Appendix 13: Detailed Description of the Environment

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1 CLIMATE

The Northern Cape region is semi-arid and receives an annual rainfall of between 250 to 500 mm, with the majority of rain falling in the summer months between October and March. On average the heaviest rains fall in mid- to late summer, with February and March being the wettest months. Thunder storms are a common feature of the summer climate and hail may accompany summer storms.

1.1 TEMPERATURE

Annual average temperatures at the Assmang Black Rock site are in the order of19 ºC. The maximum temperature (experienced in December) is in the order of 33 ºC whilst the minimum temperature (-2 ºC) occurs in July as expected.

Monthly maximum, minimum and average temperatures based on CALMET modelled data at the site for 2009, are presented in the figure to follow.

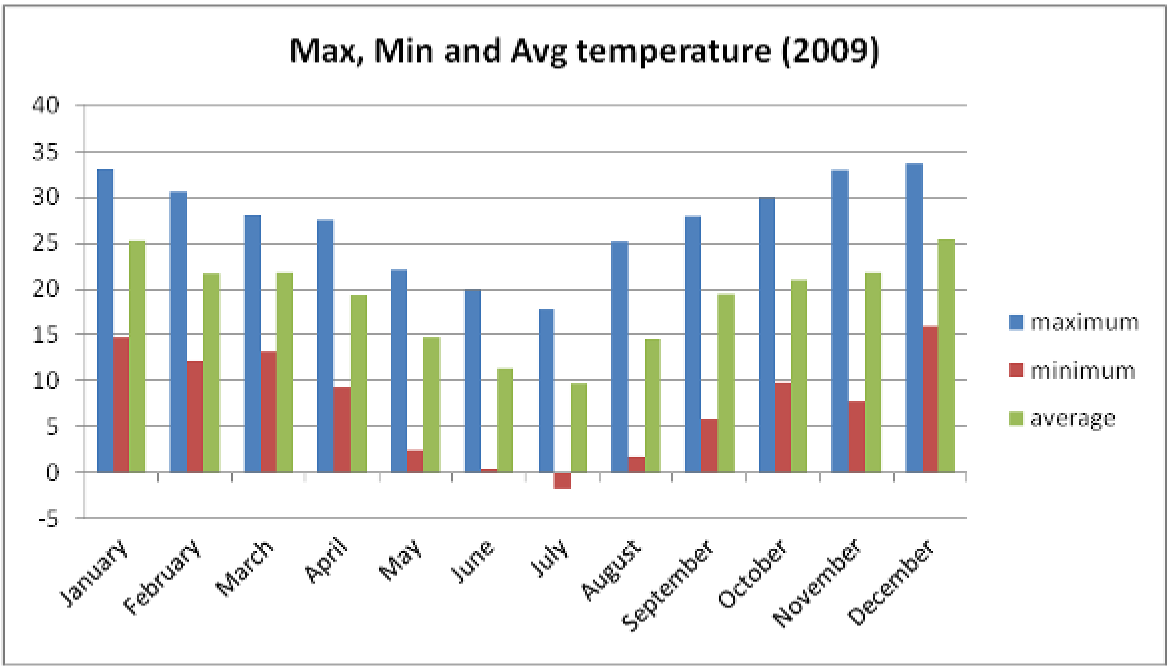

Figure 1-1 : Monthly minimum, maximum and average temperature profiles at the Assmang site based on CALMET modelled 2009 data.

1.2 RAINFALL

1.2.1 MEAN MONTHLY AND ANNUAL RAINFALL (PAST 50 YEARS)

The mean annual rainfall in the Kuruman area is 460 mm, of which the majority falls in summer (Table 1-1).

Table 1-1: Rainfall Record (Average Monthly Rainfall in Millimetres)

J	F	M	A	M	J	J	A	S	O	N	D
48	111	102	50	5	7	0	1	18	29	32	54

The predicted rainfall for the quaternary catchment however is only 352 mm per annum, which is likely to be a closer approximation of rainfall at the mine site.

1.2.2 MAXIMUM RAINFALL INTENSITIES PER MONTH

The recorded maximum rainfall intensities (Kuruman Weather Station) are indicated in (Table 1-2).

Table 1-2: Rainfall Intensity

Duration/time period	Rainfall (mm)
60 minutes	56.0
24 hours	99
24 hours/50 years	92,9
24 hours/100 years storm events	104,6

1.3 WIND

Wind roses have been developed from modelled CALMET-based wind speed and wind direction data at the site. Annual and monthly wind roses indicating prevailing wind direction and wind speed classes throughout each season and the year (2009) are presented in Figure 1–2 to Figure **1-4**. The length of the colour-coded line is proportional to the frequency of occurrence of wind blowing from that direction. Wind speed classes are also colour coded, and the length of each category is proportional to the frequency of occurrence of wind speed category.

Wind roses have been derived from CALMET model data for 2009. The general wind pattern at the BRMO site throughout the year is predominantly from the north easterly sector, with a pronounced westerly component. In general, wind speeds throughout the year, and within each season, vary from calm (0.5 m/s – 1.4 m/s at 6% frequency) to light (1.4 m/s – 2m/s at 5.9% frequency) to slightly stronger gusts (>2 m/s, 88.1% frequency) at the BRMO site. There is a significant wind component directly from the north north-easterly sector throughout the year. The seasonal wind rose plots indicate the periods and wind patterns that contribute to this phenomenon and demonstrate the shifting wind pattern during the year.

Wind directions vary seasonally throughout the year. In summer and spring there is a strong prevalence of westerly, west-south-westerly and north-easterly winds. These are the most common directions from which winds blow however there exists a strong prevalence from all sectors (directions) throughout these seasons. Throughout autumn and winter, winds tend to generally prevail from all sectors however with lower frequency. There is also a strong occurrence of winds from the north-east-north sector in autumn and winter.

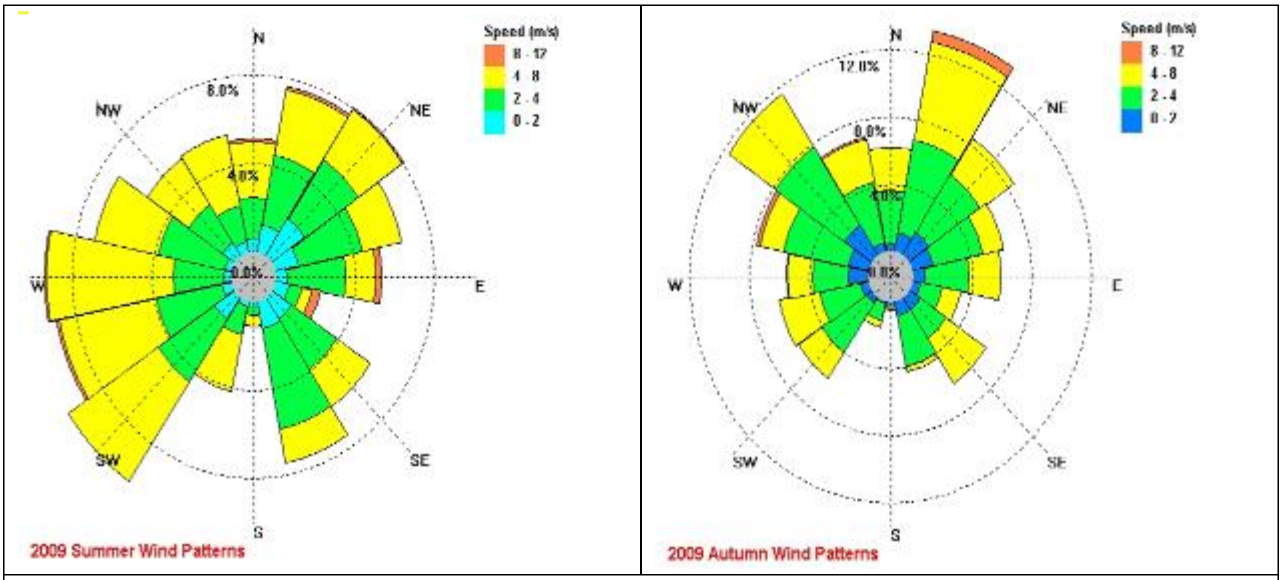

Figure 1-2: Seasonal wind rose plots for the BRMO site produced from CALMET prognostic modelled data (2009)

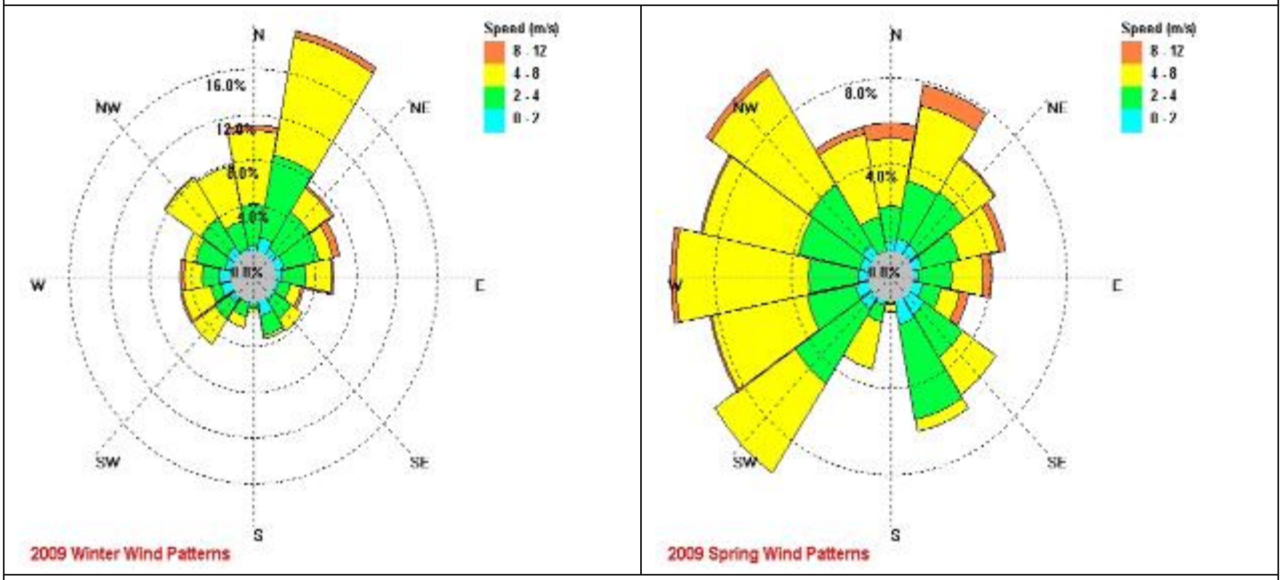

Figure 1-3: Seasonal wind rose plots for the BRMO site produced from CALMET prognostic modelled data (2009)

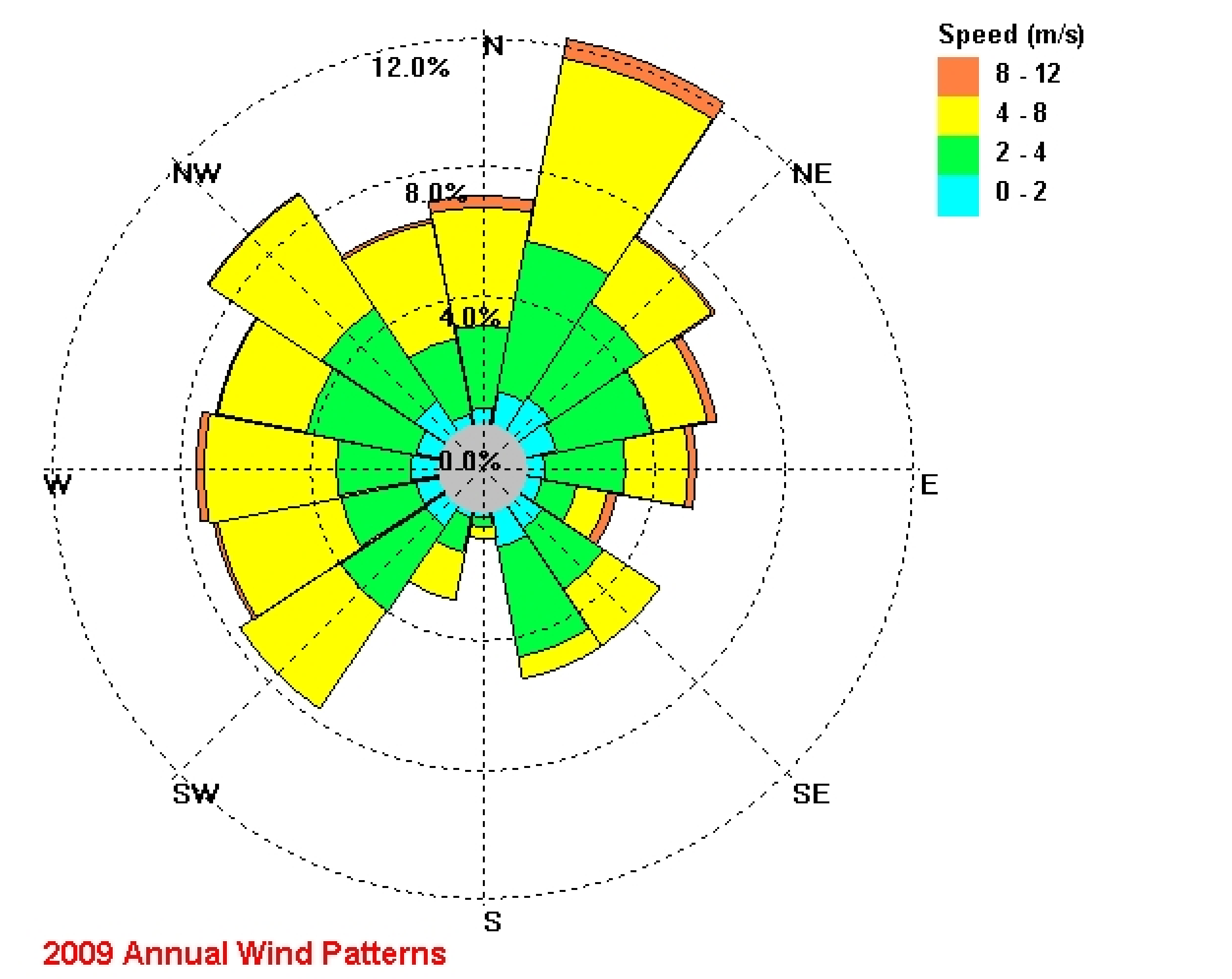

Figure 1-4 : Annual wind rose plots for the BRMO site produced from CALMET prognostic modelled data (2009)

2 QUATERNARY CATCHMENTS, TOPOGRAPHY AND SURFACE DRAINAGE DIRECTIONS

The quaternary catchments for Black Rock and the western part of Nchwaning Mine fall within D41K quaternary catchment. The quaternary catchment for Gloria and eastern part of Nchwaning Mine falls within the quaternary catchment D41M. The Sedibeng Vaal-Gamagara pipeline is the main source of water for all the mining areas. There is limited surface runoff in the Kalahari area, due to high infiltration during rain events combined with the relative high evapotranspiration potentials (Ivuzi Environmental Consultants, 2010).

The topography ranges from 1100 mamsl in the south west from where it dips to 990 mamsl towards the Gamagara river in the north east. The Gamagara is a non-perennial stream/river to the west of the study area.

3 GEOLOGY

BRMO lies within the Kalahari Manganese Fields, which in turn lies within a large structural basin that extends approximately 40 km south to north and 5 km to 15 km east to west, dipping gently northwest. At Black Rock, near the northern end of the basin, the viable manganese ore bodies lay within Transvaal System rocks about 300 m from surface, beneath Kalahari Formation sands and calcretes, Dwyka tillites and Waterberg System shales and quartzites.

The Kalahari Formation consists of a sequence of flat-lying unconsolidated sediments with a maximum thickness of approximately 125 m. Aeolian sand, limestone and red clay are the typical sediments encountered. At Black Rock and the farm portions of Belgravia and Nchwaning, the Hotazel, Mapedi and Lucknow Duplication of the formations have occurred through thrust faulting (Assmang, 2010). The average thickness of the Hotazel Formation is approximately 40 m, however due to thrusting, faulting and later erosion it is difficult to determine the original sedimentary thickness of the Mapedi and Lucknow Formations (Assmang, 2010).

The manganese ores of the Kalahari Manganese field are contained within a sequence of pre-Cambrian sediments of the Transvaal Supergroup and is confined to the Hotazel formation of the Griqualand West Sequence (Assmang, 2010). Three manganese ore horizons are found as inter-bedded layers in the Hotazel iron formation. The Hotazel formation of the Griqualand West Sequence is uncomfortably overlain by shales of the Mapedi and quartzites of the Lucknow Formations belonging to the Olifantshoek Group. Uncomfortably overlying these units are glacial tillites of the Dwyka Formation of the Karoo Sequence (400 Ma) with a maximum thickness of 130 m (Assmang, 2010). The youngest rocks represented in the Kalahari manganese field belong to the Kalahari Formation (3 Ma).

The Transvaal Strata became progressively more strongly folded towards the craton margin and a major thrust fault zone is present immediately to the east of it. Evidence of compressive faulting or thrusting was provided by drilling and mapping of both the Black Rock outcrop and underground workings and confirmed the existence of a large and imbricate thrust fault complex (Assmang, 2010). The Black Rock outcrop represents part of the thrust nappe structure.

4 SOIL

The Gloria Mine has been in operation since 1980. No soil baseline surveys were conducted at BRMO prior to development of the mine. The soils in the region are, however, typical of the Kalahari with yellowish red fine-grained sands dominating the physical structure of the soils (Table 4-1). As expected in a sandy, semi-desert, environment the organic carbon status of the soils is low (± 0.1%). A specialist soil assessment was subsequently undertaken as part of the EIA (Full Report attached hereto as Appendix 5.4), the results of which follow (Table 4-2).

Table 4-1: Profile Description for BRMO Reference Soil		
Profile 1 (BRMO Reference Soil) Namib: Kalahari		
Horizon	**Dept. (cm)**	**Description**
A	0-20	Orthic A, Yellowish red (5YR5/6), dry, sandy, apedal, frequent roots.
B	20-120+	Apedal (structure less), Yellowish red (5YR5/8), loose, sandy Roots frequent to few

The soil has a thin orthic A horizon indicated by the darker soil colour due to some organic matter accumulation. The B horizon extended very deep.

Table 4-2: Soil Analytical Data for BRMO Reference Soil		
Depth (cm)	0-20	20-120+
pH (H_20)	7.3	7.4
Clay %	1.5	1.5
Silt%	0.2	0.1
Very fine sand%	16.4	15.1
Fine sand	60.2	61.0
Medium sand	15.5	15.9
Texture	Sand	Sand
Exch Ca (mgkg^{-1})	106	170
Exch Mg (mgkg^{-1})	51	41
Exch K (mgkg^{-1})	31	30
Exch Na (mgkg^{-1})	0.2	0.7
P (Bray 1)	2.8	3.7

4.1 INTERPRETATION OF SOIL ANALYSIS RESULTS

The following interpretation was provided for the BRMO soils by the soil scientist who undertook the required specialist soil investigation:

- pH is moderate;
- P content is low and therefore renders the soil fertility low;
- Ca and Mg is moderate to low, indicative of the very sandy and low clay content soil;
- K is moderate and therefore renders the soil fertility low;
- Physically the soil is very sandy, low in clay and silt content and loose. Due to the texture of the soil there is no indication that the soil will become compacted when stockpiled as was experienced with the soil that was stockpiled in Black Rock; and
- The fertility of the soil is on the low side that can typically be expected from sandy soils.

5 BIODIVERSITY

No ecological surveys were carried out prior to commencement with mining at Gloria Mine in 1978. An ecological assessment was subsequently carried out by the Department of Environment and Nature Conservation (NCDENC), focussing on the vegetation in the Assmang-owned Belgravia game farm, situated west of the site and accessed through Black Rock.

While the aforementioned study provides useful background information, a lack of development site specific ecological information warranted that a specialist biodiversity assessment be commissioned specific to the proposed development site. To this end, Scientific Aquatic Services (SAS) were appointed to the EIA project team to undertake the necessary ecological assessment of the proposed expansion area (SAS Report Reference: SAS 211022).

5.1 BIOME AND BIOREGION

Biomes are broad ecological units that represent major life zones extending over large natural areas (Rutherford 1997). This assessment site falls within the Savannah biome

(Rutherford & Westfall, 1994). Biomes are further divided into bioregions, which are spatial terrestrial units possessing similar biotic and physical features, and processes at a regional scale. This assessment site is situated within the Eastern Kalahari Bushveld Bioregion (Musina & Rutherford, 2006).

5.2 VEGETATION TYPE AND LANDSCAPE CHARACTERISTICS

While biomes and bioregions are valuable as they describe broad ecological patterns, they provide limited information on the actual species that are expected to be found in an area. Knowing which vegetation type an area belongs to provides an indication of the floral composition that would be found if the assessment site was in a pristine condition, which can then be compared to the observed floral list, and so give an accurate and timely description of the ecological integrity of the assessment site. When the boundary of the assessment site is superimposed on the vegetation types of the surrounding area, it is evident that the subject property falls within the Kalahari Thornveld and Shrub Bushveld veld type (Acocks, 1990) and Kathu Bushveld vegetation type (Musina & Rutherford, 2006).

5.3 SURROUNDING PROPERTIES/LAND USES

The subject property is located within the present BRMO surface rights area. Mining infrastructure currently used within the surface rights area includes Black Rock Mine, Nchwaning II Mine, Nchwaning III Mine and Gloria Mine. The area earmarked for the expansion of the Gloria Mining Operations is located between the existing Nchwaning II and Gloria Mine Operations and will ultimately 'link' the two. The proposed infrastructure is located between an existing gravel road primarily used by mining vehicles (north-east) and the R380 (south-west), with a railway line in the central portion thereof. As a result of existing roads the proposed area is isolated from similar ecological habitat to some degree. All farm portions included within the surface rights area are presently rented to farmers primarily for extensive cattle grazing. The exception is the Belgravia farm currently managed as a game farm by BRMO with higher species diversity. Vegetation transformation within the proposed Gloria Mine expansion areas was more evident within areas located close to farming related infrastructure such as gravel roads, fences and water points, with special mention of *Acacia mellifera* encroaching into natural vegetation.

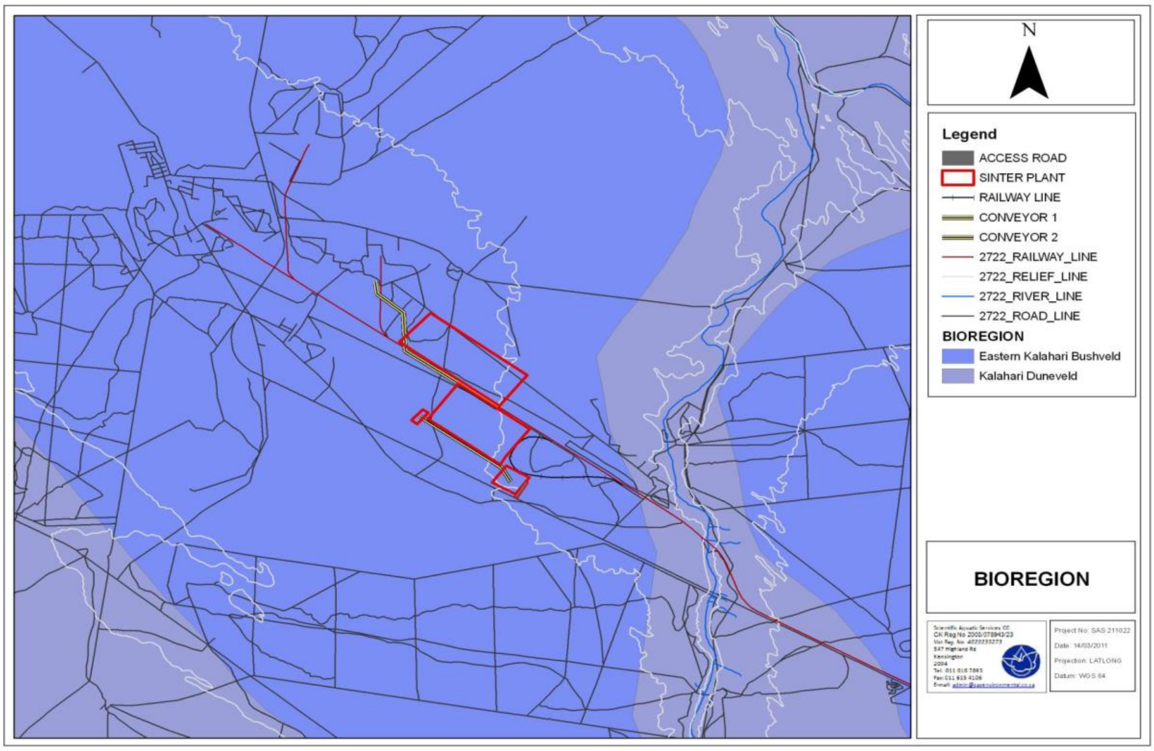

Figure 5-1: Bioregions associated with the study area (Mucina & Rutherford, 2006).

5.4 ECOLOGICAL CONDITION AND FUNCTIONING

Faunal and floral communities within the subject property are regarded as relatively uniform. As a result ecological condition and functioning are also considered uniform throughout the majority of the study area, with the exception of some areas where vegetation transformation was encountered as a result of anthropogenic (i.e. human) activity leading to a lower ecological condition as well as function.

5.5 HABITAT DESCRIPTIONS

5.5.1 HABITAT UNIT 1: OPEN VELD

The open veld habitat unit is located close to the existing Gloria Mine infrastructure where the majority of the habitat unit has remained largely undisturbed (Figure 5-2); however some impact on overall ecology was noted as a result of mining as well as cattle grazing activities. Mining related activities are largely confined to the borders of existing mining infrastructure and although the entire habitat unit is used for cattle grazing some areas such as waterholes and gravel roads have seen more disturbances, thus lowering the overall Present Ecological State (PES) of the habitat unit.

It is deemed important that mining expansion within this habitat unit coincides with proper planning to ensure the proposed footprint stay as small as possible and do not encroach on bordering less impacted open veld areas in the future.

5.5.2 HABITAT UNIT 2: TRANSFORMED AREAS

Historically these areas could have supported a diversity of grassland floral species which provided foraging habitat for various grassland faunal species. However, site clearing and construction of the access road and railway line has led to transformation within the habitat unit (Figure 5-2). Little natural vegetation is left within these areas and alien vegetation encroachment was evident during the assessment. As a result it is doubtful that this habitat unit in its PES will provide suitable refuge for a great diversity of faunal species. However, it should be noted that protected plant species, currently not threatened by the existing road and railway line, were observed within the road servitude namely *Ammocaris coranica, Harpagophytum procumbens, Acacia erioloba* and *Acacia haematoxylon*. It is deemed important that all these species be left undisturbed and if necessary be rescued and relocated with specific reference to *Ammocaris coranica* and *Harpagophytum procumbens,* or species to be cut and destroyed propagated for future rehabilitation with specific reference to *Acacia erioloba* and *Acacia haematoxylon*.

The transformed habitat unit is considered of low ecological importance and any mining related activities within these areas are deemed to have no significant impact on the PES of the transformed areas. However, it is deemed important that no protected floral species be disturbed, or be rescued and relocated if necessary, as well as the removal of any invader or exotic plant species alongside the access road and within the new development area.

Figure 5-2: Conceptual Illustration of Habitat Units within the Subject Development Area

5.6 FLORA

All floral species encountered were identified within each proposed infrastructure area, namely the sinter plant, tailings dam, railway line, two conveyor lines as well as an access road. Due to the small size of the vertical shaft and stockpile area these were included within the southern conveyor and access road, respectively. It should be noted that although no alien species are listed in this section, they are discussed separately in a subsequent section. There is a notable difference between the species diversity of each respective area assessed. A percentage was calculated for the total number of species identified within each proposed area with regards to the total number of floral species found throughout the subject property.

Table 5-1: Dominant floral species identified within the area earmarked for the expansion. Species identified within a specific area are marked with a *.

Scientific Name	Conveyer South	Conveyer North	Tailings Dams	Shaft Access Road	Sinter Plant Complex
Acacia erioloba	*	*	*	*	*
Acacia haemotoxylon	*	*	*	*	*
Acacia mellifera	*	*	*	*	*
Acacia hebeclada			*	*	*
Gewia flava	*	*			*
Pogonarthia squarrosa	*				*
Heteropogon contortus		*			
Aristida congesta subsp congesta				*	
Eragrostis echinochloidea					*
Digitaria eriantha				*	
Eragrostis lehmanniana	*	*	*	*	*
Schmidita kpappophoroides	*	*	*	*	*
Schmidita kalihariensis	*	*	*	*	*
Stipagrostis uniplumis	*			*	*
Aristida meridionalis					*
Aristida stipitata	*		*		*
Commelina benghalensis					*
Senna italic					*
Pennisetum setaceum				*	
Sesamum triphyllum				*	*
Verbesina encelioides	*			*	*
Cymbopogon excavatus					*
Ziziphus mucronata			*		*
Melinis repens			*		
Ammocaris coranica	*	*	*		*
Harpogophytum procumbens		*		*	*

The impact from anthropogenic activity on the natural vegetation of the area is evident when looking at the percentages. The northern conveyor located closest to the existing mining infrastructure calculated a percentage of 38%. The proposed tailings dam area as well as the southern conveyor each calculated a percentage of 42%. The low percentage calculated for the tailings dam can be expected, if its location is taken into consideration. This area is located between an existing railway line and gravel road with mining infrastructure located to the west and east. As a result edge effects are leading to an overall decline in vegetation diversity of the entire area. The southern conveyor does show a lower percentage than what was expected, however it is located next to the proposed sinter plant and therefore should display relatively the same diversity in floral species. The percentages calculated for the access road (54%) and the sinter plant (77%) showed an increase. These areas are located the furthest away from anthropogenic activities, with the exception of the northern portion of the access road which did show invasive species encroachment at the time of the assessment, leading to some decline in overall species diversity of the entire access road area.

Species diversity was relatively uniform throughout the subject property. However, it is important to take the percentage of each grass species within the specific community into consideration. The less disturbed the veld the more uniform percentages will be obtained between species within the same community. Dominance of one grass species, as can be seen for all transects done within the northern portion of the subject property, shows historical disturbance. Areas situated south of the existing railway line showed higher species diversity and abundance and areas situated north of the railway line showed less diversity and abundance. The northern portion is located between the existing railway line and mining operations. Construction and operational activities have led to a decrease in overall abundance and diversity of grass species. Diversity and abundance of species increases towards areas located further away from these anthropogenic activities such as the areas located within the proposed sinter plant.

5.6.1 RED DATA LISTED (RDL) FLORAL SPECIES

An assessment considering the presence of any RDL plant species, as well as suitable habitat to support any such species, was undertaken. The complete PRECIS (Pretoria Computer Information Systems) red data plant list for the grid reference (2722BB) was enquired from SANBI (South African National Biodiversity Institute). No floral species considered of concern within the applicable QDS were listed. However, individuals as well as possible habitat for floral species listed within schedule 3 and 4 of Environmental and Conservation Ordinance No.19 (1974), floral species listed within the Threatened and Protected Species Regulations (NEM:BA, 2004), as well as trees listed within section 15(1) of the National Forests Act (1998), were searched for during the biodiversity assessment. Protected species found within the study area are listed in Table 5-2 and depicted in Figure 5-3. The species identified were not confined to one specific area and were identified throughout all proposed development areas.

Figure 5-3: Protected Floral Species Identified on Site

Table 5-2: Protected Floral Species Identified on Site

Scientific Name	Common Name	Regulation
Acacia erioloba	Camel Thorn	National Forests Act (1998)
Acacia haemotoxylon	Grey Camel Thorn	National Forests Act (1998)
Ammocaris coranica	Karroo Lily	Schedule 4 Environmental and Conservation Ordinance No. 19 (1974)
Harpogophytum procumbens	Devil's Claw	Schedule 4 Environmental and Conservation Ordinance No. 19 (1974)
Babiana hypogaea	Bobbejaanuintjie	Schedule 4 Environmental and
Boophane disticha	Bushman's poison bulb	Schedule 4 Environmental and

5.6.2 EXOTIC AND INVADER FLORAL SPECIES

Alien invaders are plants that are of exotic origin and are invading previously pristine areas, or ecological niches (Bromilow, 2001). During the assessment of the proposed Gloria Mine expansion area very low alien and weed species diversity were noted. It is however evident within the region that grass species known to thrive in disturbed places are the species noted to quickly establish if areas are disturbed. As a result the natural species diversity declines and grass species known to thrive in disturbed places dominates instead of shrub/forbe weed species. Significant amounts of *Acacia mellifera* were noted within areas close to present or historical anthropogenic activities. Within the areas where *A. mellifera* dominates, very little natural vegetation was noted.

5.6.3 MEDICINAL PLANTS

Medicinal plant species are not necessarily indigenous species, with many of them being regarded as alien invasive weeds. The majority of the medicinal plant species are located throughout the subject property and are not restricted to specific habitats within the subject property. All the species known to be of medicinal value are regarded as widespread and common for the region, except for *Harpagophytum procumbens,* listed as a protected species within the Threatened and Protected species regulations (NEM:BA, 2004). Although protected, *H. procumbens* are relatively widespread within the area and the proposed mining expansion is not regarded a threat for the survival of this species if all footprint areas are kept as small as possible; with no encroachment onto neighbouring open veld areas as well as the rescue and relocation of the individuals to be disturbed.

Table 5-3: Traditional Medicinal Plants Identified on Site

Species	Common Name	Plant Part Used Medicinally	Medicinal Uses
Senna italica	Wild Senna	Roots	Used to treat influenza, indigestion, liver and gall bladder complaints, gastrointestinal disorders, dysmenorrhoea and uterine pain.
Ziziphus mucronata	Buffalo-thorn	Roots, bark & leaves	Warm bark infusions are used as expectorants in cough and chest problems, while root infusions are popular as a remedy of diarrhoea and dysentery. Decoctions of roots and leaves are applied externally to boils sores and glandular swellings.
Harpagophytum procumbens	Devil's Claw	Roots	Used to treat rheumatism and arthritis, and as a general health tonic. Infusions of the dried root are a cure for digestive disorders and a tonic in lack of appetite. It is also taken as an analgesic, especially during pregnancy and the treatment continued after labour. An ointment is made from the root material which is applied to sores, ulcers and boils.

5.7 FAUNA

5.7.1 MAMMALS

Small mammal trapping was conducted by the specialists in areas identified as suitable small mammal habitat, however no mammals were trapped. The unsuccessful trapping rate was considered by the specialist to be a result of habitat degradation, no water flow within the riparian system or wetland areas and activities such as mining operations and main road crossings and is not considered a true presentation of the small mammal species community that inhabits the subject property. Evidence of the Common Duiker (*Sylvicapra grimmia*), White-tailed Mongoose (*Ichneumia albicauda*), Suricate (*Suricata suricatta*) and Scrub Hare (*Lepus saxatilis)* have been noted within the proposed development areas. Field signs (diggings) of Porcupine (*Hystrix africaeaustralis*) were also noted by the relevant specialist during the site assessment.

A list of small and larger mammal species recorded in the Belgravia Game farm, next to Black Rock Mine, is listed in Appendix B to the Specialist Biodiversity Assessment (Scientific Aquatic Services Report Reference: SAS 211022), that allows one to compare species that could potentially have occurred in the proposed development area; where conditions in the Game Farm could be reasonably assumed to mimic the pre-mining ecological status of the proposed development area. The subject property in its present state is not considered optimal habitat for larger mammal species, however habitat is considered important for the survival of various smaller mammal species.

Evidence of a cave on the Black Rock Mine was noted by the biodiversity specialist. This 'cave' is in fact remnants of old open pit excavations that took place historically at Black Rock Mine. This area could provide suitable habitat for bat species in the area, including threatened species occurring within the Northern Cape Province (Appendix A to specialist biodiversity assessment (Scientific Aquatic Services Report Reference: SAS 211022)). Important to note is that although five (5) RDL mammal species (bat species) had a probability of occurrence (POC) of more than 60% in the area, the aforementioned open-cast diggings will not be affected by the sinter plant or mine expansion proposed at BRMO; where Probability of Occurrence (POC) factors the known distribution range (D), habitat suitability of the site (H) and availability of food sources (F) on site were determined for each of the species. Each of these variables is expressed a percentage (where 100% is a perfect score). The average of these scores provided a Probability of Occurrence (POC) score for each species. The POC value was categorised as follows:

- 0-20% = Low;
- 21-40% = Low to Medium;
- 41-60% = Medium;
- 60-80% = Medium to High; and
- 81-100% = High.

5.7.2 POC = (D+H+F)/3

Table 5-4: Northern Cape Threatened Mammal Species with a POC > 60%

Scientific Name	Common Name	Conservation Status	POC
Miniopterus schreibersii	Schreibers' Long-fingered Bat	Near threatened	58
Rhinolophus fumigatus	Ruppell's Horseshoe Bat	Near threatened	61
Rhinolophus clivosus	Geoffroy's horseshoe Bat	Near threatened	61
Rhinolophus darlingi	Darling's Horseshoe Bat	Near threatened	62
Rhinolophus denti	Dent's Horseshoe Bat	Near threatened	61

5.7.3 BIRDS

All bird species seen or heard during the time of the specialist's assessment were recorded. This was done for the duration of three days in summer. Surveys were conducted across the entire subject property. The table below lists all the bird species identified during their assessment. The complete list of bird species expected for the QDS

2722BB (Roberts Multimedia Birds of Southern Africa) is included in Appendix A of the attached specialist Biodiversity Assessment for BRMO.

Table 5-5: Recorded Bird Species for BRMO (SAS assessment, 2011)	
Common Name	**Conservation Status**
Cape turtle Dove	Not threatened
Red-eyed Dove	Not threatened
Laughing Dove	Not threatened
Jacobin Cuckoo	Not threatened
Barn Owl	Not threatened
African Palm Swift	Not threatened
Little Swift	Not threatened
Lilac-breasted Roller	Not threatened
Southern Yellow-billed Hornbill	Near Endemic
Pied Crow	Not threatened
Cape Crow	Not threatened
African Red-eyed Bulbul	Near Endemic
Kalahari Robin	Near Endemic
Cape Glossy Starling	Near Endemic
Southern Masked-weaver	Not threatened
Crowned Plover	Not threatened
Cape Sparrow	Near Endemic
Groundscraper Thrush	Not threatened
Great Sparrow	Not threatened
Yellow Wagtail	Not threatened
Lesser grey Shrike	Not threatened
Swallow-tailed Bee-eater	Near Endemic

A total of three RDL bird species showed a POC of more than 60 %. All RDL bird species with a POC of more than 60 % is listed in the table below. The majority of these bird species are known to reside in either bushveld, or grassland, habitat. The subject property has mainly undisturbed grassland and bushveld but activities such as the mining and grazing of cattle from the adjacent farmers makes the habitat less suitable for RDL bird species to occur. As a result the bird species of concern as listed below that inhabit grasslands are more likely to be found on the Belgravia Game farm, next to Black Rock Mine, than anywhere else on the proposed development site.

Table 5-6: Northern Cape Threatened Bird Species with a POC > 60%			
Scientific Name	**Common Name**	**Conservation Status**	**POC**
Gyps africanus	African White-backed Vulture	Near threatened	62
Gyps coprotheres	Cape Griffon (Cape Vulture)	Vulnerable	61
Coracias garrulus	European Roller	Near threatened	62

5.7.4 REPTILES

The only reptile species that were identified during the biodiversity specialist's assessment, namely *Dendroaspis polylepis* (Black Mamba), was found dead along the roadside. The subject property does offer habitat for various other reptile species within all the identified habitat units, however reptile species of concern will be restricted to areas with fewer anthropogenic activities, such as the eastern portion of the subject property, where no mining activities currently take place.

5.7.5 AMPHIBIANS

No suitable wetland habitat or undisturbed grassland was encountered within the subject property. These habitat types are known to provide habitat for many amphibian species. It is, therefore, doubtful that the subject property will sustain viable amphibian populations.

5.7.6 INVERTEBRATES

No suitable habitat was found for two potentially relevant RDL butterfly species known to occur in the Northern Cape. *Anthene lindae* (Linda's Hairtail), for example, has been recorded within the Witsand Nature reserve. This species usually occur in areas where *Acacia erioloba* is sparsely scattered. *Crysoritis trimeni* (Trimen's Opal) occurs within vegetated coastal dunes and thus no suitable habitat for this species exists within the subject property.

5.7.7 ARANEAE

No evidence was encountered of any *Mygalomorphae* arachnids ('Trapdoor spiders') in the grassland habitat unit. No burrows were identified, but it should be noted that these species are notoriously difficult to detect.

5.7.8 RED DATA FAUNAL SENSITIVITY INDEX SCORE (RDSIS)

All the faunal species that were assessed during the calculation of the red data sensitivity index score (RDSIS) for the site, as being potentially applicable to the RDSIS, are included in Appendix A to the specialist Biodiversity Assessment attached hereto. However, only those species that were found to have a 60%, or greater, chance of being found on the site (POC) where included in the calculation of the sensitivity index score. Eight species were found to have a POC of 60% or greater, discussed in detail in the sections above. The eight faunal species comprising Table 5-4 and Table 5-6 were used to calculate a Red Data Sensitivity Index Score (RDSIS) for the proposed development area.

The RDSIS assessment of the subject site was shown by the relevant specialist to yield a moderate score of 37%, indicating low to medium importance to Red Data Listed (RDL) faunal species conservation within the region.

6 SURFACE WATER

6.1 CATCHMENT DESCRIPTION

The Gloria Mine is located on the northern bank of the Gamagara River, within quaternary catchment D41k. The local topography is largely flat, dipping to the east into the Gamagara river bed. The Gamagara river catchment comprises both quaternary catchments D41k and D41J that cover an area of 8094 km^2. Within this catchment only 5182 km^2 is considered to drain to a surface drainage feature due to the flat and sandy nature of the area.

6.1.1 AFFECTED WATER RUN-OFF

The BRMO is located in the Gamagara River catchment. The Gamagara River is the nearest identifiable water course and forms the south eastern boundary of the Gloria Mine. Run-off from the existing mine site is likely to be limited due to the flat topography and sandy substrate. The old tailings dams at Gloria Mine are, however, situated on the bank of the Gamagara River, but there is little evidence of erosion of this material towards the river course.

6.1.2 ANNUAL AVERAGE RUN-OFF IN CATCHMENT AREA

A sizeable proportion of the Gamagara River Catchment does not yield run-off to any surface drainage feature due to the flat sandy nature of the region. The estimated run-off for the region is in the order of 1.5 mm.

6.1.3 NORMAL FLOW OF WATER IN CATCHMENT AREA

The Gamagara River only flows at surface in very wet years. The last record of flow in the river adjacent to the mine was in the summer of 1988.

6.2 SURFACE WATER QUALITY

There is no surface water within the area of the Gloria Mine, although the Gamagara River bed runs along the south eastern edge of the mine property.

6.3 DRAINAGE DENSITY OF DISTURBED AREA

No streams are present within the mine area. The area is largely flat.

6.4 SURFACE WATER USAGE

No surface water resources are available for use. Water needs of the plant and domestic use are met by off-take from the Vaal-Gamagara pipeline. Water dewatered from underground is also used to supplement plant water requirements, thus limiting off-take from the Vaal-Gamagara pipeline.

7 GROUNDWATER

In the absence of any existing information pertaining to groundwater (i.e. quality and quantity) for the region in which BRMO is situated, a specialist groundwater study was commissioned as part of the EIA process (Full Report available in Annexure 5.2 hereto). During the execution of the aforementioned study, a borehole (groundwater) census was undertaken within an approximately 10 km radius of BRMO (Figure 7-1). This is the first such groundwater hydrocensus undertaken in the vicinity of BRMO.

This entailed the relevant specialist visiting boreholes, taking a photo, recording their locations, measuring the depth to the groundwater level and groundwater sampling. A water sample was taken for the analysis of the major groundwater anions and cations at each identified and accessible borehole.

The aim of the groundwater investigation was to assess and characterise the potential impact the proposed sinter plant/mine expansion will have on the geo-hydrological environment at BRMO. A risk based approach was followed whereby the emphasis of the investigation was to quantify the risk associated with the soil and groundwater pathways and receptors, impact on groundwater levels as well as groundwater qualities.

7.1 HYDROCENSUS

A hydrocensus was conducted on the BRMO mining site and in the surrounding area, during February 2011. The position of all the boreholes relative to the mining area can be seen in Figure 7-2. A total of 23 boreholes were identified during the hydrocensus studies. Water levels could not be measured in seven of these boreholes due to obstructions. Groundwater is mainly used for domestic and stock watering purposes, thus most of the boreholes are equipped with pumps. In most instances this is also the sole source of reliable and clean domestic water.

Although 23 boreholes were visited during the hydrocensus only two boreholes were situated on BRMO's property at the Gloria Mine. These boreholes are used as production boreholes for mining related purposes such as process water. The lack of groundwater monitoring data at BRMO renders the development and understanding of a geo-hydrological conceptual model difficult.

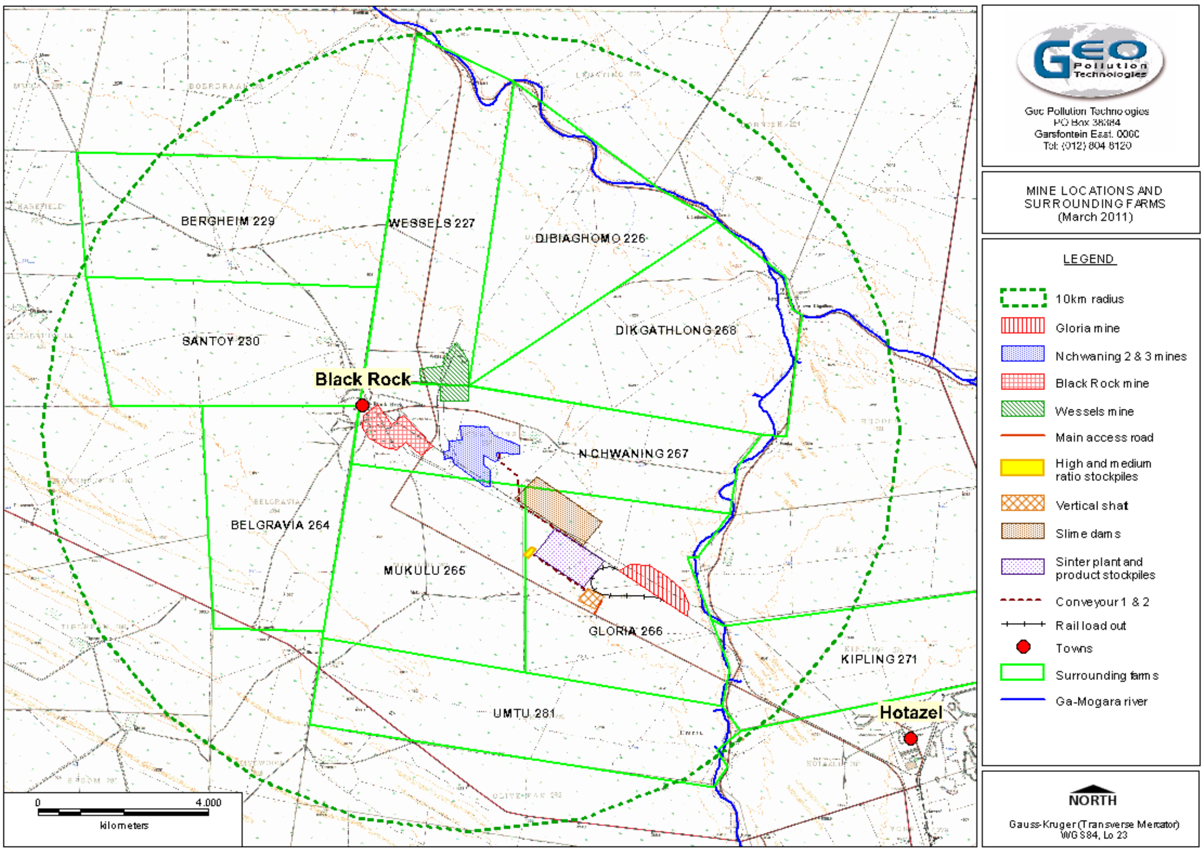

Figure 7-1: Map showing extent of groundwater investigation

7.2 WATER LEVELS

The use of water levels in the prediction of groundwater flow directions is a commonly used practice. The groundwater levels as levels above mean sea level determine the local direction of groundwater flow, while the changes in the levels could identify whether mining is impacting on groundwater levels. Water levels were measured at various locations within an approximate 10 km radius of the BRMO during a hydrocensus (Figure 7-2).

Groundwater in an unconfined, or water table, aquifer normally follows the weathered zone which in turn mimics the topography to a large degree. The groundwater level is generally deeper in higher lying areas and shallower near drainage areas like local streams or rivers. Usually a good relationship should hold between topography and the static groundwater level. This relationship can be used to distinguish between boreholes with water levels at rest, and boreholes with anomalous groundwater levels due to disturbances such as pumping or local geo-hydrological heterogeneities.

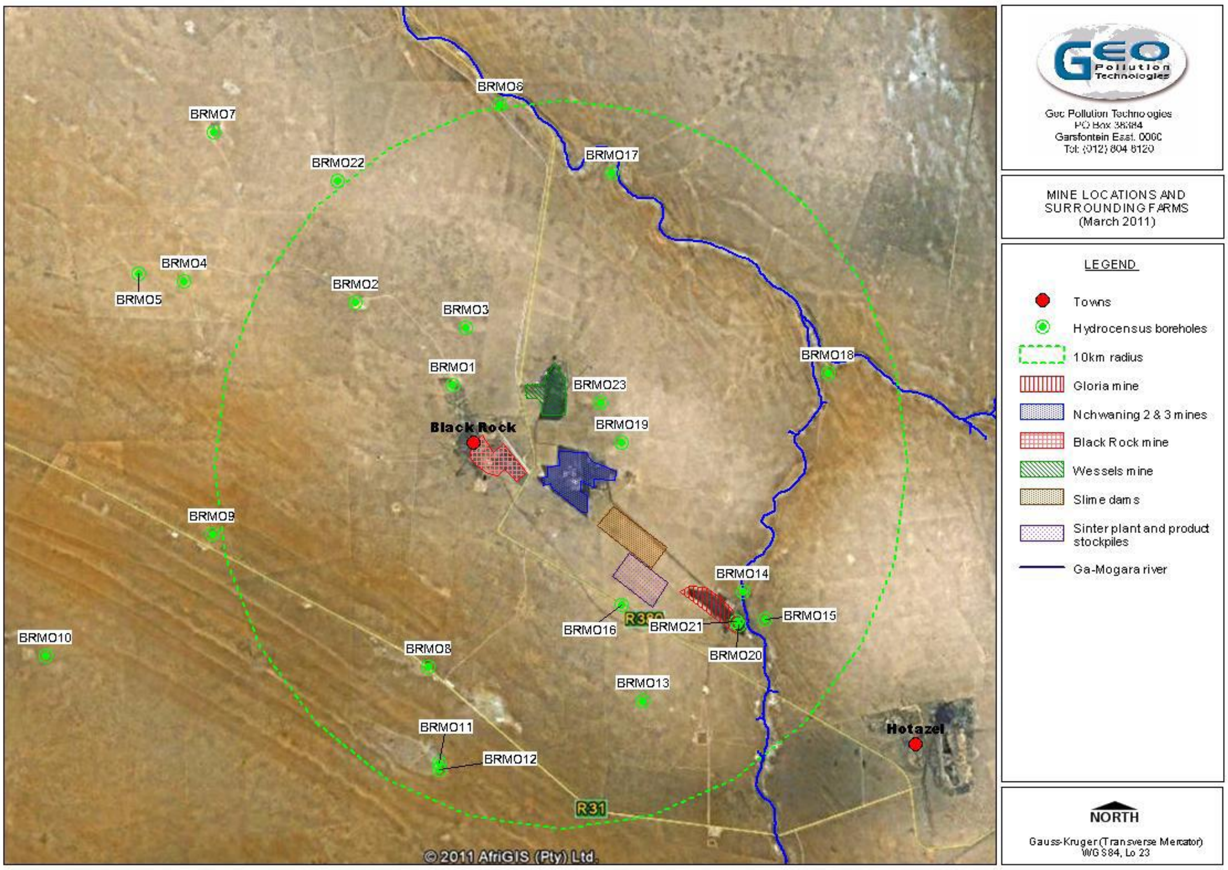

Figure 7-2: Location of boreholes visited during hydrocensus

The correlation between topography and static groundwater levels over the site can be described as poor. This could be attributed to the fact that most boreholes in the hydrocensus were utilised, thereby unnaturally lowering the static groundwater level. This general relationship is useful to make a quick calculation of expected groundwater levels at selected elevations, or to calculate the depth to the groundwater level (unsaturated zone). Although there is not a good correlation between the static groundwater level and surface elevation it was observed that the groundwater in most boreholes emulate the topography to a certain degree (Figure 7-3).

In Figure 7-3 it can be seen that water levels follow the topography in boreholes BRMO-2, 3, 5, 6 11, 12, 17 and 18. If BRMO-7 and BRMO-20 are excluded, general groundwater levels follow the topography south-west to north-east across the site towards the non-perennial Gamagara river.

7.3 WATER QUALITY

All the constituents analysed for are displayed in Table 7-1. The results of which are interpreted by the groundwater specialist in the following section.

The only elevated constituents compared to the maximum allowable drinking water standard (SANS 241) were found in boreholes BRMO-1 and BRMO-9. The elevated constituent was NO_3 as N. These elevated values rendered the water quality of BRMO-1 and BRMO-9 as potentially negative to human health. The source of the elevated nitrates may be due to livestock such as horses and cattle contaminating the water in the vicinity of these boreholes were the sample was taken. All other anions/cations analysed for in Table 7-1 by means of ICP-OES were either below the detection limit of the analytical method, or at levels acceptable to drinking water standards. This renders the water quality as good for the hydrocensus samples analysed.

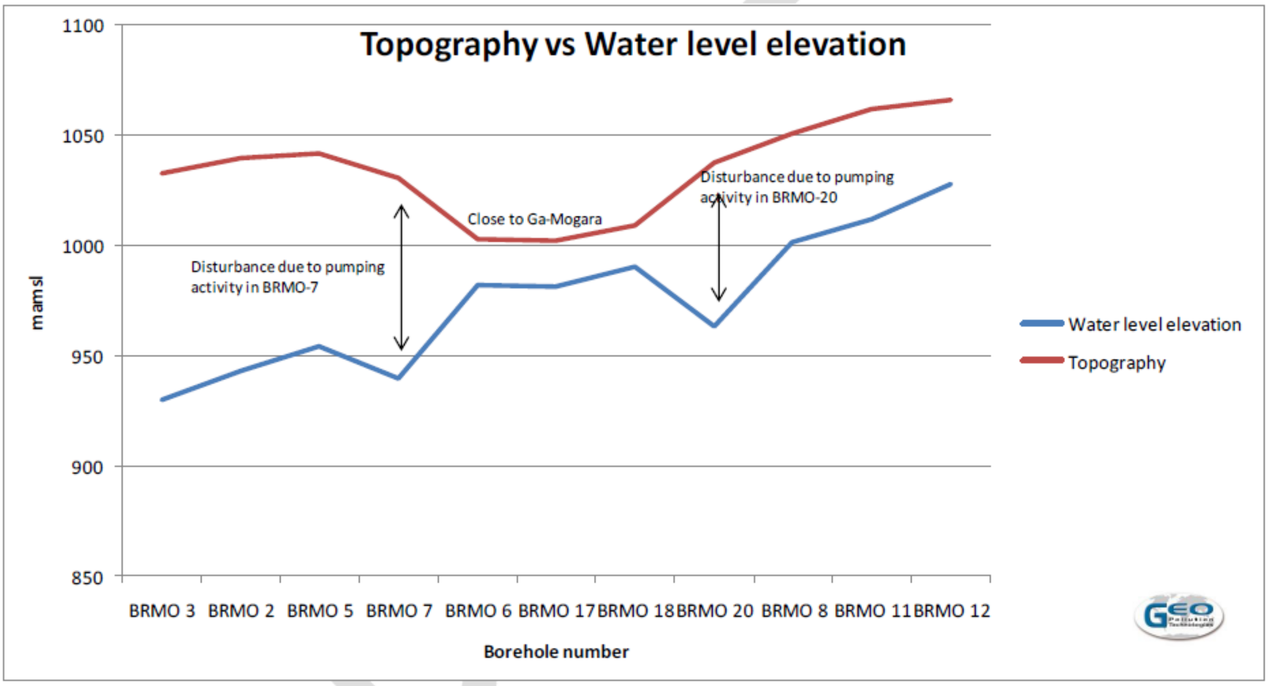

Figure 7-3: Water level elevation graph

7.4 HYDROGEOLOGY

The development site is underlain by the Kalahari formation. This formation at BRMO consists of a top layer of aeolian sands followed by calcrete of tertiary age. If weathered the calcareous sands have the favourable characteristics of porosity and permeability. There is limited surface run-off in the Kalahari area Due to high porosity and permeability of the Kalahari sands (high infiltration rates during precipitation), the calcrete deposit below the top layer of Kalahari sands acts like a sponge.

The potential of groundwater occurrence will depend on the presence of secondary alteration and fracturing in the calcrete. Weathering and fracturing in the calcrete may increase the aquifer potential, thus zones of weathering and fracturing within the calcrete will act as targets for potential groundwater exploration. The maximum depth of the Kalahari formation is +/- 125 m (Assmang, 2010). The arithmetic average depth of the water levels below surface in the boreholes found at BRMO is 69.6 mbgl with a maximum depth of 110 m below surface. If the depth of the Kalahari formation is considered with the water levels found in the hydrocensus it can be concluded that the farmers tap their water from this weathered/fractured calcrete aquifer. The average recharge values assigned to calcrete is ± 10% of the mean annual precipitations (MAP) Vegter, 2005. From the boreholes sampled the water quality is generally good.

7.4.1 CONCEPTUAL GROUNDWATER MODEL

Due to the high infiltration rate, the calcrete layers will act like a “sponge” absorbing the water from the unsaturated zone (Kalahari sands) until saturated and becoming groundwater in the calcrete. The potential for significant amounts of water to be released from the matrix of the calcrete if unweathered is negligible and therefore the potential of groundwater occurrence will depend on the presence of secondary alteration (weathering) and fracturing of the calcrete. The Dwyka tillite of the Karoo Supergroup which underlies the Kalahari formation (where present) combined with the Transvaal Supergroup quartzites below the tillite will act as a restricting layer inhibiting groundwater from further downward movement. As most of the farmers visited in the hydrocensus constantly abstract water from the calcrete aquifer the measured water levels in the hydrocensus are not a true representation of the static water level as they are affected by pumping.

The conceptual groundwater model, which incorporates the conceptual constructed geology and water levels of the measured boreholes, is shown in Figure 7-4. The conceptual groundwater model is based on the general stratigraphic column, as borehole logs were unavailable at the time of reporting, and caution should thus be used in the interpretation thereof.

Table 7-1: Results of the cation and anion analyses for samples compared to SANS 241 Ed. 6.1, 2006 (GPT, 2011)

Sample No.	BRMO 1	BRMO 2	BRMO 4	BRMO 5	BRMO 6	BRMO 7	BRMO 8	BRMO 9	BRMO 10	BRMO 11	BRMO 12	BRMO 13	BRMO 15	BRMO 16	BRMO 18		Class I	Class II
Data source	GPT	GPT	GPT	GPT	GPT	GPT	GPT	GPT	GPT	GPT	GPT	GPT	GPT	GPT	GPT			
Sample date	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11	Feb-11			
Ca	105	14	38	40	71	39	64	70	23	83	85	5	74	70	76		150	300
Mg	64	13	24	25	77	35	31	31	20	42	43	2.9	45	72	53		70	100
Na	65	149	86	79	47	114	48	55	52	57	56	154	11	38	25		200	400
K	9.9	4.5	6.4	6.7	5.2	10.2	7.9	8.5	8.7	9.8	9.9	14.9	2.3	2.9	3		50	100
Mn	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.039	<0.025	<0.025		0.1	1
Fe	<0.025	<0.025	<0.025	1.34	<0.025	<0.025	<0.025	<0.025	0.04	0.043	<0.025	0.114	0.045	<0.025	<0.025		0.2	2
F	<0.2	0.9	0.3	0.3	<0.2	0.6	<0.2	<0.2	0.3	<0.2	<0.2	0.3	<0.2	<0.2	<0.2		1	1.5
NO_3	33	4.2	8.2	8.5	3.8	3.9	10	23	3.6	9.9	8.7	8.8	2.8	6.3	3.1		44	88
Cl	177	75	62	61	143	95	84	68	37	170	180	36	25	118	41		200	600
SO_4	38	89	50	43	60	51	29	48	29	36	36	32	14	56	21		400	600
M-Alk($CaCO_3$)	336	236	252	248	372	328	256	264	216	260	256	320	400	416	440		-	-
pH	7.7	8.8	7.6	7.7	7.8	7.6	7.7	7.9	8.3	7.5	7.5	8.1	7.6	7.5	7.3		5.0 - 9.5	4.0 - 10.0
EC	131	87.6	79	77.4	113	100	81.8	85.3	55.8	116	115	84.9	68	103	81.3		150	370
Cat/An Bal. %	95.5	96.2	96	96.9	96.2	97.3	95.4	93.5	94.3	95	95.1	93.1	96.7	94.1	98.3		-	-
Notes																		
Blue = Class I																		
Tan = Class II																		
exceeds maximum allowable drinking water standard																		
na- not analysed																		
All concentrations are presented in mg/l, EC is presented in mS/m																		
0 = below detection limit of analytical technique																		

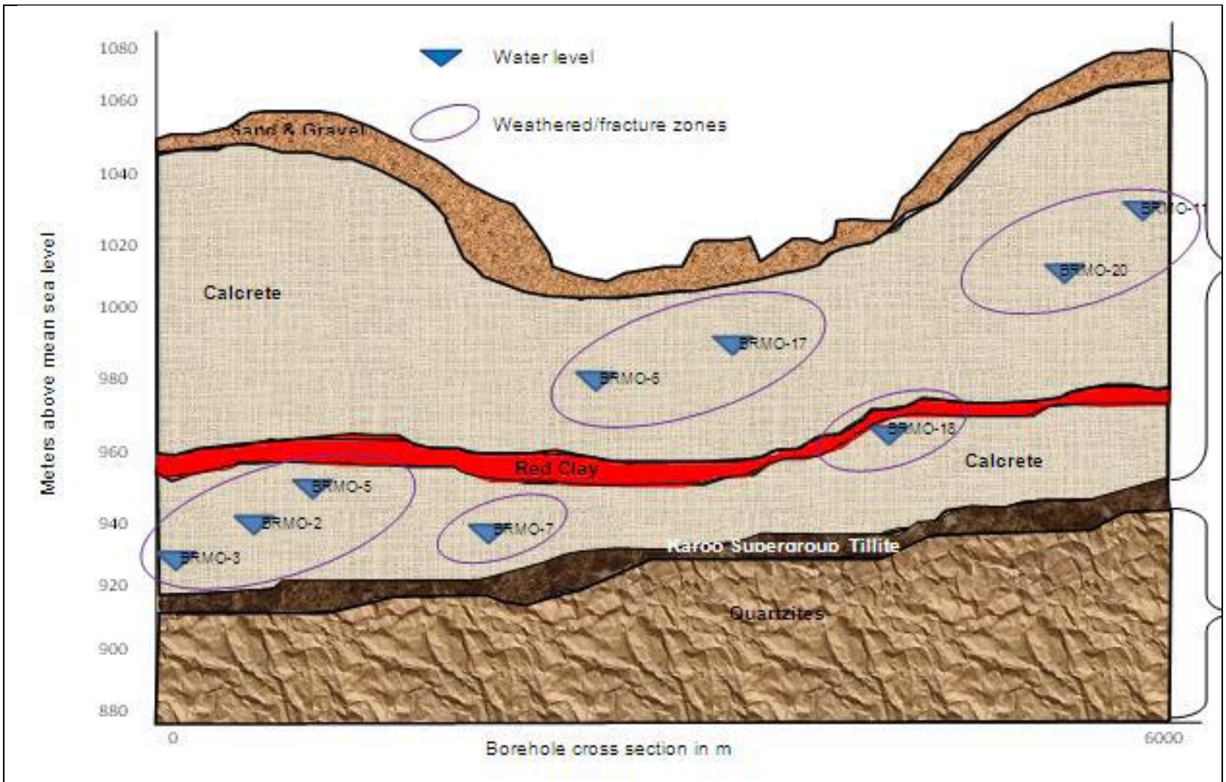

Figure 7-4: Conceptual model of Kalahari Formation Calcrete Aquifer

7.4.2 BRMO AQUIFER CLASSIFICATION

Using the 'National Aquifer Classification System' of Parsons (1995), the calcrete aquifer used by the farming community's boreholes visited during the hydrocensus and used for general farming should be regarded as a 'major aquifer system', based on the following:

- Public supply and other purposes - the aquifer plays a major role in the livelihood of the farming community surrounding BRMO; and
- Water quality - the water quality is good; where-

a major aquifer system is described by Parsons (1995) as follows, "*Highly permeable formations, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good*".

7.5 AIR QUALITY

The land surrounding the Gloria Mine is predominantly farmland with as many as seven other mining operations within a 10 km radius thereof. Active mining, crushing and screening of ore is taking place at Nchwaning II mine to the north. The dust originating from the existing Gloria plant was not specifically listed under the Atmospheric Pollution Prevention Act (Act 45 of 1965). It is however important to note ambient air quality limits for dust fallout are put forward for such in the NEM:AQA.

The principal sources of dust are ore transfer points on conveyor belts, loading and handling activities associated with product piles and the crusher operation. Vehicle movements on un-surfaced roads on the mine sites also contribute dust. Offsite dust transport is, however, limited. The potentially affected areas and persons include the adjacent farmer Mr. Reynecke, Kalagadi Manganese Mine, Ntsimbintle Mining and the BHP Billiton Wessels Manganese mine located about six kilometres north of the mine.

8 NOISE

No baseline noise studies had previously been carried out to determine the contribution of the BRMO to the local noise levels. As such a specialist noise survey was commissioned as part of the EIA in order to assess the prevailing ambient noise at the boundary of the BRMO mining area.

8.1 NOISE SENSITIVE RECEPTORS

The noise sensitive areas in the vicinity of BRMO are identified as Hotazel, south-west of the Gloria Mine, Schoonspruit Village, south of the Nchwaning II Mine, Acacia Guesthouse/farm, east of Nchwaning II Mine and the Black Rock Mine Village, west of Nchwaning III mine.

The following observations were made by the relevant specialist with respect to noise characteristics at the Black Rock Mine- and Schoonspruit Villages:

8.1.1 SCHOONSPRUIT VILLAGE

- Domestic and traffic noise from R380 road make up the prevailing ambient noise at this location; and
- Noise from Nchwaning II was slightly audible along the eastern side of the village.

8.1.2 BLACK ROCK MINE VILLAGE

- Domestic traffic and distant noise from Wessels Mine, as well as limited Nchwaning II Mine activity noise was audible within the village.

8.2 PREVAILING AMBIENT NOISE LEVELS OVER BRMO

37 noise measuring points were utilised in and around the BRMO mine lease area to determine the prevailing ambient noise levels of the study area (Figure 8-1). The following noise sources were observed in the vicinity of and the boundaries of the study area as part of the aforementioned baseline noise assessment:

- Heavy duty vehicle noise;
- Distant traffic noise from the R380 road;
- Noise from exploration drill rigs;
- Distant mining noise – ventilation fan noise;
- Existing conveyor type noise;
- Farming type noise;
- Insects;
- Birds; and
- Wind noise.

The difference between actual noise, the ambient noise level, the time of the day and the duration of the activity, will determine how people will respond to sound and what the noise impact will be. In order to evaluate such, there must be uniform guidelines to evaluate each scenario. To this end SANS10103 of 2008 has laid down sound pressure levels for specific districts and has provided the following continuous noise level limits for district types (Table 8-1).

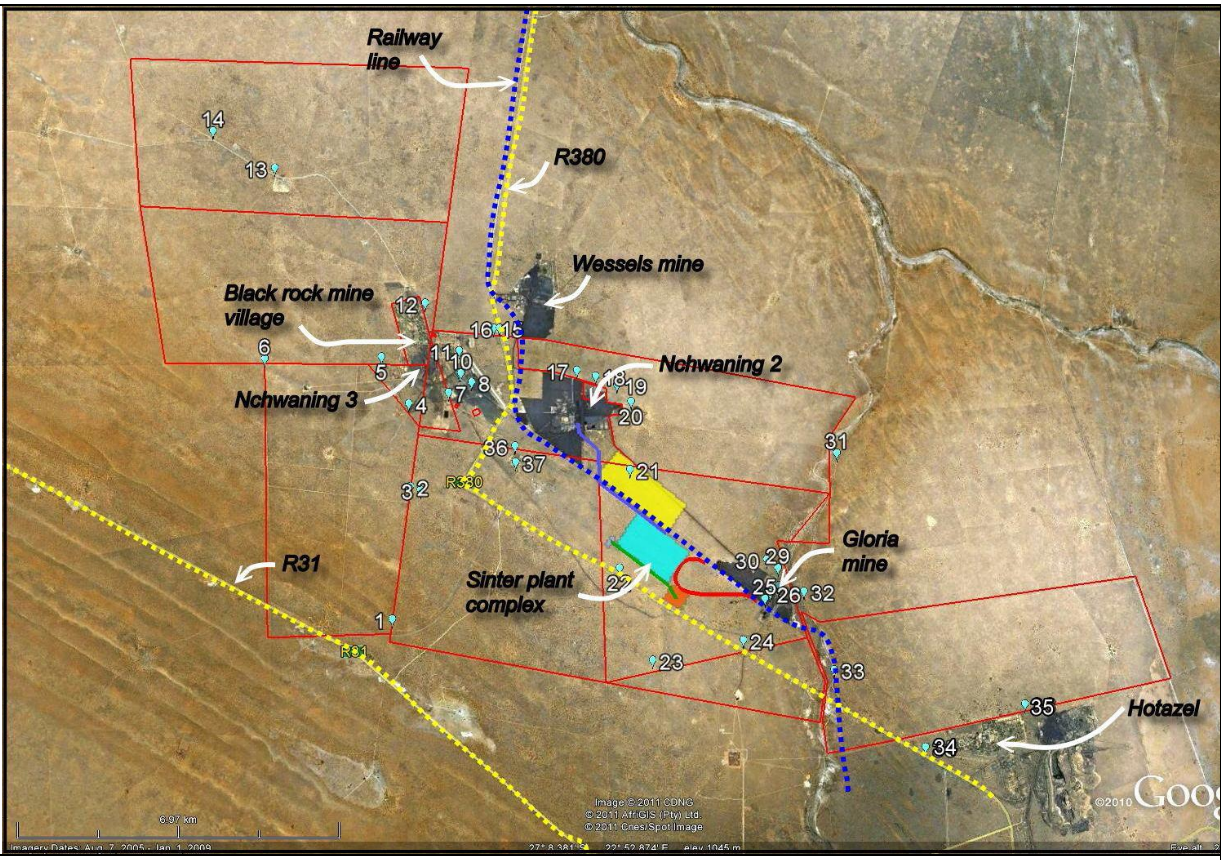

Figure 8-1: Aerial image of noise measuring points relevant to BRMO

Table 8-1: SANS10103 ambient noise level (day- and night time) limits for different districts

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

8.3 BRMO NOISE CHARACTERISTICS/LEVELS

The prevailing ambient noise levels measured at the 37 aforementioned measuring points are displayed in Table 8-2 that follows. Noise readings for the night time period were not done at all of the measuring points due to naturally occurring insect noise; which was the predominant noise for these specific measuring areas and in excess of 50.0 dBA at times.

The following observations were made by the noise specialist in respect of characteristic noise at the individual mines making up BRMO:

8.3.1 NCHWANING III MINE

- The traffic noise from the R380 road was at times audible along the eastern side of the mine;
- Mine ventilation fan noise, traffic noise and mining noise was audible close to the sources and slightly audible at a distance from the source but not audible along the eastern and southern boundary of the mine;
- Manganese ore is transported underground via decline shaft to the Nchwaning II Mine;
- There were no Articulated Dump Trucks (ADTs) in operation along the internal roads between the Nchwaning III and Nchwaning II Mines;
- Mine activity noise was audible along the northern and western boundary of the mine. The source of the noise was observed to be from mine activity noise at the Wessels Mine located north thereof; and

- The feeder road to the offices and complex is mostly used by normal traffic and LDVs type vehicles.

8.3.2 NCHWANING II MINE

- ADTs make use of the entrance road to the mine as they transport the manganese ore from the mine to the end-user;
- Mine activity noise is audible at the boundary of the mine;
- The mine vent shaft is close to the eastern boundary of the mine and the vent noise/mine activity noise is audible at the abutting guesthouse;
- Traffic noise from R380 is audible at the mine; and
- Crushing noise is audible along the eastern boundary of the mine.

8.3.3 GLORIA MINE

- Crushing and mechanical ventilation noise is audible along the southern side of the mine at the entrance road and at the gravel road;
- Reverse signal noise audible at some measuring points;
- The hostel on the property is not occupied; and
- The proposed site for the sinter plant is between the R380 road and the railway line.

The prevailing ambient noise levels (as measured) in the vicinity of structures and infrastructure proposed as part of the sinter plant and mine expansion project are provided in Figure 8-2.

Table 8-2: Measured noise levels for day- and night time periods at BRMO

Position	Day time			Night time		
	Leq -dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA	Leq - dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA
1	**38.5**	61.0	25.0	**46.8**	66.8	37.8
2	**46.1**	63.0	33.5			
3	**75.3**	77.4	69.7			
4	**35.8**	58.8	23.0	**42.6**	45.2	40.8
5	**39.1**	62.3	28.8	**50.4**	53.0	45.9
6	**34.1**	63.6	28.1			
7	**58.9**	65.4	48.7			
8	**70.7**	72.6	69.0	**71.6**	73.1	70.3
9	**54.0**	75.1	48.0	**55.9**	65.3	53.1
10	**54.1**	76.0	34.3	**47.6**	60.5	39.4
11	**43.6**	61.8	36.4	**45.6**	58.0	39.8
12	**38.8**	60.3	31.4	**40.8**	48.1	36.4
13	**35.8**	61.9	21.8	**40.7**	47.2	37.0
14	**31.0**	61.9	20.1			
15	**63.5**	80.3	30.5	**59.8**	77.2	37.2
16	**60.2**	79.0	33.6	**54.0**	76.1	41.8
17	**57.7**	72.9	42.4	**49.0**	58.6	44.1
18	**44.4**	56.0	42.4	**47.1**	54.2	45.2
19	**46.1**	59.2	42.2	**50.5**	55.7	47.9
20	**46.6**	53.6	35.0	**53.2**	53.2	46.0
21	**37.1**	61.9	30.2			
22	**62.7**	81.5	28.1	**54.0**	76.1	41.8
23	**39.8**	63.3	28.7			
24	**65.6**	83.1	33.8	**54.0**	76.1	41.8
25	**61.7**	66.6	56.6			
26	**81.3**	86.8	76.1			
27	**89.7**	97.1	79.0			
28	**50.8**	58.2	46.2			
29	**39.3**	64.0	30.6			
30	**40.4**	61.5	34.9			
31	**40.4**	63.4	26.1	**42.6**	45.2	40.8
32	**42.8**	62.7	34.3	**42.6**	45.2	40.8
33	**40.4**	59.9	29.3	**42.6**	45.2	40.8
34	**61.3**	82.2	24.9	**54.0**	76.1	41.8
35	**39.3**	55.0	29.3	**45.6**	58.0	39.8
36	**43.3**	52.6	37.8	**40.8**	48.1	36.4
37	**47.9**	58.8	40.6	**40.7**	47.2	37.0

The main noise sources at this section of BRMO is the R380 road, with a constant flow of traffic, and the south-eastern side of the existing Gloria Mine, where the existing crushers and ventilation shaft produce noise levels between 85.0 dBA to 89.7 dBA. The presence of the railway on the south-western side of the product stockpile area and crushing plant at Gloria Mine produce a maximum sound pressure level of 89.7 dBA every time the train pass this point. Due to the presence of a railway/road intersection close to the crushing plant at the entrance road to the Gloria Mine the 'hooter' of the train produces a sound pressure level of 110 dBA during the hooting period.

The noise sources along the south western side of the Gloria Mine are higher because of the noisy activities such as the ventilation shaft, crushing activities and the train noise that take place on this side of the mine. The existing mine activity noise was slightly audible on the south eastern side of the mine (measuring point 32 and 33), north eastern side of the mine (measuring points 29 and 30) and along the R380 road (when there was no traffic).

The traffic noise, farming activity noise, railway noise, existing mine activity noise makes up the prevailing ambient noise level in the vicinity of the study area. The prevailing ambient noise level at measuring points 21, which is north west of the Gloria Mine, point 22 which is west of the mine and point 31 which is north of the mine, is made up out of farming, wind and insect noises. The mining related noise at Gloria Mine was not audible at these measuring points. The prevailing noise level may change according to the season of the year when farming activities increases and this noise becomes the predominant contributor to the higher noise levels. There is furthermore an increase in the prevailing noise levels during the rainy season when insect noise can increase the prevailing noise level by 5.0 dBA to 7.0 dBA.

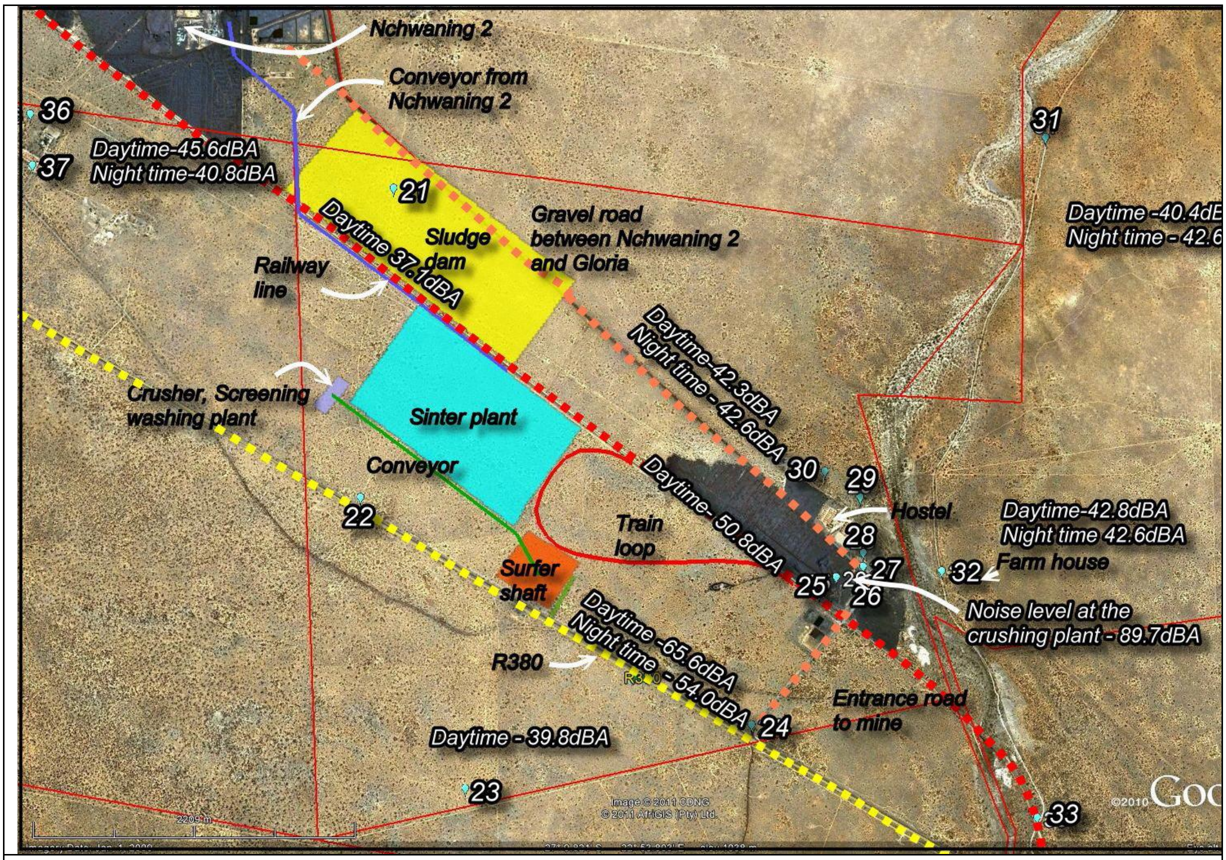

Figure 8-2: Prevailing ambient noise levels in the vicinity of the proposed sinter plant and mine expansion area

9 VISUAL AESTHETICS

The general appearance of the Black Rock mines complex is dominated by the manganese ore-rich koppie after which the mine was named. The koppie bears communication antennae and water storage reservoirs. In addition, the area to the east and south of Black Rock koppie contains various mining infrastructure including administrative offices, hostel accommodation, ventilation and man/materials shafts and opencast pits at the base of the koppie. Between the koppie and the Kuruman road the landscape is dominated by the manganese stack floor, adjacent to which there is a rail line.

The infrastructure at Gloria Mine is similar to that described above, but is far less visible from the Kuruman road as the mine is set back further from the road. The end tipped fine ore dump is just visible from the road.

10 ARCHAEOLOGY, HERITAGE & CULTURE

A Cultural Heritage Impact Assessment, inclusive of a specialist report on the Stone Age of the Northern Cape (relevant to Assmang BRMO), was concluded in September 2009. During this Phase 1 Heritage Assessment only one archaeological sensitive area was identified with relevance to the sinter plant and mine expansion project and which seemed to be restricted to a zone within the bed of the Gamagara River. A representative collection of mostly Early Stone Age (ESA) and Middle Stone Age (MSA) artefacts have been documented at this locality. The large cutting tools evidently form part of an Acheulean assemblage. However, the collection is not large enough for the MSA tools to be assigned to particularly phases within the MSA. The range of tool types, the diversity of raw materials used as well as the presence of formal tools types reflect various instances of site utilisation over a very long period of time. As the lithics were uncovered during quarrying it is probably that sub-surface assemblages may be present. The calcretes should accordingly be marked as archaeological-sensitive areas.

One of the recommendations made in the aforementioned study was two-fold as follows:

- A watching brief was recommended for the locality under review; and
- It was also recommended that no development, mining or quarrying should take place within a 100 m distance from the middle of the Gamagara River; where if any development should take place in this 100 m zone, a full phase II archaeological heritage impact assessment must be undertaken.

Given that the proponent proposes the construction of a new railway bridge over the Gamagara River adjacent to the existing bridge, a site specific Heritage Impact Assessment for this area of the Gamagara River was commissioned for the EIA and concluded in May 2011 (Appendix 5.3 attached hereto).

A total of 14 sites with a Stone Age origin were recorded during the survey (Figure 10-1). It is, however, envisaged that many more sites could still be uncovered in the area, with fairly dense grass cover in certain areas, as well as red Aeolian sand dunes, rendering them invisible. The existing old railway bridge, adjacent to the area where the new rail crossing is proposed, can be considered as a 15th site.

Figure 10-1: Distribution of identified archaeological sites relevant to proposed railway bridge

The Stone Age sites, as well as the stone tools recorded in the area are similar to the one identified by Kusel in 2009. The sites are characterized by scatters of flakes, cores and more formal tools (ESA to MSA/LSA), situated in erosion dongas and quarries, as well as in calcrete formations overlain by red (Aeolian) sand dunes (Figure 10-2). In certain areas the red sand dunes are being eroded (wind erosion), exposing the calcretes and Stone Age artefacts.

Figure 10-2: Photographic examples of ESA and MSA tools recorded on site

The sites vary from low density scatters with only a few artefacts, to areas with thousands of cores, flakes and more formal tools. The significance of the sites is seen as medium to high, and although many might not be impacted on by the development (depending on final engineering design), it is envisaged that any development activity will uncover Stone Age sites and occurrences in the area. This is also true for the new rail crossing, which will be in the Gamagara riverbed. Stone Age artefacts are located in and on the river banks, and the likelihood of uncovering archaeological material is very high. It is therefore recommended that Phase II mitigation is undertaken on some of the sites identified in the area to minimize the impact of the development. This will entail mapping of the sites, as well as controlled surface sampling of material.

11 SOCIO-ECONOMIC ENVIRONMENT

The Gloria Mine falls within the John Taolo Gaetsewe District Municipality (formerly Kgalagardi) that is one of the five districts of the Northern Cape Province of South Africa. It is located in the Joe Morolong Local Municipality, which was formed after amalgamation of the District Management Area and Moshaweng Local Municipality following local government elections in May 2011.

This chapter provides a synopsis of the socio-economic characteristics of the study area. This is essential as it provides both qualitative and quantitative data related to the economies under observation. This data is used as a baseline to assess the socio-economic impacts of the project under review.

The following socio-economic indicators are summarised, with a full socio-economic baseline characterisation available in the Socio-economic Impact Assessment (Appendix 5.8):

- Population size and growth;
- Average household size;
- Income and Expenditure patterns;
- Labour Market dynamics;
- Production; and
- Gross Domestic Product per Region.

11.1.1 SOCIO-ECONOMIC BASELINE SUMMARY

The JT Gaetsewe District Municipality, where the proposed activity is to take place, comprises of 179 863 people and 45 040 households, thus representing 16.4% of the provincial population. Over the last decade, the size of the municipality from a population perspective has been growing at the same rate as the average growth rate observed in the rest of the province; however it is half the rate observed in that of the country. Given the historical trend, it was estimated that by 2025, the South African population could reach 54.7 million people, whilst the JT Gaetsewe DM's population would grow only by about 6 000 people. At the same time, it is expected that the household size in JT Gaetsewe will continue growing at a slow pace as was observed in the past ten years or so and, if this trend continues, its household numbers would increase to 4.1.

Households residing in the JT Gaetsewe District Municipality have relatively the same level of income as the average household in the Northern Cape province, but it is significantly lower than the average household income in South Africa. This means that the Northern Cape and the JT Gaetsewe DM households do not have the same level of access to economic opportunities as the rest of South Africa.

The labour market in the primary study area comprises of 33 684 employed and 15 763 unemployed people. It has a smaller labour participation rate (47.5%) than in South Africa but significantly lower participation rate than in the Northern Cape, which explains a lower average household income earned by JT Gaetsewe DM households versus South African households. The unemployment rate in JT Gaetsewe DM is higher than in any of the analysed areas. This, however, could be explained in terms of employment generation and the low labour participation rate. These discouraged job seekers are not considered to be economically active and are not included in the calculation of the unemployment rate. Therefore, the actual unemployment rates are deceiving and do not reflect the actual need to create new employment opportunities for people in the primary study area, as well as the rest of the country.

Since 1996, the performance of the JT Gaetsewe DM's economy was growing on average at a faster rate than that of the country or the province. Since 1999, however, the JT Gaetsewe DM's economy has been struggling when the Rand depreciated, experiencing a negative growth rate far below that of economies in the Northern Cape or South Africa. The JT Gaetsewe DM's economy is very sensitive to the changes on the global and regional arenas, due to the dependency of the mining sectors; its territory sector though is relatively developed but since it is reliant on the derived demand and the local disposable income, any changes in the mining sector's employment situation would have spin offs (positive or negative) in the tertiary sector.

The situation with housing and service delivery in the area varies. On one hand, the access to formal dwelling in the dsinter is better than that in the rest of the country. However, it appears that influx of people of the last few years increase the size of informal dwellings. With respect to water and sanitation, the area shows a typical rural and per-urban profile with a significant portion of households having access to water outside their dwellings and using pit toilets.

- Given all of the above, it can be concluded that the primary area is in need of investment to stimulate its economy and create new jobs. Ideally, such investment should focus on diversification of local economic activities to reduce the dependency on the mining sector and create new value chains within the local economy. Any new developments in the municipality should also take into account the local housing and service delivery situation and, if possible, put interventions in place that would assist in improving access to formal dwellings as well as access to basic services.