy, formation of inversion layers and mixing of air. The temperature for the study area is included in Section 4.1. Temperature, wind and topography have an influence on atmospheric stability and depth, as such, these factors are important components in the AERMOD.

c) Measured Ambient Air Quality

Booysendal commenced with dustfall monitoring at four monitoring points at and around BS1/2 in October 2015. Dustfall is also monitored at BS4 since October 2015, while an existing network exist at BN since 2009. The locations of the network is included in Figure 4-32for BS4 and Figure 4-33 for BN including BS1/2. The results for BS4 indicates that outfall levels are low except for one exceedance >600 mg/m^3/day at the quarry area. As exceedance only occurred once in the year this area is still complying to the National Dust Control Regulations (NDCR). The results for BS4 and BN are respectively included in Table 4-31 and Table 4-32.

BN has a dust fallout network consisting of fifteen single dust buckets. Dust fallout measured during the period September 2015 and August 2016 was all below the NDCR for residential areas (600 mg/m^2/day) except for BN11 which measured 619 mg/m^2/day in September 2015 and 1691 mg/m^2/day in October 2015. BN11 is directly associated with the construction activities at BS1/2, indicating that additional dust abatement measures may be required.

Figure 4-32 Dust Monitoring Network at BS4

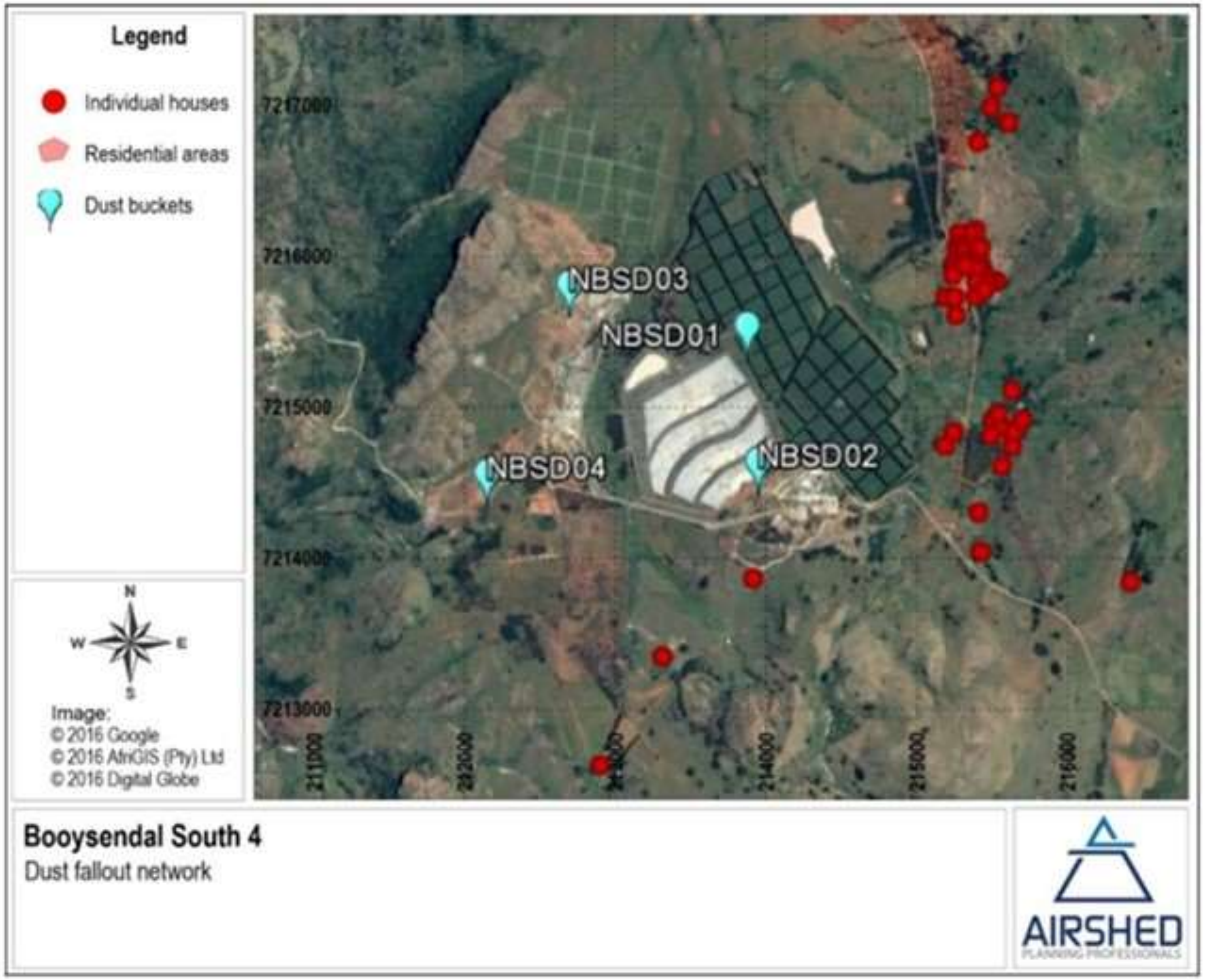


Figure 4-33 Dust Monitoring Network at BN and BS1/2

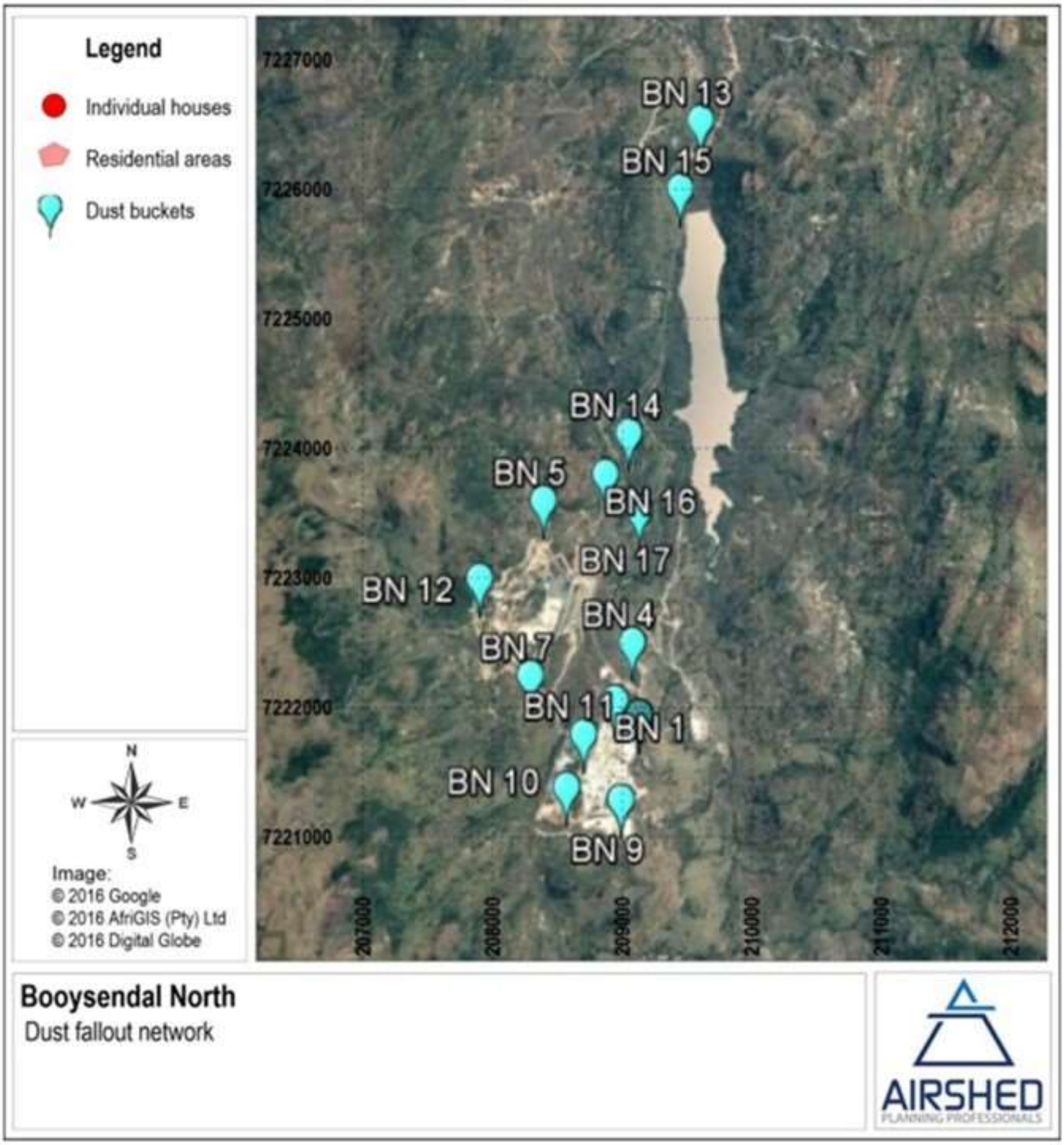


Table 4-31 Dust Monitoring Results for BS4

Sampling month	Dustfall levels (mg/m²/day)			
	NBSD01	NBSD02	NBSD03	NBSD04
	Kiwi	Central	North Quarry	South Quarry
	25.1508°S; 30.1622°E	25.1587°S; 30.1629°E	25.1484°S; 30.1503°E	25.1594°S; 30.1448°E
Oct-15	50	55	89	97
Nov-15	135	54	60	72
Dec-15	171	176	88	104
Jan-16	74	122	96	130
Feb-16	93	18	20	56
Mar-16	65	12	716	6
Apr-16	107	23	5	95
May-16	40	0	0	0
Jun-16	57	11	4	24
Jul-16	94	61	105	81
Aug-16	10	120	104	11
Sep-16	16	17	28	17

Table 4-32 Dust Monitoring Results for BN and BS1/2

Site			Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16
1	West	25° 5.550' S; 30° 6.800' E	31	32	13	27	12	41	9	9	21	21	19	43
2	East	25° 5.610' S; 30° 6.922' E	22	36	23	32	43	5	48	10	36	17	25	26
4	Cemetery	25° 5.308' S; 30° 6.882' E	33	32	30	16	11	120	15	8	20	23	15	32

Site			Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16
5	Tailings North	25° 4.718' S; 30° 6.435' E	12	35	19	16	16	20	36	16	17	8	20	17
6	Tailings East	25° 5.610' S; 30° 6.922' E	16	63	20	57	98	29	53	36	19	20	14	57
7	Tailings South	25° 5.450' S; 30° 6.378' E	9	18	18	25	15	20	17	5	19	8	9	177
9	Eskom South	25° 5.963' S; 30° 6.837' E	47	72	43	53	19	17	37	11	67	91	208	213
10	DMS Stockpile	25° 5.913' S; 30° 6.567' E	30	29	60	46	27	27	11	17	30	36	44	26
11	Plant	25° 5.693' S; 30° 6.647' E	619	1691	323	84	48	59	134	41	139	69	38	148
12	Tailings West Waterdam	25° 5.047' S; 30° 6.123' E	12	19	26	22	172	26	8	161	12	11	7	33
13	Bridge	25° 3.092' S; 30° 7.192' E	18	14	25	19	20	24	19	13	23	16	9	26
14	Powerline	25° 4.430' S; 30° 6.853' E	60	44	26	19	31	8	32	20	26	18	21	32
15	Main Road Dam	25° 3.387 'S; 30° 7.093' E	16	21	33	16	18	23	18	16	34	24	14	27
16	1.8 Line	25° 4.603' S; 30° 6.738' E	14	107	46	50	41	34	20	25	24	19	22	13
17	Helipad	25° 4.753' S; 30° 6.905' E	38	55	21	41	40	16	27	9	39	150	21	23

d) Existing Sources of Air Emissions

- Vehicle emissions in the project and surrounding area which cause the release of NO_2, SO_2, CO_2 and low levels of VOCs.
- Agricultural practices which include ploughing, application of fertilizer, loading of crops will release PMs, NO, NO_2, NH_3, SO_2, and VOCs.
- Fugitive dust emissions as a result of mine operations, gravel roads, agriculture, tiling operations and wind blow dust over open areas.
- Biomass burning from veld fires and incomplete combustion processes.

4.14.4 Sensitive Receptors

Please refer to Section 4.14.2

4.14.5 Gap Analysis and Limitations

The following limitations, gaps and assumptions were identified when conducting the assessment report:

- MM5 metrological data for 2013 to 2105 was used;
- Quantification of source emissions was restricted to the project area, although background sources were identified;
- Only routine emissions were estimated and modelled and no accidental release was considered;
- Vehicle emissions were not quantified – impact will be localised and not exceed NAAQS;
- The remined TSF1 information was not available at the time that the report was conducted and could not be quantified. Therefore, simulated air quality impacts will be higher, although it is the opinion of the air quality specialist that it is not likely to exceed NAAQS at sensitive receptors;
- The vent shaft parameters were assumed based on similar operations;
- A qualitative assessment for the short-term construction and closure phases, and a quantitative assessment for the operational phase were conducted; and
- No $PM_{2.5}$ or PM_{10} baseline measurements for the site was available and therefore a cumulative assessment of these parameters could not be carried out.

4.15 GREENHOUSE GAS EMISSIONS ASSESSMENT

A greenhouse gas (GHG) emissions assessment was undertaken by Kirjani Green Energy (Pty) Ltd in October 2016. The Kirjani study is included with the Airshed study in Annexure L. The purpose of the assessment was to gain an understanding of the of the potential GHG emissions which may result from the Booysendal South Expansion Project.

The purpose of the study was to establish to what extent the Booysendal South Expansion Project will lead to enhanced GHG emissions and thereby contribute to global warming.

4.15.1 Methodology

Emission factors: Emissions that will originate from site is associated with the burning of fossil fuels mainly from vehicles, machinery and generators and include carbon dioxide (CO^2), methane (CH_4) and nitrous oxide (N_2O). The emission factors for the site were modelled. An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. In this case, emissions are inferred from the total volume of fuel purchased.

Reporting: The GHG study reported on Scope 1 emissions for which the mine is directly responsible as result of the burning of fossil fuels from vehicles and machinery used on site.

4.15.2 Area of Influence

The impact of global warming is experienced globally and impacts all ecosystems.

4.15.3 GHG Assessment

Actual diesel and oil consumption figures and forecast diesel and oil consumption figures for BS were used to assess the GHG emissions. The results of the assessment indicated that the mine will likely be responsible for emissions of Scope 1 carbon equivalents of not more than approximately 19 500 tons per year. At the current assumed carbon tax rate of R120 per ton, this may result in a tax liability of not more than R2 340 000 per year.

However, with offsets and other rebates, this amount per ton should be drastically reduced to between R6 and R40 per ton, or a potential liability of between R43 000 and R286 720. No final decision has been made on carbon taxation as yet and these figures are simply to serve as indicators.

4.15.4 Sensitive Receptors

Global impact as climate change is a phenomenon which impacts on everybody and all ecosystems.

4.15.5 Gap Analysis

Various limitations, restrictions and gaps were noted and identified in the GHG assessment. During the GHG assessment no data pertaining to the potential release of hydro fluorocarbons associated with the refrigeration systems within the Booysendal operations was available. It was advised that it was not expected that emissions would make a material difference to the overall carbon equivalent profile of the Booysendal Mine.

The project definition has changed since the GHG assessment was conducted and will therefore requires an update once the project definition has been finalised. No data on electricity use and forecast use was available at the time of that the assessment was conducted. The GHG emission calculations may therefore be underestimated and should be revised and updated once the project definition has been finalised.

4.16 TRAFFIC

The traffic impact assessment (TIA) was undertaken by Hamatino Consulting Engineers. The TIA is applicable for the new access road from BS4 where it ties into the D874 and into the R577 Roossenekal – Mashishing Road. The purpose to the TIA was to assess if access is appropriate in terms of safety standards and to assess if the increased traffic can be accommodated safely especially at the various intersections. The road configuration is included in Figure 4-34. The TIA is included in Annexure Q.

4.16.1 Methodology

The first step in the traffic study was to carry out traffic counts at the intersections indicated in Figure 4-34 to obtain background traffic volumes. The traffic count was done on Tuesday 7 February 2017 from 18:00pm to Wednesday 08 February 18:00pm.

The traffic count was followed by a trip generation where the increase in traffic has been calculated and analysed in terms of type of vehicles, trips, peak flows. Determine if the road intersections will be able to handle the additional traffic volumes. For this purpose, the aaSidra & Traffic for Windows computer software design package was used.

4.16.2 Area of Influence

The new main access road will have an impact on all road users of the Village access road, the D874 and the R577 road users.

4.16.3 Baseline Traffic Study Findings

The traffic survey findings indicated very low traffic flow volumes on all the roads. A summary of the traffic data is included in Table 4-33.

Traffic peak analysis was conducted using the Trafix for Windows and Sidra Intersection 5.0 software package to determine the existing levels of service (LOS), the V/C ratio and the delays experienced at the intersections. This provides an indication for the need of traffic management measures at the intersections. It was found that the intersections are classified as Service A roads, which are free flowing traffic of which the intersections at background do not require upgrade.

The future expected traffic volumes and trip generation were based on traffic counts at the Mototolo Intersection D212. This access road provides access to Thorncliff, Magareng, Helena, Mototola and BN. The trip generation for the new access road is therefore based on a worst-case scenario. The most trips are expected to be associated with the operational phase, and the forecast trip generation for this phase is included in Table 4-34.

Figure 4-34 Road Configuration

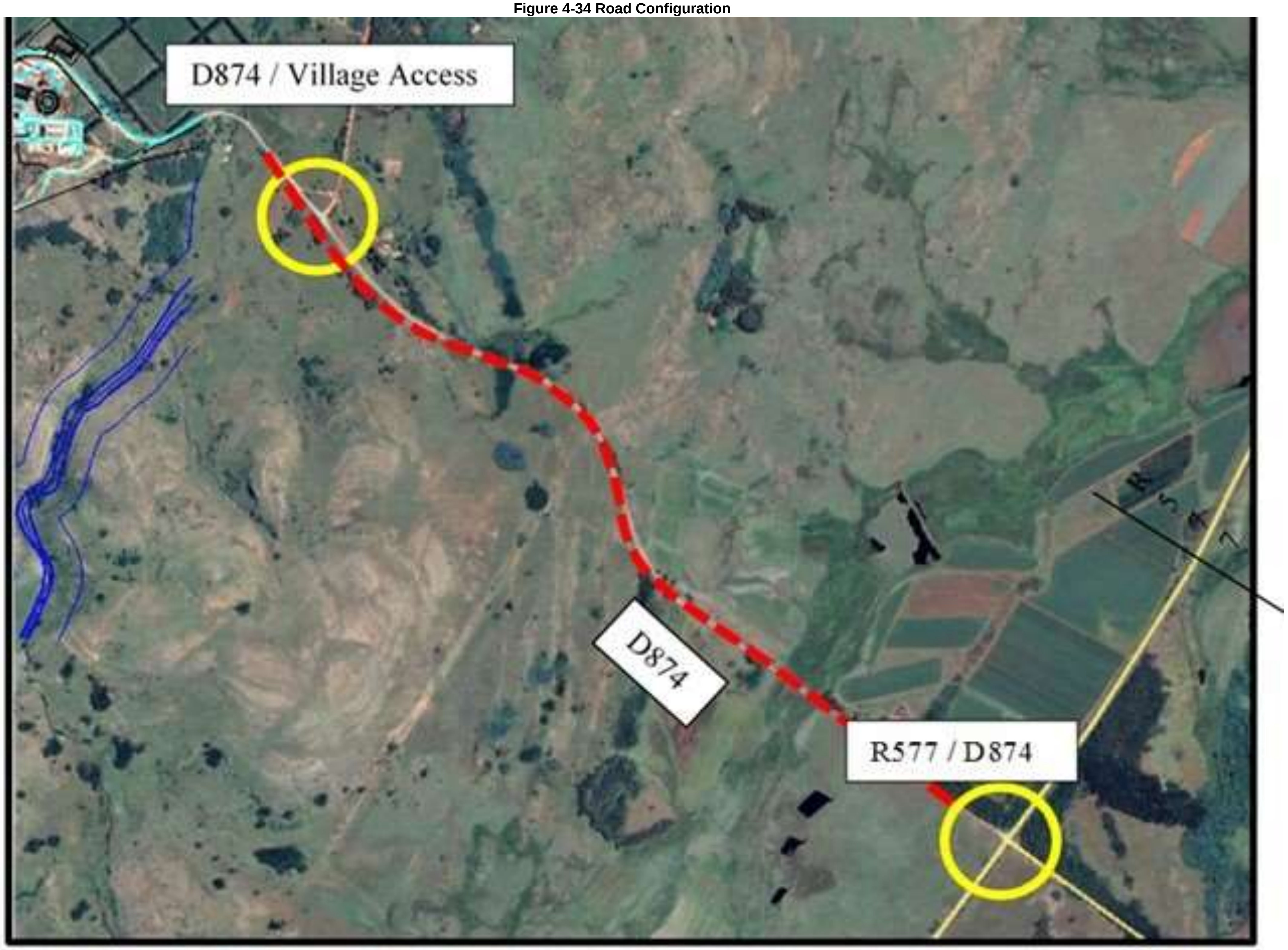


Table 4-33 Traffic Count Summary

Intersection	2017 Count	Peak hour	Peak hour Factor
ADT TRAFFIC			
R 577 / D874	389 Vehicles through intersection (sum of all directions)		
D 874 / Village Access	133 Vehicles through intersection (sum of all directions)		
AM PEAK HOUR TRAFFIC			
R 577 / D874	39	06:00 – 07:00am	0.61
D 874 / Village Access	17	06:15 – 07:15am	0.61
PM PEAK HOUR TRAFFIC			
R 577 / D874	46	15:30 – 16:30pm	0.68
D 874 / Village Access	21	16:00 – 17:00pm	0.75

Table 4-34 Trip Generation Findings for the Operational Phase

Land Use	Trips	Trip Increase	Adjusted Volume	Directional Split	DIRECTIONAL SPLIT	
					IN	**OUT**
ADT DAILY TRIPS						
Booysendal Mine	850	20%	1020	50 ; 50	510	510
WEEKDAY AM TRIP GENERATION						
Booysendal Mine	128	20%	153	85 ; 15	130	23
WEEKDAY PM TRIP GENERATION						
Booysendal Mine	94	20%	112	20 ; 80	22	90

It is expected that 85% of the traffic will be flowing in the direction of Mashishing, 5% in the direction Roossenekal and 10% into the villager road.

4.16.4 Sensitivities

The village access road is a gravel paved road and is extremely steep coming down to the D874. The speed limit on the road is 80km reduced to 60km at the intersection. The potential increase in traffic which could lead to traffic incidents around the village and R577 intersections which are the main sensitivities.

4.16.5 Gap Analysis

At the time when the TIA was undertaken, the expected future trip volumes were not available. Therefore, the trip generation was conducted using data and findings based on similar mines in the area.

4.17 VISUAL

The visual impact assessment (VIA) was done by Geographic information systems mapping. (GISM). The scope if the assessment was to determine the potential visual intrusion which could result from the Booysendal South Expansion Project and Section 24G and cumulative. The VIA is included in Annexure S.

4.17.1 Methodology

a) Field Survey

One photographic and field reconnaissance survey was undertaken from 9 to 10 February 2016 on the site and the surrounding area. The study area was scrutinized to the extent that the receiving environment could be documented and adequately described. Data collected during the site visit allowed for a comprehensive description and valuation of the receiving environment, quality of the scenic resource, valuation of the sense of place, as well as the scope and extent of the proposed Booysendal South Expansion Project. Local homesteads/settlements and roads were identified as critical views/sensitive receptors and visited in order to determine sensitivity and visual exposure of these receptors.

The photography survey was undertaken using a digital Canon camera and 50mm equivalent lens. Overlapping (50%) landscape format photographs which were taken are joined together using computer software to create a single panoramic image for each viewpoint. The photographer also notes the GPS location of the viewpoint and takes bearings to visible landmarks whilst at the viewpoint. (Please refer to Annexure S for illustrations of the photo locations and photo orientation).

b) Landscape Analysis

The assessment of landscape and visual impacts is both quantitative and qualitative. The assessment describes what would be affected and how it will be affected. The level of visual modification magnitude), makes a judgement regarding the capacity of the landscape to accommodate change by assigning a visual receptor sensitivity and then assesses the significance of the resulting impact. These factors and the ways in which they are combined to identify the extent of visual impact include:

- Project Components - In order to understand the scope and scale of the proposed project the physical characteristics of the project components need to be described and illustrated;
- Landscape Baseline - To evaluate the impacts of the proposed project, the inherent scenic values of the landscape were determined by describing the setting, visual character and the sense of place;
- Magnitude Assessment - Estimate the magnitude of the visual impact by assessing the following factors:
    - Define the extent of the which the project can have on the visual environment by identifying all possible observation sites from which the proposed infrastructure would be visible (i.e. ZVI) and the viewing distance from these observation site;
    - Determine the visual absorption potential (i.e. ability of the landscape to accommodate the proposed project from a visual perspective);

- Sensitive Visual Receptors - Determine the sensitivity of the critical views/visual receptors that may be affected by the proposed project (e.g. residents, motorist and tourist); and
- Spatial Modelling - Modelling of Visual Impacts using GIS software based on the spatial data, landscape analysis and the findings obtained from the field survey.

4.17.2 Area of Influence

The zone of visual influence was determined as a buffer area of approximately 10km around the project (refer to Figure 4-35).

4.17.3 Baseline Visual Findings

The project components play an important role in terms of visibility. The model takes into consideration, the height and extent of the infrastructure and lightning arrangements. For landscape and hydrology baseline refer to Section 4.2 and Section 4.7.3 respectively. The valley and mountainous nature of the area will play an important role in screening of visual impacts.

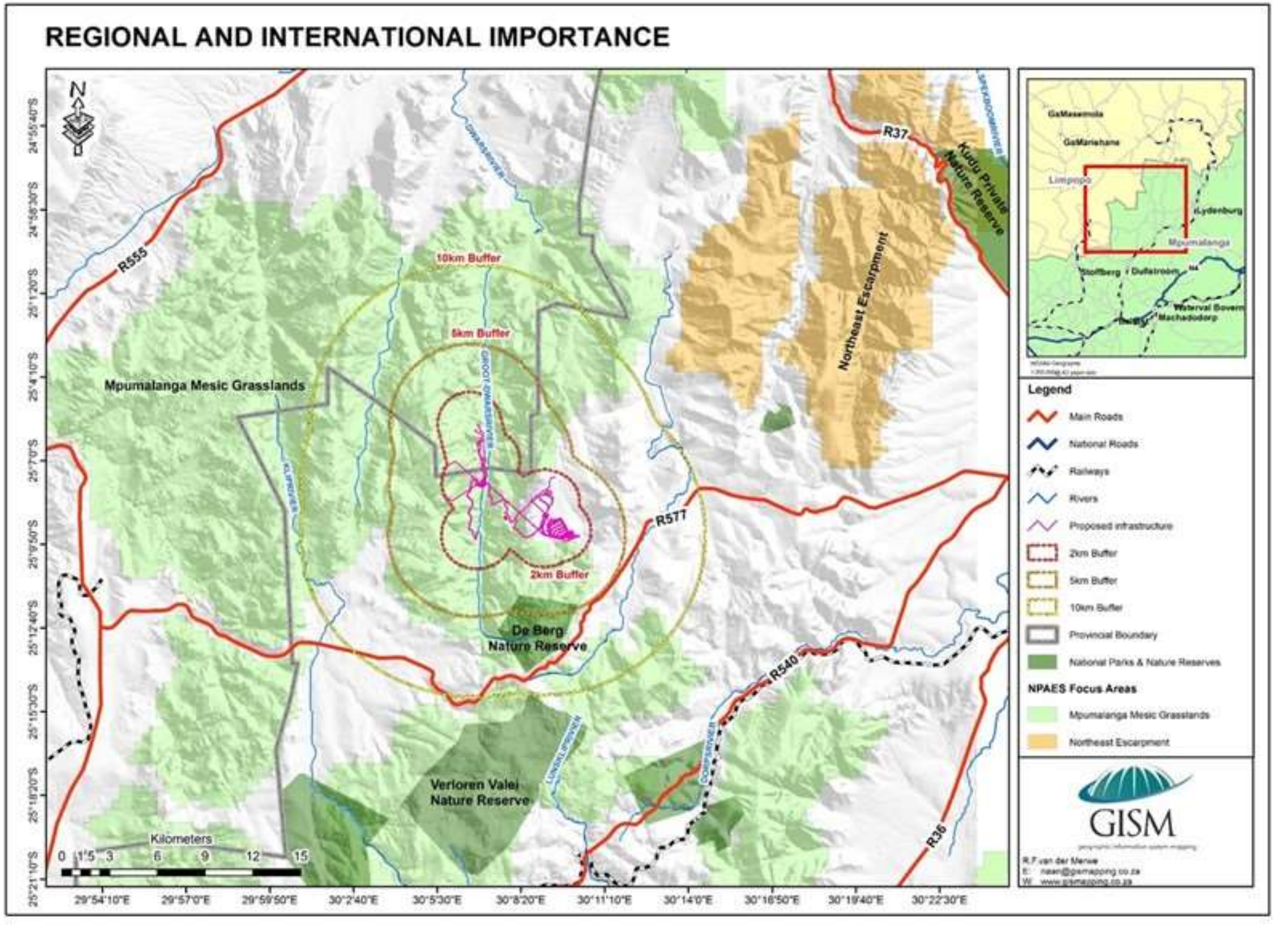
Vegetation: The bulk of the proposed infrastructure footprint occurs in the Sekhukhune Mountain Bushveld, with areas of Sekhukhune Montane Grassland vegetation in the higher areas on the eastern, southern and western sides of the Groot Dwars River valley. On the eastern part of the ZVI there is an area of Lydenburg Montane Grassland. Typically, the vegetation profile consists of open and closed savannah areas with average height of 2.5m to 5m. Grasses and shrubs form the lower canopy of vegetation. The nature of the vegetation within the ZVI will contribute in screening the proposed infrastructure to some extent.

Road Networks: The project area is located within a remote part of the Mpumalanga and Limpopo provinces and is relatively inaccessible via use of the road. The current transport network within the immediate area mainly comprises of a network of informal dirt tracks and pathways. The nearest main road is the R577 Main Road (Roosenekal – Lydenburg road) which forms part of the Steenkampsberg Pass. The ZVI analysis indicates that the proposed infrastructure will not be visible from the R577 main road.

Land Use: There are limited land owners. Some livestock farming is taking place to the east and the bulk of the surrounding land is owned by mine houses. The land use is therefore deemed less sensitive to visual intrusion than the instance of tourism.

Residential: The project area is largely undeveloped and rural with some smaller settlements to the east (Petlas and Chomas Families) of the project area, and some individual homesteads (Groenewald and Nel homesteads) located mainly to the immediate southeast of the project area. Some homesteads are also located to the west of the Groot Dwars River valley (located on the eastern boundary of the Klein-Dwarsrivier valley) but the analyses reveal that these homesteads will not be affected directly by the proposed development associated with the Booysendal South Expansion Project. Various potentially impacted residents were approached in order to request permission where necessary to gain access, take photographs and gather field notes but this level of assessment excludes surveys to establish viewer preference and consequently their specific sensitivity.

Figure 4-35 Zone of Visual Influence



Sense of Place: Central to the concept of sense of place is that the landscape requires uniqueness and distinctiveness as perceived by its inhabitants. The sense of place in the various areas can be described as follow:

- North - The visual character of the northern section is dominated by conventional mining activities (BN, Anglo Platinum-Glencore Mototolo JV, Glencore's Helena Mine followed by Glencore's Magareng and Thorncliffe Mines and further north the Assmang Dwarsriver Mine, Anglo Platinum's Twickenham Mine and to the west the African Rainbow Minerals' Two Rivers Mine, and associated infrastructure. Operational and security lighting associated with the various mines generate direct light and a general glow within this section at night. Mining and associated activities provide the northern section with a distinct sense of place associated with commercial mining and exploration activities.

- South and West - The area is located in a natural, elevated 'vessel' that opens to the north and which is contained by the dramatic Steenkampsberg Mountains on three sides. From higher vantage points the rural nature and rugged character of the scene is evident. These factors combine to create the perception that the place has a rather unique natural and biodiversity quality and character. However, there is a sense that the beauty and 'wildness' of the area is being compromised to the north with the presence of the existing mining operation and its necessary support infrastructure. The southern section of the Groot Dwars River valley is not inhabited and not easily accessible, this is combined with the visual splendour of the landscape adds to the uniqueness of this section. These characteristics as mentioned before, provide this section with a distinct aesthetic and natural sense of place. This section also includes the ridge line associated with the Klein-Dwarsrivier valley to the west and homesteads located within the Klein-Dwarsrivier valley.
- East - The eastern section has a rural character and is more accessible and populated than the southern section. The area is associated with limited agriculture and some existing mining activities located at BS4. Operational and security lighting associated with the existing BS4 operations generates direct light and a general glow at night. The landscape has been impacted by the existing mining operation and invasive plant species, some settlements and limited farm homesteads. However, the sense of place of the study area is established with the combination of natural valleys and the surrounding mountains. The typical character eristic is that of a rural area within a natural landscape.

Visual Quality and Character: The once spectacular and 'wild', rural landscape, especially in the southern section, is being compromised by the presence of 'foreign', seemingly 'out of place' activities associated with the existing mining operations, prospecting sites, Eskom power lines and the encroachment of alien vegetation, located within the northern and eastern sectors. For this reason and when considered together, the whole study area's (e.g. 10 km buffer area) aesthetic value is reduced to moderate.

4.17.4 Ecosystem Services

The ecosystem services applicable to the visual receptor perspective is included in Table 4-35.

4.17.5 Sensitive Receptors

Potential sensitive receptors are those who might experience visual intrusion because of the Section 24G activities. The location of sensitive receptors is indicated in Figure 4-36.

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4.17.6 Gap Analysis

- Detailed lighting plans were not available;
- Architectural design style and colour were not available to assess the visual softening;
- A viewer preference analysis was not done;
- Changes to site layouts would not have been addressed;
- Findings are restricted to the information at hand and the quality of the spatial data; and
- The major limitation of any VIA is related to subjective opinion.

Figure 4-36 Sensitive Receptors

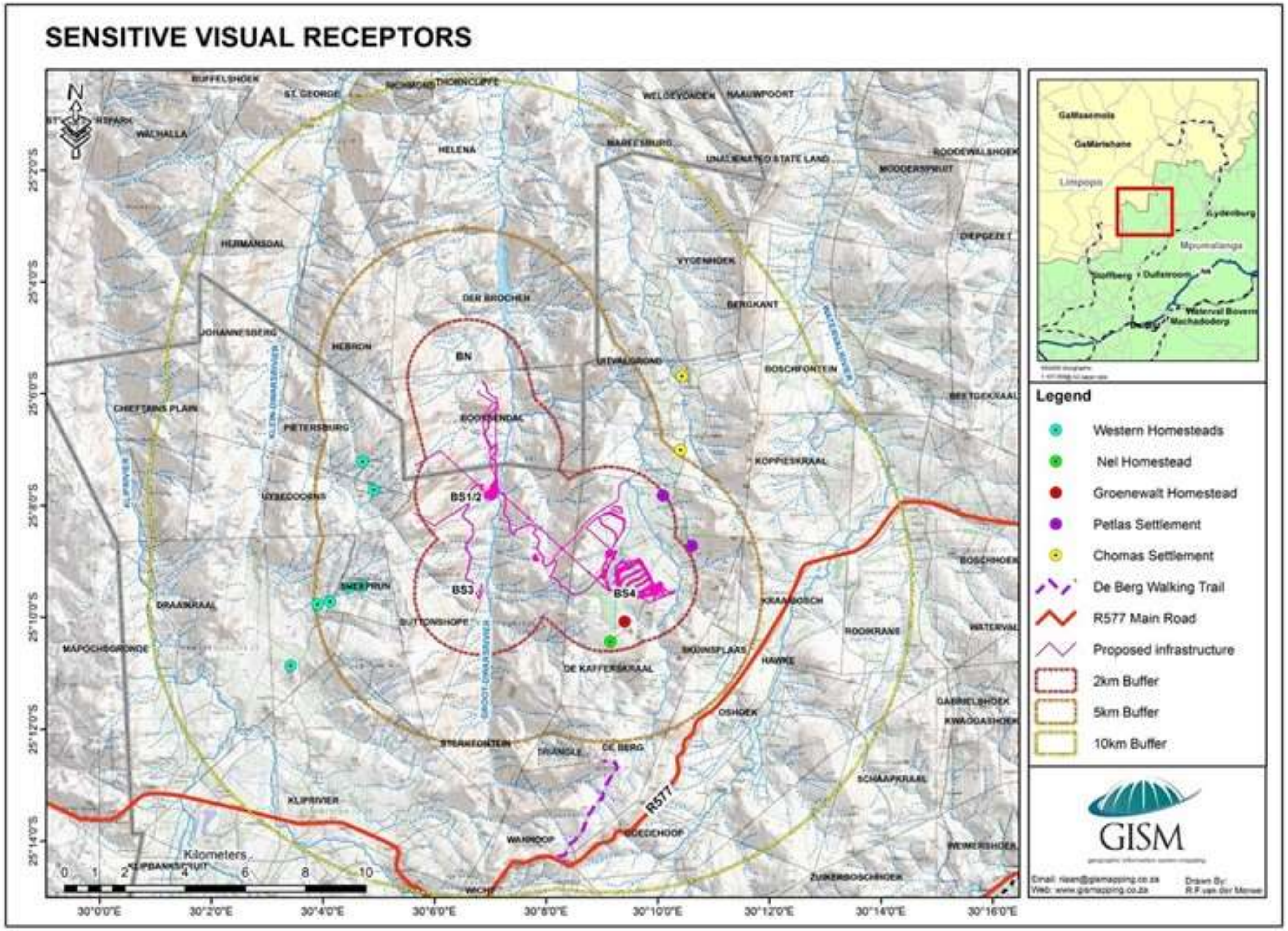


Table 4-35 Visual Ecosystem Service

Service	ES Category	Description	Additional information (including threats, and availability of alternatives to ES)	Relevant habitats	Importance to Beneficiaries	Replaceability
Recreation and aesthetic enjoyment	Cultural Services	It is assumed that scenic wilderness areas form the core recreation amenity in this area due to the high positive aesthetic appeal.	Removal of scenic wilderness areas to install mine infrastructure will reduce the scenic quality of the immediate area and therefore the recreation and aesthetic value of the surrounding environment.	Pristine/ Natural habitats.	**Low** Localised visual perceptions of the economically marginalised communities of the population may be influenced by the short term economic and job opportunities that will exist rather than the direct visual perception of the project. **Moderate** Other residents Geographic proximity estimated at <10km.	**High - Low** Spatial alternatives are dependent upon type of sensitive receptor. For local residents the views are irreplaceable as the views are static, whereas local motorist the views are dynamic.

4.18 SOCIAL

The scoping phase of the social impact assessment (SIA) was undertaken by Mosidi Mpalele; after she sadly passed away, the impact assessment phase was done by Social Enterprise Solutions. The study is included in Annexure M. The purpose and focus of the study was to gain an understanding of the socio-economic environmental of the southern sector of the Booysendal Mine operations as it is foreseen that a significant amount of the workforce will be sourced from this area.

Three target populations were identified as part of the baseline study, namely:

- Target populations in close proximity of the site who can be directly affected by the activities;
- Local target population mainly associated with ward 5; and
- The regional target population of the Ehlanzeni and Sekhukhune District Municipalities.

The focus area of the SIA populations whilst also providing a high-level summary of the regional target populations.

4.18.1 Methodology

a) Desktop Review

The purpose of the desktop review was to gather secondary data for the project area. Sources consulted included:

- Documents derived from the information request to the client (i.e. SLP 2015 to 2019, Stakeholder Engagement Policy);
- Socio-economic and demographic statistics (sourced from Statistics South Africa's 2011 Census data);
- Integrated Development Plans (IDPs), Local Economic Development Plans (LEDs) and Spatial Development Frameworks (SDFs) of the Ehlanzeni and Sekhukhune Districts, as well as the Thaba Chweu Local Municipality; and
- Available maps and imagery.

b) Social Surveys and Primary Data Collection

Using a variety of research tools, including questionnaires, primary data were collected for the socio-economic baseline study between 16 to 20 January 2017. These research tools included community information sheets, focus group meetings, and key informant interviews. A total of eight focus group meetings were held in four communities. To ensure participation of all groups, including vulnerable groups (woman, children and aged population) the meetings were separated.

Key informant interviews were held with the Ward Councilor of Ward 5, the Chairman of the Emerging Contractors Forum and Principals at Shaga Primary School and Tonteldoos Secondary School. The interviews sought to verify and expand on data gathered during the focus group meetings

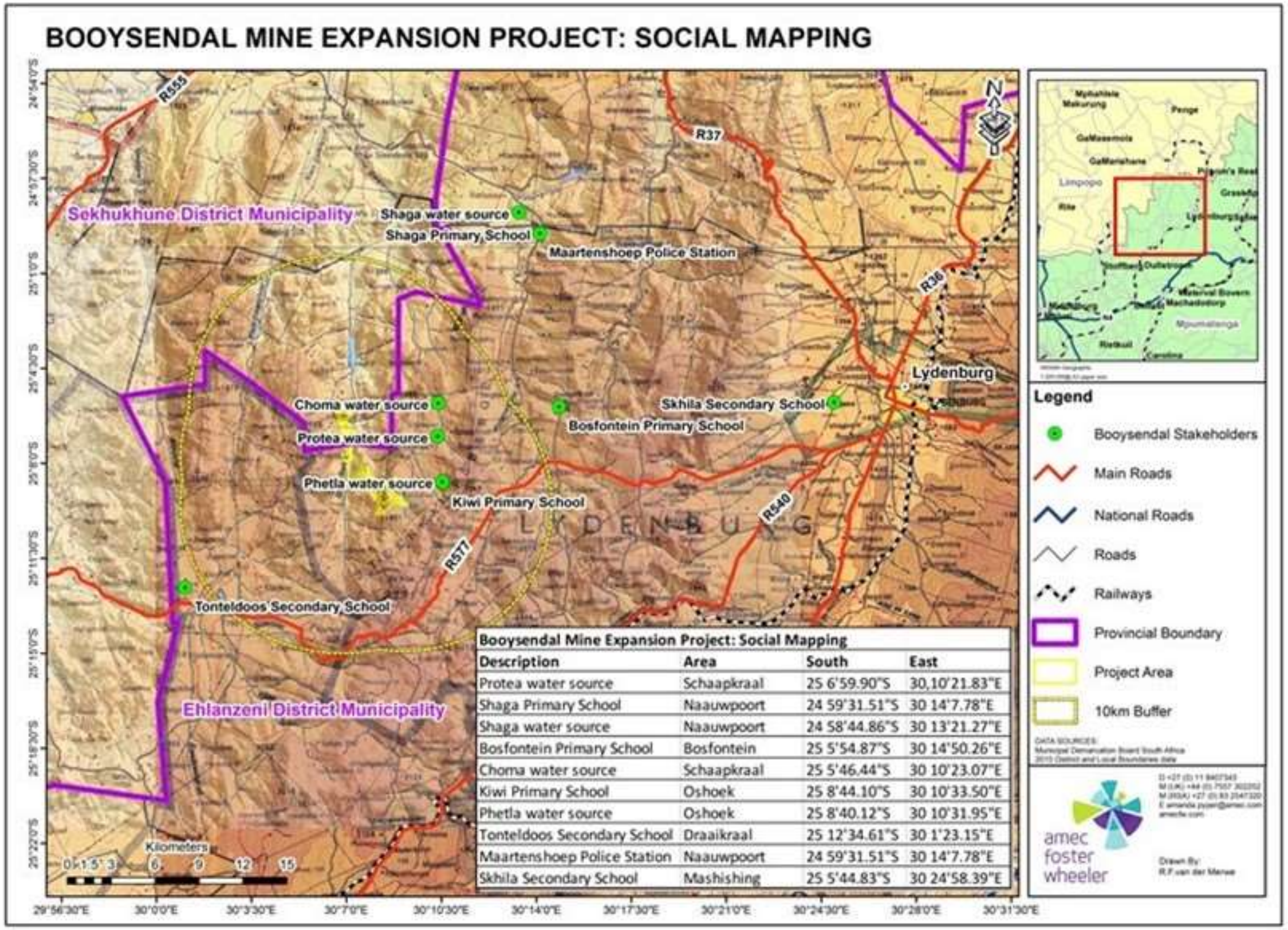
c) Data Analysis and Reporting

In each of the communities, comparable qualitative social data was collected. Primary data gathered from the focus group discussions and key informants, as well as, observations made by the study team on livelihood strategies, infrastructure, services and amenities were transcribed. In order to strengthen and increase the levels of confidence in the qualitative findings of the social study, primary data was triangulated with secondary data. The outcome resulted in the development of a Social Baseline Report, a SIA and a Social Management Plan (SMP).

4.18.2 Area of Influence

Social mapping was performed to identify communities located in the area of the BS expansion which includes the Section 24G areas. In the initial phase, target populations were identified and mapped. This mapping was further refined to include the main communities to the south within a 10km radius who could potentially benefit of be impacted by the activities. During the public consultation process, this was further expanded by wat of consultation with commercial farmers in the area. The main communities and 10km buffer which delineates the AoI are included and depicted in Figure 4-37.

Figure 4-37 Social Area of Influence and Potential Affected Communities



Booysendal Mine Expansion Project: Social Mapping			
Description	**Area**	**South**	**East**
Protea water source	Schaapkraal	25 6'59.90"S	30,10'21.83"E
Shaga Primary School	Naauwpoort	24 59'31.51"S	30 14'7.78"E
Shaga water source	Naauwpoort	24 58'44.86"S	30 13'21.27"E
Bosfontein Primary School	Bosfontein	25 5'54.87"S	30 14'50.26"E
Choma water source	Schaapkraal	25 5'46.44"S	30 10'23.07"E
Kiwi Primary School	Oshoek	25 8'44.10"S	30 10'33.50"E
Phetla water source	Oshoek	25 8'40.12"S	30 10'31.95"E
Tonteldoos Secondary School	Draaikraal	25 12'34.61"S	30 1'23.15"E
Maartenshoep Police Station	Naauwpoort	24 59'31.51"S	30 14'7.78"E
Skhila Secondary School	Mashishing	25 5'44.83"S	30 24'58.39"E

4.18.3 Social Baseline

The detailed baseline findings are included in Annexure M, while this section contains a summary for background and an understanding of the socio-economic environment.

4.18.3.1 Municipalities

BN falls in the Sekhukhune District Municipality (SDM) which mainly falls outside of the project development. According to the 2016/17 Integrated Development Plan (IDP) the municipality has a population of 1,076,840 inhabitants, of which 99% are Africans, and the remainder 1% comprise Whites, Indians and Coloureds. The IDP further sates that the three main contributors to Gross Geographic Product (GGP) in the Sekhukhune economy are community services (3.62%), mining (2.38%) and trade (2.66%).

BN falls in ward 31 of the Greater Tubatse Local Municipality (GTLM) of the SDM. GTLM is characterized by a weak economic base, inadequate infrastructure, major service backlogs, dispersed human settlements and high poverty levels.

BS, where the bulk of the development is taking place, falls within the Ehlanzeni District Municipality. The 2016/17 IDP for the Ehlanzeni District Municipality indicates that total population of is 1,688,615 of which 91,06% are Black South Africans, and the remainder 8,94% comprise Whites, Coloureds, Indians and Other racial groups. The IDP further states that in 2011 the unemployment rate for people between the ages of 15 and 65 was 32,32%, and majority of the population in Ehlanzeni are dependent on social grants.

BS falls within ward 5 of the Thaba Chweu Local Municipality (TCLM) which has a population of 98,387 with a total of 34,521,75 households. Poor and inadequate basic services have also contributed to the scattered nature of settlements in the rural areas of the TCLM, which makes infrastructure development challenging and costly.

4.18.3.2 Social Contents of TCLM

The population growth rate of the GTLM from 2011 to 2016 was 8%. According to the IDP this can be attributed to an influx and general movement as a result of mining activities. The TCLM on the other had experienced a slight population decline from 1996 to 2011.

The demographic structure of the TCLM indicates that approximately 25.17% of the population is under the age of 14years, 4.92% are aged 65+ and 69.91% is between 15 and 65. Approximately a third of this population by demographic structure is economically inactive consequently contributing to a large dependency ratio. The gender ratio is fairly even with 51% of the population being female and 49% being male. The most commonly spoken language is Sepedi (94%), followed by iSiZulu (1.2%), English and Afrikaans (0.5% each).

The economy of the TCLM is mainly characterised by and dependant on agriculture (33%) followed by manufacturing (22%), community services (16%) and trade and catering (11%), which contribute to 19% of the district municipality GGP. The main economic activities in the TCLM is forestry, mining (32%) and tourism.

The economy in the GTLM remains predominantly rural. According to the GTM IDP (2016/17), the area is economically the most marginalised region in the Limpopo Province. Although the IDP (2016/17) indicated that the main economic drivers in GTM are agriculture, services and construction, it also stated that the area is solely dependent on government handouts and remittances from migrant labour.

Employment: Given that the economic characterisations in TCLM, it is mainly driven by mining, tourism, agriculture and forestry sectors, many employment opportunities come from the mining sector (23.9%) followed by trade (18.1%), community services (14.7%) and agriculture (14%). The key informant interviews indicated that in Mashishing (Mashishing) 80 small businesses are registered with the Emerging Contractors Forum in the sectors of construction, catering, engineering and maintenance, which are supported by the local municipality with training and skills development.

Whilst the project area is located in a region endowed with tourist attractions, agricultural and mining land, a large proportion of the population in TCLM remains unemployed, unskilled and impoverished. Per the TCLM IDP (2016 – 2017), the unemployment rate in 1996 was sitting at 18,64% whereas in 2001 it was at its highest at 25,12%, which dropped to 20,49% in the year 2011. People with disabilities, women and youth are vulnerable to unemployment in TCLM. In 2011, 28,04% of women and 26,56% of youth were unemployed. The unemployment rate in the GTLM is higher than in TCLM. In 2011 the unemployment rate was 41%, and according to the GTM IDP (2016/17) the unemployment rate is projected to increase to 47% by 2020.

Household Income:
According to TCLM IDP (2016/17) about 7,500 households have an annual income of between R19,000.00 and R38 000.00, while about 10,000 households have an average annual income of between R1.00 and R4 800.00. At least 32,000 households have an annual average income of between R76,400.00 and R153,000.00, and a minority group of about 77 households have an annual income of above R1 million.

In GTLM, a great proportion of the population, 48.25%, do not earn an income, while 2.,65% of the population earn between R1 –to R400 per month, followed by 2.58% who earn between R401 and R800 per month, and 12.89% earn between R801 and R1600 per month.

Education: According to the Census 2011, only 21% of the population in TCLM achieved a matric qualification, a majority of the population (28%) have some form of secondary schooling, while 20% have some primary schooling and only 5% have completed primary school, illustrating a significant need for schools and the associated facilities in the municipality.

In the GTLM, an estimate 20% of the population have no schooling, and only 16% of the population achieved a Grade 12 pass in 2011.

Health Care: Currently Sabie, Mashishing and Matibidi each have three public hospitals and three public clinics, and although mobile clinics operate in farm and rural areas, these clinics do not adequately meet community healthcare needs and are often an unreliable service. Due to the high levels of poverty in some of the areas of the local municipality, people cannot afford to pay for transport to public healthcare facilities, and are in serious need of mobile clinics. The main causes for deaths in the TCLM is included in Table 4-36.

Table 4-36 Main Causes for Death in the TCLM

Number (ranking)	Causes	Number of deaths in 2011
1	Tuberculosis	188
2	Influenza and pneumonia	140
3	Intestinal infectious diseases	99
4	Other external causes of accidental injury	98
5	Other forms of heart disease	59
6	Diabetes	55
7	Cerebrovascular diseases	54
8	Hypertensive diseases	47
9	Certain disorders involving the immune mechanism	35
10	Ischaemic heart diseases	25

Although HIV/AIDS is not listed as a primary cause of the death in the area, according to the TCLM IDP (2016/17) the rate of HIV infection is increasing in the area. In 2009 HIV prevalence stood at 30.20%, while in 2010 it stood at 39.70%. (TCLM IDP, 2016/17). There is a total of 26 medical facilities in GTLM, which mainly constitute regional clinics that provide localised inputs to the community.

Services – Water, Sanitation and Refuse Removal:
In rural communities, a majority of households do not have regular adequate water supply, and most households rely on water sourced from nearby rivers and springs (Key informant interview, 2017). In communities with drilled boreholes, no maintenance plans are in place, and as a result, many boreholes are broken, non-functional and in need of repair. In 2011 a total of 1072 households in TCLM did not have access to basic water facilities (TCLM IDP, 2016/17), and 21% of households used unventilated pit latrines (Mphahlele Wessels & Associates, 2016. The two water treatment plants in Mashishing are in dire need of refurbishment.

Without bulk water supply, the municipality is also unable to provide communities with bulk sanitation, where approximately 1,619 households in farm areas are without access to basic sanitation. As an interim solution, the municipality is rolling out Ventilated Improved Toilets (VIPs) until the problem of bulk supply of water is addressed and resolved, which will ultimately solve the sewerage network and reticulation backlogs. (TCLM IDP, 2016/17).

A process of developing water and sanitation master plans to deal with problem is underway. A Water Service Development Plan (WSDP) is in place, which depicts the current status quo and requirements for bulk water and sanitation service delivery. (TCLM IDP, 2016/17). In the local municipality, it is estimated that 84% of the population does not have access to refuse removal services.

In GTLM the majority of the population use unventilated pit latrines, and almost 5.5 % of the households use VIP toilets. Most villages in GTLM do not have access to refuse removal and, dumping and burning of waste is the more common way of disposing waste.

Housing: Data from the 2011 Census (Statistics SA, 2011) describe 68,45% of households in the municipality as formal housing types, 20,36% as informal housing and 3,95% as traditional housing types. According to the IDP, 58,82% of housing types in Ward 5 are formal housing types, 22,77% are informal housing, and 12,66% as traditional housing types.

The GTLM IDP (2016/17) describes 83,91% of the housing types in the Greater Tubatse Municipality as formal housing types, 7,31% as informal housing types, and 7,83% as traditional housing types, and the total number of people on the RDP housing waiting list stands at 2749.

Electricity: TCLM provides electricity to the urban areas, businesses and industrial sites, while electricity in the rural areas is provided by Eskom. Although there has been a steady growth in electricity supply since 1996, approximately 4,314 rural households in TCLM do not have access to electricity, which amounts to about 16% of all the households in TCLM. (TCLM IDP, 2016/17)

According to the GTLM IDP (2016/17) a total number of 144 villages are electrified, and 56 villages are still without electricity supply.

Transportation: In general the main roads between Lydenburg, Sabie, Graskop, and Pilgrim's Rest are in relatively good condition. The TCLM IDP (2016 – 2017) acknowledges that the roads within the towns and villages (including the paved and unpaved roads) are not being maintained. Buses and minibus taxis are presently the two major modes of transport.

In GTLM, buses and taxis are the main mode of public transport, and although the GTM IDP (2016/17) recorded 405 taxi vehicles, 18 public buses, and a number of private bus companies operating in the area, the IDP also stated that there is lack of public transport facilities and that an overwhelming majority of the taxi facilities are informal.

Development Challenges: The TCLM IDP (2016/17) identifies the following key challenges to development in the area:

- Inadequate institutional capacity of the TCLM;
- Inadequate budgeting for operations and maintenance;
- Low education and skills base;
- Human settlements development and population growth; and
- Prevalence of TB and HIV/AIDS.

The baseline conditions present an ideal opportunity for Booysendal to expand their current SLP commitments with the new expansion to the benefit of the communities.

4.18.3.3 Project Area Socio-economic Baseline

Insight into the communities surrounding the Section 24G project expansion was mainly obtained through key focus group meetings.

Governance: The following governance structure is applicable to the communities in the project area:

- Ward Committees – elected community members who work closely with the Ward Councillor, and are responsible for service delivery in the communities located in the Project Area;
- Community Development Forums – elected community members responsible for identifying and communicating community development needs to the Ward Committees;
- Communal Property Associations – landowners in the Project Area governed by the Communal Property Associations Act 28 of 1996 (CPA Act); and
- Traditional Councils – elected traditional leaders governed by the Traditional Leadership and Governance Framework Act of 2003 (Framework Act) who are responsible for preserving cultural heritage resources, managing land and natural resources, supporting local development, and maintaining peace and communal justice systems.

In the study area, relationships between the governance structures and amongst community members vary from community to community. For example, in the Phetla community the primary governance structure is the Phetla Communal Property Association (CPA), which comprises an elected CPA Executive made up of land claimants and Traditional Council representatives from the Limpopo Province. The Choma CPA Executive does not recognise or engage with the newly established Community Development Forum, which is primarily made up of labour tenants who resided in the area prior to the land claims. The CPA Executive perceives the Community Development Forum as competing for authority and jostling for political power within the community (Key informant interview, 2017).

In general, community governance in the Project Area is complex and overshadowed by conflict over land claims and mistrust of community leaders who are perceived as not being representative of the broader community, corrupt and restricting access to natural resources and employment opportunities with mines in the area. Engagement by the mine with only CPA Executive structures and community leaders is likely to be ineffective and to further contribute to existing views of mistrust between community members and community leaders.

As an alternative to solely communicating to neighbouring communities through existing governance structures and/or relying on CPAs to communicate key project messages to constituencies, the mine is advised to consider sharing project information during community meetings that are representative of the local communities impacted by the project. This may potentially improve trust between the mines and the neighbouring communities, and assist the mine with gaining the support of the local communities for the Booysendal South Expansion Project and related mining activities.

Demographics: The population comprises both land claimants and labour tenants, with the majority of land claimants moving to the Project Area in 2012. Accurate population figures are not available for communities in the Project Area, however, estimates were collected in consultation with community representatives and verified by community members in focus group meetings. The figures are included in Table 4-37.

Table 4-37 Population Figures for Project Area Communities (Source: SES Community Information Sheet, 2017)

Community	Estimate Households	Estimate Population
Phetla	50	450
Choma	53	477
Shaga	700	7000
Stageng	800	8000
Total	**1 603**	**15 927**

The average household size is 9.94 people with a complex extended family composition.

Age and Gender: Information from the focus group meetings indicated that between 57% and 60% of the population was younger than 18 years. Few people were over the age of 60. There is therefore a high dependency ratio and a low life expectancy. According to the communities this can be attributed to poor healthcare facilities and the spread of communicable diseases such as tuberculosis and HIV/AIDS.

The information indicates that females (62% to 55%) outnumber the number of males (38% to 45%).

Ethnicity and Religion: The majority of the population is Sepedi (90%), with 10% Ndebele. The main religion is Christianity while 50% also practice various traditional religions.

Land Use and Access to Land: Many communities moved back into the area after successful land claims. Community members can acquire one-hectare of land through the traditional council and CPAs. At present, the influx into the area is characterised by illegal squatting, and this was most evident in the Choma and Phetla communities.

Ownership and Tenancy: The main landowners in the project area are CPAs and Booysendal Mine. During the study, only one private farmer was identified in Shaga. According to community members in Shaga, the farmer recently acquired the farm, which is not under a land claim, and employs seasonal labourers to work on the blueberry farm.

Education: There are 3 primary schools and 1 secondary school located within the project area. Two of the three primary schools in the Project Area are located in the Shaga community. These include Shaga Primary School and Bosfontein Primary School. The third primary school, Kiwi Primary School, is located in the Phetla community, and the secondary school, Tonteldoos Secondary School, is located in Stageng. Pupils in Stageng do not attend primary schools in the project area, and majority of these students are enrolled at Sisabonga Primary School in Rossenekraal, Limpopo. The schools, location, number of pupils and teachers are included in Table 4-38. School attendance at the schools consulted as part of the assessment report was high. Bussing children to school has contributed to these high attendance figures. The conversion to Grade 12 is however significantly low as pupils often leave school at various stages for diverse reasons.

Table 4-38 Primary and Secondary Schools in the Project Area

School Name	Location	No. of teachers	No. of pupils	Fees (per annum)
Shaga Primary School	Shaga	3	60	R0.00
Bosfontein Primary School	Shaga	11	304	R0.00
Kiwi Primary School	Phetla	4	62	R0.00
Sisabonga Primary School	Roossenekal	11	667	R0.00
Tonteldoos Secondary school	Stageng	13	297	R0.00
Skhila Secondary School	Mashishing	29	761	R350.00
Mashishing Secondary School	Mashishing	1554	52	R450.00

Challenges experienced in the area include lack of secondary schools, lack of transport, shortage in textbooks, increased number of orphans, no library / computer / laboratory facilities, limited extramural facilities, no flushing toilets and no administrative buildings for teachers.

Healthcare: A mobile clinic is supposed to provide healthcare services to the communities, but this service is unreliable. The closest healthcare services are located in Mashishing at the Hospital, Clinic and a clinic in Mashishing Township. Cost of transport, treatment and demand for healthcare at these facilities makes it inaccessible for the communities. In addition, traditional leaders are expensive. Many self-medicate using traditional herbs collected in the nearby forest.

The most commonly reported ailments and diseases included high blood pressure, diabetes, tuberculosis, diarrhoea, and colds and flu.

Housing: Most houses are built with cement and brick and corrugated roofing with one or more outbuildings. There are very few traditional houses and some shanty houses are present. Some houses have pit latrines.

Energy: Although there is electricity, financial conditions restrict the use thereof, therefore many households use wood for cooking and candles for light.

Water supply: The Protea Farms Community Forum was the only community having gravity fed communal pipes provide water to household stands. Other communities collect water from springs and streams, mainly tributaries of the Groot Dwars River. Water security in winter months can be a problem and the water quality was reported to be poor reportedly leading to high number of cases of diarrhoea. Government supplied boreholes were identified however, have not been maintained.

Sanitation: Some members have pit latrines while a large number make use of the bush.

Refuse Removal: There are no services, refuse is disposed of in public places, in the open or burnt.

Roads and Transport: There are no taxis of public transport in the area. People walk by foot to the R577 where taxis are found. The cost varies between R120 and R160 return to Mashishing or Roossenekal.

Livelihood Strategies: Although mines employ people, lack of transport make it difficult for employees to effectively remain employed. Seasonal labour on farms have declined due to the land claims. All the households are dependent on subsistence farming including livestock rearing (chickens, cattle, sheep and goats) and planting of maize, sorghum, beans, potatoes and some fruit trees. There are no informal businesses in the area from which income can be generated.

Although harvested medicinal plants (i.e. African potato, *lengana* and aloe) are used for household consumption, it was reported that some people sell traditional herbs, and that *lawang* was commonly sold to Somalis.

In communities, it was reported that a number of community members are artisans with varying skills. These skills include welding, driving, operating heavy machinery, construction, bricklaying, baking, catering, and sewing but don't hold formal qualifications required by the mines. Therefore, skills training and development was identified, as a priority community need.

Income and Expenditure: Dependence on social grants are very high due to unemployment which is the main source of income. The main household expenditure is on transport, food, energy, airtime and clothes.

4.18.4 Ecosystem Services

The following ecosystem services were identified during the focus group surveys:

- Provisional: Grazing livestock, subsistence farming, collecting wood for heat and building material, collecting clay for pottery, harvesting honey and collecting grass for thatching and brooms. It is not foreseen that the mine will impact on these activities;
- Graves and cultural-heritage sites: some of the sites are in the mine properties. Access arrangements with communities must be discussed.
- Plants for medicinal use: as the mining right area is fenced it is assumed that these are mainly collected in the project area and therefore it is not foreseen that the project will impact on availability.

4.18.5 Vulnerable Communities

There is a vast majority of the population within the project area who can be regarded as vulnerable due to high levels of unemployment and poverty. The most vulnerable is the 60% youth population followed by the old-aged and female population.

4.18.6 Gap Analysis / Limitations

The following limitations must be borne in mind when interpreting the results of the baseline study:

- In a relatively short period of time it is impossible to gain an in-depth understanding of the local social and political dynamics of the area. The insights on land claimants, and the tensions between the land occupants remains superficial, and on-going community liaison is necessary to understand these complex power struggles and varying narratives;
- Although clear directives were given to community leaders on the purpose of the social study, there were instances where focus group meetings were overwhelmingly attended by youth hoping to secure employment opportunities with the mine; and

- Mistrust of the CPA leaders has prevented open and transparent discussions with focus group participants on governance related issues. An example was in Phelta focus group meetings which were attended by CPA Executive members and their participation in these meetings prevented land occupants from voicing their opinions on the CPA leadership structure and the effectiveness of this structure in representing their interests.

4.19 CULTURAL HERITAGE ASSESSMENT

Two cultural heritage surveys were undertaken. The first by Heritage Contracts and Archaeological Consulting (HCAC) and second by Dr Julius CC Pistorius Agroecologist and Heritage Consultant. The first study was done on the original BS1/2, BS3 and the various linear infrastructure components. This study provides important pre-construction heritage baseline data. The results of this study were incorporated into the second study which focussed on BS4, the two new Merensky portals and an assessment of the impacts of the Section 24G activities on potential cultural-heritage resources. The later report is included in Annexure R.

4.19.1 Methodology

The field surveys for the first study was conducted on from 2 to 5 February 2016, 8 to 12 February and again on 22 March 2016. The field survey for the second survey were undertaken on 1 and 2 of November 2016 and again on 17 November 2016. For each of the surveys, GPS tracks were taken for the foot surveys, although the signal at times got lost. Additional surveys on smaller gravel tracks were also undertaken by 4x4 vehicles. The tracks for the second survey are included in Figure 4-38 and in Figure 4-39

Figure 4-38 Track Log BS4 and Section 24 Heritage Study Source: JCC Pistorius, June 2017)

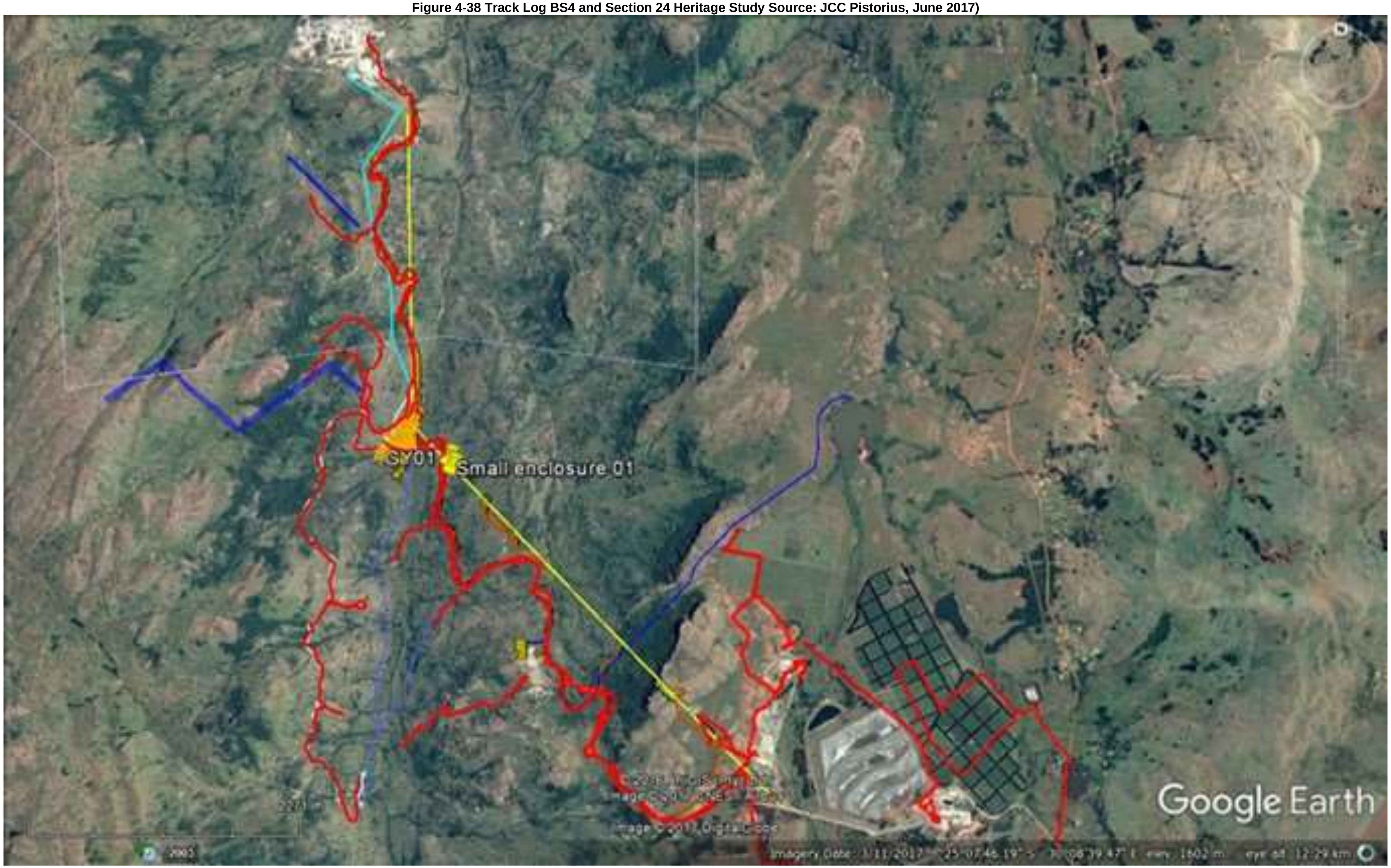
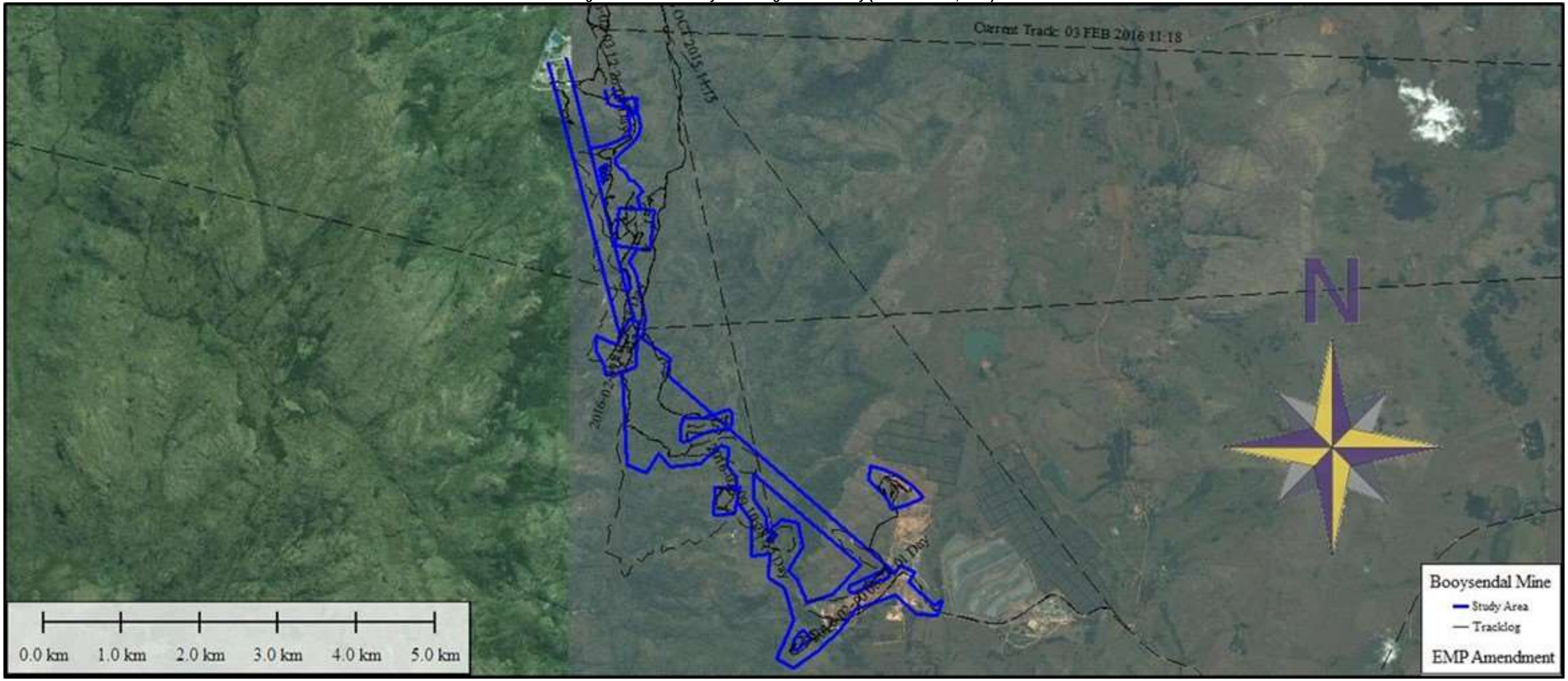


Figure 4-39 GPS Survey Track Logs HCAC Study (Source HCAC, 2017)



The studies also undertook extensive desktop review of previous studies done in the area, maintained databases from PHRA, the Archaeological Data Recording Centre at the National Flagship Institute (Museum Africa) in Pretoria and SAHRA's national archive (SAHRIS).

The NHRA has prescribed a methodology in which the significance of impacts on heritage sites need to be undertaken. This rating is based on the use of 2 rating (grading) schemes, namely:

- A scheme of criteria which outline places and objects as part of the national estate as they have cultural-historical significance or other special value (outlined in Section 3 of the NHRA [Act No 25 of 1999] The rating of the impacted sites are included in Section 8.
- A field rating scheme according to which heritage resources are graded in three tiers (levels) of significance based on the regional occurrence of heritage resources (Section 7 of the NHRA [Act No 25 of 1999). The ratings or the applicable impacted resources are included in Section 8.

Consultation will take place as part of the overall consultation process.

4.19.2 Area of Influence

The AoI is based on the disturbance footprints and a corridor on both sides as indicated in Figure 4-40.

4.19.3 Baseline

a) Type of Heritage Resources

The study found that there are heritage resources representing various eras present in the study area. These include:

- Early Stone age, dating back from 2.5 million to 250 000 years ago;
- Middle stone age, dating back 250 000 to 22 000 years ago. A limed number of these artefacts are present on site;
- Late stone age, dating back around 20 000 years ago. Some rock graving dating back to this period were found on the eastern slopes of the Groot Dwars River; and
- Late iron age, stretching from AD1600 into the nineteenth century. Especially stone walled settlements along the eastern edge of the Groot Dwars River Valley associated with the Choma and Petla tribes which dates back to this era (the historical period in this area is associated with the Ndzundaza-Ndebele and Voortrekkers settling in the area).

b) Heritage Resources of the Study Area

The HCAC study identified 49 heritage sites in the vicinity of BS1/2, BS3 and the various linear infrastructure components. The location and nature of the sites is included in Table 4-39 and the location of the sites area is depicted in Figure 4-40

Table 4-39 BS1/2, BS4 and Linear Infrastrucuture Corridor Cultural-Herigtage Sites (Source: HCAC, 2017)

FIELD NUMBER	TYPE SITE	LONGITUDE	LATITUDE
344	Historical Ruin	30° 06' 55.5553" E	25° 05' 53.9016" S
345	Historical Ruin	30° 07' 01.9849" E	25° 06' 50.1949" S
346	Historical Ruin	30° 07' 05.0483" E	25° 06' 51.8832" S
347	Cemetery	30° 07' 04.3609" E	25° 06' 54.3563" S
350	Iron Age	30° 07' 07.7520" E	25° 06' 57.3659" S
351	Stone Cairn	30° 07' 09.8977" E	25° 06' 57.6288" S
352	Communal Grinding Area	30° 07' 09.7031" E	25° 06' 58.3201" S
353	Historical Ruin	30° 07' 13.6201" E	25° 06' 40.8419" S
354	Historical Ruin	30° 07' 03.7236" E	25° 07' 37.1279" S
355	Historical Ruin	30° 07' 04.7927" E	25° 07' 38.4493" S
356	Historical Ruin	30° 07' 04.1771" E	25° 07' 40.1231" S
357	Historical Ruin	30° 07' 20.0280" E	25° 07' 56.5068" S
358	Terracing	30° 07' 43.1401" E	25° 08' 13.0885" S
359	Stone Cairn	30° 07' 45.6851" E	25° 08' 14.9603" S
360	Terracing	30° 07' 44.4757" E	25° 08' 16.7065" S
362	Historical Ruin	30° 07' 10.3331" E	25° 08' 18.5640" S
363	Possible Graves	30° 07' 10.3835" E	25° 08' 18.1609" S
365	Stone Cairn	30° 07' 43.4497" E	25° 08' 41.3449" S
366	Terracing	30° 07' 48.1513" E	25° 08' 44.3364" S
367	Terracing	30° 08' 05.8560" E	25° 09' 00.1260" S
368	Terracing	30° 08' 04.3404" E	25° 09' 00.7093" S
369	Rock Engraving	30° 07' 19.4088" E	25° 05' 31.7004" S
370	Iron Age	30° 08' 46.8169" E	25° 09' 17.9029" S
372	Linear Stone Wall	30° 08' 50.9171" E	25° 08' 43.1629" S
373	Historical Ruin	30° 08' 51.9901" E	25° 08' 44.2607" S
374	Cemetery	30° 08' 19.0859" E	25° 09' 42.5808" S
375	Stone Cairn	30° 08' 13.5241" E	25° 09' 44.8777" S
376	Linear Stone Wall	30° 08' 19.9969" E	25° 09' 44.1683" S
378	Terracing	30° 06' 39.4199" E	25° 05' 59.6185" S
379	Iron Age	30° 6'39.87"E	25° 6'8.13"S
600	Terracing	30° 07' 10.7868" E	25° 06' 56.5956" S
601	Terracing	30° 07' 11.9820" E	25° 06' 46.8144" S
602	Grave	30° 08' 47.2000" E	25° 09' 01.0000" S
603	Historic Pedi Complex	30° 08' 45.0000" E	25° 09' 01.0000" S
604	MSA	30° 08' 45.0000" E	25° 09' 02.8000" S
605	Stone Kraal 2	30° 08' 31.4000" E	25° 09' 28.2000" S
606	Stone Kraal	30° 08' 34.8000" E	25° 09' 26.0000" S
607	Grave	30° 08' 41" E	25° 09' 30" S
608	Iron Age	30° 07' 26.2000" E	25° 06' 59.3001" S
609	Iron Age	30° 07' 18.6001" E	25° 07' 12.9000" S
610	Iron Age	30° 07' 56.3401" E	25° 08' 53.6399" S
611	Iron Age	30° 07' 45.9600" E	25° 08' 52.6800" S

FIELD NUMBER	TYPE SITE	LONGITUDE	LATITUDE
612	Iron Age	30° 07' 55.2601" E	25° 08' 53.2799" S
612	Iron Age	30° 07' 54.9599" E	25° 08' 52.9199" S
613	Iron Age	30° 07' 50.3401" E	25° 08' 52.1399" S
614	Iron Age	30° 07' 45.3601" E	25° 08' 49.4999" S
615	Iron Age	30° 07' 44.7599" E	25° 08' 48.4200" S
616	Iron Age	30° 07' 43.4401" E	25° 08' 47.8801" S
617	Iron Age	30° 07' 42.4799" E	25° 08' 50.3400" S

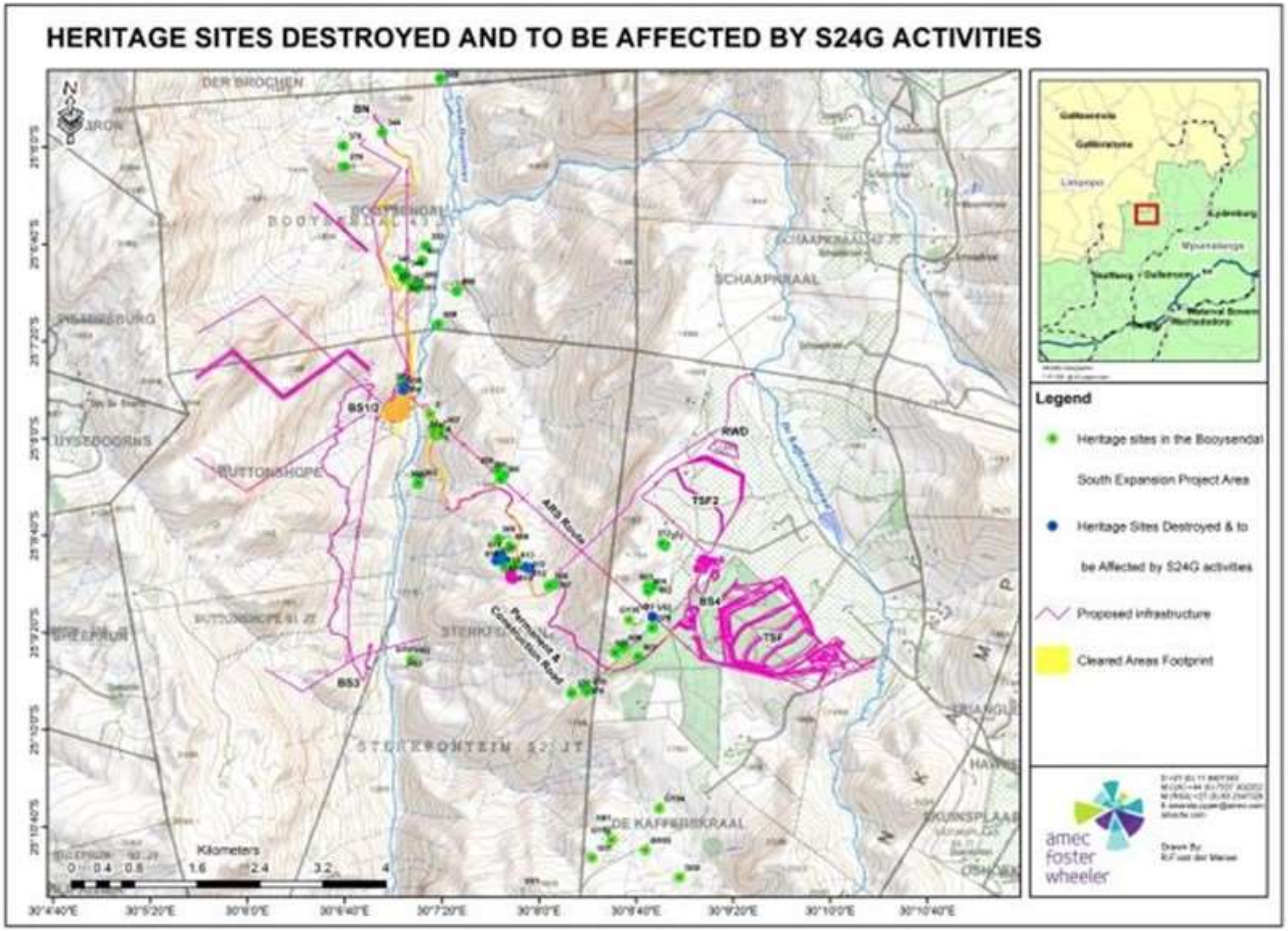
In addition to the sites identified by HCAC, another 6 sites dating back to indigenous historical times and 7 grave sites were identified as part of the JCC Pistorius Study in 2017. The sites are included in Figure 4-40 and described in Table 4-40.

Table 4-40 BS4, Merensky and Section 24G Heritage Sites (Source, JCC Pistorius, June 2017)

LEGEND ON MAP	HISTORICAL VILLAGE	COORDINATES	SIGNIFICANCE RATING
	Historical Remains		
H01	Historical House Coetzee family	25º 10.667'S; 30º 08.511'E	**Medium to high**
H02	1st Hamlet in Groot Dwars River Valley	25º 09.517'S; 30º 07.124'E	**Medium to high**
H03	2nd Hamlet in Groot Dwars River Valley	25º 09.610'S; 30º 07.067'E	**Medium to high**
V01	Village against the slope of a hill	25º 11.099'S; 30º 07.871'E	**Medium to high**
V02	Village situated between and next to boulders	25º 09.224'S; 30º 08.782'E	**Medium to high**
V03	Close to GY05 dates from more recent past	25º 09.216'S; 30º 08.662'E	**Medium to high**
	Graves and Graveyards		
GY01	Three graves on bottom of Groot Dwars River Valley	25º 09.517'S; 30º 07.124'E	**HIGH**
GY02	Graves of Coetzee family associated with HH01	25º 10.755'S; 30º 08.500'E	**HIGH**
GY03	Graveyard of the Phetla community with 13 graves	25º 10.826'S; 30º 08.732'E	**HIGH**
GY04	Holds approximately 15 graves	25º 10. 538'S; 30º 08.828'E	**HIGH**
GY05	Holds nine graves	25º 09.244'S; 30º 08.619'E	**HIGH**
G01	Single grave in iron frame	25º 10. 877'S; 30º 08.367'E	**HIGH**
G02	**Single grave with upright stone acting as headstone**	**25º 11. 012'S; 30º 08.968'E**	**HIGH**

The detail around the various sites are included In Annexure R.

Figure 4-40 Location of the Cultural-heritage Sites at BS1/2, BS3, BS4, Section 24G and the Linear Infrastructure Corridor (Source JCC Pistorius 2017))



c) Palaeontology

According to the SAHRIS Paleo sensitivity map, most of the study area is classified as being of zero palaeontological sensitivity although the developments on the farm De Kafferskraal are in an area marked as of low palaeontological sensitivity. According to SAHRIS no palaeontological studies are required. A previous Paleontological study on the farms Hoogland 38-JT, Sterkfontein 52-JT and Sterkfontein 74-JT which was done by Rubidge (2011) concurs with the SAHRIS recommendations (Van der Walt and Celliers 2016).

4.19.4 Ecosystem Services

There are ecosystem services applicable to Cultural services. Through the cultural-heritage finds and identifications on site, this service is applicable in two ways:

- spiritual and historical sites which are related to religious or heritage value; and
- science and education – the loss of cultural heritage sites and the loss of intrinsic knowledge.

The value and potential impacts on ecosystem services associated with cultural resources are included in Table 4-41. Damage to some of the sits of low-medium significance already occurred.

Table 4-41 Cultural Ecosystem Services

Service	Description	Relevant Areas	Importance	Replicability
Graves and gravesites	Loss of self and possibly ancestral linkages	Various around the corridors of development	High	Irreplaceable if damaged Replaceable if relocated
Heritage sites	Damage or destruction of cultural-heritage sites	Loss of our historic knowledge and places of cultural and religious importance	Depending of the site, importance can differ from low to high in this area	Irreplaceable if destructed without mitigation

4.19.5 Sensitivities

The sensitive sites are deemed the sites which could still be impacted on by the Section 24G and any future activities. This is addressed in more detail in the impact assessment in Section 8.

4.19.6 Gap Analysis / Limitations

The heritage assessment noted and identified the following gaps and limitations:

- The findings, observations, conclusions and recommendations reached in this report are based on the specialist’s best scientific and professional knowledge and available information at the time when the site visit was undertaken.

- This heritage survey may have missed heritage resources in the project area as heritage sites may occur in in tall grass or thick clumps of vegetation while others may be located below the surface of the earth and may only be exposed once development commences.
- Some areas could not be surveyed in totality due to the rugged and demanding terrain, inaccessible parts of the terrain and limited time. However, the survey is considered appropriate for the nature and the level of investigation required.

4.19.7 Cultural-Heritage Impact Assessment

The location of the cultural-heritage sites in relation to the development footprints are clearly indicated in Figure 4-40.

Clearing in the area of BS1/2 and construction of the BS1/2 terrace lead to the destruction of:

- Historical ruins (indicated as 355 and 356 in Figure 4-42); and
- Iron Age features number 610, 6111, 612, 614, 615, 616 and 617 have been destroyed.

The location of these finds in relation to the development is included in

Figure 8-8 and Figure 8-9.

The construction of the ARC could possibly impact in one section on the Historic Village HV02 as it is possible that one of the towers will be constructed in the site.

As indicated previously in Section 4.19.1, NHRA has prescribed a methodology which has to be used to determine the significance of impacts on heritage sites. This rating is based on the use of 2 rating (grading) schemes, namely:

- A scheme of criteria which outline places and objects as part of the national estate as they have cultural-historical significance or other special value (outlined in Section 3 of the NHRA [Act No 25 of 1999].
- A field rating scheme according to which heritage resources are graded in three tiers (levels) of significance based on the regional occurrence of heritage resources (Section 7 of the NHRA [Act No 25 of 1999).

The criteria for the rating is included in more detail in the Specialist Report (Annexure R).

Figure 8-8 Iron Age Sites Destroyed in the Northern Section of the BS1/2 Footprint (Source: JCC Pistorius, June 2017)

Figure 8-9 Destruction of Iron Age Sites in the Central BS1/2 Area (Source: JCC Pistorius, June 2017)

The significance of the impacts on the heritage sites are included in Table 4-42.

Table 4-42 Significance Rating Cultural-heritage Sites Impacted

Heritage Resources Impacted by the Section 24G Activities				
Legend on Map	**Heritage resource**	**Significance**	**Motivation**	**Cause of impact**
355	Historical ruins	Low-medium	See rating below	**BS1/2**
356	Historical ruins	Low-medium	See rating below	**Infrastructure**
610	Iron Age feature	Low-medium	See rating below	**BS1/2**
612	Iron Age feature	Low-medium	See rating below	**Infrastructure**
611	Iron Age feature	Low-medium	See rating below	**Cleared area**
614	Iron Age feature	Low-medium	See rating below	**Cleared area**
615	Iron Age feature	Low-medium	See rating below	**Cleared area**
616	Iron Age feature	Low-medium	See rating below	**Cleared area**
617	Iron Age feature	Low-medium	See rating below	**Cleared area**
Heritage Resources to Potentially be Impacted by the Section 24G Activities				
Legend on map		**Significance**	**Motivation**	**Cause of impact**
HV02	Iron Age and or historical ruins	Low-medium	Low-medium	**ARS**

Cumulative impacts on the cultural-heritage are foreseen due to the following:

- An increase in population numbers and settlements due to job creation. These settlements may expand and further expose or damage heritage resources. This also includes the possible looting of archaeological sites whether to be utilized for building material or for the illegal collecting of artefacts.
- The Booysendal South Expansion Project is but one of a number of developmental projects in the Groot Dwars River Valley which all have a detrimental influence on the archaeological record and cultural landscape of this ecozone.
- Due to the magnitude, size and surface area to be covered by the project and probably to be increased in the future the archaeological record of the mining area can be obliterated. This increasing the importance of managing the recorded heritage resources in a responsible manner.
- Heritage resources deliberately destroyed by the project as well as those of low significance which are studied before they are destroyed all contribute to the context and significance of the larger cultural landscape.
- Cultural historical landscapes and heritage resources are non- renewable and cannot be replaced once they have been altered or destroyed.

Management measures applicable to the heritage resources include:

Regular six monthly inspection of heritage resources and ensuring its protection;

- Obtaining permits from SAHRA for the mitigating work;

- Maintain at least a 30m corridor from the outer edge of graves and heritage resource and any development footprint; and
- Demarcated and fence all gravesites.

Recommendations and Reasoned Opinion

The cultural-historical remains in the Booysendal South Expansion Project Area do not have outstanding heritage significance. Most of the remains have been recorded and have been briefly described. It seems as if no graves or graveyards will be impacted by the development. These remains have high significance and may not be affected by the project prior to alternative legal arrangements and approval.

A limited number of historical remains have been destroyed as a result of S24G activities whilst a historical village may be affected when the ARC system is constructed. Mitigation measures have been proposed and management measures have been outlined in the Heritage EMP which have been further incorporated in the overall EMP for the remaining heritage resources in the Booysendal South Expansion Project Area.

There is no reason from a heritage point of view why the proposed Booysendal South Expansion Project considering all alternatives discussed herein, cannot proceed if the mitigation and management measures recommended in Cultural-Heritage Report and accompanying EMP have been implemented.

Note: It is important to note that the management measures for the impacts have been included in the EMP in great detail as this will become a working document for implementation on site and which will be legally binding. The EMP consists of the main document and the management plans prepared by specialists.

5. PUBLIC PARTICIPATION PROCESS

The stakeholder engagement process was undertaken in terms of Chapter 6 of GN 982 of 4 December 2014 as amended in GN 326 of 7 April 2017. The Public Participation Guidelines of 10 October 2012 published in GG36769 were also considered.

The purpose of the stakeholder engagement process is to provide stakeholders and the I&APs with sufficient and accessible information in an objective manner to assist them to:

- Raise issues of concern and suggestions for enhanced benefits and commenting on reasonable alternatives;
- Verify that their issues have been recorded (Comments and Responses Report) and considered in investigations; and
- To allow stakeholders and I&APs to contribute relevant local information and traditional knowledge to the process.

The stakeholder engagement process is an ongoing process throughout the application process. The process followed to date is summarised in the following sub-sections.

5.1 STAKEHOLDER DATABASE

The initial stakeholder database was compiled using the existing Booysendal database. This was expanded from consultation information provided by the specialists. The social specialist has undertaken household surveys within the potentially affected communities and contributed largely to the expansion of the database.

Various stakeholders have registered as I&APs as a result of the extensive distribution of BIDs, notices and the placement of site notices. This database will be updated throughout the project. Registered I&APs will be kept informed on the progress of the Section 24G Application process. The current stakeholder database is included in the Stakeholder Engagement Report which included under Annexure B.

5.2 PROJECT ANNOUNCEMENT

The Section 24G Application process and the availability of the Draft Section 24G Report was announced to the I&APs by means of the following:

- Advertisements in the local Steelburger newspaper and in the regional Daily Sun newspaper. Advertisements were published on Friday, 2 June 2017 and Friday, 30 June 2017. Proof of placement of the advertisements are included in Annexure B.
- BIDs were compiled and distributed. The BIDs are available in Sepedi, SeSotho, English and Afrikaans. Refer to Annexure B for the BIDs. BIDs have been distributed:
    - To all stakeholders on the stakeholder database on 2 and 8 June 2017;
    - By hand to those who were visited while the site notices were placed on 9 and 10 June 2017;
    - At a meeting held between Booysendal Mine and members of the Booysendal South Forum which met for a monthly meeting on 5 June 2017.

- A Registration and Comment Sheet was distributed with every BID, inviting stakeholders to register as I&APs and to provide their comments on the proposed application BIDs will also be distributed at meetings proposed during the public review of the Draft Section 24G Report.
- Site notices were placed on 9 to10 June and on 23 and 24 June 2017 respectively all around the Booysendal Mine on main roads and at public places. Appendix B provides a description of where the 20 site notices were placed on 9 and 10 June 2017 and again on 23 and 24 June 2017 as well as a photo of each of the site notices placement.
- Telephonic notification to key I&APs and landowners.
- Placement of a notices and the BIDs on the Amec Foster Wheeler website (www.amecfw.com/booysendal).

5.3 COMMENTS AND RESPONSES

All comments that were received during the project announcement period and which are to be received during the review period of the Draft Section 24G Report will be captured in a CRR – Version 1. The CRR is updated on a continuous basis and at the end of the process, is presented to the authorities and other I&APs together with the final reports as a full record of issues raised, and how the issues were considered during the project.

The following versions of the CRR are proposed:

- CRR Version 1: To be submitted with the Draft Section 24G Report in Appendix B. This CRR captures comments and issues raised until 22 June 2017. Comments received after this date will be captured in version 2 of the CRR; and
- CRR Version 2: To be submitted with the Final Section 24G Report and will include all comments received during the focus group and commenting authority's meetings and during the review period of 7July 2017 to 8 August 2017.

5.4 WAY FORWARD

The Draft EIA, EMP and associated will be made available for a 30-day comment period from 7 July 2017 to 7 August 2017 for public review. The documents will be made available as included on Table 5-1.

Table 5-1 Availability of Section 24G Documents for Public Review

Printed Copies		
Mashishing Public Library, 41 Viljoen Street, Mashishing (Tel: 013 235 3700)		
Maartenshoop Police Station, Naauwpoort Farm (Tel: 013 235 4041)		
Electronic Copies		
Website download	www.amecfw.com/booysendal	
CD copy	Please call Anelle Lötter	082 804 5890

Meetings with various stakeholders have been planned to discuss the outcome of the Section 24G EIA, EMP and specialist studies. These meetings are planned for the week of the 3 to 7 July 2017 when this report will become available and for 12 and 13 July 2017 with commenting authorities. The attendance registers for these meetings and the updated Comments and Response Report (CRR) will be included in the final Section 24G EIA Report. The dates and venues of meetings are included in Table 5-2.

Table 5-2 Stakeholder Meetings

DATE	TIME	MEETING AND VENUE
27 June 2017		Dry-run meeting
28 June 2017	08:00	Booysendal South Forum meeting
Monday, 3 July 2017	06:00	Depart Pretoria for site
	11:00	Meeting with representatives of the Tshufi community
	15:00	Meeting with representatives of Protea Farms, Mashishing
Tuesday, 4 July 2017	09:00 – 12:00	Shaga Community and CPA Shaga primary to be confirmed
	14:00 – 17:00	Phakaneng Choma Community and CPA Pakaneng
Wednesday, 5 July 2017	09:00 – 12:00	Phetla CPA To confirm with CPA and traditional council
	14:00 – 16:00	Phetla Royal Council
Thursday, 6 July 2017	10:00 – 12:30	Commercial farmers Hall of Steenkampsberg Boerevereniging
	14:00 – 16:00	Makua Royal Council
Friday, 7 July 2017	10:00 – 12:00	Meeting with representatives of the Thaba Chweu Municipality in Mashishing at municipality
	14:00 – 17:00	Makua CPA To confirm with CPA and traditional council

5.5 WAY FORWARD

5.5.1 Final Reports

All comments received during the Section 24G consultation process will be considered and the reports will be finalised. A Final Section 24G Report will be submitted to the authorities, and made available to I&APs for the final comments. Comments on the final report will be directed to the DMR Limpopo Regional Office and the specific case officer Mr Mr Kolani Thivhulawi. I&APs will be requested to copy their comments to the EAP and public participation office.

The availability of the final report and where a copy can be obtained, will be announced as follows:

- Advertisement in the Steelburger newspaper;
- Telephonic notification to key stakeholders; and
- Email to I&APs on the database.

The final reports will be submitted to the relevant competent and commenting authorities for their consideration on a decision of the Section 24G authorisation.

5.5.2 Competent Authority Decision

The decision and the detail of the decision of the CA on the Section 24G application will be communicated to register I&APs. In light of the conditions stipulated, the I&APs will be made aware of their rights to appeal the decision in respect of the Section 24G Application and the proposed process to follow in this regard. The legislative and required public participation activities will end once the appeal period has lapsed.

5.6 COMMENTS

A summary of comments raised to date includes:

- Job opportunities;
- Request for additional information and request for discussions around the outcome of the Section 24G Reports;
- Whether activities have stopped and if criminal charges have been laid;
- If an independent Environmental Compliance Officer (ECO) have been appointed;
- Recommended that an ECO be appointed by DMR of the Department of Environmental Affairs;
- The fact that mines place a lot of emphasis on health and safety but that environmental aspects are neglected;
- Commented on the need for pro-activeness from the Booysendal Environmental department;
- SAHRA advises that a case number needs to be opened and documents uploaded on the system;
- Protection of high priority agricultural land should be a priority;
- Assistance with roads have been requested;
- Notification on the blasting schedule has been requested;
- Concerns were raised on potential vandalism of heritage sites and graves; and
- Concerns about water security.

The CRR is included in Annexure B.

6. PROJECT NEED AND DESIRABILITY

Booysendal has identified a window of opportunity to increase production in order to meet short to medium term projected demands for platinum. Having acquired BS4, the mine believes it could fast-track its expansion byutilizing the existing infrastructure at BS4 which is currently in care and maintenance. Having acquired the Booysendal Mining Right and Everest Mining Right respectively which include the full extent of the project area, the Booysendal Mine proceeded with construction and developments to realise the opportunities identified.

6.1 SOCIO-ECONOMIC BENEFITS

The expansion project has economic benefits for South Africa due to the increased platinum production and local socio-economic benefits as a result of job creation, capital expenditure on contractors, materials and equipment. The longevity of the life of mine and significant employment opportunities will further contribute to improving the social and economic conditions and minimise the occurrence of retrenchments and/or early mine closure.

During construction phase, it was indicated that at the peak of construction, a labour force of up to 3200 labourers will be required. The project has an estimated capital spend of R4,199,800,000 over 5 years. The projected turnover (2016 values) is expected to be R2.7 billion of which some 8 to10% (about R250 million) will represent ongoing capital investment for the projected life of mine.

The majority of the labour force will be sourced from the Thaba Chweu Local Municipality (Mpumalanga Province) as this is the direct labour sending community and the direct area of influence.

Booysendal indicated that a total of total of 2,746 direct and contract employment opportunities will be created during the operational phase with a further 4,119 indirect employment opportunities forsuppliers and new small business owners to serve and assist with the operations. With the high dependency ratio in the area, it is expected that a total of 365,882 people will benefit from the Booysendal South Expansion Project. Booysendal indicates that currently 60% of the employees at BN are sourced from local communities. This means that a significant amount of the current annual wages of R505,372,151 filters through to the local communities and households. The same principles for employment currently implemented at BN will be implemented at BS.

In addition, Booysendal indicates that preferential procurement from Historically Disadvantaged South Africans (HDSA) at Booysendal is currently 87.18%. The Booysendal South Expansion Project will require further procurement and will enhance benefits and business development in communities. Booysendal also contributes R86,639,513 to Government revenues. This contribution will increase with the continuation of the expansion activities.

Local economic development spent by the mine since 2014 was calculated to be R8,926,913. Booysendal indicates that the expansion of the mine will assist in the continuous development spend, including investment into local schools and development centres. The SLP will be updated to include commitments for the southern section of the Booysendal Mine operations where it is foreseen that the most of the employees will be sourced from.

The local Government Handbook (Source: http://www.localgovernment.co.za/locals/view/ #demographic) indicates that the dependency ratio for the larger Ehlanzeni District Municipality in which most of the Booysendal South Expansion falls is in the order of 66.4 per 100 in 2016. In addition, the official unemployment in Thaba Chweu is 20.5% and the youth unemployment is 27.10%. The triple down effect, which the jobs will have in the area, will be significant and will lead to benefits to at least 20,000 people directly. In addition to the direct benefits, indirect benefits will be created through procurement, with a focus on procurement from HDSAs.

In terms of Booysendal's approved 2015 to 2019 SLP other increased benefits and advantages are likely to increase this includes:

- Technical skills training which will lead to further empowerment of employees;
- Training through the Clicker site: e-learning and practical assessment methods to date benefitted approximately 2,746 employees and contractors;
- Adult based education and training (ABET) programme will be expanded into the community;
- More learnerships as part of the Skills development strategy. To date, 23 learners have benefitted from learnerships and 4 are still in progress;
- Portable skills training which can be applied outside of the mining industry, including amongst others basic training in: welding; electricity; plumbing; finance; leadership; and entrepreneurship;
- Career progression plans to develop the skills of individuals;
- Employee mentorship programs to fast track on the job training and skills development;
- Skills and qualification enhancement through internships and bursary plan; and
- Implementation of an employee equity program.

The value of these training programs in the rural communities will further contribute to employment and marketability during and after mine closure.

6.2 ENVIRONMENTAL FACTORS

Booysendal believes that it has sufficient measures in place to mitigate and manage the Booysendal South Expansion Project's environmental impacts pending the approval of the Section 24G Application. Booysendal indicated that it is already implementing mitigating and management measures to manage the identified impacts associated with the Section 24G activities. This includes the implementation of the 2010 Construction Phase Policy (SHE SPEC 101). In 2014 Booysendal, was awarded an environmental management award by the DWS for its industry leading performance in managing its dirty water system.

Booysendal has appointed a full time independent ECO to oversee construction activities. WBHO, one of the main construction contractors has in the meantime also appointed an environmental officer to manage impacts which occurred as a result of commencement of the construction activities. SLR developed a Silt and Erosion Guideline for BS1/2 and the immediate surrounding construction area for implementation. This should assist in mitigating some of the impacts identified which have resulted from the construction activities.

The environmental unit at Booysendal has established a nursery at BS4. Plants recovered during pre-clearing are taken to the nursery for use in the concurrent and post-construction phase rehabilitation process. Amec Foster Wheeler was appointed to undertake a full suite of environmental studies to assess the impacts of the Section 24G activities and to propose management and mitigating measures over and above the measures included in SHE SPEC 101. The specialist management plans are included as Annexures to the EMP and a comprehensive management plan has been compiled as part of this submission.

Booysendal is currently managing the Booysendal Conservancy Trust on the Farm Buttonshope 51JT and portion 1 of the Farm Sheeprun. The conservation area is managed as a protective area to “off-set” the BN impacts and covers an area of 256.9596 hectares. As part of the Booysendal Conservancy Trust, rehabilitation of old exploration and farm tracks is done where alien vegetation is also eradicated. A total area of 50 hectares have been rehabilitation between 2011 and 2016 and another 550 trees have since been planted.

6.2.1 Off-set Strategy

Booysendal has appointed an off-set specialist to develop an off-set strategy for the impacts associated with the Booysendal operations. A draft strategy is being developed with the input from the ecology specialists who were involved in the Section 24G investigations and the MPTA. As part of the specialist scopes of work, they had to identify offset requirements for the impacts associated with the Section 24G activities. The off-set strategy will culminate in a formal and binding offset agreement. The purpose of the offset strategy (included in Annexure N) will be to offset an area of loss of at least 441 hectares and possibly 600 hectares of the listed threatened ecosystem and CBA in which the activities are located.

In addition to the loss of habitat, there are negative impacts on several Species of Conservation Concern, and on the ecological functioning of threatened wetlands and a FEPA river. In terms of wetlands, key criteria for offset design (*i.e.* to incorporate sufficient wetland restoration as well as the selection of a sufficiently large feature (such as an entire quinary or perhaps quaternary catchment) in the offset for the maintenance of a viable population of *Enteromius*) will be applicable.

This study proposes taking a high-level approach – *i.e*. not offsetting each specific biodiversity priority area and feature, but rather constructing a metric for the entire impact, and then selecting candidate offset sites and rehabilitation actions to cater for each feature and to counter-balance the impact as far as possible. This contemplates taking a prudent mapped impact area of 450 hectares and adding in a 10% buffer to cater for unforeseen impacts and edge creep by contractors. It is suggested that a total area of 500ha be used as the departure point for offsetting calculations. This must be revisited if additional footprint impacts are planned or likely to occur, or if further applications for authorisation are being considered.

The Draft Off-set strategy indicates that the following off-set requirements should be reached:

- Locate and secure 15 000 hehctares of conservation worthy property portions ideally within the Sekhukhune Mountain Lands listed ecosystem, containing representative examples of the vegetation types: Sekhukhune Mountain Bushveld and Sekhukhune Montane Grassland (or, failing that, within the Steenkampsberg Montane Grassland or other more endangered montane grassland type in the region).
- If sufficient good quality wetland habitat (PES score B or greater) is not located in these parcels, Booysendal must secure the balance of the required 77 hectares of wetlands and have them declared as a Nature Reserve or as part of an existing Nature Reserve.
- Rehabilitate as much wetland functioning as possible by removing all drains, incisions and illegal cultivation in these wetlands. This should include the wetlands in the upper Everest tributary (which is incised and eroded) even though they should not count towards the area target for wetlands noted

above. This rehabilitation is to be done under the auspices of a plan approved by MTPA and the specialists involved in this assessment, and the primary objective is to restore habitat and river condition for *Enteromius* cf *motebensis* and improve the PES score for this reach to at least a B category.

- Ensure at least one entire quinary catchment is effectively conserved, rehabilitated and not under immediate threat from land use change and invasive alien plants, to provide habitat for impacted fish species and an improvement in ecological functioning. It appears that the entire Groot Dwars River upstream from the bridge needs to be protected to meet the required mitigation.
- Remove all large woody alien vegetation and weeds (especially *Acacia spp, Populus* and *Eucalyptus*) species within the conserved catchment and the broader offset area, rehabilitate the area underneath to indigenous grass, and control all regrowth and seedling emergence for 10 years. There are at least 164 hectares of mapped infestations of listed Category 1 & 2 Invasive Alien Species upslope and upstream from the impacted areas in quaternary catchment B41G which should be removed by Northam, in addition to the removal of these species on land they already own.
- Aim to remove or control the abundance and spread of all invasive alien (such as Largemouth Bass) and extralimital indigenous (Sharptooth catfish) fish species especially those with an impact on indigenous fish (and *Enteromius cf motebensis* in particular). It is recommended that targeted sampling of the dams (TKO as well as Der Brochen) should be conducted continually (can be included as part of biomonitoring programme) to remove as many as possible individuals of these unwanted species. The application of a targeted piscicide such as rotenone, to carefully controlled dams and reaches of specific rivers could also be further investigated as an additional option for control (provided it is expressly under the guidance of MTPA).
- Provide for the financial means to secure the successful conservation management of the offset areas (and obviously, the remaining mine lease area) for at least the life of the mine.
- Conclude an implementation agreement (including reference to appropriate management plans for Mining Right area and Offset area) with MTPA to clarify roles and responsibilities and financial provision made towards securing all these outcomes above. The implementation agreement needs to stipulate milestones and outcomes for implementing the offset, and consequences for non-performance.
- The successful conclusion of the implementation agreement should be a suspensive clause in the Environmental Authorisation, precluding Northam and/or Booysendal from continuing with the listed activities until the agreement is concluded. Further, certain of the listed activities seeking authorisation, should be suspended until a certain percentage of the offset has been achieved (for instance 7000 ha).

There are some difficulties in securing properties which are located in the mining right area and which has viable ore reserves to be mined in future. Potential offset sites which conform to the requirements for offset is still to be finalised. Refer to detailed Draft Strategy in Annexure N.

7. PROJECT ALTERNATIVES

The alternative assessment incorporates the findings made by the specialists where development has not yet occurred and where alternatives are therefore not applicable.

7.1 MINING ALTERNATIVES

Two UG2 mining alternatives were considered as part of the initial trade-off studies, namely to undertake mining from two portal developments or to have one portal with two shafts and several adits. The latter was deemed the preferred alternative.

Table 7-1 Mining Alternatrives

Preferred Alternative One Portal	**Alternative 1: Two portals**	**No-go Alternative**
Reduced surface footprint	Potentially doubling of the current footprint	No new disturbance no job generation
Smaller area of habitat fragmentation	Increased habitat fragmentation	No habitat fragmentation
Some sections have already been disturbed due to historic agricultural practices. Impact on CBAs therefore less	Disturbance of large section of CBAs	No disturbance of CBAs
Impact on heritage resources 355 and 365	**Impact on heritage resources 355 and 365**	No impact
Finding: The one portal development is currently taking place on site. With effective environmental management and rehabilitation actions this option should be acceptable		

7.2 MAIN ACCESS ROAD ALTERNATIVES

No alternative alignment of the main access road between BN to BS1/2 were considered as the road mainly follows the alignment of an old exploration road. Two different alignments for a section of the road between the valley boxcut and BS4 were considered. Refer to Figure 2-1. The preferred alignment follows the existing road alignment more closely. Alternative 2 follows a new section from BS4 and then only comes back onto the existing alignment. From the valley boxcut onwards, both these roads follow a new alignment.

Both the alternatives cross through CBA sections and seep wetland sections and neither of them are therefore ideal. Given that the clearance for the road is finalised, it is not at this stage feasible nor advised to look at other alternatives which could cause additional impacts.

7.3 POWER ALTERNATIVES

Two powerline off-take options and two capacity options were considered. Consideration was given to either a 33kVA or a 132kVA capacity line either from BN to BS1/2 or from BS4 to BS1/2.

Table 7-2 Power Alternatives

Preferred Alternative 1 132kVA line from BN	**Alternative 2: 132kVA from BS4**	**No-go Alternative Current 11kVA**
Follows the road alignment in some sections	To follow road alignment	Runs along the Groot Dwars River
The area from BN to BS1/2 historically is more disturbed, although new sections will be disturbed	Keeping the powerline as close as possible to the road alignment may reduce impacts and the need for additional clearance for access and laydown areas	Small pylon footprints. Area already disturbed
Finding:		

7.4 ORE TRANSPORT OPTIONS

Table 7-3 Ore Transport Alternatives

Preferred Alternative - ARC	Road Trucking of Ore	Overland Conveyor	No-go Alternative
Lower capital cost	Lower upfront capital cost	Cost of installation of the conveyor is more expensive than that of the ARC	No capital cost investment
Lowest maintenance requirements and cost	Highest operating cost as a result of road and truck maintenance cost	Operational cost more expensive than that of the ARC	No maintenance requirements
More suited for the steep terrain	Alignment has been designed for with heavy vehicles in mind according to provincial standards	Larger disturbance will be required for the construction of the conveyor against the steep slopes	No new disturbance
Smaller overall disturbance and footprint	Clearing of a large corridor	Footprint requirements for the overland conveyor is larger than that of the ARC	No habitat fragmentation
Static Operation. Provision can be made for bird management	Increased traffic (84 return trips per day) poses a threat to fauna and worker health and safety	Migration barrier	Habitat will remain intact
Designed not to cause spillages	Less prone to spillages than conveyor	Spillages from the conveyor over this distance in area will be more difficult to clean up thus higher contamination risk	No risk of spillage

Preferred Alternative - ARC	Road Trucking of Ore	Overland Conveyor	No-go Alternative
Maintenance done on top of the ARC, thereby limiting the need for service roads	Heavy traffic may require more regular maintenance of the road and higher road safety risks	Service road along the conveyor required leading to a larger footprint	Management of undisturbed area as game farm
Sound pressure levels between 3 to 6 times lower than that of conventional conveyors. Sound frequency unknown	Higher noise levels as the ARC, though not continuous.	Higher noise disturbance levels as the ARC	Natural noise levels only
Impact on Historic Village H02	Impact on heritage resources 610, 612a, 612b	**Impact on Historic Village H02**	No cultural-heritage imapct
Higher visibility for villages at the east due to the higher towers May not blend in with the natural landscape	Lowest visual intrusion, but light pollution from cars using the road at night will occur	Less visible from the east as the system is lower, but could be aesthetically incompatible	Aesthetic character will remain
Disturbance in water courses and wetlands	Several crossings which will require culverts. Crosses seep wetlands	Easier to avoid water courses and wetlands as it is more flexible	Natural flow paths will remain intact

7.5 TKO PIPELINE ROUTE AND OFF-TAKE ALTERNATIVES

Two alternative route options were assessed for the potable water supply line from the TKO dam at BS4 to BS1/2:

- Alternative 1 - runs along the western side of TSF2 at B4, down the escarpment then following the alignment of an exploration route.
- Runs next to the existing pipeline to the BS4 plant from where it will tie into the main access road reserve to BS1/2.
- The no-go alternative where no new pipeline is constructed and water provision.

Table 7-4 TKO Pipeline Route & Off Take Alternatives

Alternative 1 – TKO Dam via new Route	Alternative 2 – TKO via Existing Route	Alternative 3 – Status Quo	No-go Alternative
	Pipeline Route Alternatives		
Clearance of new CBA vegetation areas and a new disturbance footprint Loss of more in-tact biodiversity units	Existing disturbance – with due care the pipeline can be accommodated in the road corridor	Pipeline could be upgraded along the already disturbed road corridor as a surface pipeline	No new disturbance or enlargement of disturbed footprints
Create new habitat fragmentation	Use if existing corridor will not create new habitat fragmentation	More disturbed area. Habitat fragmentation existing	Removal of existing line will contribute to overall rehabilitation
Less energy consumption	Higher energy requirement	Highest energy requirement	No additional energy consumption

Closest route – more cost effective	Longer pipeline required – higher cost	Pipeline more than 6km – highest cost	Removal of existing pipeline and rehabilitation
Impact of route on the environment has not been assessed by the specialists as this was provided after the specialist studies have been completed. Real impacts to biodiversity thus not quantified	Assessed as part of the specialist investigations (except for a last-minute change in the route construction)	Main access route alignment assessed and impacts described. More disturbed areas	No need for additional disturbance
Finding: Taking consideration of the specialist findings and the impacts assessed, it is recommended that Alternative 3 be implemented			
Potable Water Abstraction Alternatives			
Alternative 1: Abstraction from the TKO Dam at BS4 Per the DRA water balance (GBP-ENG-REP-001, 2017) an abstraction volume of 2,748m³/m from the TKO dam is required. Although BS4 has a current allocation under the existing IWUL abstraction could have an impact on the flow of the Everest stream and ultimately the Groot Dwars River which will result in cumulative impacts to the flows and aquatic and wetland systems.			
Alternative 2: Take-off from the Lebalelo Pipeline An alternative proposed by the consultant is that the current status quo be continued where water is sources from BN. Currently water for BS1/2 is sourced from two boreholes approved under the existing IWUL allocation for BN. The approved abstraction volume for these two boreholes is 131,000m³/a. Current usage at BS1/2 is between 8,000m³ and 9,000m³. In addition to this, BN has a 7Ml/day allocation from the Lebalelo Water User Association. Current take-off from Lebalelo is on average around 40,000m³/m, which is well below the monthly allocation of 217,000m³. Taking water from the Lebalelo will mitigate the risk of cumulative impacts on the Groot Dwars River system. In event of shortage of water from the water provided, short term abstraction from the boreholes will ensure water security.			
Alternative 3: Status Quo - Abstraction from Boreholes Long term abstraction from the boreholes alone taking consideration of overall impact of the development on groundwater can further aid in reduction of groundwater levels and recharge of the Groot Dwars River system. During operational phase this water should just be used in the event of shortage from Lebalelo.			

8. IMPACT ASSESSMENT, MANAGEMENT AND MITIGATING MEASURES

8.1 IMPACT ASSESSMENT METHODOLOGY

The aim of the impact assessment was to identify the impacts related to the current construction activities, future construction activities, mining and associated activities during the operational phase and potential impacts related to closure within the area of influence (AoI). In terms of the International Finance Corporation Performance Standards the AoI is defined as:

"The area likely to be affected by:
- *the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project;*
- *impacts from unplanned but predictable developments caused by the project that may occur later or at a different location;*
- *indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent;*
- *Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.*
- *Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted."*

Impact identification was done using a matrix, containing the activities/aspects on the y-axis and the potential impacts on the x-axis. Where impacts were foreseen the internaction point was ticked. All imapcts which were foreseen by the specialists were carried across into the main impact assessment.

The aim was further to differentiate between:
- Direct impacts – impacts caused by the action and which occur at the same time and place;
- Indirect impacts - are caused by the action and are later in time or further removed in distance, but are still reasonably foreseeable; and
- Cumulative impacts - are impacts which result from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions.

As a quantitative assessment methodology alone can be very subjective, Amec Foster Wheeler opted for combined qualitative and quantitative evaluations system. The impact assessment methodology includes a description of the impact and an assessment of the significance of the impact.

8.1.1 Description of Impacts

Each potential impact is described separately to gain a clear understanding of the nature thereof in relation to the activities. The description includes:
- Activities responsible for the impact;

- Risk or impact caused by the activity;
- The phase in the project life cycle when the activity could be expected;
- Indication if the nature of the impact - negative or positive impact; and

Classification of impact as direct, indirect or cumulative.

8.1.2 Impact Significance

The significance of an impact is a combination of the consequence of the impact and the probability that the impact occurs. Both a description and a rating was assigned to each component to as far as possible avoid subjectivity. The significance was assessed without mitigating measures and reassessed should the recommended mitigating measures be implemented. For each impact the following was considered:

- The likelihood or probability of the impact occurring (see Table 8-1 contains the rating scale for likelihood)
- Duration: It is important to note that the anticipated life of mine (LoM) is more than 50 years, therefore four time periods were considered (refer to Table 8-2)

Extent: provides a description of the area which will or is affected by the impact. The weighting of the extent is provided in

- Table 8-3
- Receptor Sensitivity: describes and weighs the sensitivity of areas, recipients or species (see Table 8-4), and
- Magnitude: provides an indication of the area or type of loss that is occurring or which is anticipated to occur (refer to Table 8-5).

The significance of the impact was calculated as: Significance = magnitude x (likelihood + duration + extent + sensitivity). The significance rating by colour identification as low to high is indicated in Table 8-6.

Impacts which cannot be mitigated to an acceptable significance level of lower than high are classified as residual impacts. Offsets recommendations for these impacts have been included.

Table 8-1 Description and Rating of Likelihood

1 = Unlikely	2 = Possible	3 = Likely	4 = Definite
Low to no probability of occurrence with the implementation of management measures	Possible that impact may occur from time to time	Distinct / realistic possibility that impacts will occur if not managed and monitored	Impacts will occur even with the implementation of management measures

Table 8-2 Quantitative and Qualitative Assessment of Duration

1 = Temporary	2 = Short Term	3 = Long Term	4 = Permanent

Possible to mitigate / immediate or quick progress with management implementation <3 yr	Impacts reversible within a short period +3 to 5 yrs	Impacts will only cease after the operational life +/- 50 yrs	Long term, beyond mine closure or irreplaceable

Table 8-3 Quantitative and Qualitative Assessment of Extent

1 = Localised	**2 = Site**	**3 = Area of Influence**	**4 = Regional/ Provincial/ National**
Localised to specific area of activities/ footprints	Confined to the site	The extent of the impacts will affect the wider area of Influence	Importance of the impact is of regional provincial or national importance

Table 8-4 Quantitative and Qualitative Assessment of Sensitivity

1 = Low	**2 = Moderate Low**	**3 = Moderate**	**4 = High**
Areas already subjected to significant degradation Non-designated or locally designated sites/habitats Non-sensitive receptor with regards to the impact type (e.g. noise receptors) No vulnerable communities	Partially degraded area Sensitive receptors present Small number of vulnerable communities present	Regionally designated sites / habitats Regionally rare or endangered species Moderately sensitive receptor regarding the impact type Some vulnerable communities present	Nationally or internationally designated sites/habitats Species protected under national or international laws / conventions High sensitivity regarding the impact type High number of vulnerable communities present High dependency

Table 8-5 Quantitative and Qualitative Assessment of Magnitude

Negative Impacts			
-1 = Low	**-2 = Minor**	**-3 = Moderate**	**-4 = High**
Deterioration of baseline conditions or functions are negligible **Nuisance** **Will not cause any material change to the value or function of the receptor/s of** **Emissions will comply with legal limits**	Moderate deterioration, partial loss of habitat / biodiversity/ social functions or resources, Emissions at times exceed legal limits Emissions reach outside project footprint	Reversible although substantial illness, injury, loss of habitat, loss of resources Notable deterioration of functions Impact on biodiversity Causes a change in the value or function of receptor but does not fundamentally	Mainly irreversible Causes a significant change in the environment affecting the viability, value and function of the receptors Substantial impact and loss of biodiversity Death/ loss of receptors Loss of livelihood

Emissions contained within footprint within limits		affect its overall viability Emissions regularly exceed legal limits Emissions will affect the wider region Livelihood of sensitive receptors are impacted	Emissions do not comply with regulations Impact on listed species
Positive Impacts			
+1 = Low	**+2 = Minor**	**+3 = Moderate**	**+4 = High**
Slight enhancement of baseline conditions or functions **Potential pollution sources are removed Slight positive change to the value or function of the receptor/s** **Project controls assists in Emissions will comply with legal limits** **Emissions contained within footprint within limits**	Minor enhancement, of habitat / biodiversity/ social functions or resources, Better control of emissions Project assist in management and control of emissions	Substantial improvement in human health habitat, and ecosystem services Notable improvement of functions Moderate improvement of biodiversity Causes a change in the value or function of receptor and improves overall viability Emissions regularly improves Livelihood of sensitive receptors are improved	Significant positive change in the environment viability, value and function Substantial impact and improvement of biodiversity Better protection of receptors Development of livelihood Emissions improve to comply with regulations Protection of listed species

Table 8-6 Significance Rating of Impacts

		Likelihood + duration + extent + sensitivity			
		Low (+ / -) ≤4	Minor (+/ -) 5 - 8	Moderate (+ / -) 9 - 12	High (+ / -) 13 - 16
Magnitude	Low (1)	Not significant	Not significant	Minor	Moderate
	Minor (2)	Not significant	Minor	Minor	Moderate
	Moderate (3)	Minor	Moderate	Moderate	High
	High (4)	Moderate	High	High	High

The activities, impacts, phase of the development when impacts and potential impacts are expected, the impact significance prior to mitigation, the required mitigating measures, significance after mitigation and impact statement for each identified activity was included in an impact table.

The following abbreviations are used in the impact tables for the various phases in the project lifecycle when the impacts occur or are likely to occur:

- CO = construction;
- OP = operational; and
- CL = Closure and post-closure.

8.2 SPECIFIC SPECIALIST AREA IMPACTS

The impact tables from the specialist studies were adapted to comprehensively cover all impacts relating to the project. Where the impact significance was regarded to be higher as a result of latest site visit the significance was adapted. The findings and opinions of the specialists were not altered otherwise in this process.

Due to the nature of the imapcts and the location of the projects, specialists were specifically requested to identify potential **cumulative impacts** where applicble. These impacts, the assessment of the significance and management requirements were included in their overall impact tables.

8.2.1 Climate Change

The greenhouse gas emissions study was conducted by Kirjani Green

8.2.2 Soil, Land Use and Land capability

The main impacts associated with the current construction activities include:

- Clearing, earthworks, compaction of soil will change the soil characteristics;
- Erosion caused by vegetation removal and ineffective or lack of erosion and stormwater control measures;
- Soil compaction impacting on land use and soil characteristics
- Lack of topsoil storage or incorrect storage practices, is leading to a total loss in topsoil or loss in functionality and productivity of topsoil;
- Permanent to long term change in land capability and land use capability. This impact is also cumulative due the increased loss of agricultural land in the wider AoI;
- Loss of ecosystem services; and
- Chemical Pollution of soils.

An assessment of impacts on soil, land use and land capability is included in Table 8-7 to Table 8-11.

Table 8-7 Soil Layer Inversion and Soil Profiles

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	Earthworks including clearing of vegetation from the surface, drilling and blasting for the initial box cut, stripping and stockpiling of topsoil for mine infrastructure and the construction of access roads and supporting infrastructure resulted in the change of soil properties.		

Risk/ Impact	These activities are the most disruptive to natural soil horizon distribution and cause soil mixing and layer inversion. It impacted on the current soil hydrological properties and functionality of the soil and may also result in a loss of topsoil, land capability and end land use. Secondary impacts resulted in loss of micro-organisms and small fauna		
Project Phase:	CO, CL, OP		
Nature of Impact	Negative		
Type of Impact	**Direct Impacts**: Change in soil chemical properties. Change in land capability **Secondary Impacts:** Loss of micro-organisms and small fauna		
Likelihood/ probability	Definite	4	4
Duration	Permanent The impact is permanent since it is impossible to re-create original soil profile distribution. However, should careful topsoil stripping have been undertaken, the impact would have lasted until the end of LoM. As it is topsoil will have to be brought in which is not optimal	4	3
Extent	Localised The impact will be localised within the site boundary.	1	1
Magnitude	High The impact on soil functionality is mainly irreversible. With the minimisation of the project footprint and protection of topsoil stockpiles, the magnitude can be reduced to moderate.	4	3
Receptor Sensitivity	Soils has a high sensitivity to earthworks. By minimising the footprint of the surface disturbance, avoiding sensitive soils, topsoil management, and concurrent rehabilitation impacts can be reduced to moderate.	4	3
Impact Significance	The impact is considered to have high significance without mitigation measures. Implementing mitigation measures (see soil management plan), will reduced the impact after mitigation to moderate.	13/4	11/3
Required Management / Mitigating Measures	Minimise project footprint which has not yet commence to absolute minimum. Correct topsoil stripping, demarcate and manage location of stockpiles and prevent stockpile erosion and contamination. Rip areas outside of footprints. Rehabilitate disturbed areas with the application of topsoil to ensure revegetation is enhanced. Avoid construction activities on hydromorphic and wetland soil types.		
Required Monitoring (if any)	Monitoring the revegetation of topsoil stockpiles and the prevention of contamination and erosion thereof. Monitor construction activities against the conditions of the EMP, Method statements and conditions of authorisation. All contractors are to submit risk assessment, management plans and method statements for soil management related to all present or proposed affected areas.		

Responsibility for implementation	Mine management All contract project managers Booysendal ECO
Impact Finding	Current impacts on soil characteristics are high. With the implementation of proper soil, stormwater, and erosion control measures it should be possible reduce current impacts. For any ongoing construction activities management measures need to be implemented pro-actively and not reactively.

Table 8-8 Soil Erosion

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	Vegetation clearance, exposure of soil and disturbance of sensitive soil forms due to construction activities lead to erosion. This is enhanced by the steep slopes, and ineffective stormwater management measures in some areas. Soil management measures e.g rock cladding implemented at road cuttings shows good results to manage erosion.		
Risk/ Impact	Soil quality is reduced because of erosion. This negatively impacts on soil quality which results from the loss of the nutrient-rich upper layers of the soil and the reduced water-holding capacity of severely eroded soils. Impacts on riparian ecosystems streams due to sedimentation also results.		
Project Phase:	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	**Direct impact:** erosion by wind and water lead to the loss of soil. **Indirect impact**: Indirect impacts of soil erosion include riparian ecosystem disruption and sedimentation. **Secondary Impact:** Relates to the reduction in provisional and regulatory ecosystem services, to sustain the nutrient cycle and flora. **Cumulative Impact:** loss of soils can lead to cumulative loss of the Sekhukhune Centre of Plant Endemism vegetation unit		
Likelihood/ probability	Without mitigation: Currently erosion is definite and can be seen on site. With mitigation: Erosion on new footprints are likely because of the topography even with the implementation of erosion prevention measures due to soil sensitivity. Where cladding, and berms have been installed erosion looks under control.	4	3
Duration	With the implementation of proper mitigating and control measures, soil erosion could reduce the duration of current impacts and the risk after final rehabilitation. However, where erosion has already taken place soil loss is permanent and indirect, secondary and cumulative impacts are inevitable and permanent.	4	2
Extent	Wider area of influence as sedimentation associated with erosion has downstream impacts and a wider impact on loss of sensitive flora and habitats.	3	1

	With effective, well designed erosion control measures, based on proper risk assessments the impact can be reduced to limited footprints.		
Magnitude	High The impact on soil functionality is mainly irreversible. With proper erosion control on stockpiles and minimising bare soil surfaces stability, the magnitude can be reduced to moderate.	4	3
Receptor Sensitivity	Soils has a high sensitivity to erosion. With the implementation of embedded controls (geotextiles, cladding, silt trap for erosion control) it can reduced to moderate.	4	3
Impact Significance	Without any mitigation, soil erosion will have high significance, especially since the site is highly sensitive to erosion impacts. With proper mitigation measures, the significance can be reduced to moderate.	15/4	9/3
Required Management / Mitigation Measures	Construction activities must be phased. Implementation of erosion control measures are essential. Management controls should be based on a risk assessment which will inform engineering mitigating design requirements. Stripping of topsoil should not be done earlier than required, reduce slope gradients as far as possible along road cuts, using drainage control measures and culverts to manage surface runoff and revegetate topsoil stockpiles as soon as possible. Sensitive soil types need to be avoided. Wetland soils should become no-go areas. Refer to soil management plan (Annexure C) or additional management measures.		
Required Monitoring (if any)	Monitoring the revegetation of topsoil stockpiles and the functioning of erosion and stormwater control measures, drains and the maintenance of roads.		
Responsibility for implementation	Mine manager Main contractor Environmental Officer		
Impact Statement Finding	Current erosion and associated impacts are high. Impact can be managed through the proactive implementation of management measures, including surface runoff, erosion control, phased construction, concurrent rehabilitation and revegetation of topsoil stockpiles.		

Table 8-9 Soil Compaction and Change in Soil Properties

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	The movement of heavy vehicles on existing and new roads, earth moving machinery while clearing areas for construction, erection of infrastructure and the development of stockpile all lead to the compaction of soil.		
Risk/ Impact	Soil compaction leads to the crushing of large micro-pores into smaller pores which reduces the amount of water available to plants, limits root penetration and reduce the water infiltration rate and results in aggravation of runoff erosion. It is fatal to macro-organisms which assist with maintaining the nutrient cycle in soils.		

Project Phase:	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	**Direct Impacts**: soil compaction in construction footprint areas **Cumulative impacts**: Loss of soils and land capability		
Likelihood/ probability	Definite	4	4
Duration	Long term The impact is usually considered to be permanent but the lithic soils on site are not affected much by compaction and the vertic and melanic soils recover naturally over time because of their swelling and shrinking characteristics.	3	3
Extent	Localised The impact will be localised within the site boundary.	1	1
Magnitude	The impact is considered high on sandy soils, but the lithic soils on site are not affected much by compaction and the vertic and melanic soils recover naturally because of their swelling and shrinking characteristics. However, the cumulative loss of soil increases the magnitude to moderate. Impact might only cease upon closure	3	3
Receptor Sensitivity	The soils in the Booysendal study area has a moderate low sensitivity to earthworks. The sensitivity can be reduced through reducing the areas of impact by restricting traffic to existing haul roads and limiting construction footprints.	2	1
Impact Significance	The impact is of minor significance both before and after mitigation because of the properties of the soil forms in the study area. Even though the mitigation measures aim to reduce the areas affected, soil compaction can only be alleviated to a certain extent with rehabilitation techniques.	10/2	10/1
Required Management Measures	Minimise project footprint as far as possible. Existing established roads should be used. Where possible, roads that will carry heavy duty traffic should be designed in areas previously disturbed. Avoid as far as possible areas with sandy soil.		
Required Monitoring (if any)	Monitor the activities of construction contractors to ensure that construction work will be restricted to the clearly defined limits of the construction site.		
Responsibility for implementation	Mine management		

Impact Finding	Impact can be managed through limitation of the construction footprint and construction on mainly lithic, vertic and melanic soils.

Table 8-10 Loss of Topsoil

Impact Component	**Impact**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Lack of topsoil management		
Risk/ Impact	Loss of topsoil will result in loss in seedbank, change in land use and land capability and a significant increase in closure cost		
Project Phase:	CP, CL		
Nature of Impact	Negative		
Type of Impact	**Direct Impact**:		
Likelihood/ probability	Definite. Due to a lack of topsoil management topsoil has been lost Should topsoil management be implemented for new construction footprints the impact can be reduced to possible	4	2
Duration	Permanent. Even with the implementation of mitigating measures topsoil cannot be recovered	4	4
Extent	Wider construction area	2	2
Magnitude	The loss of topsoil is significant due to the area of development. This can be reduced in future should proper topsoil management be implemented	4	2
Receptor Sensitivity	Soil in the area is highly sensitive. Avoidance of sensitive soils can mitigate the sensitivity	4	2
Impact Significance	Current loss of topsoil has a high significance.	14/4	10/4
Required Management Measures	Demarcated topsoil stockpile areas as close to where rehabilitation has to take place. Separate wetland and other topsoil types. Strip topsoil and store. Avoid movement on topsoil stockpiles. Mange stockpiles in accordance with the soil management plan		
Required Monitoring (if any)	Monitor topsoil stockpiling and movement onto stockpiles		
Responsibility for implementation	ECOs of Contractors Contractor Mangers Booysendal ECO and Environmental Officer Mine Manager		
Impact Finding	The topsoil which has been lost due to current activities will not be recovered. It is essential that effective topsoil management practices be implemented to reduce the effect.		

Table 8-11 Impacts on Land Use and Land Capability

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	The land use and capability of the Section 24G areas as well as areas already affected by mining activities have industrial or non-productive land capability. In these areas, land have been cleared of vegetation because of construction and on-going operational activities. As a result of these drastic changes, soil in these areas is currently not supporting ecosystems or production activities.		
Risk/ Impact	Loss of agricultural and wilderness land. Final rehabilitation may not restore the area to its former land use and land capability. Land capability will change from arable, grazing, wetland and wilderness to industrial.		
Project Phase:	CP, OP, CL		
Nature of Impact	**Direct Impact**: Land use and land capability within the footprint areas will be affected **Cumulative Impact**: The wider AoI has been exposed to significant mining and associated residential development taking up agricultural land which will be aggravated by the additional loss associated with the project.		
Type of Impact	Negative		
Likelihood/ probability	Definite	4	4
Duration	Without mitigating measures the impacts will last well after activities have ceased With mitigating measures the land use can be restored to some extent after final rehabilitation	4	3
Extent	Extent of land use change is within a larger AoI. Reducing development footprints and implementing erosion control measures, topsoil stockpile practices can limit the impact	3	2
Magnitude	The impact is high without mitigation because there is a complete change of land use within the footprint area. With mitigating measures the impact can be reduced to moderate.	4	3
Receptor Sensitivity	Moderate sensitivity as the change in land use is regional. This remains moderate even with mitigating measures.	3	3
Impact Significance	Currently high, can be reduced to moderate	14/4	12/3
Required Management Measures	Project footprints need to be minimised. Disturbed areas outside of the formal footprints must be rehabilitated before the next rainy season. Topsoil stockpiling must commence in dedicated areas according to the characteristics of the topsoil to ensure effective rehabilitation and restoration of end land use. All footprints must be fenced. It is foreseen that current land rehabilitation activities may be able to restore the land capability back to wilderness land capability and in best case scenarios, grazing land capability." lost can be replace with commercial fertilizer to some extent, however, it may not be possible to restore the initial nutrient balance and restoration of nutrient cycles may take a few years.		

Required Monitoring (if any)	Monitor activities to ensure that it remains within the designated footprint areas.
Responsibility for implementation	Contractor Managers ECO's of contractors Environmental Officer of Booysendal Booysendal Mine Manager
Impact Finding	Current impacts on land use and land capability is high due to the extent of the development, activities outside of footprints and loss of topsoil. Should management measures be implemented, the impact can be reduced to moderate

Residual Impacts

There are residual soil impacts which cannot be mitigated at this point in time. This include the loss of topsoil and the change in the character of soils in the areas where construction commenced. These impacts should be offset with the overall offset management plan which is currently being developed for the project.

Recommendations and Reasoned Opinion of the Soil Scientist

The recommendation from the soil scientist is that the project be authorised based on the following:

- The project falls within a larger area where mining developments are intermixed with conservation and farming activities. Additional mining projects will therefore contribute to the growth of the local economy.
- However, the project will still result in significant impacts on soil resources and their associated land capabilities as well as the ecosystem services provided by the soil resources. The existing Booysendal project activities have already resulted in impacts on the soil resources and as is the case with the Section 24G activities.

It was, therefore recommended that the Booysendal South Expansion Project continues and that the project developers take immediate and proper action towards soil conservation and maintaining soil quality. Wherever soil quality has already been compromised, proper land rehabilitation should commence and rigorous monitoring of soil management should be part of this project going forward.

8.2.3 Hydrogeology

The two potential most significant impacts associated with the groundwater environment includes:

- Dewatering of the Aquifer at BS1/2 and the Merensky and BS4 as the latter will serve as make-up water for BS1/2;
- Recovery of groundwater levels at the in the underground BS1/2 and Merensky mines;
- Contamination of the aquifer at BS1/2; the Merensky mines and at the BS4 TSF1 and underground backfill areas; and
- Increased volume of underground water at BS4 due to backfilling and an increase of decanting at the valley boxcut.

a) Aquifer dewatering BS1/2 and BS4

During the construction phase of the BS1/2 portal and shaft complex it was calculated that the expected inflows into the underground workings will range between 5 and 10 m^3/day. The expected zone of influence of the groundwater level drawdown cone will be limited and less than 100m from both the UG2 and the Merensky reef declines. No dewatering will be required at BS4 during the construction phase. The formation of a drawdown cone during the construction phase will therefore be limited.

During the operational phase “groundwater inflows into the BS1/2 area (UG2 and Merensky reef operations) will increase over time as the mining area expands. Peak inflows of around 940 m^3/day are reached during the year 2038 (year 22 of the life of mine) for the Merensky Reef operations, and 770 m^3/day for the UG2 operations, after which the inflows will decrease. This is because the rate at which the mining increase slows down during the years 2039 and 2040, therefore less un-dewatered rock is broken. Active mining in the BS1/2 area ceases mid-2041. As the host rock around the mining area is dewatered, the inflows will decrease over time.

The zone of influence of the groundwater level drawdown around the BS1/2 and BS3 underground mining areas due to the mine dewatering was simulated using the numerical groundwater flow model.

The numerical model results (refer to Figure 8-1) of the conceptual drawdown in groundwater level indicates a drawdown stretching north to south along the eastern boundary of the underground mine area where the mining elevation is closest to surface. It is predicted that at the end of LoM the zone of influence of the groundwater level drawdown cone will reach the Groot Dwars River. As indicated in the numerical groundwater model, water will be drawn from the Groot Dwars River towards the underground mine at a rate of approximately 110 to 120 m^3/day. The normal average flow in the Groot Dwars River is 29 460 m^3/day. The impact that the drawdown cone will have on the flow of the in the Groot Dwars River will be less than 0.5 %.

Make-up water for BS1/2 will be drawn from the valley boxcut at BS4 during the operational phase at a rate of 655m^3/day. In 2011 Future Flow calculated the inflow into this underground mine to be between 850m^3/day to 900m^3/day. The make-up water requirements are therefore less than the inflow requirements and should not contribute to the drawdown.

Dewatering and the formation of a drawdown cone will only be applicable up to the operational phase, thereafter water levels will start to recover.

During closure and decommissioning the groundwater levels in BS1/2 will rise again at a rate of between 600 to 700 m^3/day up to a level where it reaches the water table (around 80mbgl) where after the rate will significantly decrease. The groundwater model predicted decanting after 115 years after mine closure at a rate of approximately 50 m^3/day. It is expected that decant water qualities will generally comply with SANS241 quality guidelines, except for Nitrate concentrations which could exceed the guideline values due to the impact of blasting agents used underground.

After mine closure, it is expected that decanting will take place at the valley boxcut at BS4 at a rate of between 800 to 3 000 m^3/day. Water qualities are expected to remain fairly good and compliant with SANS241 drinking water standards except for nitrate (13 mg/L) which exceeds the guideline value slightly (11 mg/L). The water quality is expected to improve further as the nitrate from blasting is flushed out of the mining area over time.

The numerical model indicating drawdown during the operational phase is included in Figure 8-1 and the assessment of the impact thereof in Table 8-12.

Figure 8-1 Numerical Model Simulating the Potential Drawdown Cone

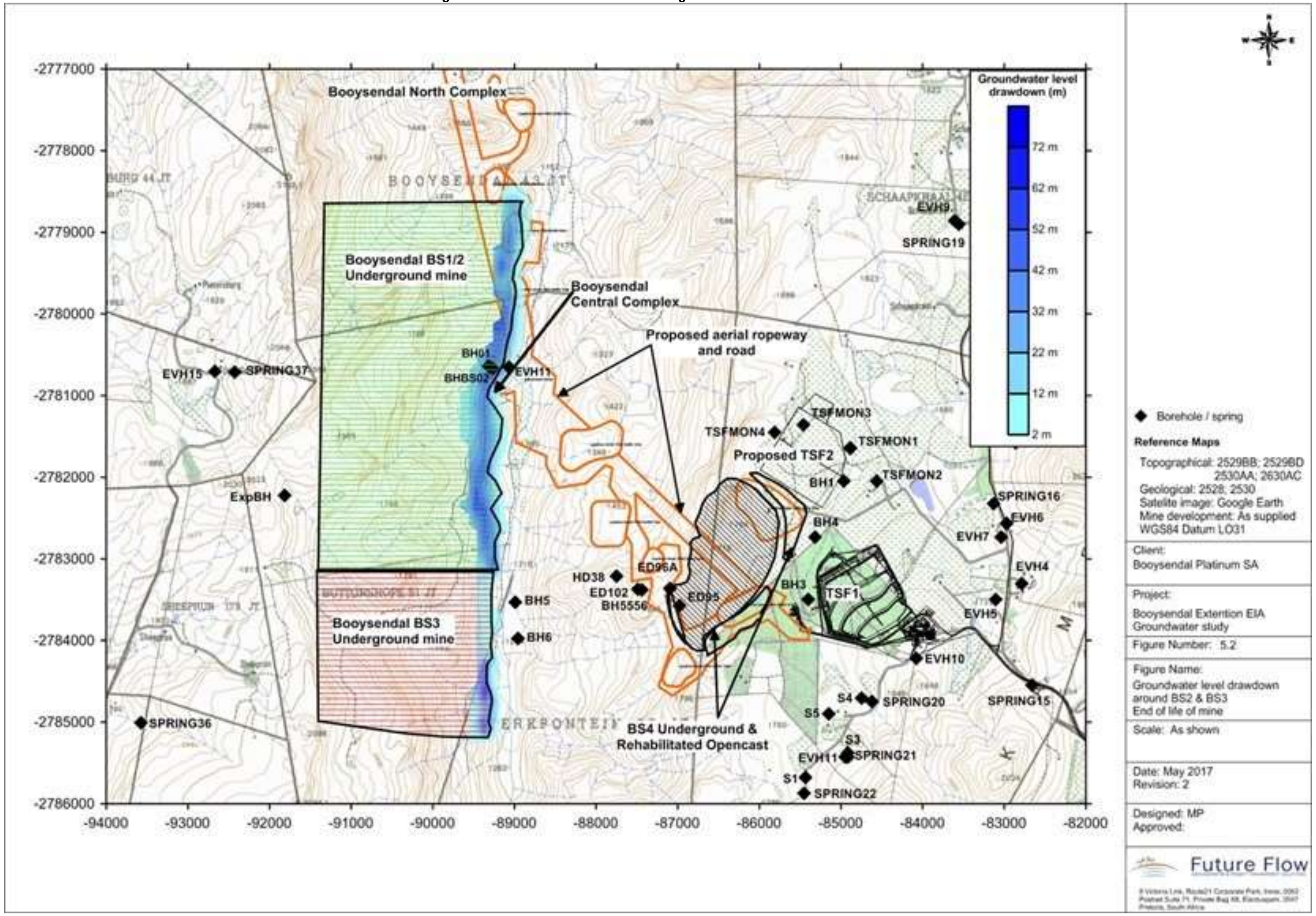


Table 8-12 Drawdown Cone Impact Assessment

Impact Component	**Impact 1**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Dewatering of the aquifers as part of the underground mining activities		
Risk/ Impact	The aquifers will be dewatered due to dewatering of the active mining areas (declines, stopes, etc.).		
Project Phase Nature of Impact	CO, OP Negative		
Type of Impact	**Direct:** dewatering of the underground excavations will have a direct impact on the groundwater levels in the surrounding aquifers. **Indirect**: Water will also be drawn from the Groot Dwars River at a rate of 110 to 120 m^3/day (<0.5 % of the average stream flow volume). **Cumulative:** Reduced flow will have a cumulative impact on the aquatic biodiversity in a system where surface impacts are impacting on water quality and the aquatic biodiversity		
Likelihood/ probability	Definite	4	4
Duration	Permanent When mining stops the mine dewatering will stop. This will allow the groundwater levels to recover to (near) pre-mining levels. It is calculated that it will take around 115 years for the water levels to fully recover.	4	4
Extent	Site The zone of impact of the groundwater level drawdown is calculated to be around 100 m from the underground mining area. This relatively small zone of influence is due to the low aquifer activity at the mining depths where most the mining takes place (150 to 950 m below surface).	2	1
Receptor Sensitivity	Moderate-Low	2	2
Magnitude	Minor The zone of impact is relatively small and there are no groundwater users that will be impacted. The stream flow volumes in the Groot Dwars River will not be impacted to a notable extent.	2	1
Impact Significance	Minor significance: There are no groundwater users that will be impacted and the impacts on the Dwars River will be negligible.	Minor 12 2	Minor 11 1
Required Management Measures	Sealing off of any major inflow areas in the underground workings, especially during the early years when mining takes place closest to the Groot Dwars River.		
Required Monitoring (if any)	Long-term monitoring of groundwater levels.		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding	There are few feasible management options, other than sealing off of high inflow zones. The impact is expected to have a moderate significance.		

b) Acid Mine Drainage Contamination transport and transport model

The environmental risk assessment informed by the Jones and Wagner 2016 results the Future Flow 2016 results and earlier GCS (2009) ABA test results indicated that the potential for AMD is low due to the low sulphate concentrations, high neutralising potential ratio (NPR) and the rock classification. The risk of AMD is, therefore low. The major elements leached from ore bodies, overlying rock material samples and TSF1 were calcium, magnesium, sodium, silicon, iron and manganese. From the results of this testwork, the elemental concentration of cadmium, cobalt, copper, manganese, nickel, lead, antimony, vanadium and fluoride exceed the TCT0 guidelines in most of the samples and all samples comply with TCT1 guidelines.

From the leachate test work, total chromium exceeds the LCT0 guideline concentration of 0.1 mg/l for one of the two ore samples and both tailings samples by a factor of 3, with the other ore sample showing a chromium concentration of <0.025 mg/l. All leachates were below the LCT1 guideline concentration. Considering the findings, it was proposed that TSF1 be lined with a Class 3 liner (see Figure 8-2). This will also reduce the current Nitrate seepage from the toe drain of TSF1.

The study further indicated that leachate from the tailings material used for backfilling will in general not have a significant impact on the surrounding groundwater qualities except for chromium, should there be any interaction between the water that drains from the backfilled material and the natural groundwater in the surrounding aquifers. The risk needs to be assessed through a proper risk assessment. The risk also need to be further understood through an assessment of any source-pathway-receptor links. Due to the depth of backfilling, it is however not anticipated that the tailings will pose a risk to the groundwater environment or users. Potential impacts from the TSF and backfilling on the groundwater regime is included in Figure 8-3.

Figure 8-2 Tailings Storage Facility (TSF1) Liner Requirements

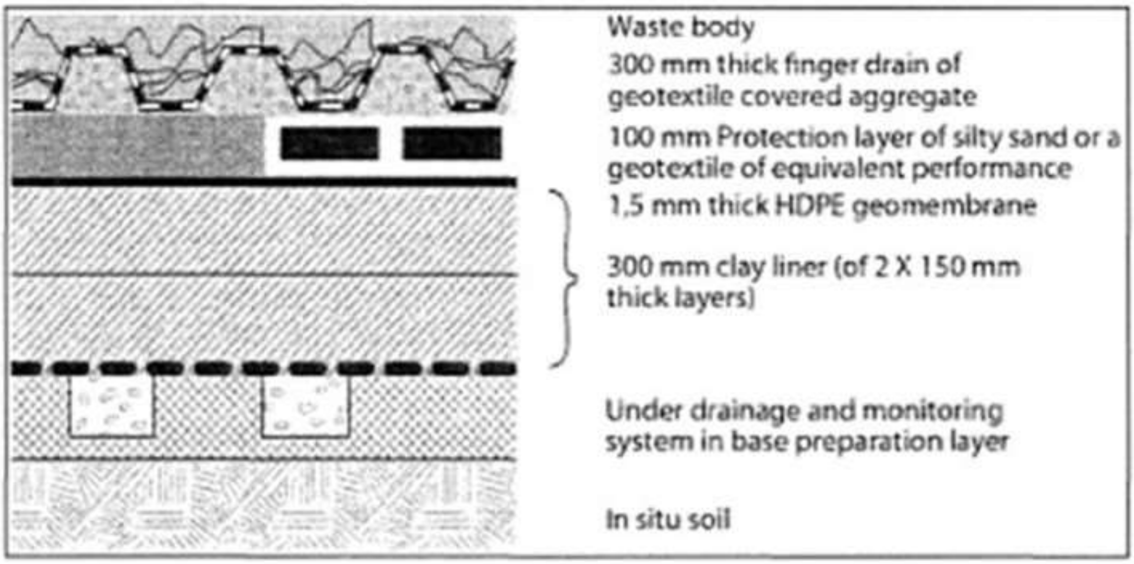
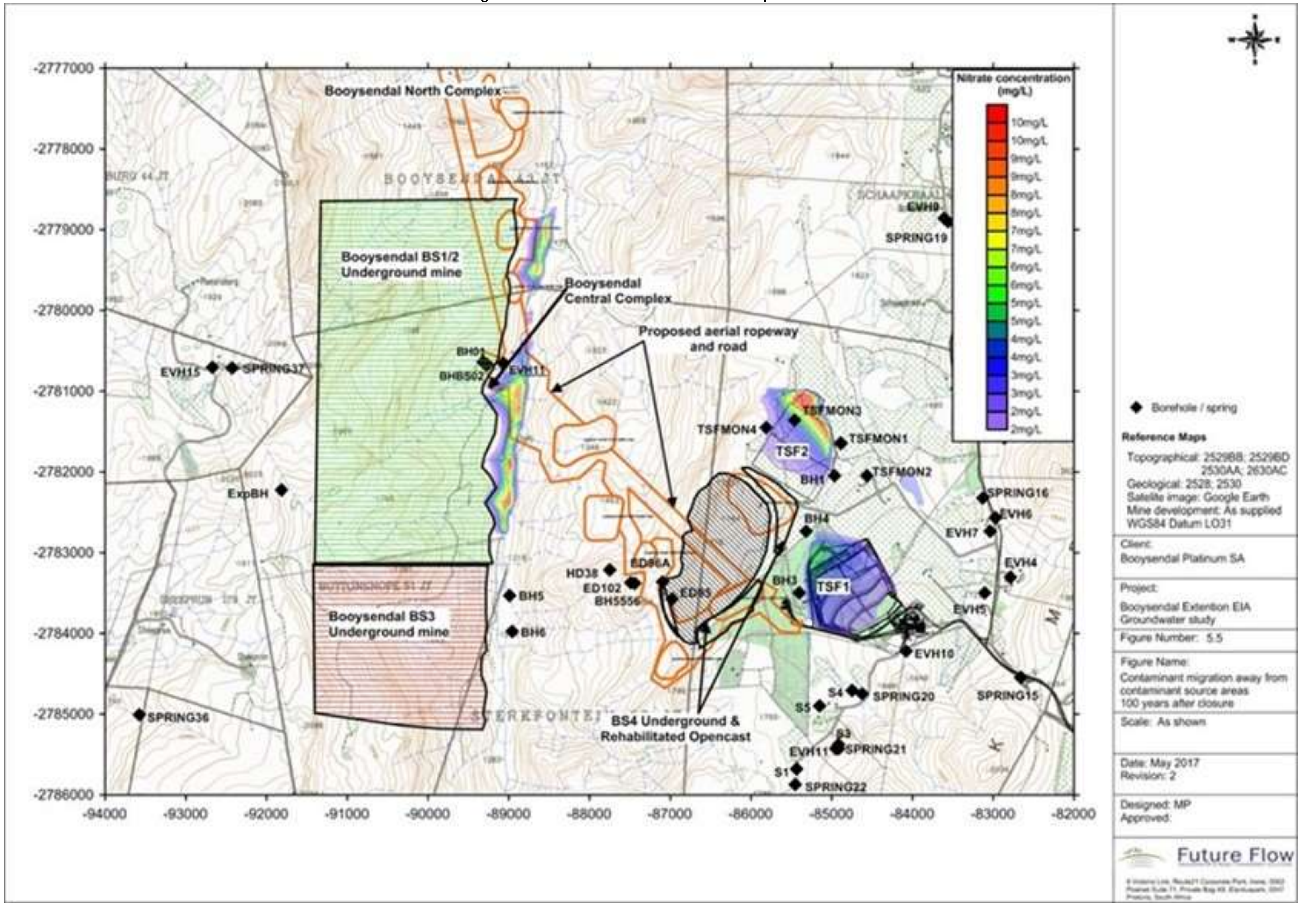


Figure 8-3 Groundwater Contamination Transport Model



c) Contamination and Transport Model

The main activities which could contribute to groundwater contamination of groundwater will mainly be the underground workings at BS1/2, TSF1, ore stockpile areas, crusher the backfill operations at BS4 and the various PCDs. The impacts on groundwater quality will commence with the operational phase and will cease only.

The risk of contamination will be significantly reduced to a minor risk where the various infrastructure components are to be lined with HDPE liners in the event of PCDs and TSF1 and with impermeable slabs, paving etc. in the case of for instance the crusher. Contaminant migration away from the existing TSF1 northwest the Everest Tributary will continue. The long-term average nitrate concentration entering the stream is approximately 3mg/. The long-term nitrate salt load contribution to the stream from TSF1 is calculated to be 70 g/day. This seepage has a cumulative impact on surface water quality and the associated aquatic biodiversity.

It is expected that seepage will commence during operational phase and into decommissioning phase. The impacts were modelled for a period of 100yrs after mine closure. From the model it can be seen that impacts will be very localised and will not migrate off site at BS4. No offsite drinking boreholes should be impacted.

The model also indicates that the groundwater impact along the BS1/2 and Merensky Portals will be very localised and should not impact any groundwater boreholes currently used for drinking purposes. The only secondary impact that may result is if the groundwater decants and flows into the Groot Dwars River. The biggest risk to groundwater contamination transport is associated with the TSF and proposed future TSF. The significance of the impacts was assessed in Table 8-13.

Table 8-13 Aquifer Contamination resulting from the Tailings Storage Facilities

Impact Component	Impact 1	Significance prior to Mitigation	Significance with Mitigation
Activity	Contamination of the aquifers due to seepage from the overlying TSF areas could occur. Monitoring results from TSF1 show existing contamination. The proposed new TSF2 will be partially lined, this lining can be damaged, or contamination of the aquifers can occur in the unlined areas.		
Risk/ Impact	The aquifers will be contaminated due to increased nitrate concentrations from seepage.		
Project Phase CO / OP / Nature of Impact	CO, OP, CL Negative		
Type of Impact	Direct: Deposition of contaminated water onto the TSF will have a direct impact on the groundwater qualities in the underlying aquifers. Contamination migrating away from TSF2 will enter the stream southeast of the stream at a concentration of 2 to 3 mg/L during operations, and will daylight in springs on the escarpment northwest of the TSF at 3 mg/L. Post operations the nitrate concentrations seeping into the stream southeast of TSF2 will decrease to background levels while the nitrate concentration in springs daylighting at the escarpment northwest of the TSF will decrease to 2 mg/L which is close to the background nitrate concentrations of 1.5 mg/L.		

	Cumulative Impact on Surface Water Resource Quality: Seepage will eventually end up in the surface water resources contributing to an increase deterioration in water quality addition to the Groot Dwars River water quality as a whole		
Impact Significance		Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Definite	4	4
Duration	Permanent Increased nitrate concentrations will be present from when the first deposition takes place. Contamination in the soil and aquifer will take many years to be attenuated post closure.	4	4
Extent	Area of influence The zone of impact of the groundwater contamination will be restricted to the area around the TSF. However, once the contamination daylights in springs, or enter the stream it can migrate far in a short time period.	3	3
Receptor Sensitivity	Moderate-Low	2	2
Magnitude	Minor The zone of impact is relatively small and there are no groundwater users that will be impacted. The salt load contribution to the water in the stream between the two TSF areas will be relatively low (70 g/day).	2	1
Impact Significance	Moderate significance there are no groundwater users that will be impacted and the impacts on the stream will be low.	Moderate 13 2	Moderate 13 1
Mitigating and Monitoring Requirements			
Required Management Measures	Monitoring of groundwater and stream water qualities Supply of alternative water resources should the community water resources be negatively impacted Partial lining of TSF1 and any other future TSF with a Class 3 liner Monitoring of the integrity of the liner through surface-and groundwater monitoring		
Required Monitoring (if any)	Long-term monitoring of water quality.		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding	This is a negative impact with a limited impact on stream qualities.		

d) Decanting

The backfilled area will be located at a higher elevation than the Valley Boxcut that is connected to it through the BS4 underground mine. This means that in the event that there is long-term seepage away from the backfilled area that bypasses the bottom barricade that is designed to intercept seepage from the backfill area (it is unlikely that the pumping system will be maintained indefinitely), the seepage will migrate through the underground mine under gravity to the level of the Valley Boxcut where it will decant from the underground mine.

The quality of the leachate that comes from the backfilled tailings material is expected to be slightly different to that of the water in the underground mine below the Valley Boxcut. Comparing the two water qualities it can be seen that the seepage from the backfilled material can be expected to have slightly elevated chromium concentrations (0.3 mg/L compared to SANS241 drinking water guideline value of 0.1 mg/L), while the water in the underground mine below the level of the Valley Boxcut is expected to have slightly elevated nitrate concentrations of 13 mg/l compared to the SANS241 guideline value of 11 mg/l.

Decanting from the underground workings (BS1/2 and the valley boxcut) is anticipated to commence only after mine closure, commencing at year 115 after closure. The hydrogeological assessment indicates that the average nitrate contribution to the baseflow seepage entering the stream is approximately 8.5 mg/L over a distance of 4 100 m. The nitrate salt load contribution to the river was calculated using the numerical model outputs at approximately 2 kg/day.

Using an average stream nitrate concentration of 0.5 mg/L as derived from the BN water monitoring program and a mean annual runoff volume of 10.761 MCM (29 460 m^3/day) it was calculated that the average impact on the nitrate concentration in the Groot Dwars River due to seepage migration away from the BS1/2 and BS3 underground mine area will lead to an increase in nitrate concentration of less than 0.1 mg/L (from 0.5 mg/L to 0.57 mg/L).

Decanting from the valley boxcut will continue at a rate of approximately 800 to 3 000 m^3/day unless the boxcut can be sealed effectively. It is expected that with continued mining Nitrate levels will increase to 13mg/l or more.

The risk to the environment as a result of decanting is twofold:

- It could lead to an increase in the nitrate loads and to some extent chrome concentrations in the river which could be detrimental to aquatic life;
- The increase in flows could have a negative impact on certain species which prefer slower and shallower habitats.

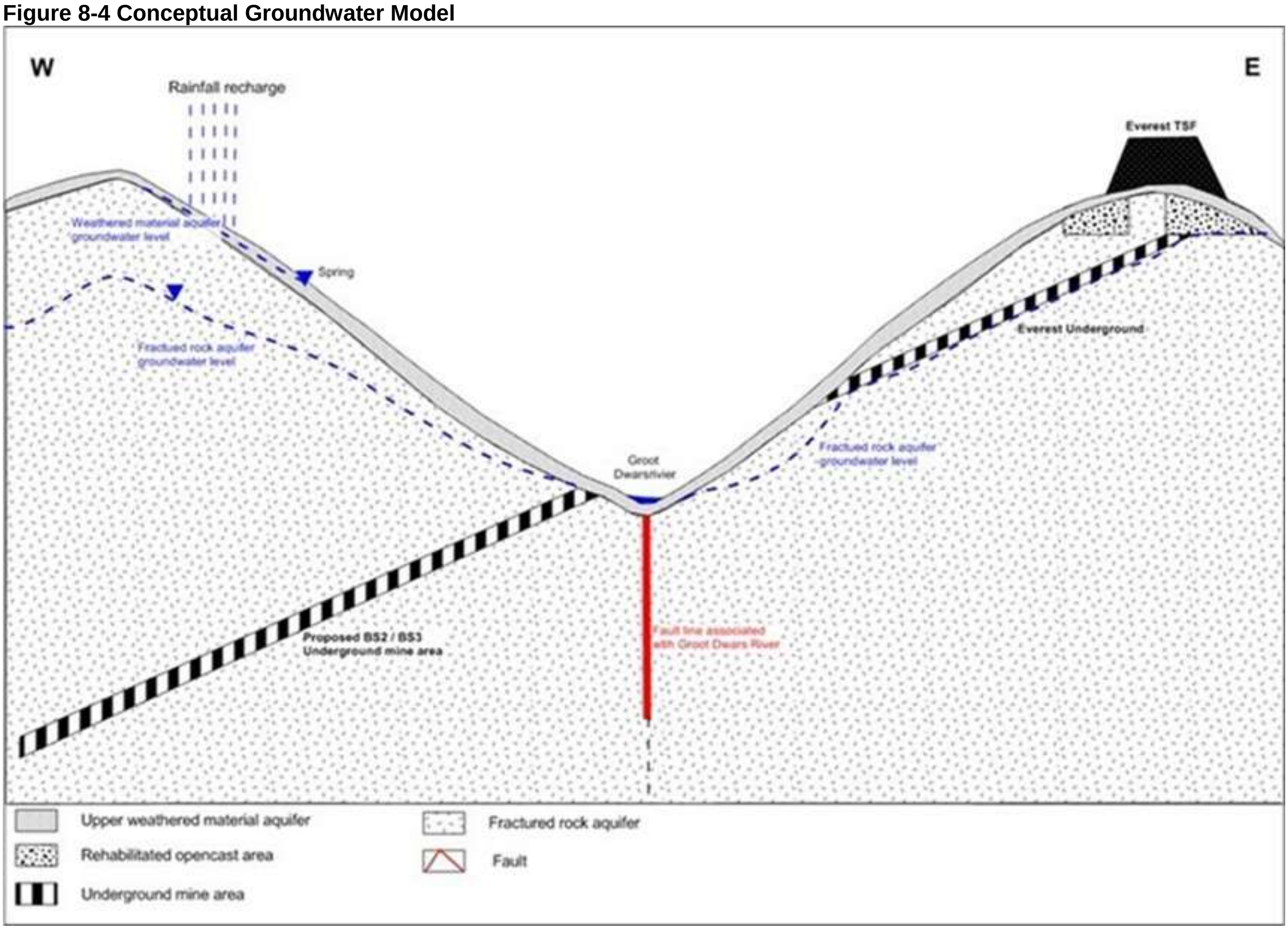
CuluIative Imapct: The combined impact of decanting on the water quality of Groot Dwars River water quality is deemed moderate. Panning for closure must be considered during the operational phase to reduce closure liabilities and long term maintenance and management after closure.

The impacts which the increase in flows and change in water quality may have on the aquatic environment may be more detrimental. (refer to Section 8.2.6. and Annexure H).

Taking consideration of the conceptual groundwater model included in Figure 8-4, it is important to note that any shallow contamination could seep from the shallow seep aquifers or daylights.

The assessment of the impact significance has however been assessed as of low significance (refer toSection 5 of Annexure E.

Figure 8-4 Conceptual Groundwater Model



Recommendations and Reasoned Opinion of the Hydrogeologist

The Hydrogeologist recommended that the project be authorized. This recommendation is based on:

- The impact assessment shows that the impact on the groundwater levels in the area are expected to be minor in terms of the zone of influence. Due to the great depth of the majority of the mining area (up to >900 mbgl) it is not expected that there will be a notable impact on the groundwater levels in the relatively shallow aquifers (<100 mbgl) that the local landowners access;
- Based on the current water qualities at Booysendal North, BS4, and the leach test results the impacts on the groundwater qualities are expected to be minor;
- The impact on the flow volumes in the Groot Dwars River is expected to be minor;
- The impact on the Groot Dwars River water quality is expected to be minor;

- There are no significant impacts expected from the construction and operation of the access road, aerial ropeway or other surface infrastructure; and
- Leach test results show that the only element of concern from the TSF is nitrate.

Overall, it can be concluded that that there are few sensitive receptors in the area and the impacts on those sensitive receptors can be managed effectively.

Condition for Authorisation

Optimal management of the proposed impacts through the implementation of the proposed groundwater management and monitoring measure, including:

- The lining of TSF1 and future TSF2 with a Type 3 liner;
- Continuation of the current groundwater monitoring program (Refer to the EMP for detail)
- Sealing of high yielding structures which will limit groundwater inflow into the underground workings;
- Lining of all PCDs with a HDPE liner;
- All potential dirty water structures must be constructed according to the Department of Water and Sanitation Best Practice Guidelines;
- Plugging of valley boxcut decant after mine closure; and
- Construction and operation of a water treatment plant to treat decant should it spill into the environment.

8.2.4 Hydrology

The main impacts associated with the current Section 24G activities are:

- Insufficient stormwater management and control at construction footprints specifically the BS1/2 terrace and the main access road;
- Erosion and siltation because of insufficient stormwater management and control;
- Contamination of surface water resources because of insufficient capacity and design of clean and dirty water and stormwater management infrastructure at BS4;
- Change in flow regimes of impacted watercourses;
- Change in the water and salt balance of the river systems;
- Spillages from the dirty water infrastructure can cause contamination of water resources; and
- Failure of process water pipelines.

The management measures for the impacts with a low significance are included in the EMP.

Water and Salt Balance

Water quality monitoring was undertaken at various points in the Groot Dwars River and in the Everest Tributary. The locations of the monitoring points are included in Figure 8-13. Salt loads were calculated for the Groot Dwars River using an upstream and a downstream point. The results from the calculations indicted that there is an increase in salt loads downstream. This can be attributed to nature of the crossing at MPB (see Figure 8-6) and the increase in sediment loads as a result of the construction activities.

There is a significant increase in the salt loads in the Everest Tributary downstream. This can be attributed to the pollutants, overflows and seepage from BS4 which flows into the stream. The salt loads are indicated in Table 8-14.

The stormwater management system at BS4 is being upgraded through the lining of PCDs, cut-off trenches, increase of capacity of the Mining PCD. These factors will lead to a decrease in salt loads and protection of the Everest Tributary. The assessment of the stormwater management upgrade is included in Table 8-15.

Figure 8-5 Salt Load Distribution in the Groot Dwars River

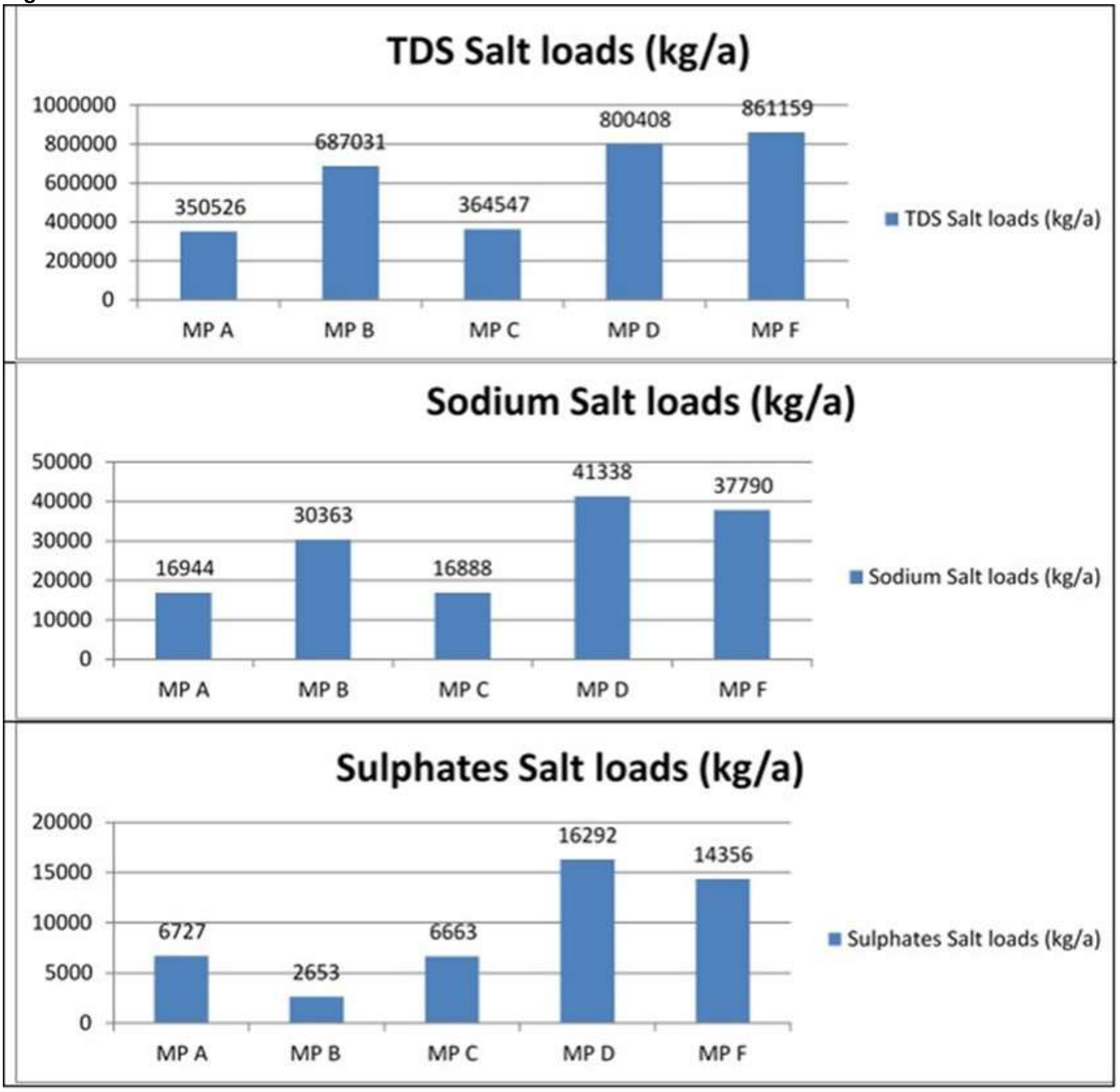


Figure 8-6 Hydrology Study Monitoring Points

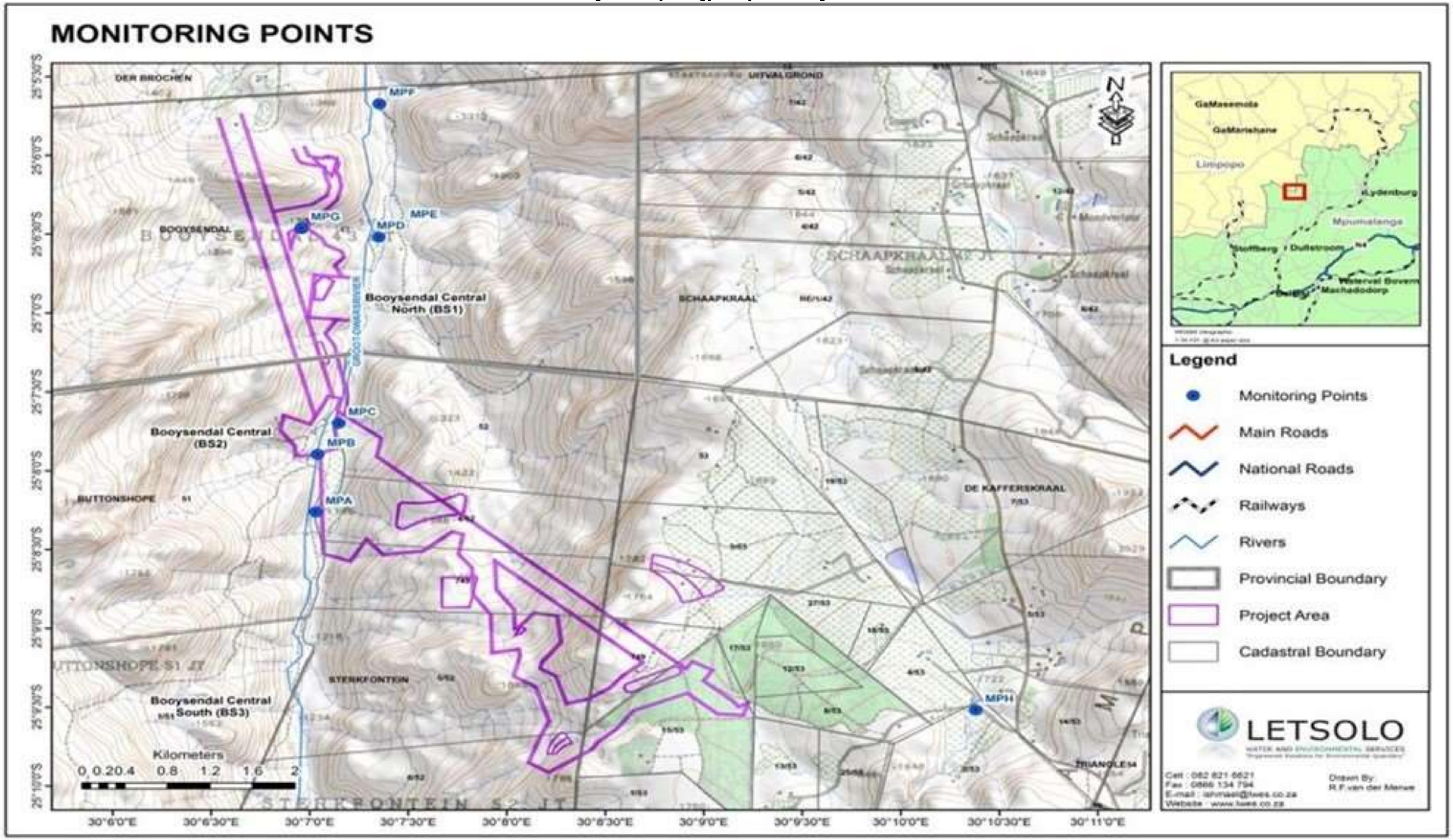


Figure 8-7 Everest Tributary Salt Loads

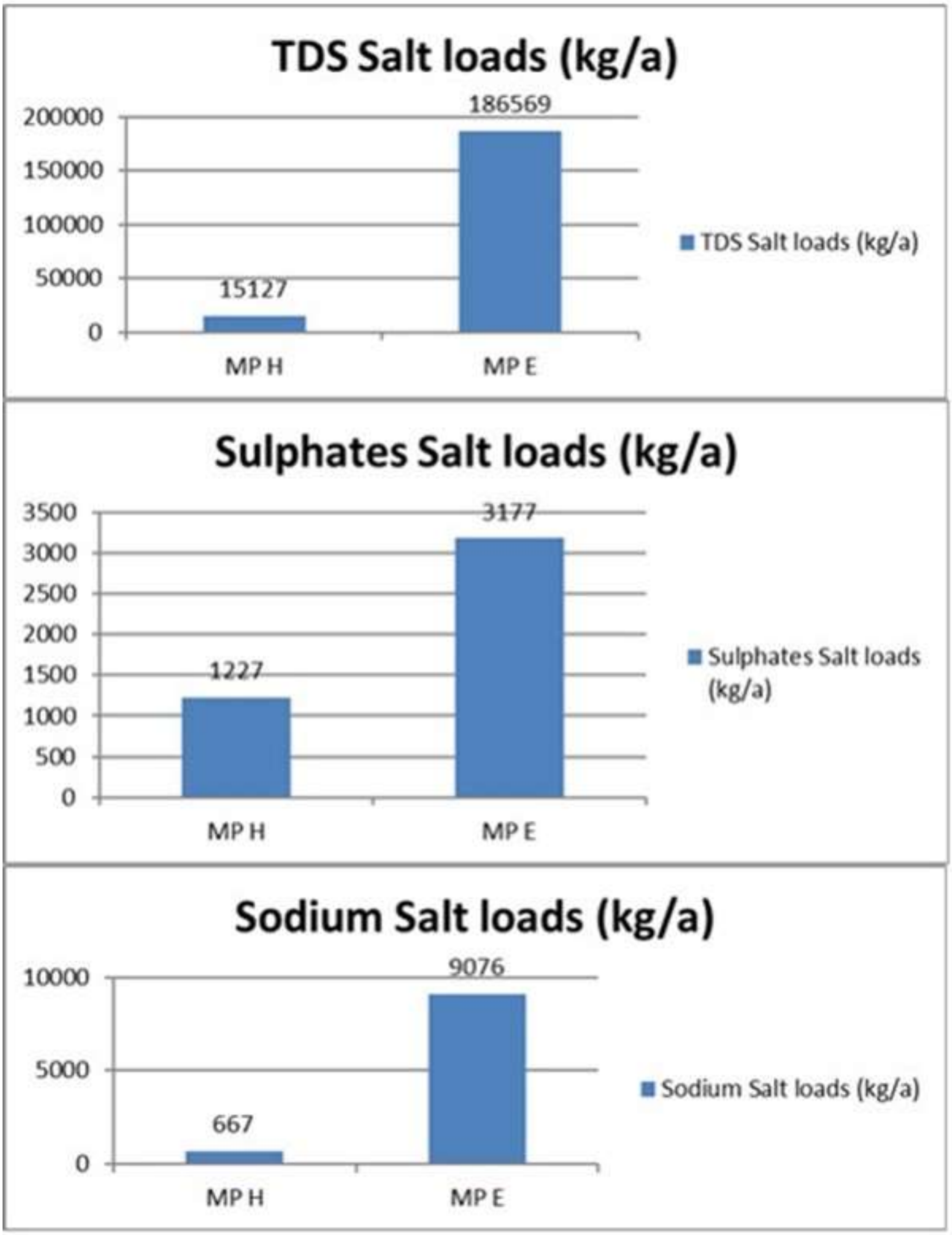


Table 8-14 Stormwater Management Upgrades at BS4

Impact Component	**Impact 1**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	1. Upgrade and lining of PCDs; 2. Decommissioning and rehabilitation of Workshop PCD; 3. Silt trap for the conveyor belt; and 4. Upgrade of sewage treatment plant.		
Risk/ Impact	Deterioration of water quality.		
Project Phase CO OP CL Nature of Impact	CO, OP, CP Positive Impact		
Type of Impact	1. Potential improvement in water quality within downstream surface water receptors; 2. Potential improvement in quality within downstream surface water receptors; 3. Potential improvement in quality within downstream surface water receptor; and 4. Potential improvement in water quality within downstream surface water receptors.		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	3
Duration	Long-term	3	3
Extent	Area of influence Everest Stream, tributary of the Groot Dwars River.	3	3
Receptor Sensitivity	Moderate	3	3
Magnitude	Moderate	3	3
Impact Significance	Moderate	Moderate +12 3	Moderate +12 3
Mitigating and Monitoring Requirements			
Required Management Measures	1. Increased PCD capacity will reduce probabilities of spillage. 2. Lining will reduce seepage of dirty water, which may migrate towards surface water receptors. 3. Workshop PCD will be replaced with a fit for purpose lined facility with suitable capacity which reduces the probability of a spillage. 4. Rehabilitation will remove a source-pathway-receptor linkage. 5. Removal of silt from storm water upstream of surface water receptor, if silt trap is maintained properly. 6. Improvement in quality of effluent discharged to surface water receptor. 7. Lining of TSF1		
Required Monitoring (if any)	Monthly surface water quality monitoring must be conducted on the proposed monitoring points.		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding			
Impact Finding	Positive Impact		

Water Quality

At this point in time it does not seem as if e-coli have increased. As a matter of fact, the upstream water quality in the Groot Dwars River and the Everest Tributary indicates higher e-coli which can be attributed to grazing practices. There is, however a general decrease in water quality. Water quality deterioration as indicted in Table 8-13 and Table 8-14 can be attributed to construction activities currently taking place. During the operational phase water quality, may further deteriorate especially in the Groot Dwars River as a result of spillages. The assessment of the significance of the impact is included in Table 8-16.

Table 8-15 Deterioration in Water Quality as a Result of Spillages and Dirty Water Systems

Impact Component	**Impact 1**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Construction of roads and supporting infrastructure in or close to drainage lines. Operation and maintenance of dirty water infrastructure. Spillages of chemicals and hydrocarbons.		
Risk/ Impact	Deterioration of water quality.		
Project Phase CO OP CL Nature of Impact	CO, OP, CP Negative		
Type of Impact	Direct: due to the close proximity of the Groot Dwars River, pollution incidents may directly result in the deterioration of water quality.		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	2
Duration	Long-term The management of dirty water infrastructure is required from the construction the post closure phase.	3	2
Extent	Area of influence The Groot Dwars Rivers a significant stream in the catchment. In the event of pollution, pollutants will be easily washed further downstream.	3	1
Receptor Sensitivity	Moderate	3	2
Magnitude	Moderate	3	2
Impact Significance	Moderate	Moderate <u>12</u> 3	Minor <u>9</u> 2
Mitigating and Monitoring Requirements			
Required Management Measures	• The clean and dirty water flow areas on a mine site was identified and flood volumes quantified.		

	• The mine must locate any sanitary convenience, fuel depots for any infrastructure which causes or is likely to cause pollution of a water resource outside the 1:50 year floodline of any watercourse or estuary. • Dirty water channel should be designed to collect contaminated water and to dispose it into the PCD. • Storage areas for chemicals and hydrocarbons, workshops need to be constructed according to best practice • Spills should be cleaned up immediately • Maintenance of all dirty water systems • Regular cleaning of clean water diversion systems • Emergency response measures must be put in place • Dirty water should be re-used in the process.
Required Monitoring (if any)	Monthly surface water quality monitoring must be conducted on the proposed monitoring points.
Responsibility for implementation	Environmental Officer and Mine Manager
Impact Finding	
Impact Finding	Impact can be managed through proper design and maintenance of hydraulic structures and through management measures

The flow regimes of watercourses will be altered due to the cut-off trenches, culverts and change in the characteristics of the surfaces. The significance of the impact is included in Table 8-16.

Table 8-16 Change in Flow Regime

Impact Component	**Impact 1**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Site Establishment and construction of required infrastructure		
Risk/ Impact	Change in flow regime Increase in hydrological yield Change in catchment characteristics		
Project Phase CO OP CL Nature of Impact	CO, OP Negative		
Type of Impact	Direct: artificial infrastructure like channels and berms, may have a significant impact on the flow regime due to the change in flow direction and velocity.		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	2	1
Duration	Long-term	3	2

	As part of clean and dirty water separation, Water management infrastructure will be required for the life of mine.		
Extent	Area of influence	2	1
Receptor Sensitivity	Moderate	3	2
Magnitude	Moderate	3	2
Impact Significance	Moderate significance	Moderate 10 3	Minor 8 2
Mitigating and Monitoring Requirements			
Required Management Measures	The location of mining infrastructure must be outside the 1:100 years Floodlines or where the 1:100 yr Floodlines are not known outside of the 100m lines. The proposed infrastructure may not impede or divert the flow, unless authorized by the DWS. Efforts should be made to minimize the dirty water catchment Dirty water channel should be designed and constructed to collect contaminated water and to dispose it into the PCD.		
Required Monitoring (if any)	Water balance studies must be conducted and amended annually. The outcomes of the study must be used as a management tool as well as a means of investigating the latest technologies for water management.		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding			
Impact Finding	Impact can be managed through reforestation programs.		

Cumulative Impacts: The salt balance indicated that there is a deterioration downstream in the Everest Tributary and in the Dwars River. Deterioratoin increases downsteram due to the cumulative contaminat loads attributed by the various mines along the river. The significance of the deterioration is a gap in this study as it is uncertain if the overall impact of mining on the Groot Dwars River was modelled. It is therefore recommendad as a management measure that the Groot Dwarst River water qulity from upstream to the confluence of the Steelpoort River be modelled. This is something which will have to be supported by all mines and the DWS who is the custodian of water resources in South Africa.

Recommendations and Reasoned Opinion of the Hydrologist

The proposed activity is recommended. Underground mining activities have lesser impacts on surface water resources when compared to opencast activities. However, due to the need of support services which may be located on the surface, it is necessary to ensure that reasonable mitigation measures are in place.

8.2.5 Terrestrial Ecology

Based on the survey and study findings NSS concluded that some activities should not have commenced in the Groot Dwars River valley because of the sensitivity and national importance of the area. The Section 24G activities caused some irreversible destruction and fragmentation of biodiversity. These impacts were worsened by the fact that clearance outside of the footprint areas has taken place and that clearance of sections of the main access road commenced after which layouts were changed. Significant impacts were identified which due to the nature of the environment cannot be successfully mitigated and managed with the implementation of the management measures included on the EMP for the Section 24G activities. These impacts include:

- Degradation of floral communities and faunal habitats from dust because of construction activities;
- Degradation of floral communities and faunal habitats duet to alien and invasive species settlement;
- Loss of CI and other fauna from dust, noise, vibration, light and contamination.

Impacts which has been rated high of which the impacts can be reduced to moderate includes:

- Degradation of floral communities and flora habitats from erosion and sedimentation resulting form the construction activities;
- Degradation of floral communities and faunal habitats from contamination through the TSF, PCDs, materials handling and spillages;
- Change in riparian vegetation structure from sedimentation and nutrient load because of construction activities close to wetlands and rivers; and
- Loss of fauna and flora resulting from hunting, harvesting and livestock practices due to influx of people;
- Loss of provisioning services from fauna and flora due to clearing, compaction, removal of spoil, contamination, development of infrastructure etc.

The required management measures for all these impacts have been included on the Section 24G EMP. Irreversible impacts which remains high even with the implementation of impact and management measures are included in Table 8-17 to Table 8-24.

Table 8-17 Localised Destruction of Floral Communities and Faunal Habitats

Commenced	**Impact: Localized destruction of floral communities and faunal habitats**		
Activities	Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Development of roads, portals, ARS South, Valley Boxcut PCD and other infrastructure.		
Risk / Impact	In the wake of commenced activities, patches of various CI and other floral communities and faunal habitats have been or will be permanently lost. Affected CI floral communities include e.g. the *Lydenburgia-Vitex-Kirkia* Rocky Thicket, *Acacia-Euclea-Hippobromus-Scolopia* Thicket, *Brachiaria-Tristachya* Exposed Rock and *Aloe-Myrothamnus-Xerophyta* Sheet Rock. Affected CI habitats include sheet rock, which is required by the locally endemic Sekhukhune and FitzSimon's flat lizards, and the *Hadogenes polytrichobothrius* flat rock scorpion, and *Vitex o. wilmsii* trees, which represent habitat for the locally endemic *Pycna sylvia* cicada.		
Project Phase	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	Direct Clearing of vegetation, blasting, earth-moving activities, and development of infrastructure has, and could continue to cause direct destruction of communities and habitats.		
		Significance prior to Mitigation	**Significance with Mitigation**
Likelihood / Probability	Definite Vegetation has already been cleared for the commenced activities.	4	4
Duration	Permanent Most developed infrastructure will remain permanently.	4	4
Extent	Site Clearing of vegetation, blasting, earth-moving activities and development of infrastructure is supposed to be limited to the project footprint.	2	2
Receptor Sensitivity	High Affected CI floral communities include e.g. the *Lydenburgia-Vitex-Kirkia* Rocky Thicket, *Acacia-Euclea-Hippobromus-Scolopia* Thicket, *Brachiaria-Tristachya* Exposed Rock and A*loe-Myrothamnus-Xerophyta* Sheet Rock. Affected CI habitats include sheet rock, which is required by the locally endemic Sekhukhune and FitzSimon's flat lizards, and the *Hadogenes polytrichobothrius* flat rock scorpion, and *Vitex o. wilmsii* trees, which represent habitat for the locally endemic *Pycna sylvia* cicada.	4	4
Magnitude	High Within the project footprint there will be a complete loss or dramatic transformation of affected communities and habitats.	-4	-4
Impact Significance	As not much can be done to avoid, minimize or reverse this impact, suitable offsetting needs to be investigated.	**High** **14** **-4**	**High** **14** **-4**

Mitigating and Monitoring Requirements	
Required Management Measures	Strictly prohibit further disturbance of natural areas beyond the project footprint. Move the ARS 'vocalisation Area' that has been planned in the valley to the distrubed habitats of BS4 Do not clear the vegetation along the full ARS route. Clearing of vegetation should be restricted to the tower footprint and access roads ONLY Laydown Areas for the ARS should only be placed in already disturbed areas such as he Valley Boxcut area - near the PCD Excavated topsoil must be stored with associated native vegetation debris for subsequent use in rehabilitation. Topsoil stockpiles must be managed to ensure that the viability of the seed bank is retained. Establish a nursery for relocation and cultivation of local indigenous flora for rehabilitation (specific species such as bulbs etc that can handle transporting and storage) Establish a Rehabilitation Plan for the site and rehabilitate all disturbed areas, which will not be developed. Rehabilitate or protect 1:30 offset ratio of the same habitat types outside Booysendal.
Required Monitoring (if any)	Monitor the success of rehabilitation efforts, seasonally. Use the Fixed Point monitoring stations mentioned in this section Monitor the condition of protected offset areas, as per the Offset Strategy recommendations
Responsibility for Implementation	Booysendal Management, Onsite Independant ECO, Construction and Environmental teams.
Impact Finding	
Impact Finding	As not much can be done to avoid, minimize or reverse this impact, suitable offsetting needs to be investigated.

Table 8-18 Fragmentation of Floral Communities and Faunal Habitats

Commenced	**Impact: Fragmentation of floral communities and faunal habitats**		
Activities	Clearing of vegetation; Blasting; Compaction of soil; Development of infrastructure - especially linear features such as the roads, ARS, fence lines, etc.		
Risk / Impact	Commenced activities have, and will continue to fragment a significant-sized portion of the Sekhukhuneland Centre of Plant Endemism, the EN Sekhukhune Mountainlands Threatened Ecosystem, the Groot-Dwars River FEPA, etc. including certain CI and other floral communities and faunal habitats. Affected CI floral communities include e.g. the *Phragmites-Schoenoplectus* Vlei System, *Fuirena-Agrostis* Seep Zones, *Faurea-Combretum-Halleria* Riparian Vegetation, *Lydenburgia-Vitex-Kirkia* Rocky Thicket and *Brachiaria-Tristachya* Exposed Rock. Affected CI habitats include the Groot-Dwars River and various small drainage lines that drain into the River, which are intersected by the road network.		
Project Phase	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	Indirect Clearing of vegetation, blasting, earth-moving activities, and development of infrastructure - especially linear features such as the ARS, roads, fence lines, etc. - will indirectly cause fragmentation of communities and habitats.		
		Significance prior to Mitigation	**Significance with Mitigation**
Likelihood / Probability	Definite Vegetation has already been cleared for the commenced activities.	4	4
Duration	Permanent Most developed infrastructure will remain permanently.	4	4
Extent	Regional/Provincial/National The commenced activites have effectively fragmented a significant-sized portion of multiple national and provincial CI areas.	4	4
Receptor Sensitivity	High The unique Sekhukhuneland Centre of Plant Endemism, EN Sekhukhune Mountainlands Threatened Ecosystem, and the Groot-Dwars River FEPA are poorly (if at all) protected, and have high national and provincial CI. Affected CI floral communities include e.g. the *Phragmites-Schoenoplectus* Vlei System, *Fuirena-Agrostis* Seep Zones, *Faurea-Combretum-Halleria* Riparian Vegetation, *Lydenburgia-Vitex-Kirkia* Rocky Thicket and *Brachiaria-Tristachya* Exposed Rock. Affected CI habitats include the Groot-Dwars River and various small drainage lines that drain into the River, which are intersected by the road network. Fragmentation of these wetlands will have a serious impact on associated wetland species such as the potentially occurring CI Natal Cascade Frog.	4	3
Magnitude	High Commenced activities have fragmented a significant-sized portion of the Sekhukhuneland Centre of Plant Endemism, the EN Sekhukhune Mountainlands Threatened Ecosystem and other CI areas. Fragmentation of the Groot-Dwars River by the road crossing near BS2 will have a severe impact on downstream and upstream wetland floral communities and faunal habitats. The same applies to the various small drainage lines that are intersected by the road network.	-4	-3
Impact Significance	Little can be done to avoid, minimize or reverse this impact. Fragmentation of drainage lines could be mitigated by construction of appropriate road crossings over these, but some might be irreversibly damaged by diversion, infilling, erosion, sedimentation, etc. Therefore suitable offsetting needs to be investigated.	**High** **16**	**High** **15**

		-4	-3

Mitigating and Monitoring Requirements	
Required Management Measures	Ensure infrastructural footprint areas are fenced in to avoid further disturbances beyond the footprint. This was evident at BS1/2 where the footprint size increased dramatically sprawling onto the surounding habitats. Avoid unnecessary fencing within natural areas as far as possible. Move the ARS 'vocalisation Area' that has been planned in the valley to the distrubed habitats of BS4 Do not clear the vegetation along the full ARS route. Clearing of vegetation should be restricted to the tower footprint and access roads ONLY Laydown Areas for the ARS should only be placed in already disturbed areas such as he Valley Boxcut area - near the PCD Strictly prohibit further disturbance of natural areas i.e. excess unnecessary roads to the Ropecon towers. This was evident in the current activities on site with excess unnecessary clearing taking place Reconstruct the bridge with fish-friendly culverts (or better) over the Groot-Dwars River at BS1/2, to avoid creating a barrier across the River. Where the road network intersects other (smaller) drainage lines, bridges or other appropriate crossings should be constructed to avoid creating barriers across these. Establish a nursery for relocation and cultivation of local indigenous flora for rehabilitation (specific species such as bulbs etc that can handle transporting and storage) Rehabilitate all disturbed areas, which will not be developed. An indigenous seed mix must be used excluding species such as TEF. Hybrids and cultivars should also be avoided. Rehabilitate or protect 1:30 offset ratio of the same habitat types outside Booysendal.
Required Monitoring (if any)	Check annually that all road crossings over drainage lines (esp. the Groot-Dwars River) are kept in good working order.
	Monitor the success of rehabilitation efforts, seasonally. Use the Fixed Point monitoring stations mentioned in this section Monitor the condition of protected offset areas, as per the Offset Strategy recommendations
Responsibility for Implementation	Booysendal Management, Engineering, Construction and Environmental teams.
Impact Finding	
Impact Finding	As little can be done to avoid, minimize or reverse this impact, suitable offsetting needs to be investigated. Construction of a fish-friendly bridge where the Main Access Road crosses the Groot-Dwars River is critical to avoid fragmentation of this River.

Table 8-19 Loss of CI and other Flora from Construction Activities

Commenced	Impact: Loss of CI and other flora from construction activities
Activities	Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Development of roads, portals, South ARS, Valley Boxcut PCD and other infrastructure.
Risk / Impact	A high diversity of flora is present in BS and especially the Valley, including numerous CI taxa. Specimens of these have, and will continue to be lost where vegetation in the project footprint is cleared. Of particular concern are species such as *Aloe barbara-jeppaea* , *Jamesbrittenia macrantha, Lydenburgia cassinoides* and *Zantedeschia pentlandii.* During our surveys we observed specimens of these, which had been destroyed or were at high risk of being destroyed where vegetation had recently been cleared. Although *Lydenburgia cassinoides* trees had been marked with danger tape along portions of the road route, many were nonetheless destroyed during clearing. Areas also were

	cleared despite Booysendal environmental personnel requesting that certain flora were removed first before clearing commenced.		
Project Phase	CO		
Nature of Impact	Negative		
Type of Impact	Direct Clearing of vegetation, blasting, earth-moving activities, and development of infrastructure has, and will continue to cause direct destruction of CI floral species specimens.		
		Significance prior to Mitigation	**Significance with Mitigation**
Likelihood / Probability	Definite Vegetation has already been cleared for the commenced activities.	4	4
Duration	Permanent Most developed infrastructure will remain permanently and, therefore, CI floral species will forever be lost from the affected areas.	4	4
Extent	Site Clearing of vegetation, blasting, earth-moving activities and the development of infrastructure is supposed to be limited to the project footprint.	2	2
Receptor Sensitivity	High Affected CI floral taxa include *Jamesbrittenia macrantha* (NT), *Lydenburgia cassinoides* (NT), *Zantedeschia pentlandii* (VU) and many others.	4	4
Magnitude	High The destruction of numerous CI floral species specimens, which were or are still rooted in the project footprint, was rated with High magnitude.	-4	-3
Impact Significance	As many CI floral species specimens have already been destroyed, only limited opportunity remains to avoid or minimize the loss of additional specimens where the project footprint has not yet been disturbed. For this reason, suitable offset measures should be investigated. Not all species might be successfully relocated, or cultivated in a nursery.	**High** **14** **-4**	**High** **14** **-3**
Mitigating and Monitoring Requirements			
Required Management Measures	Ensure infrastructural footprint areas are fenced in to avoid further disturbances beyond the footprint. This was evident at BS1/2 where the footprint size increased dramatically sprawling onto the surounding habitats. Obtain permits to relocate CI floral species specimens that remain in undisturbed parts of the project footprint. This includes permits under the Forest Act 1998 for species such as *Lydenburgia cassinoides* (NT) Establish a nursery for relocation and cultivation of local indigenous flora for rehabilitation (specific species such as bulbs etc that can handle transporting and storage). Tree cuttings of certain species can also be taken and grown. Investigate *Jamesbrittenia macrantha* survival rates in nursery environment Rehabilitate all disturbed areas, which will not be developed. An indigenous seed mix must be used excluding species such as TEF. Hybrids and cultivars should also be avoided. Rehabilitate or protect 1:30 offset ratio of the same habitat types outside Booysendal.		
	Monitor the condition of rescued CI floral species specimens in the nursery, weekly.		

Required Monitoring (if any)	Monitor the success of rehabilitation efforts, seasonally. Monitor the condition of protected offset areas, as per Offset Strategy
Responsibility for Implementation	Booysendal Management, Construction and Environmental teams.
Impact Finding	
Impact Finding	The need to establish and manage a nursery in Booysendal for CI and other local flora cannot be over-emphasized.

Table 8-20 Loss of CI and other Fauna from Habitat Destruction and Vehicle Traffic

Commenced	**Impact: Loss of CI and other fauna from habitat destruction and vehicle traffic**		
Activities	Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Infilling; Stockpiling; Reworking of TSF1; Vehicle traffic, Construction and operation on the Ropecon.		
Risk / Impact	Multiple CI faunal species occur in BS, and specimens of these have, and will continue to be lost by the above-mentioned activities. Faunal taxa that are most vulnerable include those that are small, slow, young, subterranean, fossorial, nocturnal and/or philopatric to affected localities. Of particular concern are: i) the locally endemic and sheet-rock restricted Sekhukhune and FitzSimon's flat lizards, and the *Hadogenes polytrichobothrius* flat rock scorpion; ii) nymphs of the locally endemic *Pycna sylvia* cicada, which live underground on the roots of *Vitexo. wilmsii* trees, and which may take many years to mature (Malherbe *et al.* 2004); iii) baboon spiders; iv) all life stages of various present and potentially occurring geographically restricted butterfly species; and v) the potentially-occurring VU Natal Cascade Frog, which is restricted to cold, clear, swiftly-flowing and densely-vegetated mountain streams.		
Project Phase	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	Direct Mortality of fauna from clearing of vegetation, blasting, earth-moving activities, and their collision with vehicle traffic is a direct impact.		
		Significance prior to Mitigation	**Significance with Mitigation**
Likelihood / Probability	Definite Mortality of fauna from the above-mentioned activities is inevitable.	4	4
Duration	Long term Fauna with long generations (e.g. *Pycna sylvia*), low fecundity (e.g. baboon spiders) and/or low densities (e.g. Cohen's Horshoe Bat) take a long time (years) to recover from significant mortality events.	3	3
Extent	Site Direct mortality of fauna from the above-mentioned activities will be limited to the project footprint.	2	2
Receptor Sensitivity	High	4	4

	Numerous CI fauna are vulnerable to destruction, especially the locally endemic and sheet-rock restricted Sekhukhune and FitzSimon's flat lizards, and the *Hadogenes polytrichobothrius* flat rock scorpion, nymphs of the locally endemic *Pycna sylvia* cicada, baboon spiders, and the stream-dependent Natal Cascade Frog.		
Magnitude	Moderate Unlike flora in the project footprint, certain CI and other fauna might have escaped destruction and, therefore, this impact was rated with Moderate Magnitude. An important exception is the subterranean larval life stage of *Pycna sylvia*.	-3	-3
Impact Significance	As certain CI faunal species specimens have probably already been destroyed, only limited opportunity remains to avoid or minimize the loss of additional specimens where the project footprint has not yet been disturbed. For this reason, suitable offset measures should be investigated.	**High** **13** **-3**	**High** **13** **-3**
Mitigating and Monitoring Requirements			
Required Management Measures	Strictly prohibit disturbance of natural areas beyond the project footprint. The construction area must be clearly demarcated on the ground and signs put in place to indicate sensitive natural features (single stand cables with hanging signs along and around infrastructure roads etc.). Obtain permits to relocate CI faunal species specimens that remain in undisturbed parts of the project footprint. Rescue specimens of CI faunal taxa (especially dragon lizards, flat lizards, flat rock scorpions, baboon spiders and Pycna sylvia cicada nymphs) from the footprint, and relocate them to nearby suitable and safe habitats with advice from a zoologist. This essentially involves an active capture process whereby a team of people under the guidance of a zoologist capture as many individuals as possible using trapping and active searching by turning rocks. During biodiversity fieldwork NSS has managed to capture dragon lizards, flat lizards, scorpions and cicadas with relative ease. It is imperative that every measure is taken to minimise harmonics that are generated the electric drive motors and cables of the ARS which may potentially have negative effects on the communication systems of avifauna and bats. Ensure that measures are put in place to minimise bird collision risk as a result of the ARS. Consultation from a suitably qualified / experienced ornithologist should be sought in this regard. Input should include, inter alia, monitoring bird collision risk. It is recommended that the principles within The Birds and Wind-Energy Best-Practice Guidelines, South Africa by Jenkins et al. (2015) should be adapted where applicable and adopted. Design of the ARS must comply with international best practice standards on high wind speed to avoid excessive dust pollution. To this end the ARS must, inter alia, be fitted with a roof that extends along the conveyer length. Limit the amount of vehicle traffic on the road network at night, and after rainy weather in summer. Construct a bridge over the Groot-Dwars River at BS1/2 to prevent vehicles from destroying aquatic and wetland vertebrates and invertebrates here. Construct suitable crossings over other (smaller) drainage lines to prevent destruction of fauna at these localities. Rehabilitate all disturbed areas, which will not be developed. Rehabilitate or protect an equivalent number of hectares, which support the same CI floral taxa, outside Booysendal.		
Required Monitoring (if any)	Monitor vehicle traffic speed, monthly throughout the Life of Mine. Check annually that all road crossings over drainage lines (esp. the Groot-Dwars River) are kept in good working order. Monitor the success of rehabilitation efforts, seasonally. Monitor the condition of protected offset areas, quarterly.		

Responsibility for Implementation	Booysendal Management, Engineering, Construction and Environmental teams.
Impact Finding	
Impact Finding	Adequate and effective control of vehicle traffic speed will be necessary throughout the Life of Mine to mitigate faunal roadkill.

Table 8-21 Loss of Supporting ES form Fauna and Flora

Commenced	**Impact: Loss of supporting services from flora and fauna**		
Activities	Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Development of roads, portals, ARS South, Valley Boxcut PCD and other infrastructure.		
Risk / Impact	Supporting services involving flora and fauna, which have been impacted by commenced activities include e.g.: § Soil formation and retention, which has been heavily impacted in areas where vegetation has been cleared and the exposed soil is now vulnerable to erosion. § Nutrient cycling, which has been impacted in all cleared areas and disturbed wetlands. § Primary production, which has been impacted in all cleared areas and disturbed wetlands. § Production of atmospheric oxygen, which has been impacted in all cleared areas and disturbed wetlands, and wherever dust affects plant photosynthesis. § Provisioning of habitat, which has been impacted wherever terrestrial and wetland habitats have been cleared or degraded by dust, erosion, sedimentation, contamination, noise, light, etc.		
Project Phase	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	Direct The above activities have caused direct loss of supporting services.		
		Significance prior to Mitigation	**Significance with Mitigation**
Likelihood / Probability	Definite Vegetation has already been cleared for the commenced activities.	4	4
Duration	Permanent Most developed infrastructure will remain permanently.	4	4
Extent	Site Clearing of vegetation, blasting, earth-moving activities and development of infrastructure is supposed to be limited to the project footprint.	2	2
Receptor Sensitivity	High The affected services have High CI. Vegetation cover is essential for maintaining local soils, which are highly erosive, and largely responsible for local plant endemism. Unique local floral communities provide critical habitat for local endemic fauna.	4	3
Magnitude	High Within the project footprint there will be a complete loss or dramatic transformation of affected communities and habitats.	-4	-3
Impact Significance	As not much can be done to avoid, minimize or reverse this impact, suitable offsetting needs to be investigated.	**High** **14** **-4**	**High** **13** **-3**
Mitigating and Monitoring Requirements			

Required Management Measures	Strictly prohibit further disturbance of natural areas beyond the project footprint. Any laydown areas planned in the valley must be reloacted to disturbed areas. No vegetation clearing along th entire ARS should be allowed - only at each tower footprint. The ''volcanisation'area of the ARS must be moved from the valley to the disturbed areas under the ARS near BS4 Excavated topsoil must be stored with associated native vegetation debris for subsequent use in rehabilitation. Topsoil stockpiles must be managed to ensure that the viability of the seed bank is retained. Establish a nursery for relocation and cultivation of local indigenous flora for rehabilitation. Rehabilitate all disturbed areas, which will not be developed. Rehabilitate or protect an equivalent number of hectares of the same habitat types outside Booysendal.
Required Monitoring (if any)	Monitor the success of rehabilitation efforts, seasonally. Monitor the condition of protected offset areas, quarterly.
Responsibility for Implementation	Booysendal Management, Construction and Environmental teams.
Impact Finding	
Impact Finding	As not much can be done to avoid, minimize or reverse this impact, suitable offsetting needs to be investigated.

Table 8-22 Loss of Regulating Services from Fauna and Flora

Commenced	**Impact: Loss of regulating services from flora and fauna**		
Activities	Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Development of roads, portals, ARS South, Valley Boxcut PCD and other infrastructure.		
Risk / Impact	Regulating services from local flora and fauna, which have been impacted by commenced activities include, e.g.: § Erosion control, which is critical given the high erosivity of local soils, and which has been heavily impacted in areas where vegetation has been cleared, and where invasive alien flora can proliferate and outcompete native vegetation. § Pollination of CI and other native flora, which are representative of the Sekhukhune Centre of Plant Endemism, due, in particular, to light and dust, which might affect the activity of moth and other nocturnal and/or herbivorous fauna. § Water regulation including flood control, retention and dissipation, which has been heavily impacted in areas where vegetation has been cleared, where soil is eroding or is being compacted, and where hardened surfaces will be constructed. § Water purification including nitrate and phosphate trapping, which has been impacted where wetlands, in particular the *Phragmites-Schoenoplectus*Vlei community, has been impacted by development of the Main Access Road across the Groot-Dwars River near BS1/2. § Carbon sequestration, air quality maintenance and climate regulation, which has been impacted wherever terrestrial and wetland vegetation has been cleared and plant photosynthesis is compromised by dust.		
Project Phase	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	Direct The above activities have caused mostly direct loss of regulating services.		
		Significance prior to Mitigation	**Significance with Mitigation**

Likelihood / Probability	Definite Vegetation has already been cleared for the commenced activities.	4	4
Duration	Permanent Most developed infrastructure will remain permanently.	4	4
Extent	Area of Influence Clearing of vegetation, blasting, earth-moving activities and development of infrastructure is supposed to be limited to the project footprint. However, loss of regulating services by wetland floral communities in BS could impact the downstream Groot-Dwars River and ultimately the already heavily impacted Olifants River.	3	2
Receptor Sensitivity	High The affected services have High CI. The local ultramafic soils are positively correlated with local plant endemism, and impacts on pollinators could have severe impacts for CI and locally endemic floral taxa. All wetlands are regarded by national and provincial government as sensitive and conservation important. The Groot-Dwars River is a national FEPA and good quality water from its upstream catchment has high conservation importance.	4	4
Magnitude	High Within the project footprint there will be a complete loss or dramatic transformation of affected communities and habitats. Wherever vegetation is cleared and soil is disturbed, there will be considerable loss in erosion control, and water retention and regulation.	-4	-4
Impact Significance	As not much can be done to avoid, minimize or reverse this impact, suitable offsetting needs to be investigated.	**High** **15** **-4**	**High** **14** **-4**
Mitigating and Monitoring Requirements			
Required Management Measures	Strictly prohibit further disturbance of natural areas beyond the project footprint. Excavated topsoil must be stored with associated native vegetation debris for subsequent use in rehabilitation. Topsoil stockpiles must be managed to ensure that the viability of the seed bank is retained. Construct a bridge over the Groot-Dwars River at BS1/2, to avoid or minimize impacts on the River. Where the road network intersects other (smaller) drainage lines, bridges or other appropriate crossings should be constructed to avoid or minimize impacts on these. Implement adequate and effective erosion control measures especially in and near wetlands. Implement adequate and effective sedimentation control measures in and near wetlands. Implement adequate and effective stormwater control measures in and around all infrastructure. Establish a nursery for relocation and cultivation of local indigenous flora for rehabilitation. Rehabilitate all disturbed areas, which will not be developed. Rehabilitate or protect an equivalent number of hectares of the same habitat types outside Booysendal.		
Required Monitoring (if any)	Check annually that all road crossings over drainage lines (esp. the Groot-Dwars River) are kept in good working order. Check annually that stormwater measures are adequate and remain effective. Check annually that erosion control measures are adequate and remain effective. Check annually that sedimentation control measures are adequate and remain effective. Monitor the success of rehabilitation efforts, seasonally.		

	Monitor the condition of protected offset areas, quarterly.
Responsibility for Implementation	Booysendal Management, Engineering, Construction and Environmental teams.
Impact Finding	
Impact Finding	As little can be done to avoid, minimize or reverse this impact, suitable offsetting needs to be investigated. Construction of an appropriate bridge where the Main Access Road crosses the Groot-Dwars River is critical.

Table 8-23 Loss of Cultural Services from Fauna and Flora

Commenced	**Impact: Loss of cultural services from flora and fauna**		
Activities	Clearing of vegetation; Increased traffic, noise, light and dust; Development of roads, portals, ARS South, Valley Boxcut PCD and other infrastructure; Increased human settlement.		
Risk / Impact	Of concern from a regional floral and faunal perspective are: § The aesthetic and heritage values including the Sense of Place and ecotourism value of the region. Of particular concern are impacts from BS such as dust, noise, light and invasive alien flora, on the nearby Davel Private Nature Reserve and the Verloren Valei Nature Reserve and Ramsar Wetland. § Flora with medicinal and other cultural uses. An example is *Catha edulis*. The leaves of this plant, which contain cathinone and cathine, and are chewed as a stimulant, are harvested in the Valley by people who reportedly have to travel long distances for this. § Research opportunities and scientific knowledge. A number of recently discovered and undescribed or recently described, and many data deficient floral and faunal taxa occur in the region. Additional undiscovered taxa may also occur.		
Project Phase	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	Cumulative The above activities are contributing to cumulative impacts on biodiversity and natural heritage in the region.		
		Significance prior to Mitigation	**Significance with Mitigation**
Likelihood / Probability	Definite The above activities have commenced.	4	4
Duration	Permanent The aesthetic value of the BS Valley has been irreversibly destroyed, and most developed infrastructure will remain permanently.	4	4
Extent	Area of Influence Noise, light, dust, traffic and other impacts from BS are impacting an area much larger than the footprint of commenced activities.	3	3
Receptor Sensitivity	High The Groot-Dwars River Valley in BS previously had extremely high aesthetic value, and supports numerous CI and locally endemic taxa, several newly discovered / described taxa, and undescribed taxa. Certain taxa such as *Catha edulis* have High economic value.	4	4
Magnitude	High	-4	-3

	Due to the scale and nature of the commenced and proposed activities, their impact on the aesthetc value of the Valley has been massive. With rapid development of the Mine, new easy and extensive access into the Valley, and possible unsustainable harvesting and hunting in BS, many taxa for which little or nothing is known could rapdily disappear.		
Impact Significance	As not much can be done to avoid, minimize or reverse this impact, suitable offsetting needs to be investigated.	**High** **15** **-4**	**High** **15** **-3**
Mitigating and Monitoring Requirements			
Required Management Measures	Strictly prohibit further disturbance of natural areas beyond the project footprint. Strictly prohibit construction, operational and decommissioning activities at night. Keep blasting to a minimum, especially during summer, which is a peak activity and breeding period for fauna. Avoid blasting on windy days. Limit the amount of vehicle traffic on the road network at night, and after rainy weather in summer. Control dust on roads using environmentally-friendly methods. Vegetate the walls of the Valley Boxcut PCD, TSF1 and other exposed areas a.s.a.p. using local indigenous flora. Ensure that the ARS generates negligible dust, noise, light and vibrations. Minimize lighting throughout the project footprint. Outside lights should be directed downwards, hooded, fitted with low pressure sodium vapor lamps, and ideally, be motion-sensitive. Rehabilitate all disturbed areas, which will not be developed. Rehabilitate or protect an equivalent number of hectares of the same habitat types outside Booysendal.		
Required Monitoring (if any)	Monitor dust levels throughout BS to maintain them within recognized safe limits (as prescribed by an Air Quality Specialist). Monitor the success of rehabilitation efforts, seasonally. Monitor the condition of protected offset areas, quarterly.		
Responsibility for Implementation	Booysendal Management, Construction and Environmental teams.		
Impact Finding			
Impact Finding	Diligent control of dust from roads, TSF1, and other exposed areas would greatly mitigate this impact.		

Cumulative Impacts

NSS indicated that Cumulative impacts from mining, agriculture, human settlement, alien plant invasion and road traffic, presents a growing threat to the region’s biodiversity and ecotourism including nearby protected areas such as Verloren Valei. Due to the extent of mining and anthropogenic activities the area the cumulative impact with the implementation of mitigating measures will remain high. Refer to Table 8-24

Table 8-24 Cumulative Impacts on Biodiversity

	Impact: Regional loss of flora and fauna		
Activities	Mining; Agriculture; Human settlement.		
Risk / Impact	Flora and fauna in the region have been impacted in places by historic and current crop cultivation and livestock farming. Mining, however, now presents the greatest threat to biodiversity in the region. According to the MTPA (pers. comm. 2014), most farms in the region fall under current mining right applications. This presents a considerable and rapidly growing threat to two national Centres of Plant Endemism, a national terrestrial Priority Area and Threatened Ecosystems, the Groot-Dwars River FEPA, Mpumalanga and Limpopo provincial CBAs, threatened vegetation types, and numerous locally endemic or otherwise CI taxa.		
Project Phase	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	Cumulative Mining, agriculture and human settlement are causing cumulative loss of flora and fauna in the region.		
		Significance prior to Mitigation	**Significance with Mitigation**
Likelihood / Probability	Likely Loss of flora and fauna in the region is likely, especially considering that most farms in the region fall under current mining right applications.	3	3
Duration	Permanent Mining, certain forms of agriculture, and human settlements leave permanent footprints on biodiversity.	4	4
Extent	Regional/Provincial/National Most farms in the region fall under current mining right applications.	4	4
Receptor Sensitivity	High Mining, agriculture and human settlement in the region threaten two national Centres of Plant Endemism, a national terrestrial Priority Area and Threatened Ecosystems, the Groot-Dwars River FEPA, Mpumalanga and Limpopo provincial CBAs, threatened vegetation types, and numerous locally endemic or otherwise CI taxa.	4	4
Magnitude	High Mining, certain types of agriculture, and human settlement generally cause dramatic and irreversible transformation of natural areas.	-4	-3
Impact Significance	Given the High sensitivity of the region's biodiversity, and the pemanency, broad regional extent, and severity of impacts from mining, agriculture and human settlement, the resultant cumulative loss of flora and fauna has High significance.	**High** **15** **-4**	**High** **15** **-3**

Recommendations and Reasoned Opinion of the Terrestrial Ecologist

NSS recommended that any environmental authorization for BS must only be granted under the following conditions:

- Clearly stipulate to what extent BS3 may be developed. From an ecological perspective, NSS recommends that BS3 should be limited to the development of one or two vent shafts, which should be located in existing disturbed areas such as the upper exploration track, and no further south than 100m north of the Waterfall Tributary 2.
- Even though Booysendal has mining rights for certain areas, offset measures for BS, which are approved by relevant authorities, must be legally binding, as stated in the draft National Biodiversity Offset Policy (GG 40733, GN 276, 31 March 2017).
- Impact management, mitigation and monitoring measures need to complied with.
- Be enforced through regular inspections by relevant authorities.

Further recommendations include:

- Extensive rehabilitation of redundant prospecting and temporary roads on all properties owned by Booysendal, until erosion and sedimentation have been effectively halted, and the regenerated vegetation in these areas supports a balance of Decreaser and Increaser I climax plant taxa, as previously described.
- Comprehensive rehabilitation of all crossings over the Groot-Dwars River upstream of BS1/2, which are impacting flow, water quality and other aspects of the system.
- Effective, long-term and environmentally-friendly control of invasive alien flora from the off-site upstream Groot-Dwars catchment and in the De Berg Conservancy (including Davel Private Nature Reserve).
- Donation of an offset area, which:
  - Must adequately and should closely represent irreversibly impacted areas.
  - Must have high national or provincial conservation priority.
  - Should not be threatened by mining and land claims (if at all possible).
  - Must be currently unprotected. As “like-for-like” offset areas are limited, previously protected private land might need to be considered.
  - Must be proclaimed without delay as a Protected Area or Environment under NEMPAA.
  - Must be managed at the expense of Booysendal in perpetuity.

8.2.6 Aquatic Ecology

The greatest current impact to aquatic ecosystems, as a result of Section 24G activities are an increase in turbidity (decline in water quality) due to construction within the river and its floodplain, changes in flow (due to infilling of the river to construct the bridge), habitat (sedimentation of eroded sediments), barriers to fish migration (bridge construction) and a decline in sensitive taxa (Heptageniidae and Athericidae were lost from the downstream sampling site and there was a very low abundance of E. cf. motebensis downstream of the bridge). A small diversion has been created where the main access road crosses a non-perennial tributary. These impacts can be mitigated to a Moderate or Low significance by effective implementation of mitigation and management recommendations and by comprehensive rehabilitation (e.g. stabilisation and revegetation of banks and responsible bridge design and construction). It is assumed that the final bridge design and construction will take place in consultation with a fish specialist, and will include measures to facilitate the movement of fish.

During the operational and closure phases of the S24G activities (i.e. activities that have not yet commenced) there will be considerable impacts due to mining. These include a decline in water levels and, therefore habitats, in the Groot Dwars River as a result of mine dewatering during the operational phase. After closure, decant of mine water will impact on water quality in the long term.

It should be noted that the effect of mine dewatering on habitat availability during low flow conditions (June to September) has not been determined; nor has the impact to the tributaries that augment the flows in the Groot Dwars River. Based on the Future Flow (2017) report, the average flow rates will not be greatly affected but, considering that fluctuations in flow are likely to be quite pronounced so high up in the catchment, impacts during low and high flow periods are considered critical in terms of maintaining habitat and water quality for aquatic ecosystems. Considering that many of the aquatic fauna have a high preference for either fast flows or deeper pools with overhanging vegetation, any changes to these conditions, especially during low flow conditions, will have significant consequences.

From the information provided it is understood that the Waterfall Tributary will be under-mined via the Merensky Portal North. This will pose a potential risk of subsidence and loss of surface water to groundwater, thus reducing flows in this tributary (which is currently perennial). The upper reach of this tributary (upstream of the main access road) has been earmarked as a potential translocation/refugium area for E. cf. motebensis. However, this potential mitigation measure cannot be reliably considered if the stream is to be under-mined. Rheophilic fish are likely to be lost from this stream if flows become non-perennial. Otter may also be affected by a decline in habitat and prey items (crabs).

Should proposed additional mining also go ahead at BS3, which will take place within the recommended buffer of 500mfrom the river (or 1km from a FEPA River), impacts due to decant and dewatering will be exacerbated. Mining at BS3 will pose a risk to the rare and threatened E. cf. motebensis which was mainly recorded from the 3km stretch of river between BS3 and the bridge crossing at BS1/2.

From the information provided it is understood that there are no plans to treat the water and, as such, impacts due to dewatering and decant will be difficult to mitigate. Additional impacts (amongst others) are likely to include:

- Water quality impacts to the Groot Dwars River due to spills and dust from the ARS.

- Water quality impacts to the Groot Dwars River due to seepage and/or spills associated with backfilling the old Everest Mine at BS4. It is understood that the seepage (which may reach the decant point valley box cut) may contain high concentrations of chromium, thus posing a risk of toxicity to aquatic biota. The greatest risk will occur after closure, when water decanting from the old Everest box-cut will reach the river. However, there is also some uncertainty in terms of ongoing seepage and the potential for spills to occur from the PCD and pipelines. (The PCD at the valley box-cut will be used to store decant water, which will then be piped to the processing plant for use there). The possibility of this occurring is considered low but the potential consequences could be significant. The current prediction is that the chromium concentration in decanting mine water may increase to 0.3 mg/l (Future Flow 2017). If undiluted, this exceeds the guideline limit for aquatic ecosystems (DWAF 1996) of 0.007 mg/l.
- Spills or leaks from PCDs (especially those in close proximity to the Groot Dwars River, such as at BS1/2 and the old valley box-cut).
- Erosion and altered flows at road crossings.

The main risks to the various reaches were identified by Clean Stream as included in Table 8-25. The most significant of the impacts have been included in this section. For the significant rating of the other impacts, refer to Annexure H1.

Table 8-25 Main Risks to the Aquatic System (Clean Stream, June 2017)

River Reach	Main Risks Posed by S24G and EIA activities
Groot Dwars River Upstream Reach - habitat for and high prevalence of *Enteromius cf. motebensis,* Pristine to Largely Natural PES. This reach is considered most at risk from Booysendal activities.	This reach will be affected by proposed mining of BS3 (EIA). Dewatering may affect flows, particularly during drier months (low flow periods). This may impact on habitat availability of *E cf. motebensis* threatened). Decant after closure will also impact on water quality within this reach, affecting sensitive and threatened aquatic species. Backfilling of the old Everest Mine with tailings from TSF1 may have additional groundwater impacts (but this is uncertain)
Groot Dwars River Middle Reach (adjacent to BS1/2) - High Ecological Importance and Sensitivity (EIS). Largely Natural PES, with a high diversity including sensitive aquatic biota; habitat for and presence of *Enteromius cf. motebensis*	This reach will be impacted by the bridge over the Groot Dwars River (S24G), as well as the ARS construction and from sediment inputs from all construction activities within the floodplain of the river and wetlands and watercourses draining into the river. There is a high risk of ore spills into the river and its catchment from the ARS during the operational phase. The proposed future mining (UG2 and Merensky Reef via the southern portal) is likely to impact upon this reach, mainly through decant after closure. Proposed EIA activities will have minimal impacts on this reach.
Groot Dwars River Downstream Reach – Moderate Ecological Importance and Sensitivity (Moderately Modified PES).	This reach will be impacted by all proposed and S24G activities as it is the receiving downstream reach. This will include all mining impacts (including decant after closure) and water quality impacts from the proposed TSF 2 (transferred to the Groot Dwars via the Everest Tributary).
Waterfall Reach - High to Very High Ecological Importance and Sensitivity (EIS). This watercourse is considered a rejuvenated Mountain Stream with good	This tributary will be crossed by: - The main access road and powerline (S24G) - The proposed ARS to BN (EIA)

River Reach	Main Risks Posed by S24G and EIA activities
water quality and Pristine to Largely Natural habitat integrity (where not disturbed by current activities). This tributary is considered important in terms of providing inputs of good water quality to the Groot Dwars River. Habitat for *Enteromius cf. motebensis* was present within the upper reach. Lower reach may provide a refuge area for fish during unfavourable conditions. Otter spoor were evident along this stream indicating that it uses it for habitat and/or foraging (crabs).	- Underground mining of the Merensky Reef via the northern portal. Dewatering (and potential subsidence) may lower the water table, reducing flows. This will impact on habitat availability, particularly E cf. motebensis
Southern Tributary - High Ecological Importance and Sensitivity (EIS) with good water quality and Largely Natural to Pristine habitat integrity; provides water of good quality to the Groot Dwars River.	This tributary will be impacted by the ARS during the construction and operational (spills) phases. Erosion from the main access road and associated stormwater infrastructure will affect sedimentation and turbidity in this stream.
Everest Tributary Upstream Reach - Very High Ecological Importance and Sensitivity; habitat for the Red-Listed *Enteromius cf. motebensis*.	Upstream of the study area. Opportunities exist for rehabilitation of instream and riparian habitats in these reaches.
Everest Tributary Middle Reach – Moderate to Low Ecological Importance and Sensitivity. Habitats are modified due to farm dams and invasion by alien trees. Water quality, however, remains relatively good.	
Everest Tributary Downstream Reach – High Ecological Importance and Sensitivity. Considered important in terms of augmenting flows and maintaining good water quality within the Groot Dwars River and providing a refuge area for fish during unfavourable conditions. Otter spoor were evident along this stream indicating that it uses it for habitat and/or foraging (crabs).	This reach will be impacted by the proposed TSF2. Water quality is likely to be compromised. These impacts may be transferred further downstream into the Groot Dwars River. Abstraction of water from the TKO Dam may have minor impacts on habitat availability.

The residual impact of these activities, even with mitigation, is likely to remain high. This is due to the sensitivity of this reach of the Groot Dwars River, as well as the presence of threatened species. There will be a loss of sensitive species and an overall decline in ecological integrity. There will also be loss of habitat for the Vulnerable fish species, Enteromius cf. motebensis, downstream of the river crossing at BS1/2.

The PES is likely to decline by one category from a B to a C downstream of the bridge over the Groot Dwars River at BS1/2 (or lower than a Category C downstream of the confluence with the Everest Tributary). The Resource Quality Objectives for this reach of the Groot Dwars River is PES C (DWS 2016).

The main impacts on aquatic biodiversity which will still have a high significance after mitigation is included in Table 8-26 to Table 8-28. These residual impacts will have to be offset.

Table 8-26 Decrease Flows in Receiving Watercourses due to Mine Dewatering

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	Dewatering during underground mining		
Risk/ Impact	Dewatering will cause a lowering of the water table and a decrease in water levels within the adjacent watercourses. It is likely that water levels in the Groot Dwars will drop, not only as a result of a lowering of the water table, but because of reduced flows in the tributaries and wetlands that feed into it. This impact is also likely to increase as mining progresses and dewatering volumes increase. This impact will be most severe during low flow periods. Low flow periods are also likely to last for longer, while flooding will become more intense (as a result of increased runoff from hardened surfaces). Pool depths will decrease, marginal vegetation habitats will become less suitable and available as water levels drop and in-current habitats will decline. This will affect diversity and abundance, with fauna with a high requirement for deep pools and fast flows declining or being lost from the affected reach of the Groot Dwars River. Water quality may also decline due to decreased dilution. Mining of the Merensky Reef via the northern portal is likely to have a significant impact on the Waterfall Tributary which will be under-mined. This tributary contains habitat which could potentially act as a refugium area for *E. cf. motebensis* as well as other sensitive species. There is a high risk that habitat features (waterfalls, rapids) will be lost. The tributary is likely to become non-perennial, resulting in the loss of flow-dependent species (including the rheophilic fish *Amphilius uranoscopus*). Otter spoor were evident along this stream indicating that it uses it for habitat and/or foraging (crabs). Availability of prey items may be affected by decreased flows. (It should be noted that the groundwater specialist report (Future Flow 2017) reports minimal flow reduction in the Groot Dwars River. However, this estimation was based on an estimated average flow rate and does not consider base flows during drier months, nor does it consider the impacts of dewatering on the tributaries and watercourses that feed into the Groot Dwars River. Furthermore, the groundwater study only considers flow volumes and velocities and does not		

	consider the indirect impacts of reduced flows on habitat suitability and availability. Minor changes in flow could have potentially serious consequences for sensitive species that have specific flow, habitat and water quality requirements.) Under-mining of watercourses (and, in particular, perennial watercourses) would pose the additional risk of subsidence and the loss of surface water to underground workings.		
Project Phase CO / OP / CL Nature of Impact	OP Negative		
Type of Impact	Indirect: Dewatering will lead to reduced flows which will cause a loss of habitat and potentially of species. Cumulative – Mining of both the Merenky Reef and UG2 will require dewatering as well as proposed future mine in the upper Groot Dwars River. The cumulative impact is expected to be highly significant as habitats are likely to be lost. It is understood that no treatment of water is planned.		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	3
Duration	Long-term	3	3
Extent	Wider area of influence Impacts will be transferred to downstream reaches	3	3
Receptor Sensitivity	High NFEPA catchment	4	4
Magnitude	High. Not easily reversed in the long term as fauna that require deep pools or fast flows may be lost from the affected reach of the Groot Dwars River.	3	3
Impact Significance	High as a result of the long term, cumulative nature of this impact and difficulty in mitigating it, together with the presence of habitat and flow specialists within the study area.	High 13 3	High 13 3
Mitigating and Monitoring Requirements			
Required Management Measures	No mining should take place under wetlands or watercourses to avoid ingress (and, therefore reduce dewatering volumes). Under-mining of watercourses (and perennial watercourses) would pose the additional risk of subsidence and the loss of surface water to underground workings. The only other possible mitigation is to treat mine water to an acceptable level and return it to the natural environment in an attenuated manner and in a way that mimics natural flows in receiving		

	watercourses. It is understood that mine water will not be treated as part of the Booysendal mining operations.
Required Monitoring (if any)	Long-term monitoring of water quality and aquatic fauna (biomonitoring). See EMP
Responsibility for implementation	Environmental Manager and Mine Manager
Impact Finding	
Impact Finding	The magnitude of this impact can only be reduced if water is returned to the environment after treatment in an attenuated way that mimics flows.

Table 8-27 Loss of Biodiversity and decline in Ecological Integrity

Impact Component	**Impact 10**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	All S24G construction and mining activities		
Risk/ Impact	Loss of habitats, sensitive species and a decline in ecological integrity and biodiversity due to a decline in water quality, altered flows and loss of habitat. The risk of this impact is considered high due to the good water quality and pristine to largely natural conditions within the watercourses, together with the catchments status as a NFEPA (National Freshwater Ecosystem, Priority Area). It is estimated that the Groot Dwars River will decline by one PES category (from PES B to PES C) downstream of the bridge as a result of mining activities at BS1/2. The Groot Dwars River downstream of the confluence with the Everest Tributary is currently a Category C but may decline to a Category C/D. The Resource Quality Objectives for this reach of the Groot Dwars River is PES Category C (DWS 2016).		
Project Phase CO / OP / CL Nature of Impact	CO, OP, CL Negative		
Type of Impact	Direct and Cumulative: This impact is considered to be associated with a range of activities that impact on flow, habitats, migration and water quality, with each activity adding to the magnitude of the impact.		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	3
Duration	Permanent	4	4
Extent	Regional importance (particularly if the NFEPA status is lost)	4	4
Receptor Sensitivity	High	4	4

	NFEPA catchment and the presence of a Red Listed (VU) fish species		
Magnitude	High This impact is irreversible as sensitive species will be permanently lost from the area.	4	3
Impact Significance	High on account of the NFEPA status and the irreversibility of the impact.	High 16 4	High 13 3
Mitigating and Monitoring Requirements			
Required Management Measures	All the mitigation measures to address impacts to water quality, habitat and flow should be implemented. The timing, quantity and quality of decant water must be predicted. In addition, a Biodiversity Management Plan should be compiled to make recommendations to protect and manage biodiversity. These recommendations should be implemented as part of a Biodiversity Action Plan. A rehabilitation plan must be compiled for each phase of mining. An offset strategy should be considered (Section 6.2.1). It may be difficult to achieve a full like-for-like offset considering the NFEPA status of the affected ecosystems and the genetic uniqueness of threatened species. Offsets are therefore likely to include a combination of conservation of critical habitat, rehabilitation and mitigation (including removing alien predatory fish species such as bass and identifying potential refugia) (See recommendations in Section 8)		
Required Monitoring (if any)	Long-term monitoring of water quality and aquatic fauna (fish, macroinvertebrates, riparian vegetation) and instream and riparian habitat integrity		
Responsibility for implementation	Environmental Manager and Mine Manager		
Impact Finding			
Impact Finding	Impacts due to decant and the degree to which they can be mitigated are uncertain. However, an overall decline in ecological integrity and biodiversity will occur. Aquatic species that are sensitive to changes in water quality, habitat and flow are likely to be lost from the Groot Dwars River downstream of the road crossing. Offset recommendations are made in Section 6.2.1. It is strongly recommended that areas be identified along the Groot Dwars River and its tributaries that can be set aside for formal conservation.		

Table 8-28 Loss of Red Data Species

Impact Component	Impact 11	Significance prior to Mitigation	Significance with Mitigation
Activity	All S24G construction and mining activities		

Risk/ Impact	Loss of Red Data Species. *Enteromius motebensis* is classified a Vulnerable in the IUCN Red List of Threatened Species (IUCN 2016). The upper Groot Dwars River is considered critical habitat for *Enteromius cf. motebensis*. Habitat for *Enteromius cf. motebensis* is likely to be compromised downstream of the bridge over the Groot Dwars River at BS1/2 as a result of Section 24G activities. It is not known what the population size or distribution of this species is in the Groot Dwars River. There is also uncertainty about its genetic uniqueness. As such, there may not be sufficient remaining habitat to safeguard this species from localised extinction.		
Project Phase CO / OP / CL Nature of Impact	CO, OP, CL Negative		
Type of Impact	Direct: activities will lead to impact		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	2
Duration	Permanent	4	4
Extent	Regional to national importance.	4	4
Receptor Sensitivity	High NFEPA catchment, Red-Listed species	4	4
Magnitude	High significance due to the restricted distribution of this species, its genetic uniqueness and its Vulnerable status.	4	4
Impact Significance	High significance. Loss of a threatened fish species from the affected reach of the Groot Dwars River. The viability of the remaining population is uncertain.	High 15 4	High 13 3
Mitigating and Monitoring Requirements			
Required Management Measures	An offset strategy should be considered (Section 8). It may be difficult to achieve a full like-for-like offset considering the NFEPA status and the genetic uniqueness of threatened species. Offsets are therefore likely to include a combination of conservation, rehabilitation and management (removing alien predatory fish species such as bass and identifying potential refugia) The habitat within the upper Groot Dwars River and upper Everest Tributary should be protected. No developments should take place within the sub-catchments containing critical habitat of this species. It is strongly recommended that sub-catchments be identified along the Groot Dwars River and its tributaries that can be set aside for formal conservation.		

	Rehabilitation measures should be considered (including alien fauna and flora removal). Migration barriers (river crossings/bridges) should be redesigned and/or addressed. The management of this species should be addressed in a Biodiversity Management Plan. A comprehensive study must be conducted to fully understand the distribution, ecology and genetic lineage of *E. cf. motebensis* within the study area and adjacent sub-catchments. This species should be monitored biannually as part of a biomonitoring programme.
Required Monitoring (if any)	Long-term monitoring of fish species, fish habitats, water quality and flow. See EMP
Responsibility for implementation	Environmental Manager and Mine Manager. Aquatic specialist appointed by the mine.
Impact Finding	
Impact Finding	The risk of localised extinction of this species from the upper Groot Dwars River is considered high. An offset strategy, together with the formal protection of remaining habitat for this species is considered essential, as are additional management measures (such as removal of barriers to migration and removal of alien fish species). This is discussed in greater detail in Section 8.

Fish species occurring in the study area have specific habitat preferences. These preferences are indicated in Table 8-29. Some of the section 24G activities which could impact on these habitats and which need to be avoided are included in Table 8-30.

Cumulative Impacts

The entire project is likely to have considerable cumulative impacts on the receiving Groot Dwars River, possibly extending beyond Der Brochen Dam into the Dwars River. It is likely that, should all S24G and proposed new activities proceed, that the PES of the receiving reach of the Groot Dwars River will decline by at least one category from a PES C to a PES D (Moderately Modified to Largely Modified). The Resource Quality Objectives for this reach of the Groot Dwars River is PES C (DWS 2016). While many of the activities, considered, individually, can be mitigated to minor or moderate levels of significance, the cumulative impacts to water quality, as well as flows, habitat and overall biodiversity and ecological integrity, will be considerable especially when the impacts on water quality downstream of the mine is considered. Therefore, the cumulative impacts of the project are likely to be of high to very high significance.

Recommendations and Reasoned Opinion of the Aquatic Specialist

Clean Stream is of the opinion that considering the sensitivity of the area (i.e. its NFEPA status, the presence of IUCN red-listed fish species, high diversity, presence of sensitive taxa and Largely Natural ecological status), it is considered inappropriate for any mining development to take place within the Groot Dwars River valley. In addition, the PES of the river immediately downstream of the study area is considered Category C (which is also the Resource Quality Objective for this reach of the Groot Dwars River). Therefore, further anticipated declines will not only result in a decline in habitat availability for a rare and threatened fish species, but may also result in the RQOs not being met.

However, S24G activities have already commenced and, as such, certain irreversible impacts have resulted. The focus should therefore be on limiting and managing the current and potential future impacts as comprehensively and effectively as possible and applying comprehensive rehabilitation measures.

It is our opinion that approval should only be granted on condition that all mitigation be strictly applied and that an offset strategy is formulated that is authorised and approved by the relevant authorities (including the MTPA). This offset should secure areas for protection in a manner that is legally binding in the long term and includes long-term provision for the finances, management, monitoring, auditing and reporting of the conserved area. The offset should aim to safeguard and rehabilitate habitat for Enteromius cf. motebensis to ensure its survival in perpetuity and should also aim to offset the loss of biodiversity within a FEPA catchment.

In addition:

- The PES of the river downstream of the confluence with the Everest Tributary should not drop below a Category C.
- No perennial watercourse should be under-mined. This includes the Waterfall Tributary (unless the impacts to aquatic habitats and flow due to mine dewatering, as well as the risk of subsidence, both of which are currently unknown, can be shown to be negligible).
- Regarding the proposed future mining at BS3, it is our opinion that this mining should not be approved as it will have considerable cumulative impacts (adding to the impacts due to activities that commenced without authorisation) within a NFEPA catchment. The proposed mining at BS3 will be located within 500 metres of the Groot Dwars River and is likely to impact upon the habitat availability and water quality of the river due to mine dewatering and decant in the long term (post-closure). The recommended buffer for a FEPA River is 1km (DEA *et al.* 2013). This reach of the river contains the highest habitat availability for, and abundance of, the rare and threatened *E. cf. motebensis* and the future survival of this species cannot be guaranteed at this stage, if mining goes ahead. Approval should only be considered if a like-for-like offset can be achieved and/or the future survival of this species can be guaranteed pending a comprehensive genetic and ecological assessment to determine the genetic uniqueness, distribution and habitat requirements of *E. cf. motebensis* within the valley. Ideally, this reach of the Groot Dwars River should be included in the offset and mining at BS3 should be avoided altogether.

Table 8-29 Fish Habitat Preferences (Clean Stream, June 2017)

	Habitat preferences								
SCIENTIFIC NAME	SLOW-DEEP (<0.3 m/s; >0.5 m)	SLOW-SHALLOW (<0.3 m/s; <0.5 m)	FAST-DEEP (>0.3 m/s; >0.3 m)	FAST-SHALLOW (>0.3 m/s; <0.3 m)	OVERHANGING VEGETATION	BANK UNDERCUT	SUBSTRATE	AQUATIC MACROPHYTES	WATER COLUMN
AMPHILIUS URANOSCOPUS	0	0	4.6	4.6	0.1	0.4	5	0	0
LABEOBARBUS MAREQUENSIS	4.4	3.4	4.1	4.4	2.1	2.7	4.5	0.2	4.1
ENTEROMIUS CF. MOTEBENSIS	3	4.7	0.2	1.3	4.7	4.4	3	0.3	0
ENTEROMIUS NEEFI	3.3	4.7	1	1.7	3.9	3.3	4.4	0.5	0.2
ENTEROMIUS TRIMACULATUS	3.9	3.2	2.3	2.7	3.9	2.6	2.3	2.8	2.8
CLARIAS GARIEPINUS	4.3	3.4	1.2	0.8	2.8	2.9	2.8	3	2.6
CHILOGLANIS PRETORIAE	0	0.6	4.3	4.9	0	0.1	4.9	0	0
LABEO CYLINDRICUS	2	2.7	3.4	4.8	0.1	0.3	4.9	0	0.4
LABEO MOLYBDINUS	3.7	1.5	3.3	4.3	0.4	0.4	4.7	0.1	1.4
OREOCHROMIS MOSSAMBICUS	4.6	3.8	1.4	0.8	3	1.9	2.1	2.8	3.9
TILAPIA SPARRMANII	3	4.3	0.9	1.5	4.5	1.9	2.5	3.6	1.1

Table 8-30 Activities to Avoid associated with each Habitat Type (Clean Stream, June 2017)

Velocity depth class or Habitat feature	General impacts and activities.
Slow deep & slow shallow	Increased flows as result of regulation, water transfer schemes, irrigation releases. **Sedimentation of pools as a result of catchment and bank erosion**.
Fast deep and fast shallow	**Decreased flows a result of water abstraction** (for agriculture, domestic, mining or industry), **flow modification** as a result of dams, **weirs** and channelization.
Overhanging vegetation	**Clearing of vegetation on stream banks** for the purpose of stream crossings (conveyer belts, roads, haul roads), **clearing of riparian zones for construction activities**, exotic vegetation encroachment replacing natural vegetation and also causing increased bank erosion, and to a lesser extent water quality deterioration (increased toxins could result in decreased availability of vegetation while increased nutrients could result in excessive growth or domination by single or a few species).
Undercut banks	**Alteration of natural water levels** (through water abstraction, flow alterations, etc.). **Physical disturbance of banks through construction** or agricultural activities.
Substrate	**Increased sedimentation (related to erosion)**, excessive algal growth (especially associated with irrigation return flows and WWTW effluents), sand mining, trampling by livestock, disturbance by bottom feeding alien species such as Common carp, etc.
Aquatic macrophytes	**Altered flow regimes**, use of herbicides.
Water column	**Decreased flows (through abstraction,** constructions of dams**, etc.) and sedimentation of pools**.

8.2.7 Wetland Assessment

The wetland study indicates that the most significant impacts will be associated with the construction phase of the Section 24G activities and specifically the BS1/2 portal and terrace, bridge crossing. A summary of the impacts identified included below. The impacts which the specialist deemed minor have not been included in detail (refer to Annexure I). The wetland management requirements have, however, been carried into the EMP. The impacts which were determined high even after mitigation has been included in detail.

a) Construction Phase

- Loss and disturbance of wetland habitat;
- Increased sedimentation and turbidity;
- Altered wetland flows due to vegetation clearance;
- Altered wetland flows due to road crossings; and
- Increase in alien vegetation.

b) Operational Phase

- Disturbance of wetland habitat;
- Altered flows due to stormwater discharge;
- Altered flows due to underground mining; and
- Water quality deterioration.

c) Decommissioning and Closure Phase

- Disturbance of wetland habitat;
- Increased sedimentation and turbidity; and
- Deterioration of water quality.

The impacts deemed moderate to high after the implementation of mitigating and management measures are included in Table 8-31 to Table 8-36.

Table 8-31 Loss and Disturbance of Wetlands

Impact Component	**Impact**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Vegetation clearance and earth-moving activities within wetland and riparian areas. Construction of road and pipeline crossings of rivers and wetland. Impedance in the wetlands during the operational phase.		
Risk/ Impact	Loss and disturbance of wetland habitat. All wetland habitat falling directly within the development footprints and construction servitudes will be lost. Construction activities, if not strictly controlled, will also result in disturbances to the wetland vegetation and habitat adjacent to the development footprints through for example uncontrolled driving in the wetland area, fire, construction of associated infrastructures, or temporary stockpiling of material in the wetland area. Such disturbances can lead to increased erosion in the wetlands (e.g. preferential flow paths created by vehicle tracks), displacement of wetland fauna, changes in wetland vegetation and invasion by alien vegetation. Blasting activities are also likely to result in disturbance and possibly displacement to wetland fauna.		
Project Phase CO/ OP/ CL Nature of Impact	CO, OP, CL Negative		
Type of Impact	Direct: clearance will lead directly to impact		
	Define Significance Categories	Significance Prior to Mitigation	Significance with Mitigation
Likelihood/ probability	Likely	4	4
Duration	Permanent Loss of wetland habitat will be permanent	4	2
Extent	Site Direct impact will be limited to development footprint	2	2
Receptor Sensitivity	High Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN.	4	4
Magnitude	High	4	2

	Loss of wetland habitat will be permanent and irreversible		
Impact Significance	High significance Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN.	High 14 4	Moderate 12 2
Mitigating and Monitoring Requirements			
Required Management Measures	Wetlands should be excluded from the proposed development footprints as far as possible. The Groot Dwars River riparian wetland and Everest tributary valley bottom wetland should be considered no-go areas. Wetland areas that have already been disturbed outside the direct construction footprint should be rehabilitated through landscaping back to the original profile, alleviation of soil compaction, and revegetation with locally indigenous species common to the area. The following further mitigation measures are recommended: • All construction areas should be fenced off/clearly demarcated prior to commencement of vegetation clearing activities on site so as to prevent access to adjacent wetlands and their associated buffer zones by construction machinery and personnel. In addition, all wetland areas should be clearly marked and demarcated as such to alert construction staff on site. All construction and operational staff should also be educated on the importance and sensitivity of the wetland systems on site. This should form part of the induction process. ▪ Develop and implement a construction stormwater management plan prior to the commencement of site clearing activities. ▪ No stockpiling of material may take place within the wetland areas and temporary construction camps and infrastructure should also be located away from these areas, with a minimum buffer of 30m maintained from delineated wetland boundaries. ▪ Rehabilitate and re-vegetate all disturbed areas as soon as possible following disturbance. ▪ An alien vegetation management plan should be drawn up by the Environmental Co-ordinator and implemented. Regular removal of invasive alien species should be undertaken. This should extend right through to the decommissioning and closure phase of the project. ▪ Detailed method statements should be developed for all wetland crossings in consultation with a wetland/aquatic specialist ▪ Wetland areas in close proximity to operational activities must be clearly demarcated and all activity excluded from these areas. ▪ Procedures must be put in place and communicated to all staff for reporting impacts to wetlands		
Required Monitoring (if any)	Long-term monitoring of wetland integrity using WET-Health or other suitable tool		
Responsibility for implementation	Environmental Manager and Mine Manager		
Impact Finding			
Impact Finding	Some wetland loss likely to be unavoidable unless layout plans altered. Wetland disturbance can be mitigated to short-term nuisance impacts if activities strictly controlled and mitigation measures fully implemented.		

Table 8-32 Increased Sedimentation and Turbidity

Impact Component	**Impact**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Vegetation clearance and earth-moving activities within wetland and riparian areas. Construction of road and pipeline crossings of rivers and wetlands.		
Risk/ Impact	Increased sedimentation and turbidity. Stripping of vegetation will increase volumes and velocities of surface runoff generated from the affected areas, increasing erosion risk within downslope receiving wetlands. Soil compaction due to movement of machinery during construction will further increase runoff, while vehicle ruts and tracks resulting from construction activity could provide preferential flow paths that lead to flow concentration, again increasing erosion risk. Increased sediment loads transported into adjacent wetlands from the sediment rich runoff generated on site will be deposited within the wetlands as flows slow down. Deposited sediments are likely to be colonised by pioneer and ruderal species, leading to deterioration of habitat quality.		
Project Phase CO/ OP/ CL Nature of Impact	CO, CL Negative		
Type of Impact	Direct: clearance will lead directly to impact		
	Define Significance Categories	Significance Prior to Mitigation	Significance with Mitigation
Likelihood/ probability	Likely	4	3
Duration	Short-term	2	1
Extent	Wider are of influence Impacts will be transferred to downstream reaches	3	3
Receptor Sensitivity	High	4	4
Magnitude	Moderate Reversible although habitat loss is likely, followed by a decline or loss of sensitive species and a decline in overall biodiversity and ecological integrity	3	2
Impact Significance	High significance Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN.	High 13 3	Minor 11 2
Mitigating and Monitoring Requirements			
Required Management Measures	A construction stormwater management plan should ideally be developed and implemented prior to the commencement of large scale vegetation clearing activities or construction activities and be maintained until the end of the construction phase. Where construction activity has already commenced, a		

	construction stormwater management plan must be implemented at the latest before the onset of the coming rainy season. Such a plan should aim to minimise the transport of sediment off site as well as prevent the discharge of high velocity flows into downslope wetlands. Sediment traps and sediment barriers should be installed where necessary, and discharge points should be protected against erosion and incorporate energy dissipaters. Vegetation clearing, soil stripping and major earthmoving activities should be phased to minimise the extent of bare soils surfaces exposed at any one time. Vegetation clearing and soil stripping should also only be undertaken immediately preceding the onset of construction activities on site, i.e. ideally not more than 7 days before the onset of construction activities. A scenario of cleared areas lying bare and unused for weeks on end must be avoided. To minimise the impact of increased runoff and sediment transport into adjacent wetlands, vegetation clearing and soil stripping should be concentrated in the dry season. Given the duration of construction activities as well as uncertainties around the commencement date, limiting all construction activities to the dry season are however likely to be impossible. Erosion within the construction site must be minimised through the following: ▪ Limiting the area of disturbance and vegetation clearing to as small an area as possible; ▪ Where possible, undertaking construction during the dry season; ▪ Phasing vegetation clearing activities and limiting the time that any one area of bare soil is exposed to erosion; ▪ Control of stormwater flowing onto and through the site. Where required, stormwater from upslope should be diverted around the construction site; ▪ Prompt stabilisation and re-vegetation of soils after disturbance and construction activities in an area are complete; and ▪ Protection of slopes. Where steeper slopes occur, these should be stabilised using geotextiles or any other suitable product designed for the purpose. Sediment transport off the site must be minimised through the following: ▪ Establishing perimeter sediment controls. This can be achieved through the installation of sediment fences along downslope verges of the construction site. Where channelled or concentrated flow occurs, reinforced sediment fences or other sediment barriers such as sediment basins should be used (refer to US EPA guidelines on Stormwater Pollution Prevention); ▪ Discharge of stormwater from the construction site into adjacent grassland rather than directly into wetland habitat. Discharged flows must be slow and diffuse; and Regular inspection and maintenance of sediment controls
Required Monitoring (if any)	Long-term monitoring of wetland integrity using WET-Health or other suitable tool
Responsibility for implementation	Environmental Manager and Mine Manager
Impact Finding	
Impact Finding	Impact can be minimised by mitigation measures but a decline in habitat integrity is likely

Table 8-33 Stormwater Discharge into Adjacent Wetlands

Impact Component	**Impact**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	**Operation of stormwater management infrastructure**		
Risk/ Impact	Impermeable surfaces and compacted soils associated with surface infrastructure (e.g. road surfaces) will result in increased volumes and velocities of run-off. It is anticipated that this run-off will be collected in the storm water system and conveyed to the watercourses and wetlands. Release of the storm water through point source discharges increases the risk of erosion within the watercourses and wetlands at the discharge point. Storm water also typically contains various pollutants that could contribute to deteriorating the water quality in the wetlands where storm water is released into the valley bottoms.		
Project Phase CO/ OP/ CL Nature of Impact	CO, OP Negative		
Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance with Mitigation
Likelihood/ probability	Likely	3	2
Duration	Long term Duration of construction phase	3	3
Extent	Area of Influence Flow impacts could extend beyond site boundaries	3	2
Receptor Sensitivity	High Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN.	4	4
Magnitude	High Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN.	4	3
Impact Significance	High significance Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN.	High 13	Moderate 11

		4	3
Mitigating and Monitoring Requirements			
Required Management Measures	• Clean and dirty storm water need to be separated. • No contaminated water should be allowed to enter the clean storm water system. Dirty storm water may not be released into the wetlands and should be contained and treated on site, or used for dust suppression. Should contaminated water enter the wetlands due to spillages or other unforeseen circumstances a wetland/water quality expert should be consulted regarding implementation of suitable mitigation and/or rehabilitation measures. • The volumes of storm water run-off should be minimised by limiting the area of impermeable surfaces and compacted soils. • Where possible, storm water should be conveyed through grassed swales rather than concrete channels to aid infiltration and reduce run-off volumes. • Where storm water and/or diverted clean water is discharged into wetlands, gabions should be constructed to contain erosion. This should be done in consultation with an appropriate wetland and storm water specialist. The gabion structure should also include measures to dissipate energy of flows and to disperse flows over a greater area. This could be achieved for example by a delta shaped apron radiating out from the point of discharge at 45 degrees, with energy dissipaters spaced across the apron.		
Required Monitoring (if any)	Long-term monitoring of wetland integrity using WET-Health or other suitable tool. Biomonitoring and water quality monitoring		
Responsibility for implementation	Environmental Manager and Mine Manager		
Impact Finding			
Impact Finding	Mitigation can reduce impact significance to Moderate and limit the impact mostly to within the site boundaries.		

Table 8-34 Water Quality Deterioration

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	**Operation of project activities, including operation of dirty water management infrastructure, operation of TSF and operation of sewage treatment plant.**		
Risk/ Impact	Ongoing project activities could lead to water quality deterioration in adjacent water resources via a number of pathways: Ineffective clean and dirty water separation Storm water typically contains various pollutants that could contribute to deteriorating the water quality in the wetlands where storm water is released into such as the valley bottoms Discharge of contaminated water. Leakage/seepage/overflow out of pollution control dams Malfunction of the sewage treatment plant. Overflow of dams from water treatment plant directly into the seepage wetlands		
Project Phase CO OP CL	OP		
Nature of Impact	Negative		

Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance with Mitigation
Likelihood/ probability	Likely	3	2
Duration	Long term Duration of operational phase	3	3
Extent	Area of Influence Water quality impacts could extend beyond site boundaries	3	2
Receptor Sensitivity	High Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN.	4	4
Magnitude	High Loss of sensitive species such as E. motebensis could occur	4	3
Impact Significance	High significance Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN.	High 13 4	Moderate 11 3
Mitigating and Monitoring Requirements			
Required Management Measures	• Clean and dirty storm water need to be separated • No contaminated water should be allowed to enter the clean storm water system • No dirty mine or dirty storm water may be released into the wetlands and should be contained and treated on site, or used for dust suppression. Should contaminated water enter the wetlands due to spillages or other unforeseen circumstances a wetland/water quality expert should be consulted regarding implementation of suitable mitigation and/or rehabilitation measures • Required PCDs should be designed to be in compliance with the applicable legislation requirements as well as accepted best management practices • To prevent seepage and leakage out of the PCDs, these facilities should be lined with a suitable engineered liner • A water quality and biomonitoring plan should be compiled and implemented (if not already in place) to monitor for any deterioration in water quality in the adjacent wetland systems • Regular maintenance and inspections of the PCDs should be undertaken to ensure operation of the dams as per design specifications. A log book of inspections and maintenance activities must be kept		
Required Monitoring (if any)	Long-term monitoring of wetland integrity using WET-Health or other suitable tool. Biomonitoring and water quality monitoring		

Responsibility for implementation	Environmental Manager and Mine Manager
Impact Finding	
Impact Finding	Mitigation can reduce impact significance to Moderate and limit the impact mostly to within the site boundaries.

Table 8-35 Altered Flows Due to Underground Mining

Impact Component	**Impact 8**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	**Underground mining**		
Risk/ Impact	Underground mining activities will impact on groundwater levels of the area, presumably resulting in a drawdown of groundwater and resultant decreased groundwater discharge into the Groot Dwars river. This will result in decreased baseflow within the river and could result in partial desiccation of the channel verges and adjacent wetland habitats.		
Project Phase CO/ OP/ CL	OP, CL		
Nature of Impact	Negative		
Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance with Mitigation
Likelihood/ probability	Likely	3	3
Duration	Long term Duration of operational phase	3	3
Extent	Area of Influence Water quality impacts could extend beyond site boundaries	3	3
Receptor Sensitivity	High Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN.	4	4
Magnitude	High	4	4

	Loss of sensitive species such as *E. motebensis* could occur		
Impact Significance	High significance Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN.	High 13 4	High 13 4
Mitigating and Monitoring Requirements			
Required Management Measures	Limited opportunity to mitigate unless suitable water can be discharged back into the river. Expected flow losses to the Groot Dwars should be quantified. Excess mine water should be treated (if necessary) and discharged back into Groot Dwars to compensate for the loss in flow. Alternative means of compensating for mine-induced flow losses could be persued, such as clearing the upper Groot Dwars catchment of alien invasive trees.		
Required Monitoring (if any)	Long-term monitoring of wetland integrity using WET-Health or other suitable tool. Biomonitoring and water quality monitoring Flow monitoring in the Groot Dwars		
Responsibility for implementation	Environmental Manager and Mine Manager		
Impact Finding			
Impact Finding	Limited opportunity to mitigate unless suitable water can be discharged back into the river.		

Table 8-36 Deterioration of Water Quality from Decanting

Impact Component	**Impact 12**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Underground mining		
Risk/ Impact	Post- closure, the mined-out voids will begin to fill with water and could eventually start decanting into adjacent watercourses, specifically the Groot Dwars. This will likely lead to deterioration in water quality, particularly in terms of metals and salts, followed by a loss of aquatic fauna.		
Project Phase CO/ OP/ CL Nature of Impact	CL Negative		
Type of Impact	Direct: decant will lead directly to impact		
	Define Significance Categories	Significance Prior to Mitigation	Significance with Mitigation
Likelihood/ probability	Likely	3	3
Duration	Long-term	4	4

Extent	The impact will be transferred to downstream reaches of watercourses and rivers	3	3
Receptor Sensitivity	High Catchment is classified as a National Freshwater Ecosystem Priority Area (NFEPA).	4	4
Magnitude	High This impact is irreversible. The magnitude depends on the quality and amount of water decanting, as well as the proximity of decant points to the watercourse.	4	3
Impact Significance	High significance, taking into account the good water quality within receiving watercourses and the prevalence of sensitive species.	High 14 4	Moderate 14 3
Mitigating and Monitoring Requirements			
Required Management Measures	Identify the location, timing, volume and expected quality of decant prior to the commencement of mining. Apply mining methods that will limit the amount of water entering mined out areas. Avoiding under-mining wetlands. Provision should be made for the management and/or treatment of decanting water well beyond closure. Acid Base Accounting Techniques and Evaluation should be applied to determine the expected quality of the water that will decant.		
Required Monitoring (if any)	Long-term monitoring of wetland integrity using WET-Health or other suitable tool. Biomonitoring and water quality monitoring Flow monitoring in the Groot Dwars		
Responsibility for implementation	Environmental Manager and Mine Manager		
Impact Finding			
Impact Finding	The degree to which this impact can be mitigated is uncertain. The magnitude depends on the quality and amount of water decanting, as well as the proximity of decant points to the watercourse. However, this impact is likely to be irreversible.		

Recommendations and Reasoned Opinion of the Wetland Specialist

In addition to the management and mitigating measures included in the impact assessment tables it is also recommended that a wetland mitigating strategy be developed. The approach, hectare equivalent calculations and requirements for the strategy have been included in the Wetland Management Plan and in the overall EMP.

The recommendation of the wetland specialist is that authorisation be granted on condition that all proposed conditions for authorisation form part of a positive authorisation, that all management measures proposed are duly implemented. The conditions for authorisation include:

- Full implementation of the proposed wetland mitigation strategy and associated biodiversity offset strategy prior to the commencement of operational mining;
- No further direct disturbances to the Groot Dwars River and associated riparian wetland. The Groot Dwars River and associated riparian wetland/habitat as well as a 100m buffer zone should be considered a No-Go area for any future developments.
- No additional road or infrastructure crossings across the Groot Dwars River other than those already in place and those proposed as part of this application.
- Full implementation of all proposed mitigation measures in this report.

8.2.8 Water Quality Assessment

From the baseline analysis, it is evident that water quality standard exceedance at BS4 is more likely at times than what is the case at BN. This can possibly be attributed to two factors:

- BS4 has been in operation longer than BN; and
- Better precautionary measures and environmental management from the onset at BN.

Nerveless, the water quality results in combination with the salt balance done by the hydrologist (refer to Section 8.2.4) and the hydrogeology findings (Section 8.2.3) provides a good indication of potential future water quality impacts. Of particular concern is the potential overall cumulative impact on water quality as indicated in the different studies. What also needs to be considered is that the addition of pollutants which could contribute to the downstream water quality where mines in the north also contribute to impacts on water quality. The Olifant's system is already under stress.

Potential impacts associated anticipated include:

- Construction Phase:
  - Surface water quality deterioration – higher SS and turbidity in water.
  - Surface-and Groundwater quality deterioration due to spills, leaks and dust.

- Operational Phase:
  - Surface and Groundwater deterioration due to seepage, spills and overflows;
  - Surface and Groundwater quality deterioration due to erosion; and
  - Groundwater deterioration due to dewatering, seepage.

- Decommissioning and Closure Phase:
  - Surface-and Groundwater deterioration due to seepage, spills and overflows.
  - Solid waste and hazardous waste spills or seepage which can contaminate Surface and Groundwater.

The impacts which cannot be mitigated to non-significant are assessed below.

Table 8-37 Impacts on Surface-and Groundwater Resulting from Construction activities

Impact Component	**Impact 1**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Construction of access roads, internal roads, roads, pipelines as well as mining activities in the catchment area		
Risk/ Impact	Surface Water: Contamination of surface water when storm water mixes with loose soils in the event of floods and rain. Increase in erosion and siltation		
Project Phase CO / OP / CL	CO		
Nature of Impact	Negative		
Type of Impact	Direct: clearance will directly lead to impact		
	Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	4	1
Duration	Long-term Live of mine	1	1
Extent	Localised Overland flow can cause higher Suspended solids in downstream areas especially after floods	2	2
Receptor Sensitivity	Moderate Low	2	1
Magnitude	Minor The magnitude will depend on the location of infrastructure components	2	1
Impact Significance	Moderate significance in the case of floods or if construction is near a receiving water system. Spillages can contribute to groundwater contamination	Moderate 18 2	Not Significant 5 1
Mitigating and Monitoring Requirements			
Required Management Measures	The higher suspended solids/turbidity can be avoided by construction of proper stormwater management measures and concurrent rehabilitation to reduce surface run-off from the construction site. Clearance should not take place close to drainage lines		

	Limit hydrocarbon spill by using designated service areas and drip trays when trucks are parked. Ensure that spills are cleaned up immediately to avoid surface and groundwater contamination.
Required Monitoring (if any)	Continues monitoring of receiving environment required, focusing on Turbidity and Suspended solids In the case of a spill, hydrocarbon analyses Total petroleum hydrocarbon) would be required
Responsibility for implementation	Environmental Officer and Mine Manager
Impact Finding	
Impact Finding	Impact can be mitigated as the effect will be short term and if management is applied the water quality can be restored overtime, as silt will settle out and reduce impact.

Table 8-38 Surface-and Groundwater Impacts from Dewatering

Impact Component	**Impact 3**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Active mine dewatering		
Risk/ Impact	Mining will occur below the local groundwater level, resulting in an influx of groundwater. Active mine dewatering would be required to ensure dry and safe working conditions, which will ultimately lead to aquifer dewatering and a decrease/lowering of the local groundwater levels.		
Project Phase (CO/ OP /CL	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	Direct: Dewatering of aquifer		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Possibility	2	2
Duration	Long-term	3	2
Extent	Regional Decline in water levels	2	1
Receptor Sensitivity	Moderate low	2	2
Magnitude	Moderate The magnitude will depend on the location of spillage	3	2

Impact Significance	Impact on groundwater level cannot be avoided or mitigated, hence the ratings are exactly the same for both before and after mitigation.	Moderate 16 2	Moderate 14 1
Mitigating and Monitoring Requirements			
Required Management Measures	Impact on groundwater level cannot be avoided if dewatering occurs		
Required Monitoring (if any)	Monitoring of existing boreholes should continue as is. Additional boreholes are however required to monitor proposed new mining and related infrastructure areas.		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding			
Impact Finding	Impact on groundwater level cannot be avoided if dewatering occurs		

Table 8-39 Surface-and Groundwater Impacts Resulting from Spillages

Impact Component	**Impact 4**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Storm water and flood management		
Risk/ Impact	Contaminated storm water can be released into the receiving environment		
Project Phase CO OP CL	OP		
Nature of Impact	Negative		
Type of Impact	Direct: Surface water contamination		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	1
Duration	Long-term Live of mine	3	1
Extent	Area of Influence Decline in water quality	3	1
Receptor Sensitivity	Moderate	3	1
Magnitude	Moderate	3	1

	The magnitude will depend on the location of spillage		
Impact Significance	High significance in the case of floods receiving surface and groundwater system contamination.	High 36 2	Not Significant 4 2
Mitigating and Monitoring Requirements			
Required Management Measures	Construction of storm water catchment drain. If storm water drains are constructed all dirty water will be diverted into storm water dams/evaporation dams Operate all dams as empty Construct water treatment plant for water which need to be discharged		
Required Monitoring (if any)	Long term continues surface water monitoring should be done. Variables includes pH, EC, anions and cations		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding			
Impact Finding	Impact can be mitigated through construction of storm water drains as this will divert the dirty water towards dirty water facilities for treatment or reuse in the plant.		

Table 8-40 Water Quality Impacts Resulting from Seepage

Impact Component	Impact 5	Significance prior to Mitigation	Significance with Mitigation
Activity	Storage facilities (chemical, waste rock and tailings facilities)		
Risk/ Impact	Surface water: Seepage from chemical stores, waste rock dumps and tailings		
Project Phase CO OP CL	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	Direct: Decline in water quality caused by seepage from improper facility designs		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	2
Duration	Long-term	3	2

Extent	Area of Influence Decline in water quality and if aquifers are polluted it can cause larger area influence	3	2
Receptor Sensitivity	Moderate	3	2
Magnitude	High The magnitude will depend on the location of spillage	4	2
Impact Significance	High significance of aquifer and surface water impacts.	High 48 4	Moderate 16 2
Mitigating and Monitoring Requirements			
Required Management Measures	Appropriate liners must be used before waste rock dump and tailings are constructed. Chemical storage units must be constructed according to chemical MSDS. Waste rock dump and tailings with the necessary cut-off drains to collect possible seepage can prevent decline in surface and groundwater.		
Required Monitoring (if any)	Long term continues surface water monitoring is required (NO_3_N, NO_2_N, SO_4, NH_4_N, NH_3_N)		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding			
Impact Finding	Mitigation is possible if construction is done according to standards. If not impact cannot be mitigated		

Table 8-41 Water Handling and Water Quality Impacts

Impact Component	Impact 6	Significance prior to Mitigation	Significance with Mitigation
Activity	Water Handling: Water removed from Box cut and mining operations		
Risk/ Impact	Surface water: Possible contaminated water from Box cut		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	OP, CL		
Nature of Impact	Negative		

Type of Impact	Direct: Contaminated water will be removed from box cut and mining area, this water ca not be disposed into the surrounding environment		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	1
Duration	Long-term Live of mine	4	2
Extent	Area of Influence Decline in water quality	3	1
Receptor Sensitivity	Moderate	3	1
Magnitude	Moderate Seepage from box cut can cause a decline in water quality	3	2
Impact Significance	High significance in the case of floods or water not pumped out efficiently.	High 39 3	Moderate 10 2
Mitigating and Monitoring Requirements			
Required Management Measures	Use of a pollution control dam that is large enough to limit the risk of spilling. Water from Box-cut can be re-used in the process plant. No discharge into the environment. If discharge becomes necessary water need to be treated to the reserve standards		
Required Monitoring (if any)	Continues monitoring of receiving environment required (pH, EC, major anions and cations)		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding			
Impact Finding	Impact cannot be mitigated, however it can be controlled		

Table 8-42 Process Water Pipelines and Water Quality Impacts

Impact Component	**Impact 7**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Water Handling: Water will be pumped to/ from pollution control dams/ sewage treatment plants/ process water		
Risk/ Impact	Surface water: Pipes used to pump water to and from dams can burst		
Project Phase CO/ OP/ CL	OP		

Nature of Impact	Negative		
Type of Impact	Direct: Contaminated water transported by pipes can be released into the receiving environment and can also contaminate the surface runoff.		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Possible	2	1
Duration	Long-term Live of mine	2	1
Extent	Site Decline in water quality	2	1
Receptor Sensitivity	Moderate Low	2	1
Magnitude	Moderate The magnitude will depend on the location of spillage	3	2
Impact Significance	High significance if regular maintenances is not done	High 24 3	Minor 8 2
Mitigating and Monitoring Requirements			
Required Management Measures	Ensure that all water management measures are effective and in working condition. Regular de-silting of drains and trenches is essential to ensure that the system is working effectivity Maintenance and management plan should address potential risks		
Required Monitoring (if any)	Inspections should be done on a daily basis, in case of a pipe bust water should be analyses to ensure compliancy to water use limits		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding			
Impact Finding	Impact can be mitigated		

Table 8-43 Impact of Water Treatment Plant on Water Quality

Impact Component	Impact 8	Significance prior to Mitigation	Significance with Mitigation
Activity	Sewage treatment plant		
Risk/ Impact	Bacteriological contamination of aquifers and surface water		

Project Phase CO/ OP/ CL Nature of Impact	OP, CL Negative		
Type of Impact	Direct: This can be a serious health impact if the sewage treatment plant is not constructed correctly.		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	1
Duration	Short-term	2	1
Extent	Site Extent of contamination can be higher if spillage is near a water system	2	1
Receptor Sensitivity	Moderate Low	2	1
Magnitude	Moderate The magnitude will depend on the location of spillage	3	2
Impact Significance	High significance in the case of spillage as both aquifers and surface water can be effected.	High 27 3	Minor 8 2
Mitigating and Monitoring Requirements			
Required Management Measures	Ensure that all water management measures are effective and in working condition. Regular de-silting of drains and trenches is essential to ensure that the system is working effectivity. No discharge into the environment Regular maintenance to the sewage treatment plants Design the plant so that treated effluent complies to the catchment water quality objectives/ or IWUL requirements		
Required Monitoring (if any)	Continues monitoring of treatment facility (Free chlorine, COD, *E.coli/* total coliforms and Faecal coliforms)		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding			
Impact Finding	Mitigation is possible if action is taken immediately.		

Recommendations and Reasoned Opinion of the Water Quality Specialist

With regards to the surface and groundwater in the Groot Dwars River valley where unauthorised activities were conducted, the foot print has already been made, the major objective now is to reduce the foot print for the future. It is strongly recommended that continuous monitoring is conducted on the surface waters. Monitoring boreholes needs to be added around the BS1/2 construction/mining area, and monitoring should be performed monthly for the first hydrological cycle. The recommended variables in this report need to be considered as well as SOG's with the option of VPH's if high concentrations were recorded at any of the BS1/2 surface or groundwater localities as well as the Groot Dwars River and its tributaries.

The following recommendations regarding surface and groundwater should be considered as part of the authorisation: Total suspended solids, dissolved oxygen and screening of oil and grease (SOG) must be added to the surface water monitoring program. Should SOG concentrations be found to exceed drinking water quality limits, then Total Petroleum Hydrocarbon analyses should also be added.

Additional boreholes have been recommended to monitor potential sources of pollution from the new activities. The proposed locations are included in Table 8-44 .

Table 8-44 Proposed new Monitoring Borehole Locations

Borehole ID	Coordinates *(WGS84)*		Elevation	Depth
	South	East	(mamsl)	(m)
		Booysendal North		
NBH01	-25.0840	30.1101	1 251	30
NBH02	-25.0902	30.1136	1 302	30
NBH03	-25.0950	30.1084	1 307	30
NBH04	-25.0987	30.1150	1 322	30
		Booysendal South		
SBH01	-25.1565	30.1514	1 710	30
SBH02	-25.1511	30.1546	1 699	30
SBH03	-25.1519	30.1515	1 702	30
SBH04	-25.1470	30.1544	1 688	30
		Proposed new mining activities		
24GBH01	-25.1617	30.1357	1 580	30

24GBH02	-25.1579	30.1423	1 698	30
24GBH03	-25.1463	30.1523	1 696	30
24GBH04	-25.1498	30.1331	1 496	30
24GBH05	-25.1487	30.1265	1 422	30
24GBH06	-25.1444	30.1266	1 421	30
24GBH07	-25.1443	30.1313	1 418	30
24GBH08	-25.1380	30.1227	1 287	30
24GBH09	-25.1356	30.1303	1 330	30
24GBH10	-25.1211	30.1194	1 204	30
24GBH11	-25.1132	30.1197	1 206	30
24GBH12	-25.1077	30.1165	1 294	30
24GBH13	-25.1002	30.1201	1 265	30

Other recommendations include that the quarterly reports should be an update of the database with time-series graphs and statistical analysis (average, maximum, minimum, 5 - 50 – and 95 percentile values as well as linear performance). Data should also be presented in a map format to present a clear picture of the water quality situation. Furthermore, an annual detailed evaluation report on the groundwater monitoring results should be prepared to investigate trends and non-compliance over the monitoring year.

Recommendations and Reasoned Opinion of the Surface-and Groundwater Specialist

Total suspended solids, dissolved oxygen and screening of oil and grease (SOG) must be added to the surface water monitoring program. Should SOG concentrations be found to exceed drinking water quality limits Total Petroleum Hydrocarbon analyses should also be added.

8.2.9 Noise and Vibration

The general finding from the noise and vibration study on the current construction phase is that as noise will be generated during the day only the noise disturbance will be insignificant during the summer and barely noticeable during winter. During the operational phase noise, will be more noticeable during the night, but will still fall within the Noise Control Regulation Limits of less than 7dBA increase.

The noise assessment took consideration of all infrastructure components which could generate noise including the operational noise outputs for the various components (refer to Table 6-4 of the noise report). It is important to note that the baseline noise levels already measured and incorporate noise levels from surrounding noise generators in the baseline results. The cumulative noise assessment took consideration of all noise generating sources.

It is foreseen that the generated noise will be noticeable during the operational phase. The cumulative operational phase noise level calculations during summer are included in Table 8-45 and for winter in

.

Table 8-45 Cumulative Noise Intrusion Levels During the Operational Phase – Summer

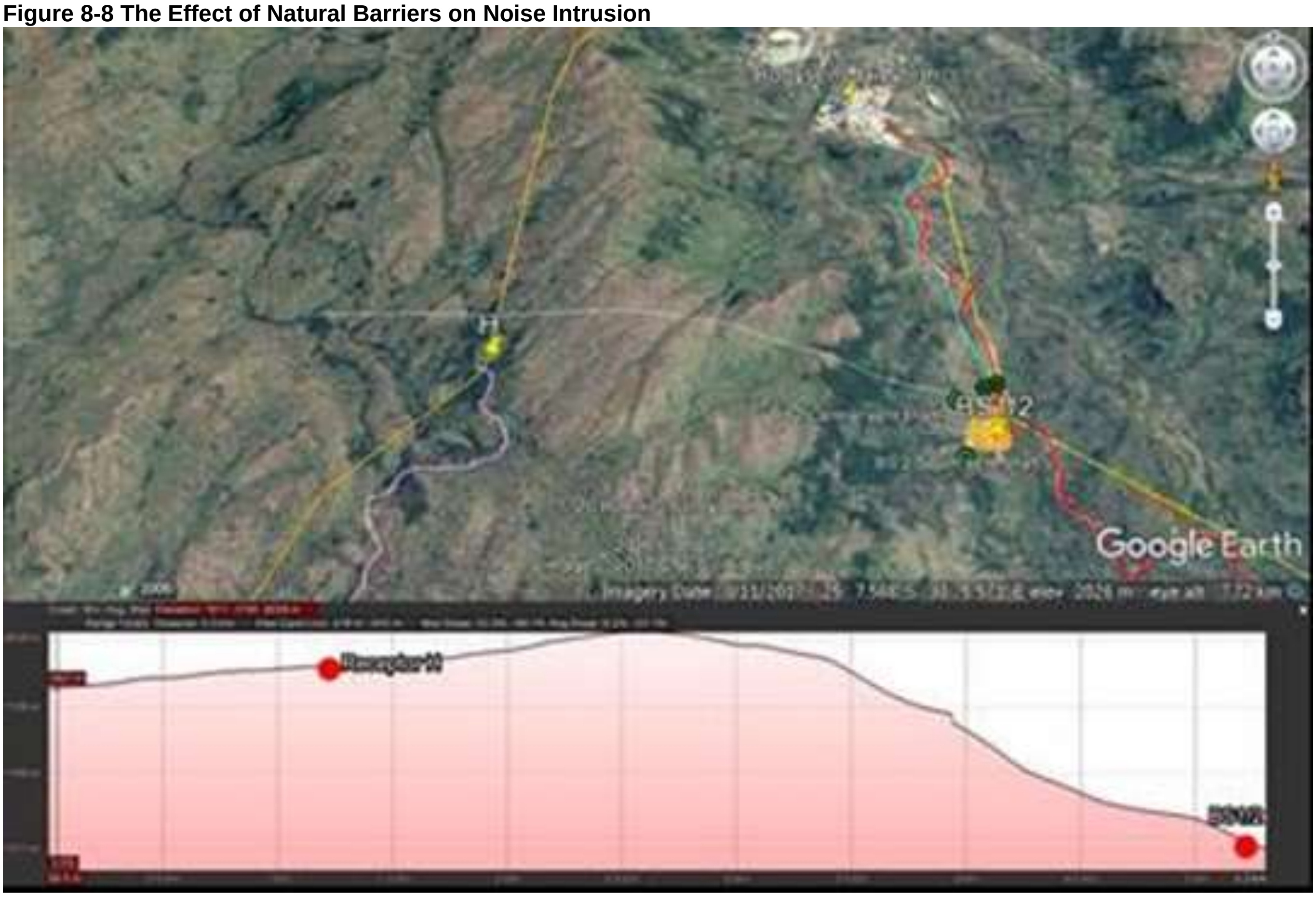
Residential property	Noise levels at the different noise receptors and the noise intrusion level during summer period in dBA														
	BS1/2 Plant	**BS1/2 north vent**	**BS1/2 central vent**	**BS1/2 south vent**	**BS3 north vent**	**BS3 south vent**	**Ropecon**	**Main access road**	**Box cut**	**BS4 plant**	**BS4 Vent shaft**	**Cumulative Levels**	**Cumulative noise level - Daytime**	**Cumulative noise level - Night time**	**Intrusion noise level - daytime**	**Intrusion noise level - night time**
A	14.7	19.5	19.4	19.7	22.6	22.8	-2.4	14.8	16.1	18.6	27.9	31.4	35.9	36.4	**1.9**	**1.7**
B	15.1	19.7	19.8	20.1	22.4	22.5	-0.8	16.4	18.0	22.6	30.0	32.5	36.3	36.7	**2.3**	**2.0**
C	13.6	18.3	18.2	18.3	19.4	19.4	-4.8	31.0	17.3	24.5	25.6	33.2	36.6	37.0	**2.6**	**2.3**
D	13.9	18.6	18.5	18.6	19.2	19.1	-5.2	21.3	16.5	22.8	25.4	29.8	35.4	35.9	**1.4**	**1.2**
E	14.8	19.5	19.4	19.4	19.4	19.2	-4.6	22.1	17.7	20.3	25.9	30.5	35.6	36.1	**1.6**	**1.4**
F	16.2	21.1	20.8	20.7	19.4	19.2	-5.7	15.2	17.7	15.5	25.3	29.9	35.4	35.9	**1.4**	**1.2**
G	14.6	19.7	19.3	19.1	19.6	17.2	-9.4	10.0	12.2	10.9	20.9	28.8	35.2	35.7	**1.2**	**1.0**
H	19.0	24.4	24.8	24.7	17.5	22.0	-6.2	8.9	7.9	6.1	18.3	30.4	35.6	36.1	**1.6**	**1.4**
I	15.7	20.3	20.8	21.1	22.6	23.1	-10.3	5.8	7.2	5.9	17.9	28.9	35.2	35.7	**1.2**	**1.0**
J	10.2	15.3	15.3	15.5	22.8	18.0	-14.8	0.9	4.4	4.0	15.1	25.9	34.6	35.2	**0.6**	**0.5**
K	8.7	13.4	13.5	13.9	17.6	15.7	-13.2	4.1	6.4	8.0	17.0	23.7	34.4	35.0	**0.4**	**0.3**
L	9.8	14.6	14.7	15.0	15.4	16.2	-11.0	14.1	8.7	11.7	18.8	24.7	34.5	35.1	**0.5**	**0.4**
M	11.3	16.1	16.3	16.4	16.0	17.8	-8.4	19.3	11.7	15.5	21.7	26.8	34.8	35.4	**0.8**	**0.7**
N	10.4	15.3	15.2	15.4	17.6	15.7	-10.7	13.4	9.7	12.5	19.3	25.2	34.5	35.2	**0.5**	**0.5**
O	11.1	16.0	15.8	16.1	16.0	15.9	-10.4	9.9	10.5	12.5	19.7	25.1	34.5	35.1	**0.5**	**0.4**
P	10.8	15.8	15.6	15.6	15.3	15.2	-11.5	7.0	9.6	10.6	18.6	23.8	34.4	35.0	**0.4**	**0.3**

Table 8-46 Cumulative Noise Intrusion Levels during the Operational Phase - Winter

Residential property	Noise levels at the different noise receptors and the noise intrusion levels during winter period in dBA															
	BS1/2 Plant	BS1/2 north vent	BS1/2 central vent	BS1/2 south vent	BS3 north vent	BS3 south vent	Ropecon	Main access road	Box cut	BS4 plant	BS4 Vent shaft	Cumulative Levels	Cumulative noise level - Daytime	Cumulative noise level - Night time	Intrusion noise level - daytime	Intrusion noise level - night time
A	14.7	19.5	19.4	19.7	22.6	22.8	-2.4	14.8	16.1	18.6	27.9	31.4	33.8	32.5	**3.8**	**6.5**
B	15.1	19.7	19.8	20.1	22.4	22.5	-0.8	16.4	18.0	22.6	30.0	32.5	34.4	33.3	**4.4**	**7.3**
C	13.6	18.3	18.2	18.3	19.4	19.4	-4.8	31.0	17.3	24.5	25.6	33.2	34.9	33.9	**4.9**	**7.9**
D	13.9	18.6	18.5	18.6	19.2	19.1	-5.2	21.3	16.5	22.8	25.4	29.8	32.9	31.3	**2.9**	**5.3**
E	14.8	19.5	19.4	19.4	19.4	19.2	-4.6	22.1	17.7	20.3	25.9	30.5	33.3	31.8	**3.3**	**5.8**
F	16.2	21.1	20.8	20.7	19.4	19.2	-5.7	15.2	17.7	15.5	25.3	29.9	32.9	31.4	**2.9**	**5.4**
G	14.6	19.7	19.3	19.1	19.6	17.2	-9.4	10.0	12.2	10.9	20.9	28.8	32.5	30.7	**2.5**	**4.7**
H	19.0	24.4	24.8	24.7	17.5	22.0	-6.2	8.9	7.9	6.1	18.3	30.4	33.2	31.7	**3.2**	**5.7**
I	15.7	20.3	20.8	21.1	22.6	23.1	-10.3	5.8	7.2	5.9	17.9	28.9	32.5	30.7	**2.5**	**4.7**
J	10.2	15.3	15.3	15.5	22.8	18.0	-14.8	0.9	4.4	4.0	15.1	25.9	31.4	29.0	**1.4**	**3.0**
K	8.7	13.4	13.5	13.9	17.6	15.7	-13.2	4.1	6.4	8.0	17.0	23.7	30.9	28.0	**0.9**	**2.0**
L	9.8	14.6	14.7	15.0	15.4	16.2	-11.0	14.1	8.7	11.7	18.8	24.7	31.1	28.4	**1.1**	**2.4**
M	11.3	16.1	16.3	16.4	16.0	17.8	-8.4	19.3	11.7	15.5	21.7	26.8	31.7	29.4	**1.7**	**3.4**
N	10.4	15.3	15.2	15.4	17.6	15.7	-10.7	13.4	9.7	12.5	19.3	25.2	31.2	28.6	**1.2**	**2.6**
O	11.1	16.0	15.8	16.1	16.0	15.9	-10.4	9.9	10.5	12.5	19.7	25.1	31.2	28.6	**1.2**	**2.6**
P	10.8	15.8	15.6	15.6	15.3	15.2	-11.5	7.0	9.6	10.6	18.6	23.8	30.9	28.0	**0.9**	**2.0**

Table 3-38 indicates the cumulative noise intrusion levels from the various receptor points (refer to Section 4.12.2 for location of receptors). From the table it can be seen that the highest summer daytime increase in baseline noise level will be experienced at location B and C by 2.3dBA and 2.6dBA respectively. These two points will also experience the highest summer night increase in baseline noise, by 2.0dBA and 2.3dBA respectively. The noise Regulations indicates that noise levels should not increase by more than 7dBA. It has, however been accepted that an increase of 5dBA becomes audible. The natural topography and implementation of noise management measures will ensure that noise intrusion levels remain within an acceptable range. The influence of topography on noise receptors are indicated in Figure 8-8. The natural barrier will contribute in limiting the noise intrusion.

Figure 8-8 The Effect of Natural Barriers on Noise Intrusion



Winter noise intrusion levels will be considerably higher during the winter. During the day regulated limits will not be exceeded but at night the noise intrusion levels at receptor B and C will exceed the noise regulation limits where it will be 7.3dBA and 7.9dBA respectively.

The calculation of individual noise sources is included in Annexure K.

An assessment of potential ground vibration and air overpressure was also done. For air blast a daytime limit of <115dBL is acceptable and <105dBL during night time. At these levels, it is determined to be not significant. The limits for ground vibration to be insignificant is <2mm/s during the day and <1mm/s during the night. Table 8-47 indicates that at none of the possible receptors the acceptable levels will be exceeded. Receptor H and I will be most susceptible to vibration (refer to Table 6-21 in Annexure K).

The ground vibration calculation results indicate that should vibration be caused it will be insignificant. The potential impacts of both ground vibration and air over pressure is therefore, deemed insignificant.

Table 8-47 Air Blast Levels in dBL

Noise receptor	BS1/2 North Vent Shaft		BS1/2 Central Vent Shaft		BS1/2 South Vent Shaft		BS 3 North Vent Shaft		BS 3 South Vent Shaft	
	Air blast level (dBL) with a charge per delay of 500kg of site-mixed slurry explosives	Air blast level (dBL) with a charge per delay of 1000kg of site-mixed slurry explosives	Air blast level (dBL) with a charge per delay of 500kg of site-mixed slurry explosives	Air blast level (dBL) with a charge per delay of 1000kg of site-mixed slurry explosives	Ai blast level (dBL) with a charge per delay of 500kg of site-mixed slurry explosives	Air blast level (dBL) with a charge per delay of 1000kg of site-mixed slurry explosives	Air blast level (dBL) with a charge per delay of 500kg of site-mixed slurry explosives	Air blast level (dBL) with a charge per delay of 1000kg of site-mixed slurry explosives	Air blast level (dBL) with a charge per delay of 500kg of site-mixed slurry explosives	Air blast level (dBL) with a charge per delay of 1000kg of site-mixed slurry explosives
A	95.7	98.1	95.6	98.0	96.0	98.4	99.4	101.8	99.7	102.1
B	96.0	98.4	96.0	98.5	96.4	98.8	99.2	101.6	99.3	101.7
C	94.3	96.7	94.2	96.6	94.3	96.7	95.5	97.9	95.6	98.0
D	94.7	97.1	94.5	96.9	94.6	97.0	95.3	97.7	95.2	97.6
E	95.6	98.0	95.6	98.0	95.6	98.0	95.5	97.9	95.3	97.7
F	97.7	100.1	97.2	99.6	97.1	99.5	95.6	98.0	95.3	97.7
G	96.0	98.4	95.5	97.9	95.2	97.6	95.8	98.2	93.0	95.4
H	101.6	104.0	102.1	104.5	102.0	104.4	93.2	95.7	98.7	101.2
I	96.6	99.1	97.3	99.7	97.6	100.0	99.4	101.8	100.0	102.4
J	90.6	93.0	90.6	93.0	90.9	93.3	99.6	102.0	93.8	96.3
K	88.4	90.8	88.5	90.9	89.0	91.4	93.4	95.8	91.1	93.5
L	89.9	92.3	89.9	92.3	90.2	92.6	90.7	93.2	91.7	94.1
M	91.6	94.0	91.9	94.3	92.0	94.4	91.5	93.9	93.6	96.0
N	90.7	93.1	90.5	92.9	90.7	93.1	93.4	95.8	91.2	93.6
O	91.5	93.9	91.3	93.7	91.6	94.0	91.5	93.9	91.4	93.8
P	91.2	93.6	91.0	93.4	91.0	93.4	90.6	93.0	90.5	92.9

All construction activities were deemed to have a low significance in terms of noise and can be mitigated with controls. Refer to table below. The only impact deemed to be of medium significance during construction phase is blasting associated with the road and ventilation shafts (see Table 8-48).

Table 8-48 Blasting Impact Assessment

Activity	***Ventilation shaft noise BS1/2 BS4 (north, central and south)***							
Project phase	*Operational phase to the Closure phase*							
Impact Summary	*Environmental noise increase at the boundary of the mine footprint and at the abutting farmhouses*							
Potential Impact Rating	***Magnitude***	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***+/-***	***Conf. level***
	Moderate -	Long	Local	Medium	Possible	Medium	-	High
Management Measures	*Equipment and/or machinery which will be used must comply with the manufacturer's specifications on acceptable noise levels and any noise sources above 85.0dBA to be acoustically screened off.*							
	Outlet of the ventilation fan to face away from any of the farmhouses.							
	Make use of the natural topography as a noise barrier.							
	Noise survey to be carried out to monitor the noise levels during these activities.							
After Management Impact Rating	***Magnitude***	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***+/-***	***Conf. level***
	Minor -	Long	Local	Low	Possible	Medium	-	High
Activity	***Blasting at remainder of the main access road between BS1/2 to and BS3 ventilation shafts***							
Project phase	*Construction phase*							
Impact Summary	*Environmental over-air pressure noise level and ground vibration increase at the abutting noise sensitive areas*							
Potential Impact Rating	***Magnitude***	***Duration***	***Scale***	***Consequen ce***	***Probability***	***Significanc e***	***+/-***	***Conf. level***
	Major -	Medium	Local	Medium	Possible	Medium	-	High
Management Measures	*Safe blasting techniques to be used and the noise level at the blasting site may not exceed 120dBL.* *The ground vibration must be controlled not to exceed 10mm/s at the residential properties.* *Ground vibration levels and air blast to be monitored during each blast.* *Such information must be kept on record of the environmental department.*							
After Management Impact Rating	***Magnitude***	***Duration***	***Scale***	***Consequenc e***	***Probability***	***Significance***	***+/-***	***Conf. level***
	Minor -	Medium	Local	Medium	Possible	Medium	-	High

During the operational phase, it is deemed that the impacts caused by the ventilation shafts and aerial rope will be of a medium significance with mitigating controls. The assessments are included in Table 8-42 and Table 8-43.

Table 8-49 Impacts and Mitigating Requirements for Ventilation Shafts

Activity	***Ventilation shaft noise BS1/2 BS4 (north, central and south)***							
Project phase	*Operational phase to the Closure phase*							
Impact Summary	*Environmental noise increase at the boundary of the mine footprint and at the abutting farmhouses*							
Potential Impact Rating	***Magnitude***	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***+/-***	***Conf. level***
	Moderate -	Long	Local	Medium	Possible	Medium	-	High
Management Measures	*Equipment and/or machinery which will be used must comply with the manufacturer's specifications on acceptable noise levels and any noise sources above 85.0dBA to be acoustically screened off.*							
	Outlet of the ventilation fan to face away from any of the farmhouses.							
	Make use of the natural topography as a noise barrier.							
	Noise survey to be carried out to monitor the noise levels during these activities.							
After Management Impact Rating	***Magnitude***	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***+/-***	***Conf. level***
	Minor -	Long	Local	Low	Possible	Medium	-	High

Table 8-50 Aerial Rope Conveyor Impact Assessment and Mitigating Requirements

Activity	***Aerial ropeway***							
Project phase	*Operational phase to the Closure phase*							
Impact Summary	*Environmental noise increase at the boundary of the mine footprint and at the abutting farmhouses*							
Potential Impact Rating	***Magnitude***	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***+/-***	***Conf. level***
	Moderate -	Long	Local	Medium	Possible	Medium	-	High
Management Measures	*Equipment and/or machinery which will be used must comply with the manufacturer's specifications on acceptable noise levels and any noise sources above 85.0dBA to be acoustically screened off.*							
	IBR sheeting cover to be used on the side facing the farm houses in areas where the conveyor will be closer than 300m from the farm houses.							
	All rollers to be serviced on a regular basis to avoid screeching of the rollers.							
	The siren when Ropecon is not operational and when it start up to be replaced with a vibrating type siren if it is approved by the Department of Labour.							
	Noise survey to be carried out to monitor the noise levels during these activities.							
After Management Impact Rating	***Magnitude***	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***+/-***	***Conf. level***
	Minor -	Long	Local	Low	Possible	Medium	-	High

Recommendations and Reasoned Opinion of the Noise Specialist

The noise specialist is of the opinion possible noise intrusion from the blasting and mine activities can be controlled by means of approved acoustic screening measures, state of the art equipment, proper noise management principles and compliance to the Local Noise By-laws, and the International Finance Corporation's Environmental Health and Safety Guidelines. The proposed noise and vibration management plan must be in place during the construction and operational phases to identify any noise increase on a pro-active basis and to address the problem accordingly.

Table 8-51 Noise Specialist Recommendations

Activity	Recommendations
Construction phase	• Equipment and/or machinery which will be used must comply with the manufacturer's specifications on acceptable noise levels and any noise sources above 85.0dBA to be acoustically screened off. • Construction activities to take place during daytime period only. • Blasting to be done during daytime and to use the safe blasting techniques. • Ground vibration monitoring must be done at the nearest residential areas during each blast. • Environmental noise monitoring on a quarterly basis. • A noise barrier from soil and/or waster rock to be constructed along the north-western side of the shafts at BS3 and along the western side of ventilation shaft at BS4. • Raise bore drill method to be used at the sinking of ventilation shafts at BS1, BS2 and BS3.

Activity	Recommendations
Operational phase	• Vehicles to comply with manufacturers' specifications and any activity which will exceed 90.0dBA to be done during daytime only. • Equipment and/or machinery which radiate noise levels between 85.0dBA and 90.0dBA to be acoustically screened off. • The ventilation shaft outlet to face away from any residential area. • Emergency generators to be placed in such a manner that it is away from any residential area. • Noise monitoring to be done along the footprint at BS1/2 to determine increased noise levels on a pro-active basis and engineering control measures to be recommended for the noise levels not to contravene the Noise Regulations. • Noise monitoring at the residential areas and the mine boundaries to be done on a quarterly basis. • The siren when conveyor, crusher, aerial ropeway is not operational and when it start up to be replaced with a vibrating type siren if it is approved by the Department of Labor. • Actively manage the process and the noise management plan must be used to ensure compliance to the noise regulations and/or standards. The levels to be evaluated in terms of the baseline noise levels.
Decommissioning phase	• Machinery with low noise levels which complies with the manufacturer's specifications to be used. • Activities to take place during daytime period only. • Vehicles to comply with manufacturers' specifications and any activity which will exceed 90.0dBA to be done during daytime only. • Noise monitoring on a quarterly basis.

8.2.10 Air Quality Assessment

The fugitive dust sources which will result from the construction phase as a result of clearance, hauling, stockpiling etc, will vary from day to day and will be of a short-term nature. These sources can be managed effectively with wet suppression on stockpiles and open areas, early revegetation, minimisation of disturbance, reduced frequency of disturbance and stabilisation though cladding, and revegetation.

The main sources of emissions that could result in air quality impacts during the operational phase, include fugitive dust from materials handling, including transport from ROM to the plant on conveyors, tipping of ROM onto the stockpiles and pad at the plant, loading and tipping of ROM at the crusher, crushing of ROM and windblown dust from the TSF and stockpiles.

To assess the potential impacts associated with the Section 24G activities and the whole of the Booysendal Mine operation cumulatively, the following scenarios were modelled:

- Scenario 1: Current operations at BN utilising the TSF at BN. The TSF at BS4 was assumed to be 100% open to wind erosion.
- •Scenario 2: Current operations at BN and proposed BS1/BS2, BS3, BS4 and Merensky portals utilising the proposed TSF at BS4. The proposed TSF at BS4 was assumed to be 40% wet as based on similar processes and the current TSF at BS4 was assumed to be vegetated (80% CE).

- Scenario 3: Current operations at BN and proposed BS1/BS2, BS3, BS4 and Merensky portals utilising the proposed TSF at BS4. The proposed TSF at BS4 was assumed to be 40% wet as based on similar processes and the current TSF at BS4 was assumed to be undergoing re-mining (50% open – exposed to wind erosion).
- Scenario 4: Current operations at BN and proposed BS1/BS2, BS3, BS4 and Merensky portals utilising the proposed TSF at BS4. The proposed TSF at BS4 was assumed to be 40% wet as based on similar processes and the current TSF at BS4 was assumed to be undergoing re-mining (100% open – exposed to wind erosion).
- Scenario 5: Current operations at BN and proposed BS1/BS2, BS3, BS4 and Merensky portals utilising the proposed TSF at BS4. The proposed TSF at BS4 was assumed to be 40% wet as based on similar processes and the current TSF at BS4 was assumed to be completely re-mined and no longer a windblown source.

From the information provided by Booysendal, the emissions factors and emissions rate were calculated for input into the emissions model. This is included in Table 8-52. Project Emissions from routine operations, Table 8-53Probable particulate emissions were also calculated as can be expected during the operational phase. This included a 50% normal control application factor for e.g. spraying. The particulate emissions associated with the various sources are included in Table 8-53.

Table 8-52 Emissions Factors to Qualify Routine Project Emissions

Activity	Emission Equation	Source	Information assumed/provided
Materials handling	$$E = 0.0016\frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$$ Where, E = Emission factor (kg dust / t transferred) U = Mean wind speed (m/s) M = Material moisture content (%) The $PM_{2.5}$, PM_{10} and TSP fraction of the emission factor is 5.3%, 35% and 74% respectively.	US-EPA AP42 Section 13.2.4	An average wind speed of 4.3 m/s was used based on the MM5 data for the period 2013 – 2015. Throughput of ROM was provided as follows: • BN: 220 000 tpm • BS1: 110 000 tpm • BS2: 110 000 tpm • BS3: 110 000 tpm • BS4: 80 000 tpm • Merensky portals: 40 000 tpm
Crushing and screening	Primary (for high moisture ore): $$E_{TSP} = 0.2\ kg/t\ material\ processed$$ $$E_{PM10} = 0.02\ kg/t\ material\ processed$$ $$E_{PM2.5} = 0.0037\ kg/t\ material\ processed$$ Fraction of $PM_{2.5}$ taken from US-EPA crushed stone	NPI Section: Mining	Crusher at BN: 220 000 tpm Crusher at BS2: 370 000 tpm Crusher at BS4: 80 000 tpm 50% control efficiency was assumed for the mitigated scenario.

Activity	Emission Equation	Source	Information assumed/provided
	emission factor ratio for tertiary crushing		
Wind Erosion	$$E(i) = G(i)10^{(0.134(\%clay)-6)}$$ For $$G(i) = 0.261\left[\frac{P_a}{g}\right]u^{*3}(1+R)(1-R^2)$$ And $$R = \frac{u_*^t}{u^*}$$ where, $E_{(i)}$ = emission rate (g/m²/s) for particle size class i P_a = air density (g/cm³) G = gravitational acceleration (cm/s³) u^t = threshold friction velocity (m/s) for particle size i u^* = friction velocity (m/s)	Marticorena & Bergametti, 1995	Particle size distribution was provided as obtained from the current TSF at BS4 material (Table 4-5). Layout of the current and proposed tailings facilities was provided. Hourly emission rate file was calculated and simulated. Impacts from the waste rock dump and other stockpiles were not simulated as information on the particle size distribution of these sources was not available. The impacts from these sources however are expected to be localised and low in magnitude in comparison to the tailings facility.
Vents	Occupational exposure limits Platinum PM = 5 mg/m³	ACGIH TLVs 1996 – Occupational Guidelines	Parameters assumed: - Diameter: 5 m - Exit velocity: 15 m/s - Height: 20 m

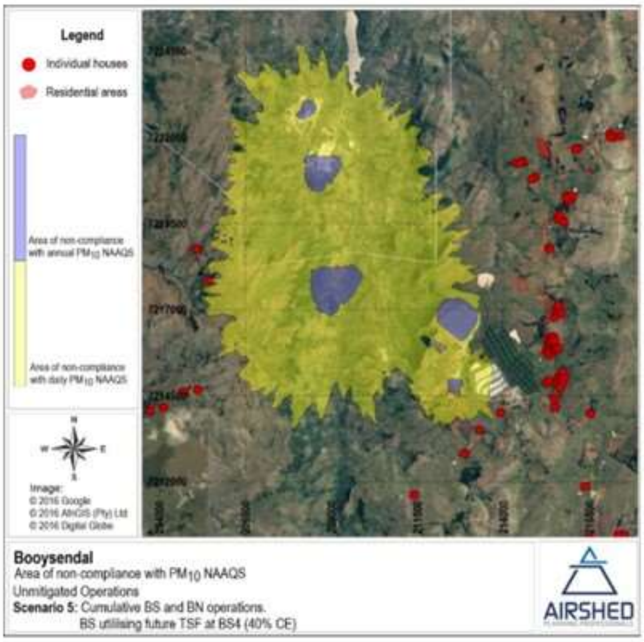
Table 8-53 Particulate Emissions form Routine Operations

Description	Emissions (tpa)			Percentage		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Scenario 1						
Wind Blown dust from the tailings facility	460.56	175.98	76.63	43.80	62.19	57.18
Materials Handling	16.40	7.76	1.17	1.56	2.74	0.88
Crushing and screening	528.00	52.80	9.77	50.22	18.66	7.29
Vents	46.44	46.44	46.44	4.42	16.41	34.65
Total	1 051.40	282.98	134.01	100.00	100.00	100.00
Scenario 2						
Wind Blown dust from the tailings facility	371.63	142.02	61.83	17.30	31.14	26.53
Materials Handling	29.56	13.98	2.12	1.38	3.07	0.91
Crushing and screening	1 608.00	160.80	29.75	74.84	35.25	12.77
Vents	139.32	139.32	139.32	6.48	30.54	59.79
Total	2 148.51	456.12	233.02	100.00	100.00	100.00
Scenario 3						
Wind Blown dust from the tailings facility	404.99	154.76	67.38	18.56	33.01	28.24
Materials Handling	29.56	13.98	2.12	1.35	2.98	0.89
Crushing and screening	1 608.00	160.80	29.75	73.70	34.30	12.47
Vents	139.32	139.32	139.32	6.39	29.71	58.40
Total	2 181.87	468.86	238.57	100.00	100.00	100.00
Scenario 4						
Wind Blown dust from the tailings facility	460.56	175.98	76.63	20.58	35.91	30.92
Materials Handling	29.56	13.98	2.12	1.32	2.85	0.85
Crushing and screening	1 608.00	160.80	29.75	71.87	32.81	12.00
Vents	139.32	139.32	139.32	6.23	28.43	56.22
Total	2 237.44	490.08	247.82	100.00	100.00	100.00
Scenario 5						
Wind Blown dust from the tailings facility	349.41	133.52	58.14	16.43	29.83	25.35
Materials Handling	29.56	13.98	2.12	1.39	3.12	0.92
Crushing and screening	1 608.00	160.80	29.75	75.62	35.92	12.97
Vents	139.32	139.32	139.32	6.55	31.12	60.75
Total	2 126.29	447.62	229.33	100.00	100.00	100.00

Potential dispersion was modelled for all eight scenarios incorporating particulate emissions that can be expected during normal routine activities, emission factors, climatic conditions, topography etc. The outcomes of the emissions model without mitigation and with a 50% mitigation indicated that particulate emissions at all sensitive receptors will be in compliance with NAAQS and NDCR limits. The biggest single source of particulate emissions is the crusher. Even when the cumulative scenario is modelled the emissions are still within the national limits. The worst-case scenario which takes consideration of the particulate emitters at BN as well is indicated in Figure 8-54. This therefore, portrays the cumulative impact from contributions from all potential mining emitters in the direct areaThe model outcome indicates that with mitigation none of the potential sensitive receptors will be affected.

The probable total dust deposition which may be caused by the operations was also modelled. Maximum daily dust deposition for residential and non-residential areas also falls within the NDCR. The modelled results are included in Figure 8-55. No sensitive human receptors are foreseen to be impacted, however the dust deposition can have an impact on the natural ecology in the area.

Figure 8-9 Scenario 5 Particulate Emissions PM_{10} Area of Non-compliance NAAQS



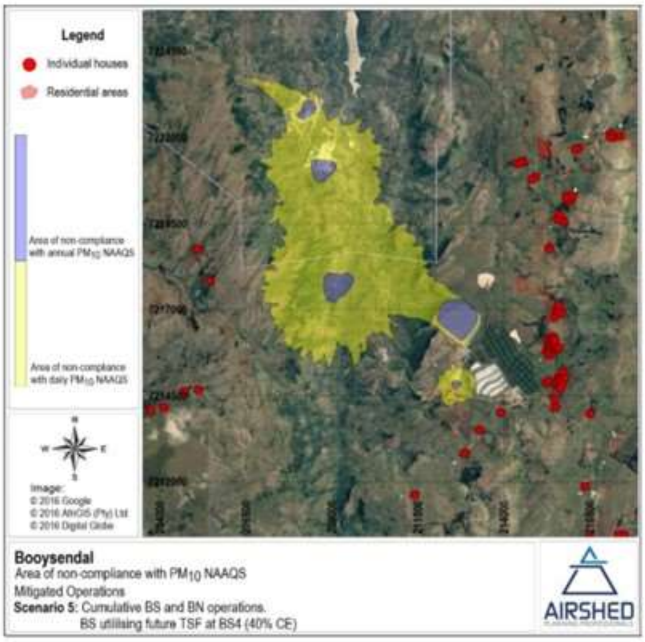
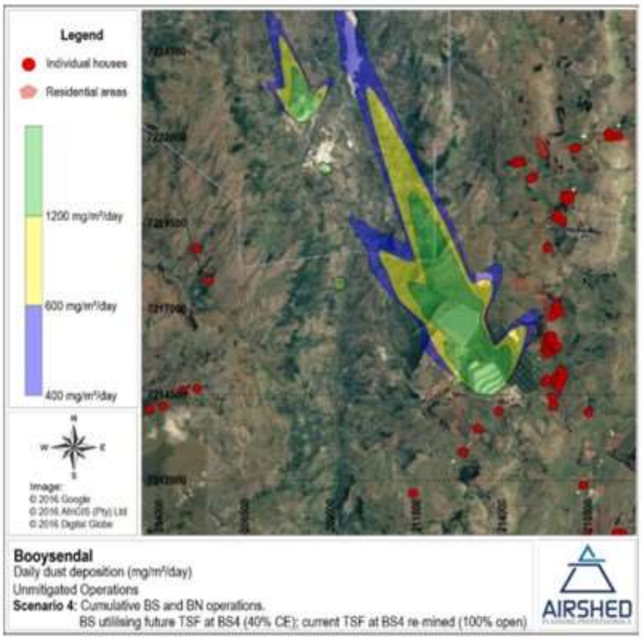
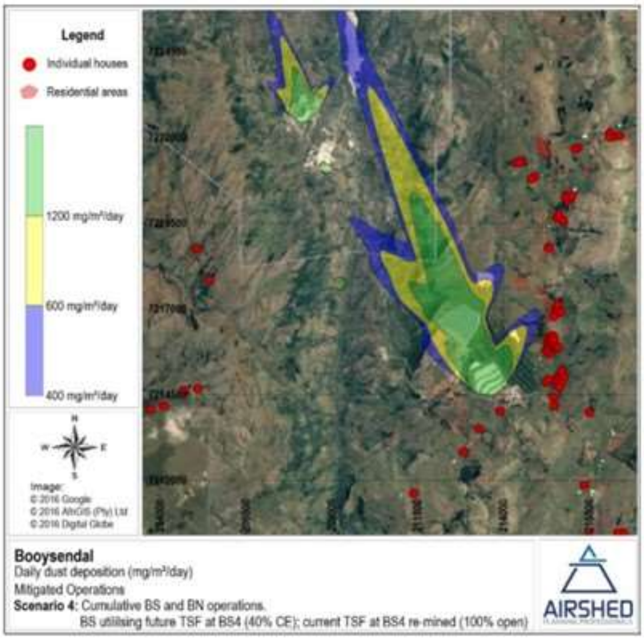


Figure 8-10 Scenario 4 Dust Deposition Results





In terms or Figure 8-9 and Figure 8-10 there are certain areas where emissions and deposition will exceed the national standards. If it is assumed the same standards applies to the natural environment it can have negative impacts on fauna and flora (also see terrestrial ecology findings in this section). It is important that dust abatement measures be applied at source, also in terms of occupational health and safety limits.

The following mitigating measures are applicable:

- Enclose the crushing operations;
- Design and construct with telescopic shute with water sprays;
- Ensure that hoods with filters area installed at the crusher;
- Vegetation / rock cladding or the sidewalls or the TSF facilities;
- Spray on the outer dry surface when windspeed exceed 4m/s;
- Risk assessment at decommissioning and closure to identify dust suppression requirements;
- Dust control open areas during construction and decommissioning through wet suppression, chemical supernatants, vegetation cover, wind breaks etc; and
- Implementation of the dust suppression plan included in the Air Quality Impact Assessment;

The impacts on emissions and dust outfall for the various phase of the project is included in the following tables.

Recommendations and Reasoned Opinion

In light of the potential impacts and the existing dust outfall network on site Airshed made the following recommendations:

- The current dust outfall monitoring network must be expanded
- There are sensitive receptors in close proximity to the development and as such it is recommended that mitigating measures on the main sources of fugitive dust be implemented.

Subject to the recommendations in the specialist report and the EMP being adhered to, it is the air quality specialist’s opinion that the Booysendal South Expansion Project could proceed.

Table 8-54 Air Quality Impact Assessment - Construction Phase

Impact Component	Impact 1	Significance prior to Mitigation	Significance with Mitigation
Activity	Transport and general construction activities		
Risk/ Impact	Gaseous and particulate emissions; fugitive dust		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure Nature of Impact	CO Negative		
Type of Impact	Deterioration of ambient air quality		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	3
Duration	Sort-term Impacts during construction	2	2
Extent	Site	2	2
Receptor Sensitivity	Moderate	3	3
Magnitude	Moderate	3	2
Impact Significance	Moderate significance as NAAQS may be exceeded off site without mitigation in place	Moderate 10 3	Minor 10 2
Mitigating and Monitoring Requirements			
Required Management Measures	Maintenance of vehicles and wet suppression or chemical treatment on unpaved road surfaces. Wet suppression where feasible. Minimise extent of disturbed areas. Reduction of frequency of disturbance. Early re-vegetation. Stabilisation (chemical, rock cladding or vegetative) of disturbed soil.		
Required Monitoring (if any)	Dustfall network as recommended in Section 6		
Responsibility for implementation	Environmental Officer		
Impact Finding			
Impact Finding	Impact can be managed through dust management plan.		

Table 8-55 Operational Phase Air Quality Impacts

Impact Component	Impact 1	Significance prior to Mitigation	Significance with Mitigation
Activity	Materials handling operations Crushing activities Wind erosion		
Risk/ Impact	Gaseous and particulate emissions; fugitive dust		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	OP		
Nature of Impact	Negative		
Type of Impact	Deterioration of ambient air quality		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	3
Duration	Long-term Impacts during operation	3	3
Extent	Area of influence	3	2
Receptor Sensitivity	Moderate	3	3
Magnitude	Moderate	3	2
Impact Significance	Moderate significance as NAAQS may be exceeded off site without mitigation in place	Moderate 12 3	Minor 11 2
Mitigating and Monitoring Requirements			
Required Management Measures	Wet suppression where feasible on materials handling activities and reducing drop height. Enclosure or wet suppression on crushing activities.		
Required Monitoring (if any)	Dustfall network as recommended in Section 6		
Responsibility for implementation	Environmental Officer		
Impact Finding			
Impact Finding	Impact can be managed through dust management plan.		

Table 8-56 Closure Phase Air Quality Impact Assessment

Impact Component	Impact 1	Significance prior to Mitigation	Significance with Mitigation
Activity	Dust generated during rehabilitation activities Demolition of the structure Tailpipe emissions from vehicles utilised during the closure phase		
Risk/ Impact	Gaseous and particulate emissions; fugitive dust		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	CL		
Nature of Impact	Negative		
Type of Impact	Deterioration of ambient air quality		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	3
Duration	Sort-term Impacts during construction	2	2
Extent	Site	2	2
Receptor Sensitivity	Moderate	3	3
Magnitude	Moderate	3	2
Impact Significance	Moderate significance as NAAQS may be exceeded off site without mitigation in place	Moderate 10 3	Minor 10 2
Mitigating and Monitoring Requirements			
Required Management Measures	Maintenance of vehicles and wet suppression or chemical treatment on unpaved road surfaces. Wet suppression where feasible.		
Required Monitoring (if any)	Dustfall network as recommended in Section 6		
Responsibility for implementation	Environmental Officer		
Impact Finding			
Impact Finding	Impact can be managed through dust management plan.		

Recommendations and Reasoned Opinion

In light of the potential impacts and the existing dust outfall network on site Airshed made the following recommendations:

- The current dust outfall monitoring network must be expanded.
- There are sensitive receptors in close proximity to the development and as such it is recommended that mitigating measures on the main sources of fugitive dust be implemented.

8.2.11 Greenhouse Gas Assessment

The assessment of the significance of the GHG emission impact is included in Table 8-57.

Table 8-57 Greenhouse Gas Assessment

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	Increase in fossil fuel usage because of an increase vehicle and machinery usage		
Risk/ Impact	Increase in GHG emissions and contribution to global warming		
Project Phase:	CP and OP		
Nature of Impact	Negative		
Type of Impact	**Cumulative Impact**: any increase in GHG emissions could cumulatively increase global warming		
Likelihood/ probability	Definite. With the implementation of energy conservation methods the likelihood can be decreased	4	3
Duration	Long term GHGs emitted by the operation will persist for the LoM. Some gasses may persist in the atmosphere for some time after closure	4	4
Extent	Global warming has a global extent	4	4
Magnitude	Minor. The contribution to the regions carbon budget will be minor	-1	-1
Receptor Sensitivity	Low. The global warming impact on the local receiving environment is may be extensive in time. However, the proportion of that for which the mine is responsible is negligible.	1	1
Impact Significance	Low significance due to the low global contribution to the impact with opportunity for mitigation.	13/1	12/1
Required Management Measures	Implement energy efficient technologies Ensure that vehicles and machinery is maintained Investigate and implement more environmental friendly technologies		
Required Monitoring	Annual carbon reporting		
Responsibility for implementation	Mine manager Environmental Officer		
Impact Finding	The significance of the impact is not of such a nature that it presents a flaw to the project.		

The separate greenhouse gas emission (GHG) calculation using the emissions factors for NO2, CO2 and CH4 was dibe. The importance is to get an indication to what extent the project could contribute to climate change. The mine will likely be responsible for emissions of Scope 1 carbon equivalents of not more than approximately 19,500 tons per year. At the current assumed carbon tax rate of R120 per ton, this may result in a tax liability of not more than R2 340 000 per year. However, with offsets and other rebates, this amount per ton should be drastically reduced to between R6 and R40 per ton, or a potential liability of between R43 000 and R286 720. No final decision has been made on carbon taxation as yet and these figures are indicative only. This impact is regarded as minor with mitigation.

8.2.12 Traffic Impact Assessment

The methodology carried out for the assessment of potential traffic impacts are based on calculations on traffic increase, the ability of the intersections to accommodate the increase in traffic (Level of Service) and to what extent it will or will not cause delays. The Booysendal peak hour traffic demand (operational phase) is expected to be as follow:

- Am peak: 153 v/h (130 in; 23 out);
- Pm peak: 112 v/h (22 in; 90 out);

The total number of trips to be generated on a daily basis is expected to be 850 trips.

In terms of level of service and service delay it is expected that the intersections will increase from a Service A to a Service B category, which from a service point of view means low stable flow with a volume to capacity ration of between 0.1 to 0.3. The intersections will therefore be able to accommodate the increased traffic volumes without any upgrades required. The calculations are included in the TIA in Annexure Q.

Safety of intersections also depend on the sight distance which impacts on safe turning. The TIA found that the sight distance at both intersections exceed the required standards stipulated in the South African Impact and Site Assessment Standards & Requirements Manual. However, the east turn from the R874 onto the R577 is marginally acceptable and will need to be monitored to assess if an additional turning lane will be required.

Recommendations and Reasoned Opinion of the Traffic Specialist

- The following recommendations were made by the traffic engineer:
- Speed humps and a speed limit of 40km per hour should be imposed at the start of the downhill approach on the D874 between km 1.85 and 3.0km followed by two sets of rumble strips/ cosbi lines between the speed hump and the D874/village intersection;
- The trees at the D874/village intersection needs to be removed to improve line of sight and safety; and
- Sealing of the village road.

The Traffic engineer is of the opinion that it is expected that all the intersections will be operating at an acceptable level by 2022 and that no upgrades are required.

It is the opinion of the EAP that road quality of the D874 may deteriorate due to the increase in traffic and specifically heavy vehicles, therefore it is recommended that the same maintenance be undertaken on this road as on the internal section of the main access road. This include:

- Routine maintenance including crack sealing, limited surface repair and drainage reinstatement;
- At year 12 – 14 after construction a suitable asphaltic overlay needs to be applied; and
- After year 26 – 30 the asphaltic overlays need to be milled and replaced with a suitable asphaltic overlay after suitable pre-treatment.

The assessment of the potential significance of the traffic impacts, potential impacts and are included in Table 8-68.

8.2.13 Visual Impact Assessment

The VIA takes consideration of various factors in modelling and determining the visual impact.

One of the factors taken into consideration in determing the magnitude of the impact is determined area within which from where the project components will be visible (the zone of visual influence or ZVI) can be seen,

The ZVI was determined using the ESRI ArcGIS Viewshed routine. It takes consideration of the height of structures, contours and associated topography. The viewshed analysis for the ARC, which will be the highest structure indicated that approximately 20% of the route will be visible to sensitive receptors on the eastern side including the Groenewald and Nel homesteads and the Petlas and Chroma settlements. Operational and security light will be visible to the inhabitants on the eastern section but not directly visible to inhabitants on the western section.

The BS1/2 stockpiles will not be visible for any receptors. Sections of the access road and original powerline alignment will be visible to the same receptors as the ARC, although the vegetation will provide some natural screening. The ZVI will be low at the project will be visible from less than 50% of the receptors. The ZVI for the ARC which will be most visible is included in Figure 8-11.

The visual impact of an object in the landscape diminishes at an exponential rate as the distance between the observer and the object increase. The visual boundary from where most of the infrastructure will no longer be visible has been determine to be at 10km radius. The only receptors within 10km from the site it will be visible to are the immediate surrounding eastern inhabitants. It is not foreseen that there will be any impact on tourists or road users.

The next step in the VIA was to identify the spatial areas that may be affected more than others mainly due to their location and the ability to view from multiple components, called the visual index. From the Groenewald homestead the ARC, main access road, TFS2 and the powerline will be visible. The Nel homestead will observe the ARC and proposed TSF2. The receptors with the highest visual index are the Petla community who are within 2km from the site and the ARC, TSF211, powerline and main access road will be visible. The receptors most prone to view the infrastructure as determined from the visual index are included in Figure 8-12.

Once the ZVI, visibility and visual impact index has been established the next stage is to determine the ability of the natural environment to screen visual impact through topography and land cover. The proposed activities have been superimposed on a photographic simulation to determine the visual absorption capacity. From the simulation, has been determined that the absorption capacity is high, thereby assisting tp reduce the visual intrusion. Figure 8-13 provides the baseline view from the Petla community and Figure 8-14 a simulated view with the various infrastructure components superimposed. The Petla community view have been chosen as they could potentially be worst affected as a result of visual intrusion. The simulation makes provision for the proposed future TSF to assess the project's cumulative impact.

From the above analysis, the magnitude of the visual impact was determined as indicated in Table 8-58. The magnitude of the impact is considered low.

Figure 8-11 Zone of Visual Influence of the ARC

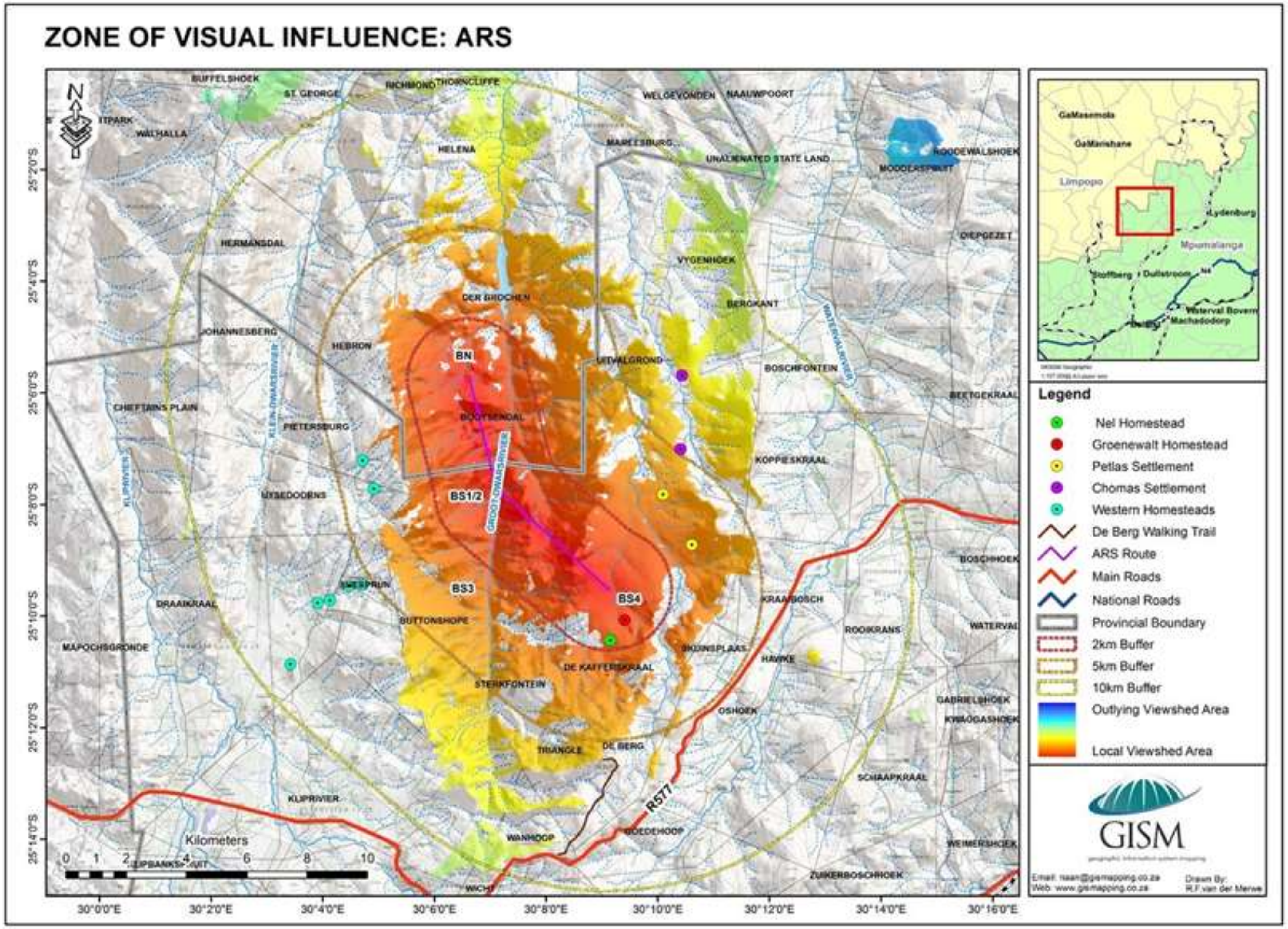


Figure 8-12 Visual Impact Index

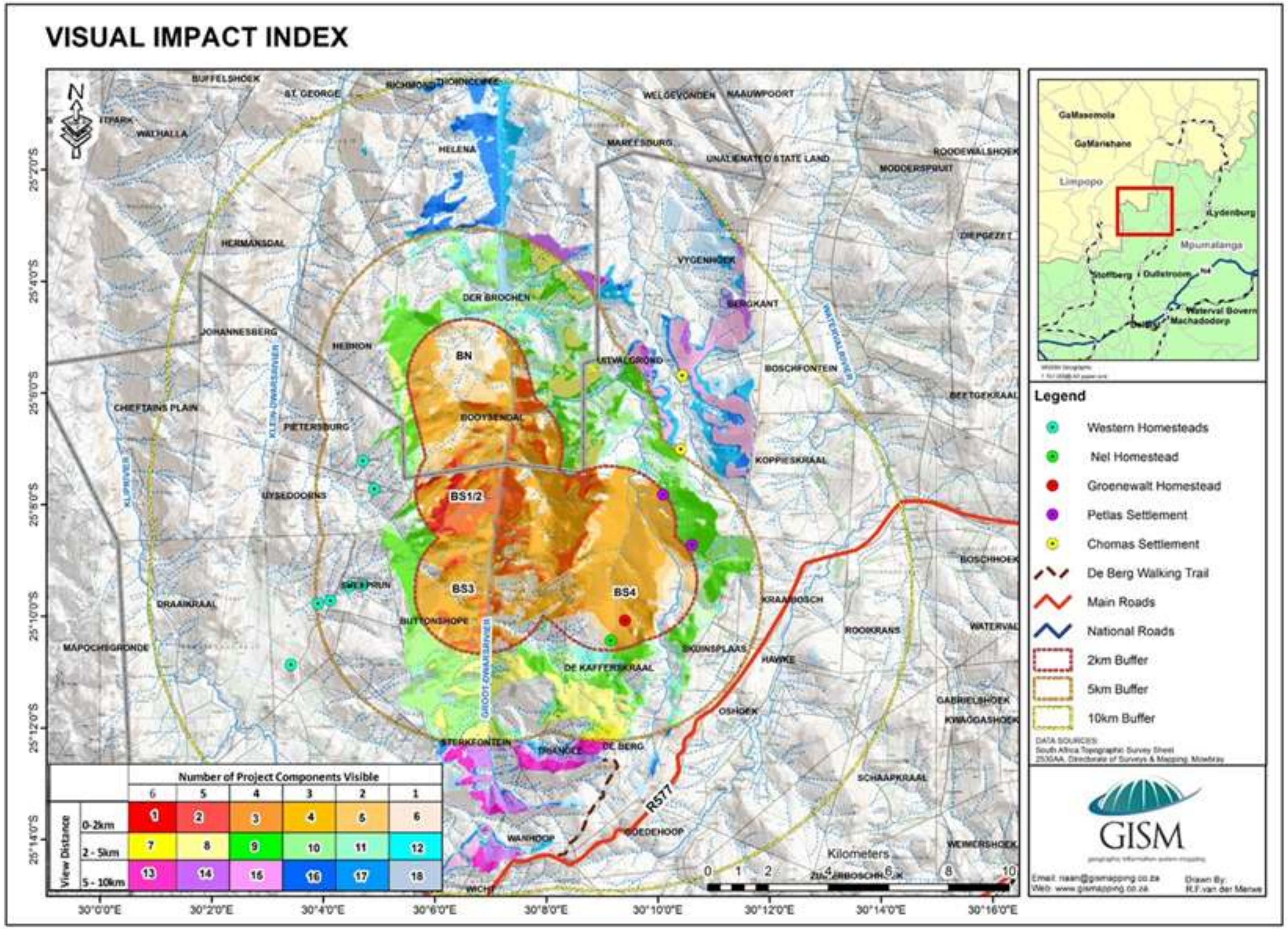


Figure 8-13 Baseline View from the Petla Community

Figure 8-14 View with Infrastructure Superimposed

Table 8-58 Potential Magnitude of the Visual Impact

	Quality of Visual Resource	Factors use to determine magnitude			Magnitude
		ZVI	Visual Distance	VAC	
Prior to construction	High to Low				
Construction & Operational Phase **Assuming mitigation is successful**		Low	High to Low	High (Low Impact)	Low
Closure Phase **(Assuming mitigation is successful)**		Low	High to Low	High (Low impact)	Low

To assess the significance of the visual impact the sensitivity of the visual receptors also had to be assessed. The visual receptors will be affected because of alterations to their views due to the proposed project. The cone of vision is relatively wide and the viewer tends to scan back and forth across the landscape. Residents of the affected environment are therefore classified as visual receptors of high sensitivity owing to their sustained visual exposure to the proposed development as well as their attentive interest towards their living environment.

The results from the VIA indicated that all impacts can be managed successfully to a minor or non-significant level with the implementation of mitigating and management measures: A summary of the impacts and required mitigating measures are provided in Table 8-62. For detail around the impact assessment refer to the specialist report in Annexure S.

Table 8-59 Visual Impacts and Management Requirements

Impact	Mitigating and Management Requirements
Landscape scarring	Concurrent rehabilitation and revegetation
Alteration of current landscape character and sense of place	An ecological approach to rehabilitation and vegetative screening measures, as opposed to a horticultural approach to landscaping should be adopted. For example, communities of indigenous plants enhance bio-diversity and blend well with existing vegetation. This ecological approach to landscaping costs significantly less to maintain than conventional landscaping methods and is more sustainable and would fit in more with the character of the landscape.
Cumulative Visual Impact as a result of expansion of the mining activities of the proposed project may increase the population growth and expand other associated infrastructure and economic	It is recommended that the TSF2 be designed with the aim of closure in mind. The design process should specifically address the geometry of the TSF2. The maximum height, area and shape of the TSF2 should be designed with regard to the area of land available, and as far as practical the final angle and shape of the TSF should blend with the natural landscape, providing that surface stability

activities, possibly reducing the visual quality of the visual resource further if not managed. Therefore, an overall cumulative degradation of the sense of place and visual resource quality is predicted.	can be achieved. Where appropriate the TMF2 should have a geometry that is irregular and does not look made-made. The gradient of the side slopes must be designed to accommodate self-succession of natural vegetation. Long unbroken slopes allow surface runoff to accelerate and may produce erosion gullies. For these reasons, it is recommended to design slopes of no greater than 20°, with benches every 7 - 10 metres of vertical height. Slopes below 20° will have reduced erosion hazards and will have a better change for re-vegetation to be successful. Top-soiling and grass seeding of the side slopes of the TSF2 should form part of concurrent rehabilitation of the TSF2. A combination of indigenous trees and shrubs should be planted adjacent to the TSF2 and auxiliary infrastructure as a 'buffer' and to partially screen views to the TSF2 were feasible.
Cumulative Visual Intrusion as a result Increased Mining	To reduce the potential of glare external surfaces of buildings and structures should be articulated or textured to create interplay of light and shade. Avoid shiny or bare metal. It is advisable to direct the slope of roofs away from critical views (e.g. homesteads and settlements).

One of the concerns expressed by the residents was the potential for night glow during the operational phase. The Project indicated that150W bulk head lights and 400W flood lights (pole mounted) at the box cut area and pollution control dam will be installed. The assessment of the significance of this impact prior and post mitigation as well as the required management measures are included in Table 8-63.

Table 8-60 Impact Significance from Operational and Security Lights

Impact Component	Impact 1	Significance prior to Mitigation	Significance with Mitigation
Activity	Operational and security lighting (construction and operational phase)		
Risk/ Impact	Light sources at night, particularly poorly directed security flood lighting, can influence the visual impact of the development. Unobstructed light sources can cause a general glow in the area and will be visible from significantly longer distances than any structural features during daylight hours.		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	CO, OP		
Nature of Impact	Negative		

Type of Impact	Direct: The impact of the proposed project after sunset will be direct for people travelling along adjacent local roads and local population living within the surrounding area. Residents and motorists would not be able to see the operational and security lighting from BS1/2 but rather a general glow emanating from the valley may be present. Cumulative: Operational and security lighting in and around the different sites might contribute to the cumulative effect of lights from the existing BS4 operation (e.g. general glow).		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely It is predicted that residents would not be able to see the operational and security lighting from BS1/2 directly as topography will screen any direct views from potential sensitive receptors. The cumulative impact caused by the general glow from the operational and security lighting is likely without mitigation. Mitigation measures could limit this general glow effectively.	3	2
Duration	Long term: Potential impacts could be mitigated or remediated once operations cease at the end of life of mine with dismantling of operational and security lighting equipment.	3	3
Extent	Area of Influence Wider region (e.g. mainly contained within the Groot-Dwarsrivier valley due to topography) as unobstructed light sources can cause a general glow in the area and will be visible from significantly longer distances than any structural features during daylight hours.	3	2
Receptor Sensitivity	Low: localised visual perceptions of the economically marginalised communities of the population may be influenced rather by the short term economic and job	1 - 3	1

	opportunities that will exist rather than the direct visual perception of the project. Moderate: Some residents (e.g. Western Homestead) have reported potential sensitivity to light pollution. These resident will not be able to observe any operational and security lights directly. The cumulative impact of the additional lights may create a general glow in the Groot-Dwarsrivier valley but it is very unlikely that it will impact the residents as the ridge line between the residents (western homesteads) and BS1/2 is around >700m in height. Mitigation measure will reduce this risk considerably.		
Magnitude	Low (Negative):	1	1
Impact Significance	Minor: Although the likelihood, duration, and spatial extent scores are relative high, the magnitude score is low. This reduces the significance of the operational and security lighting impact to a minor significance score and therefore a minor impact without mitigation.	Minor 12 1	Not Significant 8 1
Mitigating and Monitoring Requirements			
Required Management Measures	Security flood lighting and operational lighting should only be used where absolutely necessary and carefully directed, preferably away from sensitive viewing areas (e.g. Nearby homesteads and local roads). Wherever possible, lights should be directed downwards and shielded to avoid illuminating the sky and minimizing light spills.		
Required Monitoring (if any)	Long-term monitoring of light pollution should be implemented to assess effectiveness of mitigation measures. A grievance mechanism must be put in place in order for them to have a vehicle to raise their concerns. This could include environmental forum meetings and grievance register.		
Responsibility for implementation	Environmental Officer and Mine Manager		
Impact Finding			
Impact Finding	Impact can be managed through mitigation measures.		

Recommendations and Reasoned Opinion of the Visual Specialist

Due to the nature of infrastructure, especially the ARC and proposed future TSF2, screening management may not be sufficient. Management should therefore focus on the rehabilitation of disturbed areas and the implementation of the management measures included in Table 8-62 and 8-63.

In the opinion of the VIA specialist the project can proceed should all visual management and mitigating measures be implemented as this will contribute to visual impacts being on the order of minor to non-significant.

It is furthermore recommended that monitoring be done. The proposed monitoring requirements which is specific to the visual monitoring are included in Table 8-65.

Impact	Monitoring Locations	Parameters	Person Responsible	Frequency
Visibility of lights at night	At local visual receptor areas (e.g. homesteads, settlements)	Disturbance to sensitive visual receptors within the project study area.	Environmental Officer	Biannually

8.2.14 Social Impact Assessment

A summary of expected socio-economic impacts are provided in Table 8-61. An assessment of the significant impacts is further described. For detailed assessment refer to Annexure M.

Table 8-61 Socio-economic Impacts

Issue	Type of Impact	Impact
Existing Impacts (S24G)		
Economic	Positive	• Job creation and increased employment • Skills development and training • Multiplier effects on the local economy
	Negative	• Loss of access to livelihood activities • Tensions over employment opportunities
Social	Negative	• Increased tension between land claimants and land occupants • Increased mistrust for community leaders
Construction Phase		
Economic	Positive	• Job creation and increased employment • Skills development and training • Multiplier effects on the local economy
	Negative	• Loss of access to livelihood activities • Tensions over limited employment opportunities and procurement contracts

Social	Negative	• Increase in informal settlements as a result of influx • Increased pressure on social infrastructure and services as a result of influx • Increased livestock theft • Social unrest due to conflicts between work seekers and land occupants • Increased tension between land claimants and land occupants • Increase in social pathologies (teenage pregnancies, school drop-outs, alcohol and substance abuse)
Health and Safety	Negative	• Visual, noise and air quality impacts • Increase in communicable diseases • Increase in traffic and road accidents
Operational Phase		
Economic	Positive	• Job creation and increased employment • Skills development and training • Regional economic development • Contribution to the fiscals • Establishment and development of SMME's • Contribution to social infrastructure development through CSR and LED projects (i.e. SLP commitments)
	Negative	• Loss of access to livelihood activities • Tensions over limited employment opportunities and procurement contracts
Social, Cultural and Heritage	Positive	• Improved access to social services and infrastructure • Improved lifestyles
	Negative	• Increase in informal settlements as a result of influx • Increased pressure on local infrastructure and services as a result of influx • Social unrest due to conflicts between work seekers • Increased livestock theft • Increased tension between land claimants and land occupants • Increase in social pathologies (teenage pregnancies, school drop-outs, alcohol and substance abuse) • Erosion of local cultural values and morals • Loss of access to medicinal plants • Increased crime • Loss of access to cultural heritage sites
Health and Safety		• Visual, noise and air quality impacts • Increase in communicable diseases • Increase in traffic and road accidents
Decommissioning		
Economic	Positive	• Donation of mine infrastructure to local municipalities
	Negative	• Increase in job losses and unemployment • Loss of income for contractors • Loss of funding and support for social infrastructure development and social services • Loss of revenue for local municipalities
Social	Negative	• Increase in alcohol and substance abuse • Social dislocation due to out-migration • Decline in lifestyles
Health and Safety	Positive	• Decrease in traffic and road accidents

Cumulative Impacts	
	• An increase in traffic, road deuteriation and road accidents • Economic growth and the development of informal economies in communities neighbouring the mine site and along the R557 • Raised expectations regarding employment opportunities • Increased demand for housing in economic hubs neighbouring the proposed mine towns • Increased loss in access to arable land, ecosystem services and cultural heritage sites

As air quality, noise and visual impacts have been addressed by others the impact assessment of these specialists will be accepted.

Job Creation It is expected that the Section 24G project will create 2,746 direct and 4119 indirect job opportunities during the operational phase. In accordance to Booysendal's recruitment policy at least 60% of these opportunities must go to local people where the skills are available. The likely trickledown effect in the local economy and the high dependency ratio, the benefit that could be created through local employment and procurement could be significant. The benefits can be optimised as indicated in Table 8-62.

Table 8-62 Significance Rating of Job Creation

Impact Component	**Impact**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Direct and indirect employment generated during the construction, operations and closure phases of the proposed mine expansion project.		
Risk/ Impact	Job creation and increased employment opportunities		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	S24G, CO, OP, CL		
Nature of Impact	Positive		
Type of Impact	Direct and indirect		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	4
Duration	Long-term Even though the benefits derived from employment experience, skills development and training are permanent, it is likely that the	3	3

	economic benefits of employment will be mostly experienced during the Life of Mine, and seize during decommissioning and closure.		
Extent	Area of Influence Employment opportunities will affect the wider area of influence	3	3
Receptor Sensitivity	Moderate	3	3
Magnitude	Moderate	3	4
Impact Significance	Given the high levels of unemployment in the communities neighbouring the proposed mine site, the benefits of employment will be significant not only for those employed but also the wider area of influence including economic hubs and local vendors.	Moderate 12 3	High 13 4
Mitigating and Monitoring Requirements			
Required Management Measures	• Prioritise employing local workers if qualified applicants with the appropriate skills are available. • Formalise local employment procedures in Human Resources policies (HR Management Plan) and contractors' agreements. • Work with community representatives to develop open and transparent recruitment procedures that are disclosed to community members. • Use various mechanisms to advertise employment opportunities before construction of the project is initiated. • Provide or facilitate training of local people in mining and general business skills before and during mining activities, such as through internships, scholarships, and/or vocational and skills training programmes.		
Required Monitoring (if any)	Monitor the numbers of local employees		
Responsibility for implementation	HR Manager		
Impact Finding			
Impact Finding	Impact can be enhanced through HR policies and Social Labour Plan skills development and training programmes.		

a) Skills Development and Training

Literacy levels in the communities remain low especially due to the early drop-offs before Grade 12. It is envisaged that local employment opportunities will be limited to predominantly semi-skilled and unskilled persons. Unskilled workers employed during the construction and operations phase will need to receive skills development and training. Booysendal Mine will need to develop and implement skills development and training programmes that target both employees and the broader populations. Skills development and capacity building is fundamental to local employment generation, sustainable development and poverty alleviation in the area, particularly amongst the youth. This include the expansion and continuation with current learnership and training programmes. Refer to Table 8-63 for impact assessment.

Table 8-63 Skills Development and Training Impact Assessment

Impact Component	**Impact**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	Provide skills development and training		
Risk/ Impact	Improved skills and employability of local community members		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	S24G, CO, OP, CL		
Nature of Impact	Positive		
Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	4
Duration	Permanent The benefits derived from skills development and training are permanent.	2	4
Extent	Area of Influence Skills development and training will affect the wider area of influence	1	2
Receptor Sensitivity	Moderate	1	3
Magnitude	Moderate	2	4
Impact Significance	Skills development and training will assist with improving employment opportunities with the mine and other	Minor 7 2	High 13 4

	businesses in the broader Area of Influence.		
Mitigating and Monitoring Requirements			
Required Management Measures	• Develop and implement skills development and training programmes that target both employees and the broader populations. • Provide or facilitate training of local people in mining and general business skills before and during mining activities, such as through internships, scholarships, and/or vocational and skills training programmes.		
Required Monitoring (if any)	Monitor the numbers of training programmes, participants and and pass rates Track employment and recruitment post training		
Responsibility for implementation	HR Manager		
Impact Finding			
Impact Finding	Impact can be enhanced through HR policies and Social Labour Plan skills development and training programmes.		

a. Regional Economic Development and Government Revenue

Regional spending in support of the mining operations is another direct positive project impact. It is expected that Government will derive revenue from the expansion project through various forms of taxes and mineral royalties applicable to mining companies. The revenue can be utilised by Government, to fund for community development programmes and improved service delivery in the GTLM and the TCLM.

As the mine cannot prescribe how taxes should be used it is recommended that the mine consult with the Government to promote social development in the communities neighbouring the mine.

At mine closure, the revenue generated by the mine will seize. No revenue will be earned by the Government, which could negatively affect government spending on social services in the area if not properly planned for. The EAP is of the opinion that management measure should be looked at. It is recommended that the mine work with Government to ensure that the future effects of mine closure is managed and mitigated. Proper schooling and training will provide skills bases outside of the mining environment.

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	The Government will derive revenue from the expansion project through various forms of taxes and mineral royalties applicable to mining companies, including but not limited to import duties, corporate tax, contributions to social funds, and value added tax		
Risk/ Impact	Regional economic development and contributions to government revenue		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	S24G, CO, OP		
Nature of Impact	Positive		
Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Definite Likelihood	4	
Duration	Long Term	3	
Extent	Regional/Provincial/National	4	
Receptor Sensitivity	High	4	
Magnitude	High	4	
Impact Significance	The revenue derived from mining can be utilised by the Government, and the Greater Tubatse Local Municipality in Limpopo and the Thaba Tchweu Local Municipality in Mpumalanga in particular, for community development programmes and improved service delivery.	High 15 4	
Mitigating and Monitoring Requirements			

Required Management Measures	• Not applicable
Required Monitoring (if any)	• Not applicable
Responsibility for implementation	None
Impact Finding	
Impact Finding	The positive benefits of the impact are high and do not require mitigation.

d) Social Infrastructure Development through CSR, LED Programmes and SLP Commitments

Currently the social services in the project area are limited and severely under resourced. In the four communities neighbouring the proposed expansion project mine there are no clinics. Water is generally sourced from rivers and springs, and the majority of the population make use of the bush for the toilet. There are also no formal refuse removal services and communities generally bury and burn their refuse or throw it into the surrounding bush. Even though all communities have at least one primary school nearby; only one community has access to a secondary school. As such there is a significant opportunity to contribute to the upliftment of living conditions, living standards and overall development

Booysendal Mine must revise the current SLP for the mine expansion project that outlines service delivery and infrastructure development initiatives. This includes a review of LED and IDP programmes for improved service delivery in the Project Area and agreements with local authorities how this will be realised. Where feasible, the Booysendal Mine will prioritise partnering with local government to improve the quality and sustainability of existing social services and infrastructure development programmes. Impact assessment is included in Table 8-64

Table 8-64 Social Infrastructure Development

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	Booysendal Mine will prepare a SLP for the mine expansion project that outlines service delivery and infrastructure development initiatives.		
Risk/ Impact	Social infrastructure development through CSR and LED programmes		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	CO, OP		

Nature of Impact	Positive		
Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Possible	3	4
Duration	Long Term Impacts will continue beyond the life of mine	3	4
Extent	Regional The impact of SLP programmes is of regional importance	3	4
Receptor Sensitivity	Moderate	2	3
Magnitude	High	3	4
Impact Significance	Significant positive change will result from the development initiatives in an area currently characterised by poor infrastructure and service delivery.	Moderate 11 3	High 15 4
Mitigating and Monitoring Requirements			
Required Management Measures	• Review LED and IDP programmes for improved service delivery in the Project Area. • Prepare a SLP for the mine expansion project that outlines service delivery and infrastructure development initiatives. • Where feasible, Booysendal Mine will prioritise partnering with local government to improve the quality and sustainability of *existing* social services and infrastructure development programmes. • SLP initiatives will be developed and implemented in consultation with local government and local communities. • Booysendal Mine can also consider, where feasible, donating project-related infrastructure to the local municipalities and neighbouring communities. This will be addressed in a Mine Closure Plan.		
Required Monitoring (if any)	Monitor SLP programmes and initiatives to determine sustainability, impacts on livelihoods and improved living standards of project beneficiaries.		

Responsibility for implementation	HR Manager
Impact Finding	
Impact Finding	Impacts can be enhanced by developing a SLP – in partnership with the Government and local communities – that aims to prioritise service delivery and infrastructure development initiatives.

e) Influx and Informal Settlements

Mining development is most commonly associated with the influx from people in search of jobs and opportunistic opportunities. This puts strain on the local services and infrastructure and additional pressure on the natural resources. To reduce these impacts, mitigating and management measures are proposed in Table 8-65.

Table 8-65 Influx of People and Informal Settlements

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	Influx of job seekers, informal vendors, and criminal opportunists into the Project Area in search of employment and other economic opportunities.		
Risk/ Impact	Increase in informal settlements as a result of influx		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	CO, OP		
Nature of Impact	Negative		
Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	4	3
Duration	Short Term Impacts can be mitigated and reversed	3	2
Extent	Area of Influence The impact of influx will affect the wider area of influence	3	3
Receptor Sensitivity	Moderate	4	3

Magnitude	Moderate	4	3
Impact Significance	Influx and the establishment of informal settlement is already occurring in the communities neighbouring the proposed mine site.	High 14 -4	Moderate 11 -3
Mitigating and Monitoring Requirements			
Required Management Measures	• Identify social management plans (i.e. Social Labour Plan and Stakeholder Engagement Plan) that can integrate aspects of an influx management strategy. • Define and identify who qualifies as a project affected person, and what benefits these individuals will receive. • Prevent illegal squatting by assisting community leaders with developing and implementing a land management system. • Adopt and disseminate clear and decisive labour and recruitment policies that promote the interests of local residents and discourage opportunity seekers settling in the area.		
Required Monitoring (if any)	Work closely with community leaders and representatives to monitor the number and size of informal settlements.		
Responsibility for implementation	HR Manager		
Impact Finding			
Impact Finding	Although influx is typically a difficult impact to manage, it is possible to reduce influx and to mitigate the impacts caused by influx by identifying social management plans (i.e. Social Labour Plan and Stakeholder Engagement Plan) that can integrate aspects of an influx management strategy.		

f) Increase in Social Pathologies

Often an increase in social pathologies is a direct result of influx and increased income for some coupled by few economic opportunities for others, and according to community members, crime has increased substantially over the past few years as fewer jobs are available and more people move in to the area. Other potential pathologies are alcohol misuse, rape, and violent behaviour. Management and mitigating measures are included in Table 8-66.

Table 8-66 Increase in Social Pathologies

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	Existing social pathologies increase as a result of influx, and improved economic opportunities.		
Risk/ Impact	Increase in social pathologies (teenage pregnancies, school drop-outs, alcohol and substance abuse, crime)		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	CO, OP, CL		
Nature of Impact	Negative		
Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	4	3
Duration	Short term Impacts can be mitigated and reversed within a short period	3	2
Extent	Site Impacts will be confined to site	3	2
Receptor Sensitivity	Moderate	4	3
Magnitude	Moderate	4	3
Impact Significance	Social pathologies are already occurring in the communities neighbouring the proposed mine site, and will be exacerbated if not managed.	High 14 -4	Moderate 10 -3
Mitigating and Monitoring Requirements			
Required Management Measures	• Adopt a clear Code of Conduct which defines the proper behaviour of employees in neighbouring communities (including contractors); and		

	• Employees must be prohibited from abusing alcohol and drugs, and stringent measures should be put in place to address offenders.
Required Monitoring (if any)	Work closely with community leaders and representatives to monitor increases in social pathologies.
Responsibility for implementation	HR Manager
Impact Finding	
Impact Finding	Social pathologies can be mitigated through appropriate HR policies and interventions that aim to ensure proper employee interactions with community members.

g) Increase in Communicable Diseases

Sexually transferable diseases, HIV/Aids, Tuberculosis and others could increase as a result of the influx of people, increase in prostitution etc. The potential significance of the impacts and required management and mitigating measures are included in Table 8-67.

Table 8-67 Communicable Diseases

Impact Component	**Impact**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	The proposed project has the potential to contribute to the spread of communicable diseases, and although HIV/AIDS and Sexually Transmitted Diseases (STDs) were not common ailments reported in the Project Area, Tuberculosis (TB) was identified as a public healthcare challenge in the immediate Project Area.		
Risk/ Impact	Increase in communicable diseases		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	CO, OP		
Nature of Impact	Negative		
Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation

Likelihood/ probability	Likely	4	2
Duration	Short term Impacts can be mitigated and reduced	3	2
Extent	Site Impacts will be confined to site	3	2
Receptor Sensitivity	Moderate	4	3
Magnitude	Moderate	4	3
Impact Significance	Communicable diseases will increase, if not managed.	High 14 -4	Moderate 9 -3
Mitigating and Monitoring Requirements			
Required Management Measures	• Work with the government and local implementing partners to support an integrated HIV and TB prevention and management programme that considers the workplace, local communities and high risk populations such as women and truckers. • Develop and implement an HIV/AIDS awareness programme that includes adequate access to HIV/AIDS-related information and condoms for all employees. Contractors are expected to develop similar procedures. • Support intensive information, education and communication (IEC) campaigns on communicable diseases in the workplace and neighbouring communities. • Support capacity building for the local government, NGO and community partners who would provide HIV and TB prevention, diagnosis and treatment services.		
Required Monitoring (if any)	• Work with local government, healthcare providers and community partners to monitor HIV and TB infection rates, diagnosis and treatment services.		
Responsibility for implementation	HR Manager		
Impact Finding			

Impact Finding	The impact can be managed through HR policies that aim to ensure proper employee interactions with community members.

Table 8-68 Increase in Traffic

Impact Component	**Impact**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	During the construction phase there will be significantly more vehicle movements on the R577 due to the delivery of equipment, construction materials, and the transportation of workers. Operational phase traffic will include approximately 850 return trips		
Risk/ Impact	Increase traffic and road accidents. Increase in pedestrian accidents		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	CO, OP		
Nature of Impact	Negative		
Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	4	3
Duration	Short term Impacts can be mitigated and reversed within a short period	3	2
Extent	Site Impacts will be confined to site	3	2
Receptor Sensitivity	Moderate	4	3
Magnitude	Moderate	4	3

Impact Significance	Increased traffic and road accidents are likely to occur, if not mitigated and managed.	High 14 -4	Moderate 10 -3
Mitigating and Monitoring Requirements			
Required Management Measures	• Mine traffic should be managed through a Transport Management Plan. This management plan might include provisions for speed bumps, road safety signs, as well as, facilitating road safety training and education programmes.		
Required Monitoring (if any)	Management and monitoring measures will be detailed in a Transport Management Plan.		
Responsibility for implementation	HR Manager		
Impact Finding			
Impact Finding	The impact can be managed through a Transport Management Plan.		

h) Cumulative Social Impacts

Traffic increase and deterioration of roads is definitely foreseen as a result of the development activities. The cumulative assessment is included in Table 8-69. In addition, the development of informal economies is also expected. The cumulative assessment is included in Table 8-70.

Table 8-69 Increase in Traffic, Road Deterioration and Road Accidents

Impact Component	Impact	Significance prior to Mitigation	Significance with Mitigation
Activity	Cumulative economic benefits accruing from the proposed mine include; increasing existing employment and job creation opportunities in the Project Area, and increasing money circulating in local economies.		
Risk/ Impact	Economic growth and the development of informal economies in communities neighbouring the mine site and along the R557		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	CO, OP, CL		

Nature of Impact	Positive		
Type of Impact	Direct and indirect		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	3	4
Duration	Long-term Even though the benefits derived from employment experience, skills development and training are permanent, it is likely that the economic benefits of employment will be mostly experienced during the Life of Mine, and seize during decommissioning and closure.	3	3
Extent	Area of Influence Employment opportunities will affect the wider area of influence	3	3
Receptor Sensitivity	Moderate	3	3
Magnitude	Moderate	3	4
Impact Significance	Given the high levels of unemployment in the communities neighbouring the proposed mine site, the benefits of employment will be significant not only for those employed but also the wider area of influence including economic hubs and local vendors.	Moderate 12 3	High 13 4
Mitigating and Monitoring Requirements			

Required Management Measures	Develop SLP programmes that aim to: • Prioritise employing local workers if qualified applicants with the appropriate skills are available. • Formalise local employment procedures in Human Resources policies (HR Management Plan) and contractors' agreements. • Work with community representatives to develop open and transparent recruitment procedures that are disclosed to community members.
Required Monitoring (if any)	Monitor the numbers of local employees
Responsibility for implementation	HR Manager
Impact Finding	
Impact Finding	Impact can be enhanced through HR policies and Social Labour Plan skills development and training programmes.

Table 8-70 Development of Informal Economies

Impact Component	**Impact**	**Significance prior to Mitigation**	**Significance with Mitigation**
Activity	The launch of mining construction activities could result in a surge in community expectations. These expectations need to be tempered before construction activities commence.		
Risk/ Impact	Raised expectations regarding employment opportunities		
Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure	CO, OP		
Nature of Impact	Negative		
Type of Impact	Direct		
	Define Significance Categories	Significance Prior to Mitigation	Significance With Mitigation
Likelihood/ probability	Likely	4	3
Duration	Short term	3	2

	The impact can be reduced within a short period of time		
Extent	Site The impact is felt by communities neighbouring the proposed mine site	3	2
Receptor Sensitivity	Minor	4	2
Magnitude	Minor	4	2
Impact Significance	Community expectations for employment opportunities are high.	High 14 -4	Minor 9 -2
Mitigating and Monitoring Requirements			
Required Management Measures	• Ensure that communities in the Project Area are aware that only a limited number of employment opportunities will be created through these developments.		
Required Monitoring (if any)	Consult regularly with community leaders and representatives to monitor community expectations.		
Responsibility for implementation	HR Manager		
Impact Finding			
Impact Finding	Expectations are already high and can be managed through a Stakeholder Engagement Plan.		

Recommendations and Reasoned Opinion of the Social Specialist

The social specialist is of the opinion that social and economic impacts can be mitigated, managed and positive impacts enhanced. This should be done through the following avenues:

- Updating the SLP to cater for the TCLM;
- HR and Procurement Policies;
- Stakeholder Engagement Plan which also reaches out to the ordinary man on the street;
- Update and implementation of the Cultural Heritage Management Plan; and
- Development and implementation of a Transport Management Plan.

8.2.15 Cultural-Heritage Impact Assessment

The location of the cultural-heritage sites in relation to the development footprints are clearly indicated in Figure 4-40.

Clearing in the area of BS1/2 and construction of the BS1/2 terrace lead to the destruction of:

- Historical ruins (indicated as 355 and 356 in Figure 4-42);
- Iron Age features number 610, 6111, 612, 614, 615, 616 and 617 have been destroyed.

The location of these finds in relation to the development is included in Figure 8-15 and Figure 8-16.

The construction of the ARC could possibly impact in one section on the Historic Village HV02 as it is possible that one of the towers will be constructed in the site.

The significance of the impacts on the heritage sites are included in Table 8-71

As indicated previously in Section 4, NHRA has prescribed a methodology which has to be used to determine the significance of impacts on heritage sites. This rating is based on the use of 2 rating (grading) schemes, namely:

- A scheme of criteria which outline places and objects as part of the national estate as they have cultural-historical significance or other special value (outlined in Section 3 of the NHRA [Act No 25 of 1999].
- A field rating scheme according to which heritage resources are graded in three tiers (levels) of significance based on the regional occurrence of heritage resources (Section 7 of the NHRA [Act No 25 of 1999).

The criteria for the rating is included in more detail in the Specialist Report (Annexure R).

Figure 8-15 Iron Age Sites Destroyed in the Northern Section of the BS1/2 Footprint (Source: JCC Pistorius, June 2017)

Figure 8-16 Destruction of Iron Age Sites in the Central BS1/2 Area (Source: JCC Pistorius, June 2017)

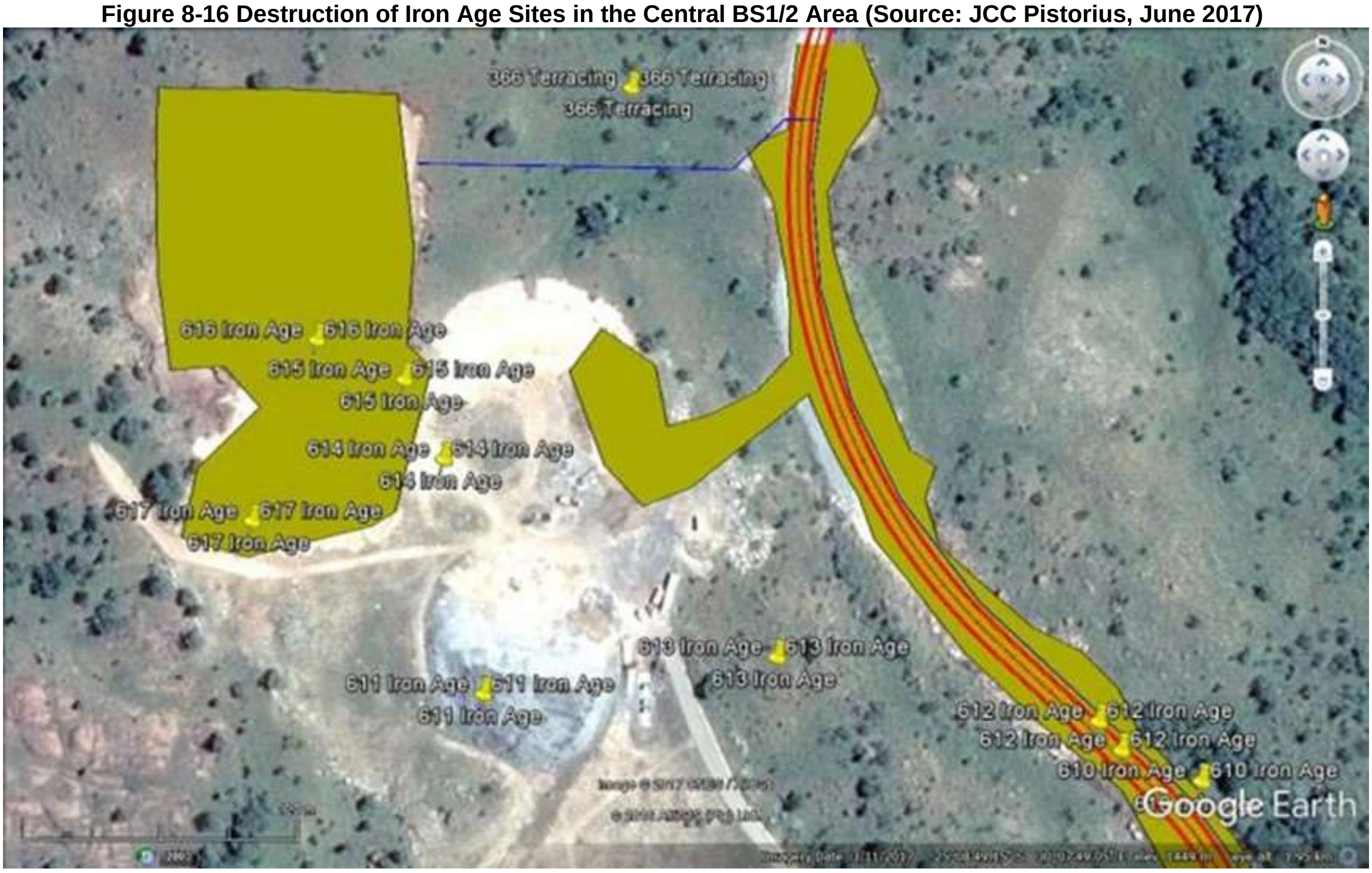


Table 8-71 Significance Rating Cultural-heritage Sites Impacted

Heritage Resources Impacted by the Section 24G Activities				
Legend on Map	**Heritage resource**	**Significance**	**Motivation**	**Cause of impact**
355 **356**	Historical ruins Historical ruins	Low-medium Low-medium	See rating below See rating below	**BS1/2 Infrastructure**
610 **612**	Iron Age feature Iron Age feature	Low-medium Low-medium	See rating below See rating below	**BS1/2 Infrastructure**
611 **614**	Iron Age feature Iron Age feature	Low-medium Low-medium	See rating below See rating below	**Cleared area** **Cleared area**
615 **616** **617**	Iron Age feature Iron Age feature Iron Age feature	Low-medium Low-medium Low-medium	See rating below See rating below See rating below	**Cleared area** **Cleared area** **Cleared area**
Heritage Resources to Potentially be Impacted by the Section 24G Activities				
Legend on map		**Significance**	**Motivation**	**Cause of impact**
HV02	Iron Age and or historical ruins	Low-medium	See rating below	**ARS**

In addition to the historic sites there were also gravesites and graves in the footprint area of the BS1/2 development. Relocation permits for the removal of these graves were obtained and the graves were moved in consultation and with the families present.

Cumulative impacts on the cultural-heritage are foreseen due to the following:

- An increase in population numbers and settlements due to job creation. These settlements may expand and further expose or damage heritage resources. This also includes the possible looting of archaeological sites whether to be utilized for building material or for the illegal collecting of artefacts.
- The Booysendal South Expansion Project is but one of a number of developmental projects in the Groot Dwars River Valley which all have a detrimental influence on the archaeological record and cultural landscape of this ecozone.
- Due to the magnitude, size and surface area to be covered by the project and probably to be increased in the future the archaeological record of the mining area can be obliterated. This increasing the importance of managing the recorded heritage resources in a responsible manner.
- Heritage resources deliberately destroyed by the project as well as those of low significance which are studied before they are destroyed all contribute to the context and significance of the larger cultural landscape.
- Cultural historical landscapes and heritage resources are non- renewable and cannot be replaced once they have been altered or destroyed.

Management measures applicable to the heritage resources include:

- Regular six monthly inspection of heritage resources and ensuring its protection;
- Obtaining permits from SAHRA for the mitigating work;
- Maintain at least a 30m corridor from the outer edge of graves and heritage resource and any development footprint;
- Demarcated and fence all gravesites;

Recommendations and Reasoned Opinion

The cultural-historical remains in the Booysendal South Expansion Project Area do not have outstanding heritage significance. Most of the remains have been recorded and have been briefly described. It seems as if no graves or graveyards will be impacted by the development. These remains have high significance and may not be affected by the project prior to alternative legal arrangements and approval.

A limited number of historical remains have been destroyed as a result of S24G activities whilst a historical village may be affected when the ARC system is constructed. Mitigation measures have been proposed and management measures have been outlined in the Heritage EMP which have been further incorporated in the overall EMP for the remaining heritage resources in the Booysendal South Expansion Project Area.

There is no reason from a heritage point of view why the proposed Booysendal South Expansion Project considering all alternatives discussed herein, cannot proceed if the mitigation and management measures recommended in Cultural-Heritage Report and accompanying EMP have been implemented.

Note: It is important to note that the management measures for the impacts have been included in the EMP in great detail as this will become a working document for implementation on site and which will be legally binding. The EMP consists of the main document and the management plans prepared by specialists.

9. RECOMMENDATIONS OF THE ENVIRONMENTAL ASSESSMENT PRACTITIONER

9.1 REASONED OPINION

Mining projects by their nature imply that there will be negative impacts to the environment. The aim should always be for the positive impacts to outweigh the negative impacts.

It is the EAPs opinion that irreversible damage has been caused to some critical biodiversity areas and conservation important species in the project area by the ongoing construction activities. There is no doubt that some of these impacts on Critical Biodiversity areas could have been avoided though detailed overall project planning and alternative assessments based on avoidance of environmental sensitivities and the pro-active management of risks. The residual impacts caused by the Section 24G impacts on the sensitive terrestrial, wetland and aquatic ecological system is in most instances irreversible. Unmitigated these impacts present a fatal flaw for the project.

The fact, however, remains that these impacts have unfortunately occurred and cannot now be avoided. Therefore, it is imperative that the impacts be managed and mitigated.

For authorisation to be granted the EAP believes the current biodiversity off-set strategy must be conclude and implemented. The off-set needs to be agreed with the relevant authorities, meet the offset requirements stipulated in the Draft National Biodiversity Off-set Policy (GG40733 GN276 of 31 March 2017) and must take consideration of the off-set requirements stipulated in the EMP and the specialist studies. The successful conclusion of an implementation agreement (including reference to appropriate management plans for Mining Right area and Offset area) with DMR, MTPA and DEA will be the only acceptable mitigation for this impact. Thus, it is recommended that the successful conclusion of the implementation agreement should be a suspensive clause in a possible Environmental Authorisation precluding Booysendal from continuing with the listed activities until the agreement is in place.

In addition, it is of the utmost importance that the management measures summarised in the EIA and detailed in the EMP are implemented immediately and that compliance to these be externally audited on a monthly basis pending the decision of the authorisation and for the duration of the operation should the project be authorised. Due to the sensitivity of the affected areas robust risk assessments which takes consideration of the environmental sensitivities, method statements which ensures that the risks are avoided and robust pro-active management measures are required. Unwavering commitment from all involved will be required to ensure that the impacts which can be remedied are successfully addressed. It is important that awareness training on the sensitivity of this environment be given to all to embed a better understanding of the sensitivity of the project area.

It is important that the overall project definition be finalised and signed off to avoid any unwanted clearance before any additional construction activities are undertaken. Where new clearance activities are planned as part of the Section 24G project or as part of future development, sensitive areas need to be avoided this include Protected Area Buffer Zones, as required by legislation and stipulated for the project in Table 9-1. These zones need to be strictly adhered to so that impacts on these sensitive environments from the project activities are reduced. It is, however, acknowledged that some deterioration of habitat condition will occur due to the project activities but these impacts need to be minimised through the recommended mitigation and management and some minimum targets have been set out in the EMPr for wetlands as one of the most vulnerable areas.

Table 9-1 Protected Area Buffer Zones for the Project

	Buffer Zone
Fauna	
All wetlands	500m
Cliff face and all sheet rock	30m
Flora	
All *Zantedeschia pentlandii* **(VU)**	500-600m
Critical Biodiversity Areas	100m
Watercourses and drainage lines	100yr floodline or 100m whichever is furthest

In addition, any new clearance undertaken, should be done in accordance with the findings of the specialist reports including avoiding the no-go areas identified by the soil specialist as included in Figure 4-6. It is imperative to protect the identified and, yet, undiscovered heritage resources which requires a heritage specialist to be on hand to advise on any chance finds during clearance and excavation activities.

Monitoring should be done in accordance with the requirements (parameters, type of monitoring, frequency of monitoring etc) included in the EMP. A summary of the monitoring programmes required are included in Table 9-2.

Table 9-2 Monitoring Plan for Booysendal South Expansion

Aspect	Component	Frequency of Monitoring
Surface water	Surface water quality	Monthly
	Water consumption levels	Weekly
Ground water	Ground water quality	Monthly/Quarterly
Bio-monitoring	Biological integrity of aquatic habitats	Biannually
Air quality	Dust fallout	Monthly
Ecology	Condition of CI floral species	Weekly
	Bird collision risk	Monthly
	Sediment composition in Groot Dwars River	Quarterly
	Camera trapping	Quarterly
	Indigenous vegetation recovery	Biannually
	Abundance of *Pycna Sylvia*	Annually
Wetlands	Wetland health and vegetation	Every two years
Soils	Soil quality	Every two years
Noise	Noise emissions	Quarterly
Visual and aesthetics	Light visibility	Biannually
	Rehabilitated vegetation growth	Annually
	Airborne dust	Quarterly
Performance assessment	Assessment of compliance to EMP commitments	Annually
Water Use Licence (WUL)	Audit of compliance to WUL commitments	Annually

The positive impacts which can result from the project cannot be denied. The project has the potential to create a significant amount of much needed local jobs, contribute to business development and social investment and be an economic impetus in an area where socio-economic conditions can, from the social data provided, be described as dire. The positive socio-economic trickle-down effect that a development of this nature can have can be significant in terms of social upliftment, investment, skills development and investment into community infrastructure as stipulated in the SLP. The national and regional socio-economic advantages through tax contribution is also significance in an industry where it becomes increasingly difficult to operate in. With a life of mine more than 40 years the long term positive socio-economic impacts are much needed. The potential negative social impacts which are normally associated with mining developments could be manged and mitigated but it will be necessary to take hands with local government and develop and implement strategies.

It might be more detrimental to the environment and the surrounding people who can so desperately benefit from the project to now cease the operations. It is therefore, the EAPs opinion that authorisation be granted with the condition that the off-set requirements, the requirements set out in the EMP and any requirements which the commenting authorities or competent authority have are met.

9.2 CONDITIONS FOR AUTHORISATION

It is recommended that the following be included as conditions for authorisation:

- The successful conclusion of the Biodiversity Offset implementation agreement should be a suspensive clause in the Environmental Authorisation, precluding Booysendal from continuing with the listed activities until the agreement is concluded.
-
- All new footprint areas must avoid biodiversity sensitive areas. Ares to be cleared must be surveyed by an experienced, qualified terrestrial ecologist before any clearance commence to assist in identify CI species and rescuing these to the nursery. Rescuing of fauna should as far as feasibly possible be done;
- All construction footprints for which construction commenced and all new activities need to be barricaded with barricading that will ensure that there is no encroachment outside of footprint areas during construction and into the operational phase. For this purpose, barricading tape is deemed insufficient;
- The potential impact of drawdown on wetlands must be better understood. It is therefore recommended that wetland modelling be undertaken and that potential risks be mitigated before the operational phase commence;
- Genetic work must be done to gain a better understanding of the IUCN Red Listed *Enteromius cf. motebensis* The water quality, including water temperature of any water decanted or discharged need to comply to the Reserve water quality limits;
- Penalties must be enforced on all contractors who do not comply with the conditions of authorisation, “Safe Operating Procedure: Environmental Construction Requirements: BSD-BNU-SHEQ-ENV-PRC-006-” or the conditions and recommendations in the various EMPs. All work in areas of non-compliance must be stopped until rehabilitation has been undertaken. Rehabilitation cost must be carried by the contractor and must be carried out by a rehabilitation specialist approved by DMR or delegated

authority. Should additional offset be required because of non-compliance this cost should also be carried by the contractor;

- The main contractor with Booysendal should be ultimately responsible for environmental compliance;
- Each contractor must appoint an ECO/EO to manage environmental compliance with the support of the contractor project manager;
- All construction activities must be preceded by an environmental risk assessment, method statement, and management measures. This should be signed off by the Mine Manager or a person duly delegated to do so;
- An environmental engineer must oversee all final design and construction activities considering the findings included in the specialist reports;
- Immediate and proper action towards soil conservation and maintaining soil quality is required. Proper land rehabilitation should commence and rigorous monitoring of soil management should be part of this project going forward.
- The lining of TSF1 with a Type 3 liner;
- All identified heritage and grave sites should be fenced. Access arrangements with the relevant communities should be agreed.
- Continuation of the current groundwater monitoring program (Refer to the EMP for detail) and addition of monitoring boreholes around the BS2 construction/mining area. Monitoring should be done monthly for the first hydrological cycle. Current variables need to be monitored and SOG's with the option of VPH's if high concentrations were recorded at any of the BS2 surface or groundwater localities as well as the Dwars River and its tributaries.
- Sealing of high yielding structures which will limit groundwater inflow into the underground workings;
- Lining of all PCDs with a HDPE liner;
- All potential dirty water structures must be constructed per the Department of Water and Sanitation Best Practice Guidelines;
- Plugging of valley boxcut decant after mine closure;
- Construction and operation of a water treatment plant to treat decant should it spill into the environment or where water quality in the Groot Dwars River indicates deterioration in trends;
- Development at BS3 should be limited to the development of one or two vent shafts, which should be in existing disturbed areas such as the upper exploration track, and no further south than 100m north of the Waterfall Tributary 2, powerline, 4m access road on existing alignment of exploration track, generators for back-up power. Due to the sensitivity of the environment, no surface development south from BS1/2 should be considered other than the BS3 infrastructure herewith mentioned;
- A biodiversity management plan which addresses impacts, mitigation, monitoring, management of offsets, rehabilitation targets, and alien and invasive irradiation must be prepared within three months of the authorisation been granted.
- All mitigation must be strictly applied and an offset strategy must be formulated. This needs to be authorised and approved by the relevant authorities (including the MTPA). This offset should secure areas for protection in a manner that is legally binding in the long term and includes long-term provision for the finances, management, monitoring, auditing and reporting of the conserved area. The offset should aim to safeguard and rehabilitate habitat for *Enteromius cf. motebensis* to ensure its survival in perpetuity and should also aim to offset the loss of biodiversity within a FEPA catchment.

- The PES of the river downstream of the confluence with the Everest Tributary should not drop below a Category C.
- No perennial watercourse (and its associated buffer) should be under-mined. This includes the Waterfall Tributary (and associated buffer of at least 200 metres) which overlies the Merensky Reef (to be under-mined via the Merensky Portal North).
- Regarding the proposed future mining at BS3, it is our opinion that this mining should not be approved if located within 500 metres of the Groot Dwars River. This reach of the river contains the highest habitat availability for, and abundance of, the rare and threatened *E. cf. motebensis* and the future survival of this species cannot be guaranteed at this stage, if mining goes ahead. Approval should only be considered if a like-for-like offset can be achieved and/or the future survival of this species can be guaranteed pending a comprehensive genetic and ecological assessment to determine the genetic uniqueness, distribution and habitat requirements of *E. cf. motebensis* within the valley. Ideally, this reach of the Groot Dwars River should be included in the offset and mining at BS3 should be avoided altogether.
- Backfilling of the defunct Everest Mine with tailings from TSF1 should not proceed until the long-term water quality impacts to the receiving Groot Dwars River (particularly in terms of the quality and quantity of decant water post-closure) is known and can be effectively mitigated to minor significance. In addition, construction of the Tailings Storage Facility (TSF2) should only proceed on condition that all mitigation be strictly applied and that groundwater quality impacts to the Everest Tributary can be reduced to minor significance.
- Full implementation of the proposed wetland mitigation strategy and associated biodiversity offset strategy prior to the commencement of operational mining;
- No further direct disturbances to the Groot Dwars River and associated riparian wetland. The Groot Dwars River and associated riparian wetland/habitat as well as a 100m buffer zone should be considered a No-Go area for any developments;
- No additional road or infrastructure crossings across the Groot Dwars River other than those proposed as part of this application. All other crossings need to be rehabilitated to enhance aquatic biodiversity and fish migration;
- Total suspended solids, dissolved oxygen and screening of oil and grease (SOG) must be added to the surface water monitoring program. Should SOG concentrations be found to exceed drinking water quality limits Total Petroleum Hydrocarbon analyses should also be added.
- A soil quality audit should be conducted every second year that will measure the soil quality;
- Implementation of the dust suppression plan included in the Air Quality Impact Assessment Report for Booysendal,
- Develop and implement an overall erosion management techniques are in place;
- Bare soil surfaces are to be covered by either vegetation or geotextiles to prevent future soil erosion incidences;
- Key performance indicators need to be developed for all management measures in accordance with limits and guidelines developed under the legislation or where no limits under legislation is provided in accordance with best practice guidelines.
- Cultural-heritage site HV02 has to be documented by means of compiling a ground plan, taking photographs and describing the spatial composition and features of the village. This task must be undertaken by an archaeologist that is accredited with the ASAPA. SAHRA will require that V02 be studied and documented before SAHRA will make any recommendations regarding the future existence of the village.

- A heritage management plan needs to be developed to include for example a chance-find procedure, standby project archaeologist, management of cultural-heritage sites within the wider environment.
- All management and mitigating measures must be effectively and comprehensively applied in accordance with the standards and measures included in the EMP and specialist management plans.

9.3 GAPS AND DISCLAIMER

The Section 24G Report findings are dependent on the information provided to Amec Foster Wheeler. The following know design changes were communicated to Amec Foster Wheeler at the time of compiling of this report which commenced on 20 May 2017:

- New section of the main access road between BS4 and the Valley Boxcut;
- The western TKO pipeline preferred alternative route;
- The revised design of the Valley Boxcut PCD;
- Laydown areas for the ARC;
- The design parameters of two Merensky shafts;
- Initially a water treatment plant would have been provided at BS1/2 to treat potential discharge water. To ensure zero discharge, the treatment plant was omitted and it is understood that any excess water will be pumped to the main PCD at BN. The delineation of the pipeline route and the design parameters were not available.

Gaps which came out of the specialist studies include:

- The potential impact of leachate from the backfilling on the groundwater resources and as a secondary impact where this decant on the surface water resources;
- Mine plan for the two Merensky adits to allow for calculations for groundwater dewatering. The groundwater model is currently based on assumptions of inflows of similar projects in the area;
- The habitat preferences, lifecycle, reaction to potential mining activities and aspects around the endemic *Pycna Sylvia* is limited;
- The impact of mine dewatering on the wetland and aquatic biodiversity;

The assessment of the impacts might be outdated as the construction activies are ongoing.

Due to the deadline date for submission of the Section 24G Reports set by the DMR and the extensive nature of the specialist studies Amec Foster Wheeler initiated it might be that not all specialist's information has been captured in the EIA and EMP. Therefore, the EIA and EMP should be read together with the various specialist studies.

Any other changes not communicated to the environmental team would also not have been considered in this report. Although due care was taken to identify and assess impacts on site it might be that some impacts were not assessed due to the continuation of construction activities and the changes. Because of these changes these areas have not been surveyed by the terrestrial ecology or soil specialist.

10. MOTIVATION FOR RESPONSE TO AN EMERGENCY

The Section 24G is carried out. The project does not address an emergency therefore no emergency response is applicable

11. DECLARATION BY THE ENVIRONMENTAL ASSESSMENT PRACTITIONER

I, Amanda Pyper, as the appointed independent environmental practitioner ("EAP") hereby declare/affirm that I:

- act/ed as the independent EAP in this application;
- regard the information contained in this report to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the ECA, the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act(s);
- have and will not have any vested interest in the proposed activity proceeding;
- have disclosed, to the applicant and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act(s);
- am able to meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations (specifically in terms of Regulation 13 of GN No. R982,) and any specific environmental management Act, and am fully aware that failure to comply with these requirements may constitute and result in disqualification;
- have ensured that information containing all relevant facts in respect of the application was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments;
- have ensured that the comments of all interested and affected parties were considered, recorded and submitted to the competent authority in respect of the application;
- have kept a register of all interested and affected parties that participated in the public participation process; and
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not.

Signature of the Environmental Assessment Practitioner:

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Name of company: Amec Foster Wheeler Earth and Environmental UK Limited

Date:

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