APPENDIX 12

SURFACE WATER IMPACT ASSESSMENT

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HOTAZEL PROJECT

SURFACE WATER BASELINE AND IMPACT ASSESSMENT REPORT

Report prepared for

prime resources (pty) ltd

Report prepared by

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REVISION TRACKING

Rev 0: Original document

Rev 1: Client comments addressed

Disclaimer

The opinions expressed in this report have been based on the information supplied to iLanda by the Client. The opinions in this report are provided in response to a specific request from the Client to do so. iLanda has exercised all due care in reviewing the supplied information. Whilst iLanda has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. iLanda does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features, as they existed at the time of iLanda investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this report, about which iLanda had no prior knowledge nor had the opportunity to evaluate.

1. INTRODUCTION

Prime Resources (Pty) Ltd (Prime Resources) commissioned iLanda Technologies (Pty) Ltd (iLanda) to conduct a surface water specialist study for the proposed Hotazel Project.

1.1 Project Background

The Department of Mineral Resources and Energy (DMRE) has accepted an application for a Mining Right (MR) made by Tawana Hotazel Mining (Pty) Ltd (THM) in terms of Section 22 of the Mineral and Petroleum Resources Development Act, 2002 (MPRDA). The types of minerals applied for are: all (Code UN); Iron and Iron bearing minerals including hematite, goethite, specularite and limonite (Code (Fe) Type (B)) and Manganese and manganese bearing minerals (Code (Mn) Type (B)).

The THM project covers portions of two farms within the Joe Morolong Local Municipality (JMLM) in the Northern Cape Province; Hotazel 280 and York 279 and is located approximately 1 km south-east of the town of Hotazel. The THM project largely incorporates the historical Hotazel Manganese Mine (HMM), and the MR area includes the residual opencast void and surface dumps of low-grade material. The mothballed processing plant and rail loadout facility fall outside the MR area. HMM stopped production in 1989. The area was historically mined by both opencast and underground means and yielded high grade manganese ore. All current plans for the project specifically exclude underground mining.

The overall area applied for is approximately 154 Ha (inclusive of the MR application area and access road). Surface infrastructure will include the opencast pit (incorporating the historical HMM void and further expansion of the opencast footprint), in-pit waste dumps (residue material), surface residue handling/storage, vehicle yard, workshop, access and haul roads, offices, stores, processing plant for the crushing and screening of mined ore, product stockpile area, run of mine pad, refuel bay and water management infrastructure. Refer to Figure 1.

1.2 Mining

- Opencast mining methods will be used to a maximum depth of 95 m.
- The orezone of the various seams is found at depths from 25 m to 91 m below the surface and the manganese seam thicknesses varies from 3 m to 27 m.
- The proposed mining process is as follows: drilling → blasting → load and haul → dry crushing and screening plant → product stockpiling → road truck loading.
- The annual Run of Mine (RoM) ore production is estimated at 0.5 Mt.
- The mining of the opencast pit will require as many as two active work areas in certain schedule overlap years.

1.3 Blasting

- The blast designs will aim for productive blasting, whilst achieving the environmental controls that are needed for mining safely at the proposed THM project.
- The blast designs (including timing and stemming requirements) will take the rock type descriptions, mining methods including planned bench height and hole diameter and the distribution of sensitive receptors surrounding the mine into account.
- The following limits will be applied:
    - Ground vibration: A maximum peak particle velocity (PPV) of 6 mm/s for the closest house.
    - Air blast: A peak air blast level of 120 dBL.
    - Maximum fly rock range: Three fly-rock limits will apply using a factor of safety of two for the safety of people, these being 100 m maximum for all blasts, a 300 m alert or exceedance range for which a special internal investigation is needed if fly rock occurs in this range at distances more than 100 m, and a 500 m clearance zone.
- Cartridge explosives and detonators will be sourced from a licensed explosive magazine provided for use by the blasting contractor, the location which will not be situated within the mining area and adjacent residential area. The blasting contractor office and ammonium nitrate silos and emulsion tank will be stored within a fenced compound to be developed in accordance with the legislated requirements.
- If ammonium nitrate prill is required in the future, it will be delivered to site by truck.

1.4 Loading and hauling

- Due to the mixing requirements, where high-grade ore will be mixed with the lower grade material from the lower benches within the pit, the loading equipment will be mobile.
- The excavators will load the 40 t haulage units with three to four passes and will be supported by a bulldozer to assist with oversize handling, ore crowding and road construction.
- RoM ore will be trucked out of the open pit and tipped onto the RoM ore stockpile.

1.5 Processing

- From the RoM stockpile, front end loaders (FELs) will feed the ore into the primary crusher (jaw crusher).
- The primary crusher will feed the screening plant. In the initial stages these will be mobile units.
- The different size fractions will be sampled and stockpiled into separate stockpiles according to grade and size at the dedicated stockpile area.
- From these stockpiles, the product will be loaded onto road trucks using a FEL according to the customer's requirements in terms of size and grade (some blending may be required).
- Water mist will be added to all processes to reduce dust generation.

- Fines will be stockpiled for sale as and when the demand arises.
- The mobile crushing and screening plant is currently planned to be located at the southern end of the new open pit.
- Road transport loading with suitable weighbridges will take place via a dedicated loading facility. Road trucks will then transport product to Lohatla for train loading, after passing over the weighbridge.

1.6 Mine entrance and access roads

- There are two main access roads to the mine, one intersects with Provincial Road D3463 from Kuruman to Severn and enters the mine at the northern easter corner, while the other road is from Hotazel town in the west and enters the mine from the north. The two roads intersect before entering the mining area.
- The main transport route to the northeast will be for Heavy Vehicles (HVs), potentially 80 – 100 trucks per day, and the main entrance to the west (near Hotazel) will be for Light Delivery Vehicles (LDV's).
- In addition, on-site access roads will be required for use by the secondary support fleets and earthmoving haul trucks, with ramps that lead in and out of the pit and haul roads for the transportation of processed products and waste amongst others.
- In order to improve mobility around the mine and to potentially reduce road user costs, a ring road (haul road) around the mine pit has been proposed. This road will also intercept stormwater which will be channelled to the stormwater ponds.
- The minimum width of all the roads is 10m as they generally have to accommodate large trucks, with sufficient space for surface water flow.

1.7 Support Equipment

- Four excavators (5 m^3 capacity) and FELs (5 m^3 capacity) will be required for flexibility and management of the various stockpiles.
- Eight trucks (in the 40 t class with 320 kW engines) will be required in the initial production period with this increasing to sixteen once steady state RoM production has been achieved.
- Three primary blast hole drill rigs will be required
- One road grader will maintain the roads on the property.
- One water truck for dust suppression on main haul routes.
- Two track dozers will be used for typical dozer functions including maintenance of dumps, drill site preparation, road building, ditching, bench repair, shovel clean-up and stockpile dozing.
- A rubber-tired dozer for lighter dozer work such as shovel excavator clean-up and road sweeping.

- Diesel LDVs will be supplied for the Mine Superintendent, Engineering Superintendent, Mining Supervisor, Blaster, Geologist, Surveyors, and the plant production crew. A total of eight units are provided for initially.
- Maintenance support vehicles and equipment will include flat deck trucks and fuel, water, and lube trucks for servicing the excavators.
- Miscellaneous units such as personnel carriers, lighting towers etc. are also provided for the support of mine operations.

1.8 Electricity

- The mine reticulation will be provided from the existing 11 kV Eskom overhead power supply line from a substation in Hotazel, which terminates close to the north-western corner of the mine, next to the existing railway line.
- A new mini substation will be connected to the incoming Eskom overhead powerline, from where the mine's offices and weighbridge will be connected by an underground power cable.
- A single Eskom 132 kV line will be brought into the main substation switching yard.
- The expected full load power requirement is calculated as 3 326 kVA. An application for 4.0 mVA has been submitted to cover the power requirements for the proposed THM project.
- The remaining facilities and plant (i.e., processing plant) will not be connected to the grid as they will use their own power. The entire processing plant will be diesel operated.
- Until such time as power infrastructure is installed on site a mix of solar and diesel generators will be used as an alternate supply source.

1.9 Water

- All potable water will be supplied through the Vaal Gamagara water scheme via a bulk water meter, managed by Sedibeng Water.
- Sedibeng Water has therefore been engaged and has provisionally approved a connection point for water supply approximately 2km south west of the mine. A design is required to be submitted to Sedibeng Water for approval.
- Water will be required for processing, mining, change houses, offices, and workshops. Each supply area will be individually metered to enhance control and minimise wastage.
- Water supply for other purposes (i.e., dust suppression and industrial use on site) will be sourced from the either the stormwater ponds or the PCD.
- The estimated that the potable water consumption volumes per day is 4 800 – 6 480 litres per day plus 10% for wastage/losses.
- The remainder of the water to be used for general purposes (i.e., dust suppression and process water purposes) will be sourced from the PCD and the stormwater ponds.
- An application for a water connection has been submitted to Sedibeng Water.

- Precipitation has collected in the open void and underground workings since the mine stopped production in 1989. This water will need to be fully removed before mining work can commence. A forced-evaporation system to eliminate water from the initial void may be implemented for water management purposes.
- A lined 5 m deep pollution control dam (PCD) is planned with a minimum capacity of 20 000 m^3.
- The site has been split into three main catchment areas, excluding the mining pit, resulting in a total of three planned stormwater ponds to store as much of the surface water as practically possible. The surface water will mainly be intercepted by the roads and channelled to the respective stormwater ponds. The capacity of the stormwater ponds is as follows:
    - stormwater pond 1 (12 250 m^3),
    - stormwater pond 2 (6 500 m^3), and
    - stormwater pond 3 (7 313 m^3).

  The ponds have been sized for a 1 in 50 year return flood.
- Mine dewatering will be carried out using diesel powered submersible pumps installed in sumps at the bottom of the pit. Water will be pumped from the open pit and discharged into the freshwater tank for use in the plant with any excess water discharged to the PCD.

1.10 Waste

- The mining project will generate general (domestic) waste and mining waste.
- Sanitation from the mine will be piped to a septic tank which will be located on the eastern side of the offices. This septic tank will have a capacity of a minimum of two (2) weeks before it is filled-up. Design drawings are to be submitted to the municipality for approval prior to start of construction. Similar to the water supply, sanitation infrastructure will only be connected to the office block.
- Non-hazardous domestic and industrial waste will be stored temporarily within a hard-standing area for covered bins/skips.
- All recyclable waste will be collected by a contractor where it will be recycled off-site. Only materials which cannot be reused, recycled or recovered will be disposed of at an appropriately licensed facility by a licensed contractor.
- An estimated stripping ratio is set at 2.98 t of waste per tonne of ore. Residue material (overburden and waste rock) arising from the development and ongoing operation of the opencast mine pit will be disposed back into the existing historical opencast void and the trailing mined out opencast void through backfilling. There will be 3 waste dumps with the following capacities and maximum heights:
    - Waste dump no.1 (3 859 493 m^3) – 15 m above current surface
    - Waste dump no.2 (3 487 682 m^3) - level with current surface
    - Waste dump no.3 (5 783 722 m^3) – 30 m above current surface
- There will also be a topsoil stockpile with a capacity of 210 000 m^3 and estimated height of 10 m and a sand stockpile with a capacity of 1 185 000 m^3 and estimated height of 20 m.

1.11 Other infrastructure

- A new weighbridge facility, which will comprise of a weighbridge and an office, is planned to be constructed between the offices and the product stockpile area, close to the northern boundary of the of the mine. This facility will be manned as per the operational requirements of the mine. In order to cater for trucks that may be overload or underloaded, a turning loop will be constructed next to the weighbridge facility to allow for easy access back to the product stockpile area.
- The new offices and parking will be located along the northern boundary of the mine. The offices will be accessible via the new access road that ties in with the main access road from the north, used by LDVs.
- A plant yard/workshop will be located on the western side of the pit, between the mine pit and a haul road that links the processing plant and the product stockpile area. This facility will mainly be used for repairs, servicing and washing of vehicles/plant. The surface will be a concrete slab with a slope towards various sumps to contain oil and contaminated water.
- A refuelling station will be located on the western side of the pit. This facility is anticipated to have at least two 30 000 l refuelling tanks and will have a concrete slab with sumps to contain oil and contaminated water.

1.12 Operating hours and staff

- The mine and plant will operate on a continuous basis, with 330 working days per annum.
- The mine will employ approximately 177 people (inclusive of outsourced service providers).
- Timeframes and scheduling of phases
- 2 years have been allowed for pre-stripping and mining infrastructure construction.
- The Life of mine (LoM) indicated by the conversion of the resource to reserve is 30 years for the open pit operation.
- Backfilling/rehabilitation will commence immediately after the commencement of the mining operation and its advance will match the depletion rate of the open pit.
- A period of 3 years is expected for final rehabilitation after closure.

FIGURE 1: PROPOSED MINE LAYOUT

1.13 Study Objectives and Terms of Reference

The study objectives and terms of reference are as follows:

- Baseline hydrological analysis
- Surface water buffer zone determination
- Impact assessment

This report constitutes the outcome of the baseline specialist studies undertaken by iLanda on behalf of Prime Resources, related to the environmental impact of the proposed Hotazel Project.

1.14 Battery Limits

The battery limits of the study are shown in Figure 2. All work is confined to this area unless otherwise specified.

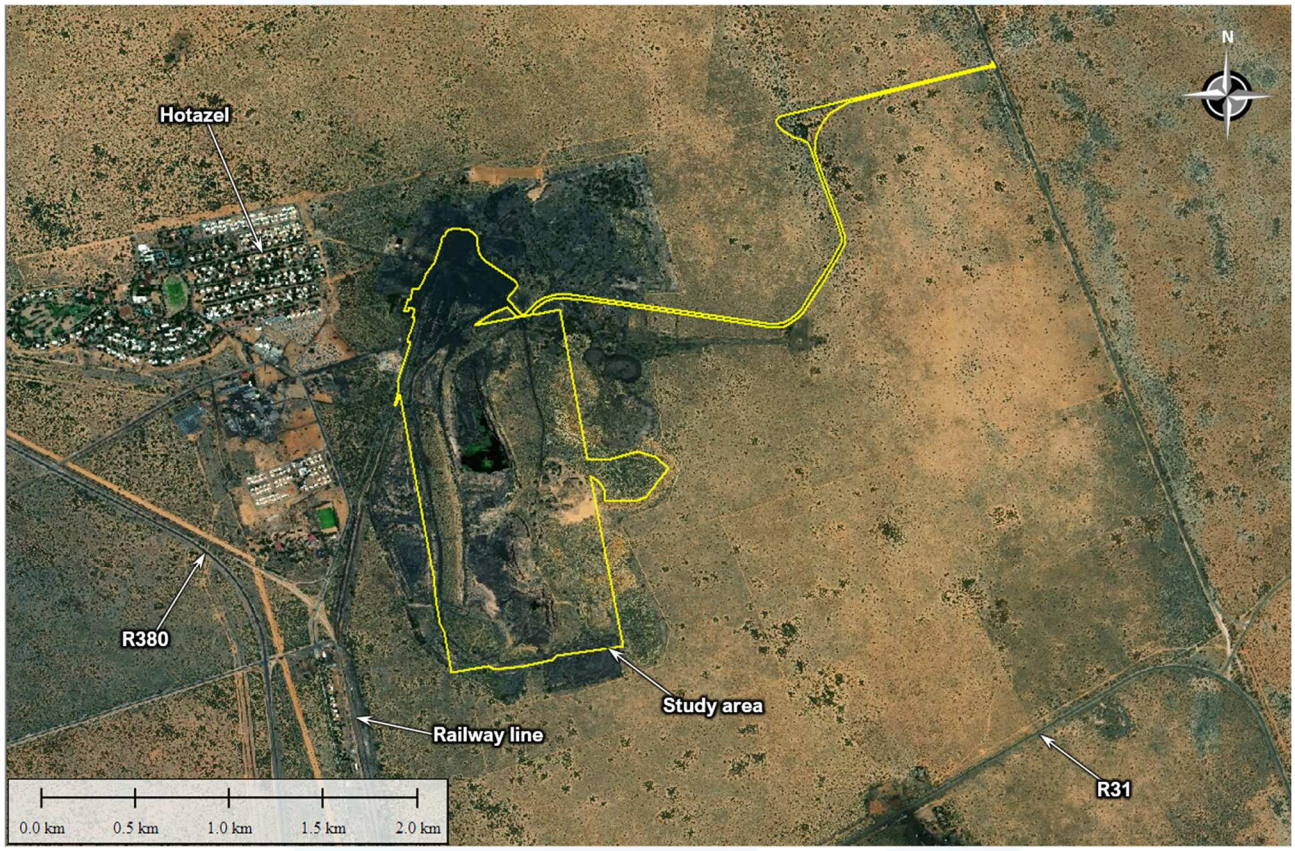


FIGURE 2: STUDY AREA AND MINING RIGHTS AREA

1.15 Legislative and Policy Framework

The following legislation was adhered to:

- The South African National Water Act, Act 36 of 1998.
- GN 704, Regulations on the use of water for mining and related activities aimed at the protection of water resources (1999).
- Mineral and Petroleum Resources Development Act, Act 28 of 2002.

2. SPECIALIST DETAILS

This specialist report was compiled by Dr Bruce Randell. Dr Randell is a Water Resources Engineer with over 18 years' experience, mostly in water resources modelling and specialist surface water studies for environmental impact assessments. Dr Randell has B.Sc. (Civil Engineering) and PhD degrees. Dr Randell's PhD thesis was in water resources.

Mogara River catchment is approximately 350 mm, decreasing from south to north. The mean annual S-Pan evaporation in the catchment is 2 350 mm.

3. REGIONAL SETTING

The operations are located in the Northern Cape Province of South Africa. The study area is located in quaternary catchment D41K (refer to Figure 3) in the Vaal Water Management Area (although in the Orange River primary catchment). The operations are located in the Ga-Mogara River catchment. The Ga-Mogara River is a tributary of the Kuruman River, which is a tributary of the Molopo River which flows into the Orange River near Augrabies. The Ga-Mogara River catchment measures nearly 8 100 km^2, but some areas are endorheic and the net catchment area measures 5 182 km^2. The mean annual rainfall in the Ga-Mogara River catchment is approximately 350 mm, decreasing from south to north. The mean annual S-Pan evaporation in the catchment is 2 350 mm.

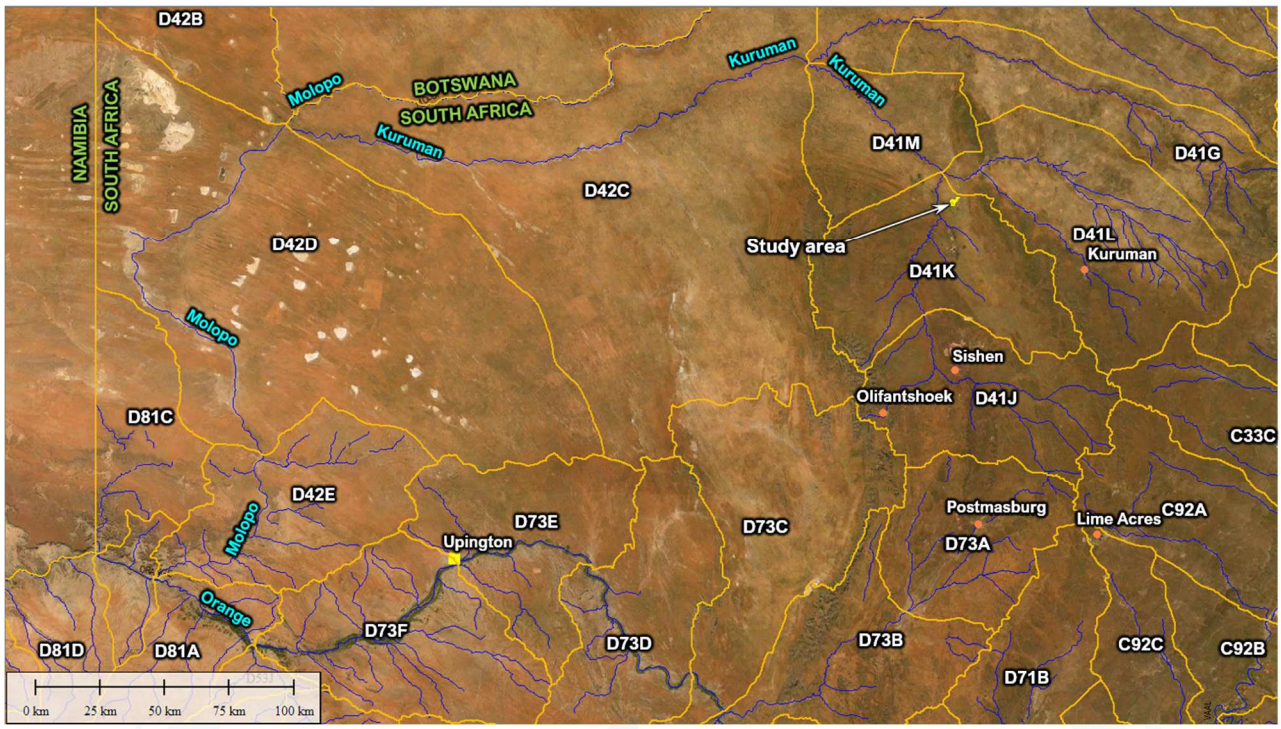


FIGURE 3: REGIONAL SETTING

4. LOCAL SETTING

The mining rights area is located south east and adjacent to Hotazel. The mining rights area falls within the study area and is shown in Figure 4.

The mining rights area is a previously mined area with the following infrastructure in an unrehabilitated form:

- Open cast pit
- Topsoil, waste rock and overburden dumps
- ROM area
- Adits, conveyor infrastructure, crushers and loading facilities
- Roads

Active mining has been absent for some time and much of the infrastructure has been partially covered with natural revegetation. The pit contained water at its deepest parts at the time of the site visit (mid-January 2021). The extensive reedbeds surrounding the water indicate that this water is permanent. Historical Google Earth imagery support this hypothesis.

Some of the topsoil stockpiles are being used by the municipality as a waste dumping ground. Waste is dumped and covered by the topsoil (refer to Figure 5). The existing Hotazel waste site (G:S:B- , Permit No.:

B33/2/441/20/P156, licence date 20 February 1995) is located within the proposed THM area. The waste site is owned by South 32 - HMM and operated by the municipality. The waste site is nearing its end of life. At this stage, only the general waste from Hotazel Town and from South 32 - HMM is permitted for disposal.

Some of the topsoil stockpiles are heavily eroded on their sides. The top surfaces appear to be stable and are not being eroded.

The infrastructure appears old and in a state of disrepair. The pit appears to have several adits into underground operations.

Apart from the township of Hotazel, the area immediately surrounding the study area is unpopulated and undeveloped.

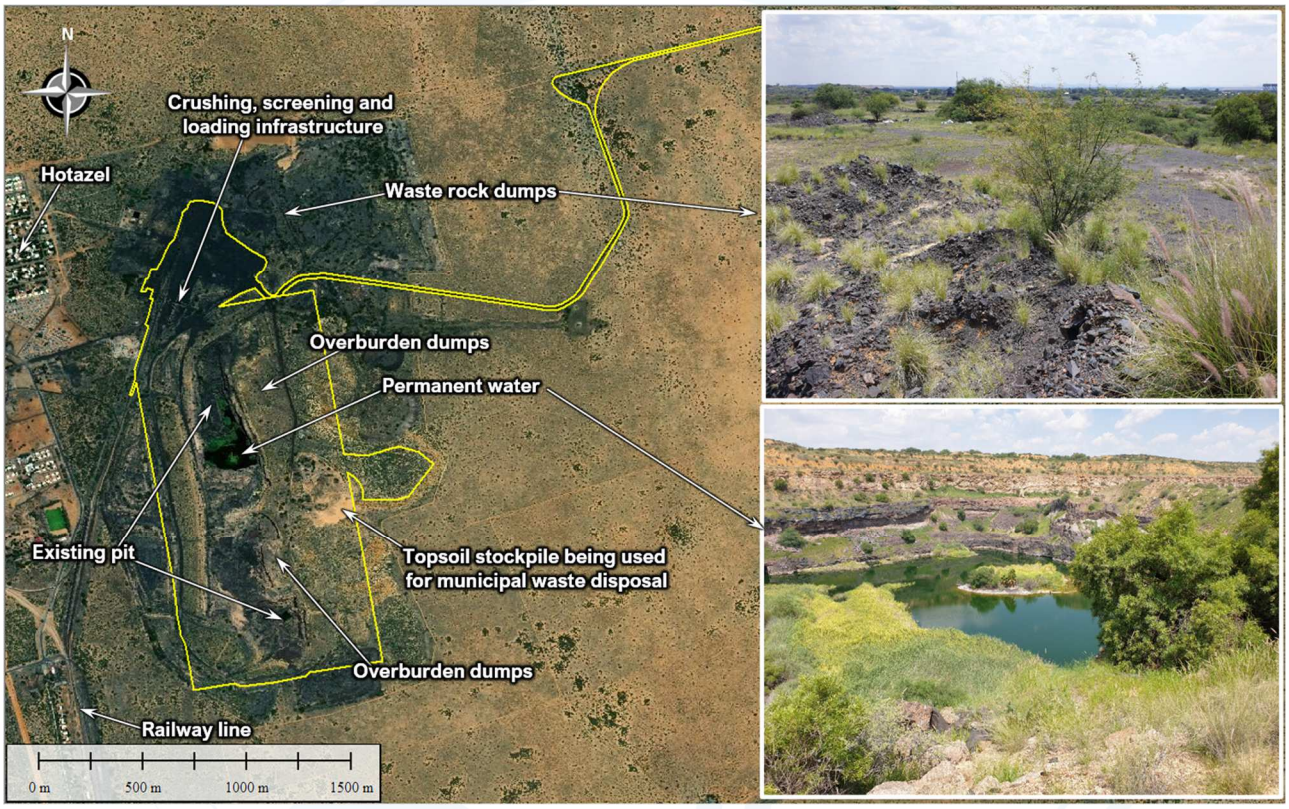


FIGURE 4: LOCAL SETTING

FIGURE 5: WASTE BEING DUMPED AND BURIED ON THE TOPSOIL STOCKPILES

5. CATCHMENT DESCRIPTION

No rivers flow in close proximity to the study area. The closest rivers are the Ga-Mogara River (5 km west) and the Kuruman River (10 km north). Both rivers have large catchments, but these catchments are arid and subsequently both rivers are non-perennial and episodic.

The catchments are largely undeveloped, although significant iron ore and manganese deposits are being mined in the Ga-Mogara River catchment. The Kuruman River catchment comprises mostly agricultural activities.

During the site visit in mid-January 2021, the Kuruman River was flowing strongly (visually estimated more than 1 m^3/s). The Ga-Mogara River was dry.

The Ga-Mogara Riverbed is being mined near the R380 highway. A large river diversion appears to have been constructed and significant construction is underway in the riverbed. These impacts are upstream of any impacts that might result from the mining operations at the proposed Hotazel Project.

FIGURE 6: CONSTRUCTION ACTIVITY IN THE GA-MOGARA RIVER

6. ENVIRONMENTAL ATTRIBUTES AND BASELINE

6.1 Topography

The topography of the surrounding area is flat. Previous mining operations have left portions of the mining rights area mining rights area with excavations and heaps. These features have naturally partially revegetated with a thin grassland covering and some shrubs. The pit is in an unrehabilitated form with steep sides and is partially vegetated (naturally).

6.2 Mean Annual Precipitation and Evaporation

The mean annual precipitation of the mining rights area is 270 mm. The mean annual evaporation of the mining rights area is 2 375 mm (S-Pan). The monthly average rainfall, rainfall days, and evaporation rates are presented in Table 1.

6.2.1 Sources of rainfall data

Rainfall data for the area was obtained from the CCWR (Computing Centre for Water Research, Natal University) database. Gauge number 0392640 (Mukulu) was used. The gauge is located approximately 13 km north west of the mining rights area. The gauge contains missing data between 1965 and 1977. An additional 20 years of daily data for the area (SAWB gauge number 0393126 1 - Tsineng - POL) was purchased from the South African Weather Bureau. The full data set therefore runs from May 1937 to November 2020, but contains the missing data described above. The data is considered representative of the mining rights area and is good quality.

6.2.2 Sources of evaporation data

The mean annual evaporation was sourced from the average evaporation for quaternary catchments D41K and D41L, documented in the Water Resources of South Africa, 2005 Study (Middleton and Bailey, 2009). The mining rights area is located close to the boundary between these two quaternary catchments. The monthly distribution was sourced from the Water Resources of South Africa Study data set, zone 8A (Midgley et al., 1990). The data is considered representative of the site.

6.2.3 Climatic water balance

The Department of Water Affairs require a climatic water balance that incorporates a list of years which have the wettest six months of the year, either November to April or May to October. In this case November to April is wetter than May to October. The wettest six months between November and April are listed in Table 2.

TABLE 1: MEAN MONTHLY RAINFALL, RAIN DAYS AND EVAPORATION DATA FOR THE MINING RIGHTS AREA

Month	Ave Rainfall (mm)	Ave rain days	Ave Evaporation (mm S-Pan)
October	15.8	1.7	272.4
November	20.8	2.4	286.9
December	41.8	3.0	297.6
January	43.1	3.8	279.8
February	49.2	4.0	212.1
March	42.2	3.8	195.2
April	30.1	2.5	145.6
May	11.2	1.1	115.9
June	8.0	0.6	91.9
July	0.9	0.2	107.1
August	4.0	0.4	155.3
September	4.1	0.6	215.2
Mean Annual	**270***		**2 375**

** Note: The sum of the mean monthly rainfall depths does not necessarily equal the mean annual precipitation.*

TABLE 2: WETTEST YEARS BETWEEN NOVEMBER AND APRIL

Rating	Hydrological year	Total rainfall between November and April (mm)
Wettest year	2009	465.2
2nd wettest year	1955	426
3rd wettest year	1999	424.8
4th wettest year	2005	386.5
5th wettest year	1964	372.3
6th wettest year	1987	366.4
7th wettest year	1954	340.7
8th wettest year	1945	334.7
9th wettest year	1942	305.1
10th wettest year	2007	301.8

6.3 Peak Rainfall Data

6.3.1 Maximum Monthly Rainfall Data

The maximum monthly rainfall data was distilled from the daily rainfall record (discussed in section 6.2.1) and is presented in Table 3.

TABLE 3: MAXIMUM MONTHLY RAINFALL DATA (MM)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
115.9	101.5	271	238.6	169.3	209.5	173.1	81.8	127.1	24.9	50.9	53

6.3.2 Peak 24-hr Rainfall Data

The peak 24-hr rainfall depths are presented in Table 4.

TABLE 4: PEAK 24-HR RAINFALL DEPTHS FOR THE MINING RIGHTS AREA

Recurrence Interval (year)	24-hour rainfall depth (mm)
2	39
10	71
20	84
50	103
100	117
200	132

The daily rainfall record, discussed in section 6.2.1, was analysed and the annual maximum series was extracted from the data. This annual maximum series was statistically analysed to determine various T-year recurrence interval 24-hour storm depths. A Log Normal fit was selected as the most appropriate statistical fit. This fit is shown in Figure 7. The rainfall record is long, consists of good data, is representative of the mining rights area, and is suitable to be used to calculate peak rainfall presented in Table 4.

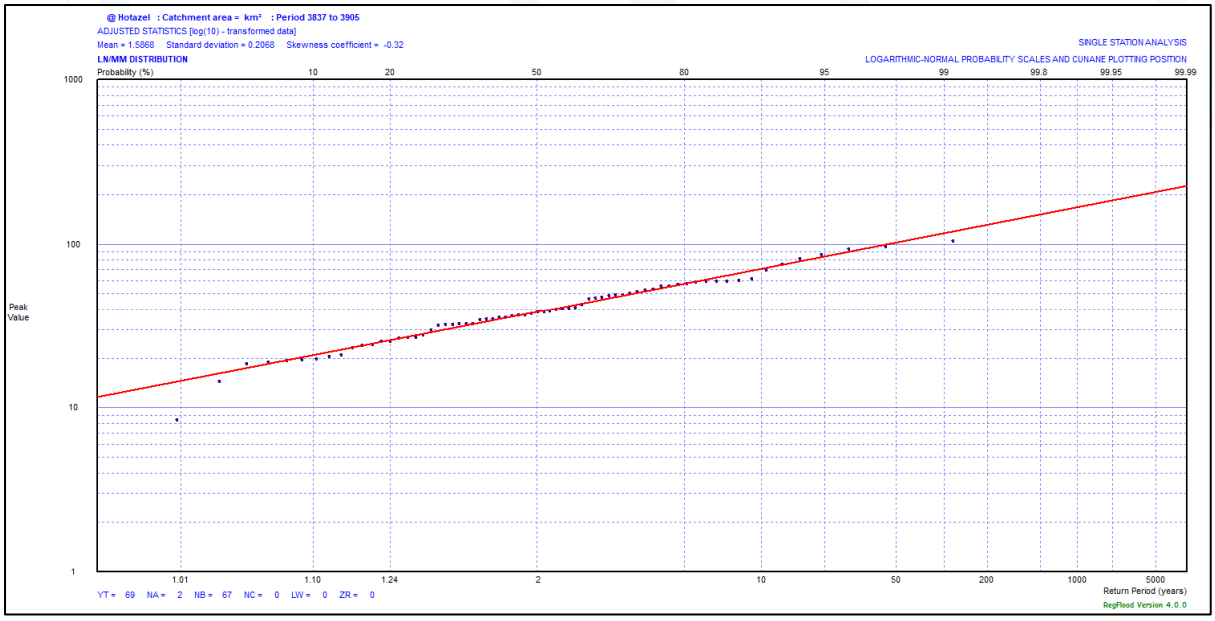


FIGURE 7: LOG NORMAL STATISTICAL FIT TO THE ANNUAL MAXIMUM SERIES

6.4 Water Management Area

The mining rights area is located in quaternary catchment D41K, in the Lower Vaal Water Management Area (although in the Orange River primary catchment).

6.5 Hydrology

No streams flow through the mining rights area. The area drains generally to the west towards the Ga-Mogara River, which flows from south to north approximately 5 km west of the mining rights area.

7. BASELINE HYDROLOGY

7.1 Catchment Delineation

The catchments were delineated using the quaternary catchments. Many portions of the catchments are endorheic (do not drain to the sea) so these areas are excluded when calculating the net catchment areas. These catchments are shown in Figure 8.

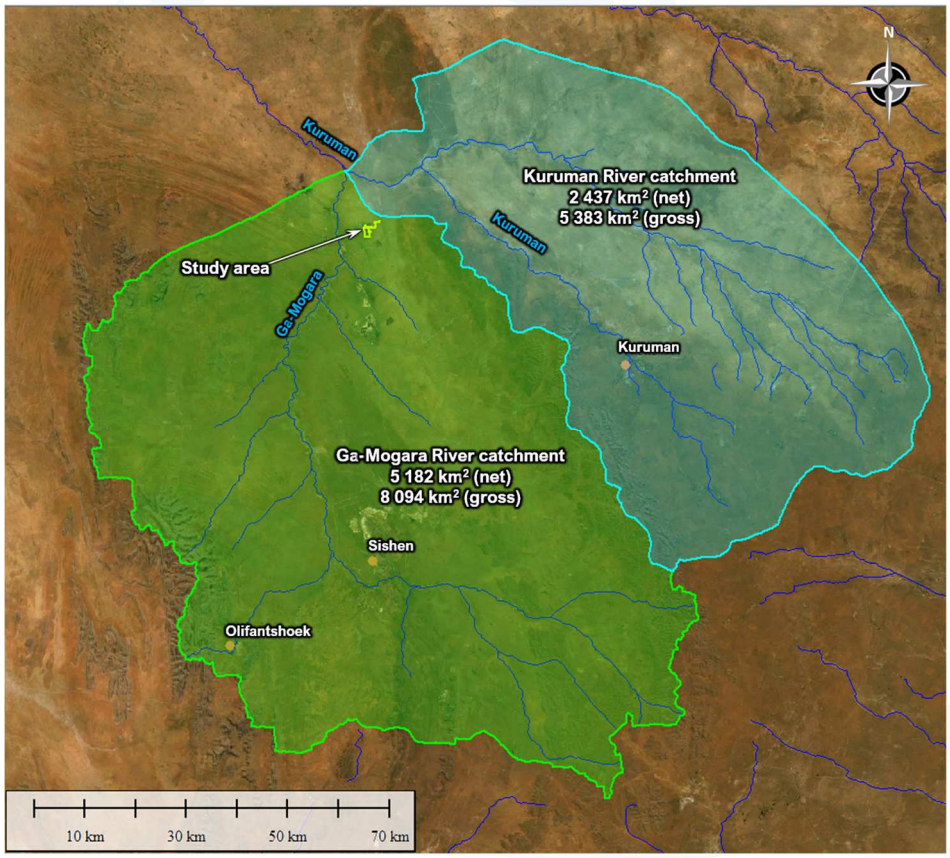


FIGURE 8: CATCHMENT DELINEATION

7.2 Mean Annual Runoff

The mean annual runoff for the quaternary catchments were obtained from Middleton and Bailey (2009) and presented in Table 5. The catchment boundaries and sizes are shown in Figure 8.

TABLE 5: MEAN ANNUAL RUNOFF

Stream	Mean annual run-off (Net Mm^3/a)
Ga-Mogara River	3.65
Kuruman River	3.36

7.3 Normal Dry Weather Flows

The normal dry weather flows are based on the average monthly flows documented in the Water Resources of South Africa, 2005 Study (Middleton and Bailey, 2009) for quaternary catchments D41J, D41K and D41L. The dry weather flows are presented in Table 6. The dry weather flows have been highlighted in bold text.

Both rivers experience occasional dry season surface flows as well as subsurface flows. Both of these contribute to higher-than-expected dry season average flows.

TABLE 6: NORMAL DRY WEATHER FLOWS IN M^3/MONTH (HIGHLIGHTED IN BOLD TEXT)

Month	Ga-Mogara River	Kuruman River
Oct	**103 412 m^3**	**115 529 m^3**
Nov	144 471 m^3	171 882 m^3
Dec	281 647 m^3	285 765 m^3
Jan	1 042 706 m^3	856 235 m^3
Feb	888 235 m^3	726 824 m^3
Mar	658 353 m^3	552 118 m^3
Apr	254 353 m^3	239 882 m^3
May	**78 706 m^3**	**103 059 m^3**
Jun	**57 882 m^3**	**85 176 m^3**
Jul	**53 882 m^3**	**80 471 m^3**
Aug	**48 353 m^3**	**75 765 m^3**
Sep	**41 882 m^3**	**69 882 m^3**

7.4 Flood Flow Analysis

The 50-year and 100-year flood peaks for the streams and rivers were calculated and the results are presented in Table 7. The flood peaks were calculated for the catchments shown in Figure 8.

The UPFlood software's Empirical method were used to determine flood peaks for both rivers the rivers and streams.

TABLE 7: PEAK FLOWS IN THE RIVERS AND STREAMS

River	50-yr	100-yr
Ga-Mogara River	621 m^3/s	789 m^3/s
Kuruman River	427 m^3/s	543 m^3/s

8. BUFFER ZONES

There are no water courses in close proximity to the study area, so no surface water buffer zones are relevant.

9. WATER QUALITY

9.1 Surface Water Users

The water quality data was compared against the South African water quality guidelines (Department of Water and Sanitation and Forestry, 1996). In selecting which guidelines to compare the data against, the likely downstream users need to be considered. The likely downstream users were determined by examining aerial photography, literature surveys and observations made during a site visit of the catchment.

The operations may affect the Ga-Mogara River, a tributary of the Kuruman River. Refer to Figure 8 for the river locations. Both Rivers are episodic.

The downstream usage classes are evaluated below:

- Domestic users – limited drinking water, but farm labourers and local inhabitants may consume this river water and use it for laundry and cleaning when water is available.
- Recreational users – it is likely that farm labourers and local inhabitants may swim in the rivers when they are flowing and may use the water for washing.
- Industrial users – there are no water quality sensitive industrial users on the Ga-Mogara and Kuruman rivers downstream of the study area.
- Aquatic users – the catchments are impacted by agriculture and mining and sensitive aquatic users are unlikely to be present. Some less sensitive aquatic species may still be present.
- Irrigation users – the river water may be used for opportunistic irrigation.
- Livestock watering – the river water may be used for opportunistic livestock watering.

The water quality guidelines considered are therefore the Domestic, Aquatic, Irrigation, Livestock watering and Recreational water quality guidelines. The water quality at the sampling point was compared to these guidelines.

9.2 Sample Locations

The Ga-Mogara River was dry during the site visit. The Kuruman River was flowing. These rivers are normally dry, so obtaining any water quality sample is opportunistic and fortunate.

iLanda sampled water quality in the Kuruman River at the location shown in Figure 9. Water quality monitoring data was collected on 20 January 2021 and analysed by an accredited laboratory. The water quality is described in more detail below and summarised in Figure 10.

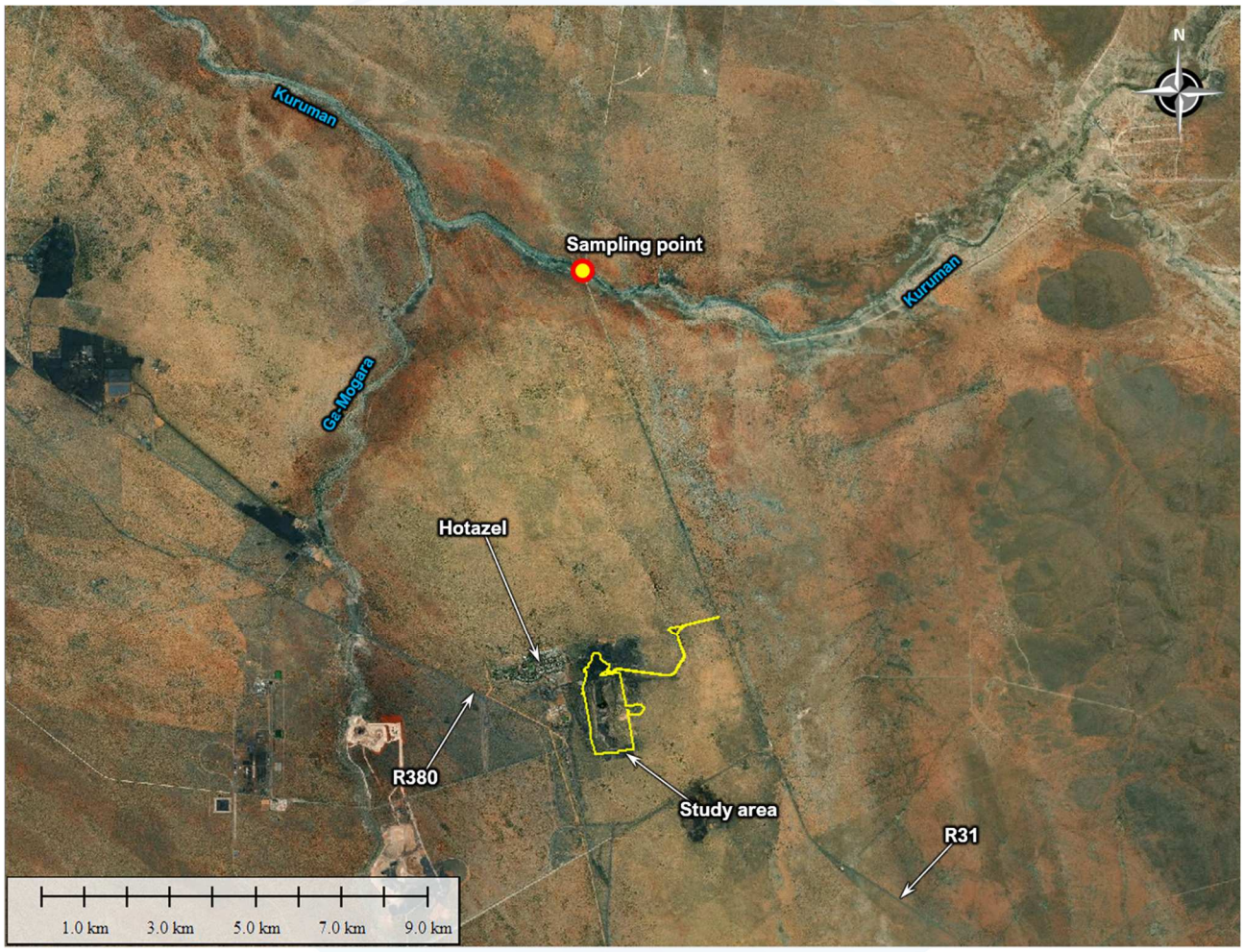


FIGURE 9: WATER QUALITY MONITORING POINT

9.3 Sample Results

The results show that the background water quality in the Kuruman River is good, with only elevated calcium, resulting in elevated TDS and electrical conductivity. This is considered naturally occurring calcium. The results are summarised in Figure 10.

It must be noted that iLanda was in the upper reaches of the Ga-Mogara River (near Kathu) in early February 2021, and the Ga-Mogara River had recently flowed strongly for a short period. Evidence left behind of this flow event, as well as video footage taken during the event pointed to high suspended solids in the Ga-Mogara River. If this is the case, it is in stark contrast to the clear waters that were flowing in the Kuruman River when the water quality was sampled. It is likely that this highly turbid water in the Ga-Mogara River will reach the Kuruman River and negatively impact the suspended solids/turbidity in the Kuruman River should the two rivers be flowing at the same time. No chemical information is available so no comment can be made on the water chemistry in the Ga-Mogara River.

Parameter	20/01/21	Comments
pH Value @ 25°C	7.7	
Conductivity @ 25°C(mS/m)	47.2	The water quality exceeds the Irrigation guideline value of (40mS/m) on 20/01/2021.
Total dissolved solids, TDS(mg/l)	336.00	The water quality exceeds the Irrigation guideline value of (260mg/l) on 20/01/2021.
Calcium as Ca(mg/l)	49.20	The water quality exceeds the Domestic guideline value - Class O (32mg/l) on 20/01/2021.
Calcium Hardness as $CaCO_3$(mg/l)	123	
Total suspended solids, TSS(mg/l)*	<1	
Magnesium as Mg(mg/l)	31.00	
Magnesium Hardness as $CaCO_3$(mg/l)	126	
Total Hardness as $CaCO_3$(mg/l)*	249	The water quality exceeds the Domestic guideline value - Class I (200mgCaCO3/l) on 20/01/2021.
Sodium as Na(mg/l)	16	
Potassium as K(mg/l)	5.4	
Total Alkalinity as CaCO3(mg/l)	211.00	
Chloride as Cl(mg/l)	28.00	
Sulphate as SO4(mg/l)	15.03	
Nitrate as NO3(mg/l)	0.20	
Nitrate as N(mg/l)	<0.100	
Nitrite as NO2(mg/l)	<0.1	
Nitrite as N(mg/l)	<0.1	
Fluoride as F(mg/l)	0.20	
Turbidity(N.T.U)*	1.20	

LEGEND				
RECREATION WATER GUIDELINE EXCEEDANCES	Value			
DOMESTIC WATER GUIDELINE EXCEEDANCES	Class O	Class I	Class II	Class III
IRRIGATION WATER GUIDELINE EXCEEDANCES	Value			
LIVESTOCK WATER GUIDELINE EXCEEDANCES	Value			

FIGURE 10:WATER QUALITY IN THE KURUMAN RIVER

10. IMPACT ASSESSMENT

10.1 Methodology for Impact Assessment

Activities on the operations have been taken through an impact assessment prior to, and post mitigation measures. The recommended mitigation measures have been included in the impact assessments. Impacts are assessed for the construction, operational, decommissioning and closure phases of the project. The methodology used for the impact assessments is presented below:

Occurrence

- Probability of occurrence (how likely is it that the impact will occur)
- Duration of occurrence (how long impacts will last)

Severity

- Magnitude of impact (the severity of the impact)
- Scale of impact (the extent of the impact).

The following ranking scales were used:

Probability (P)	Duration (D)
5: Definite/don't know 4: Highly probable 3: Medium probability 2: Low probability 1: Improbable 0: None	5: Permanent 4: Long-term (ceases with the operational life) 3: Medium-term (5-15 years) 2: Short-term (0-5 years) 1: Very short-term (0-1 week)
Scale (S)	**Magnitude (M)**
5: International 4: National 3: Regional (within a 100 km radius) 2: Local (within a 5 km radius) 1: Site only 0: None	10: Very high/don't know 8: High 6: Moderate 4: Low 2: Minor

The impact is calculated as: Impact score = (M + D + S) x P. The maximum Impact score is 100. The impact ratings were based on the Impact score and are rated as follows:

- High environmental impact: Impact score between 60 and 100.
- Medium environmental impact: Impact score between 30 and 59.
- Low environmental impact: Impact score between 0 and 29.

10.2 Summary of Impacts

The impact assessment is discussed in detail in the following sections. A summary table of the impacts is shown in Table 8.

TABLE 8: IMPACT ASSESSMENT SUMMARY

Phase	Impact	Pre mitigation scores						Post mitigation scores					
		P	D	S	M	Score	Impact	P	D	S	M	Score	Impact
Construction	Topsoil stripping	3	2	1	2	15	Low	3	2	1	1	12	Low
	Construction related pollution	3	2	2	4	24	Low	2	2	2	4	16	Low
Operational	Bulk water demand and supply impact on existing industrial operations and communities	3	3	3	4	30	Med	2	3	3	4	20	Low
	Evaporators	0	0	0	0	0	None	0	0	0	0	0	None
	Contaminated water discharge	5	4	2	4	50	Med	1	1	2	2	5	Low
	Leaking or burst dirty water pipes	4	3	2	4	36	Med	3	3	1	2	18	Low
	Loss of catchment yield	5	5	0	0	25	Low	5	5	0	0	25	Low
	Wash bays and workshops	2	1	3	4	16	Low	1	1	3	2	6	Low
	Diesel spillage	4	3	1	4	24	Low	1	3	1	4	8	Low
	Vehicle fleet-related pollution	3	2	2	4	24	Low	2	2	2	4	16	Low
Decommissioning	Removal of surface infrastructure and rehabilitation	3	2	1	2	15	Low	3	2	1	1	12	Low

10.3 Impacts During the Construction Period

10.3.1 Impacts due to topsoil stripping

Impact assessment

During the construction phase, topsoil from all greenfield facility footprints should be stripped and stockpiled for future use. This may result in the following impacts:

- Areas that have been stripped of vegetation and topsoil will be prone to erosion. This could lead to increased suspended solids being transported with storm water. Runoff from the area is very low. The existing site topography and the flat surrounding topography result in storm water flows that are very small in aerial extent and this impact is considered very small.
- Any topsoil stockpiles will be prone to erosion prior to it being vegetated. If natural re-vegetation takes more than one season to completely cover the topsoil stockpile, the resultant erosion could lead to increased suspended solids being deposited into the surrounding areas.

The affected areas will be small. Erosion impacts will be short-term and will cease once the facilities are constructed and the topsoil stockpile is vegetated.

Mitigation

Mitigation of the impacts should include the following:

- Areas that are stripped should be optimised to limit unnecessary stripping.
- Storm water from upslope of the stripped areas should be diverted around these areas to limit the amount of storm water flowing over from these areas.
- The timing of the topsoil stripping should be optimised to limit the time between stripping and construction. Where practical constraints exist and areas need to be left stripped for long periods, contour ploughing, or ripping could reduce run-off and hence reduce erosion.
- Dry season construction is preferable where practical.
- If natural revegetation does not cover the topsoil stockpiles, they can be hydro seeded to speed up vegetation cover.

Residual impact

The residual impacts will likely be very low as sediments will unlikely be transported into the Ga-Mogara River.

Cumulative impact

Topsoil stripping will add to sediment loads produced by erosion from upstream activities. Should sediments reach the Ga-Mogara River, these sediment loads will be small compared to the sediment loads in the Ga-Mogara River.

10.3.2 Impacts due to construction related pollution

Impact assessment

During the construction phase a significant number of vehicles will be driving around the site. In addition to this, fuels are stored on site and chemicals are used during normal construction activities. This may result in the following impacts:

- If the construction vehicles are poorly maintained, hydrocarbon spills could cause pollution if washed off roads by storm water.
- Vehicle wash bays are a common source of hydrocarbon pollutants.
- Leaks from fuel depots could result in surface water pollution.
- Spillage and unsafe storage of chemicals could result in surface water contamination.

The affected areas will be the entire construction site. Spillage impacts will be short-term and will cease after the completion of construction. If soils have become contaminated, this will leach out into the ground water over a prolonged period.

Mitigation

Mitigation of the impacts should include the following:

- All construction vehicles should be well maintained and inspected for hydrocarbon leaks weekly.
- Wash bay discharge water should flow through an oil separator.
- Fuel depots and refuelling areas should be bunded.
- Chemicals should be stored in a central secure area.
- Regular toolbox talks on the responsible handling of chemicals should be undertaken.

Residual impact

Runoff is low so surface water impacts will likely be very low.

Cumulative impact

There are potential sources of hydrocarbon pollutants in the study area. However, runoff is low so cumulative impacts will also be low.

10.4 Impacts During the Operational Phase

10.4.1 Impacts on potable water demand and supply impact on existing industrial operations and communities

Impact assessment

Sedibeng Water is the distributor for bulk water in the area. Sedibeng Water have limited water resources to work with and current infrastructure also provides limitation on how much water that can be supplied to the area.

The proposed operations will require water for dust suppression and processing. Some of this water will be sourced from Sedibeng Water. This additional demand may result in existing users' demand not being met. The Sedibeng Water line will be tapped off approximately 2km south west of the mine. The likely route appears to be to the south of the Hotazel township, but the tap off will need to cross linear infrastructure such as roads and railway lines. The pipeline servitude and design must still be submitted to Sedibeng Water.

Mitigation

Sedibeng water should have supply agreements with their existing customers and should not allocate additional water to new customers that they cannot deliver. Sedibeng Water are responsible for the allocation of their water resources. However, the proposed operations must implement the following to minimise water use:

- A water consumption and demand management strategy must be employed on the operations and updated annually, as per the WC/WDM guideline written by the South African Department of Water Affairs.
- The mitigations outlined in Section 10.4.3 should be adhered to.

Residual impact

The impact will cease with the cessation of the operations. The magnitude of the impact is not known as Sedibeng Water's operations and resource margins are opaque.

Cumulative impact

The cumulative impact could be additional water supply interruptions to existing Sedibeng Water customers.

10.4.2Impacts of Evaporators

Impact assessment

The water that currently lies at the base of the existing pits will be evaporated using evaporator fans. The evaporator models to be used are not known. However, common to all evaporator fans is that they are loud, consume significant amounts of electricity and experience high fallout (typically 40% - 60%). The water in the pit has no bearing on the surface water resources in the area, and therefore there are no surface water impacts through its removal.

Forced evaporation is not the most water efficient way to dispose of water, especially in a water scarce area. However, there are no known operations within a practical distance that could use the water. If the water was treated and discharged into the environment, it would evaporate and infiltrate and offer limited benefit to the environment. It is too far to practically pump the water to the Ga-Mogara or Kuruman Rivers.

Mitigation

Evaporator fans should be ideally located below the pit perimeter so that their fallout will remain in the pit. This may also reduce noise impacts on surrounding communities, but this aspect should be addressed in the noise impact assessment.

THM should be open to others taking the water away by tanker, subject to THM's safety and procedural requirements and the third party absolving THM of any liabilities that may result from the collection, transport, or use of the water.

Residual impact

The impact will cease with the cessation of the forced evaporation.

Cumulative impact

There are no cumulative impacts

10.4.3 Impacts due to contaminated water discharge

Impact assessment

The opencast pit, RoM and product stockpiles, the processing plant, waste dumps, vehicle yard and workshops, and the refuel station should be considered as dirty areas. Storm water and seepage generated from these areas will likely be contaminated and have a detrimental effect on the water quality in the Ga-Mogara River, should runoff reach the Ga-Mogara River.

The operations must undertake to comply with Government Notice 704 of the South African National Water Act (Act 36 of 1998). This act limits discharges of contaminated water from mining related activities to less than once in 50 years on average. Storm water from dirty areas must be routed to a dirty water management system, in accordance with Government Notice 704 of the National Water Act (Act 36 of 1998).

Should a legal discharge occur as a result of extreme rainfall conditions, the surface water systems should have enough capacity to dilute poor quality water. The impacts from extreme rainfall conditions should be low and will last for a short duration.

Mitigation

Mitigation of the impacts must include the following:

- The pollution control dams are sized for the 50-year storm. This implies that the dams will have zero operational storage and be operated empty *all* of the time. This is unlikely the case. If so, the dams should be resized to comply with a 50-year spillage frequency, in accordance with Government Notice 704.
- The pollution control dam water levels must be constantly monitored. Steps and procedures must be put in place to manage situations where water builds up in the pollution control dam above the operational storage level.
- The pollution control dams must be operated empty as far as practicable and cannot fulfil the same role as a water storage dam, unless specifically designed to fulfil both purposes.
- Water reuse from the pollution control dam must be maximised.

Residual impact

Based on the assumption that proper management will take place and that infrastructure is adequately sized, the residual impacts will be low. Impacts could occur during the life of the operations.

Cumulative impact

The impacts resulting from contaminated water discharges in accordance with Government Notice 704 of the South African National Water Act, Act 36 of 1998 may result in short-term water quality deterioration in the surface water systems.

10.4.4Impacts due to leaking or burst dirty water pipes

Impact assessment

Water pipes may transport polluted water between the pollution control dams and other facilities on the operations. If any of these pipes burst, poor-quality water could be pumped into the environment.

Mitigation

Mitigation of the impacts should include the following:

- It is preferable to run the dirty water pipelines through areas already serviced by dirty water systems where possible.
- Pipelines should be subjected to frequent patrols. An efficient system of reporting should be available to allow the immediate tripping of pumps should a leak be found.

Residual impact

The residual impacts of a pipeline burst could be the contamination of the soil in the location of the burst. Contaminants will continue to be leached into the water systems over a long period (1-5 years) following a pipe burst.

Cumulative impact

The impacts resulting from leaking or burst dirty water pipes will result in water quality deterioration in the surface water systems.

10.4.5 Loss of catchment yield

Impact assessment

Storm water generated from the dirty areas discussed in Section 10.4.3 must be considered as dirty and must be collected in the dirty water system. This water would have contributed to the flow into the surface water systems and in the local wetlands. The impounding of this water will result in a reduction in the yield of the catchment.

These potential losses are quantified in Table 9.

TABLE 9: LOSS OF CATCHMENT YIELD AS A RESULT OF SURFACE OPERATIONS (% OF MAR)*

Parameter	Loss of yield impact
Total catchment loss	509 m^3/yr
Impact on the Ga-Mogara River	0.0%

** Note: MAR is mean annual run-off*

Refer to Figure 8 on page 18 for stream locations.

Mitigation

As is best practice, dirty areas should be minimised. This will have the dual benefit of smaller dirty water management systems and reduction in catchment yield loss.

Residual impact

After the surface operations have been rehabilitated after their intended life, run-off from the dirty areas can be returned to the environment (assuming proper rehabilitation is done). The pollution control dams can also be removed. The pit will remain a permanent depression and surface water yield from this footprint will be zero. The permanent loss of catchment yield is therefore anticipated to be less than 400 m^3/year, and the residual impact is considered negligible.

Cumulative impact

The impact on the Ga-Mogara River will be negligible.

10.4.6 Impacts due to wash bays and workshops

Impact assessment

Organic and nutrient pollution may result from the wash bays and workshop areas. These areas should be bunded and all water should be contained, collected and routed to an appropriate treatment facility. Impacts are likely to be low and will last during the life of the operations.

Mitigation

Mitigation of the impacts should include the following:

- All drains that collect the wash water and storm water must be maintained regularly. These should be free of debris and silt.
- All diversion canals, trenches and conduits must be designed to convey run-off from a 50-year design storm.
- The wash bays and workshops must be equipped with oil separators to remove hydrocarbons from wash down water.

Residual impact

The residual impacts of the wash bays and workshops will likely be low. The impacts will occur for the life of the operations.

Cumulative impact

There are potential sources of hydrocarbon pollutants in the study area. However, runoff is low so cumulative impacts will also be low.

10.4.7 Impacts due to diesel spillage

Impact assessment

Power will be partly supplied by diesel generators. Hydrocarbon pollution may result from diesel spillages. Impacts are likely to be low and will last during the life of the operations.

Mitigation

Mitigation of the impacts should include the following:

- Diesel storage should be concrete bunded, with bunds sized to accommodate at least the volume of a single diesel tank with a freeboard greater than the 50-yer storm depth.

Residual impact

The residual impacts of the diesel spillages are likely to be very low.

Cumulative impact

There are potential sources of hydrocarbon pollutants in the study area. However, runoff is low so cumulative impacts will also be very low.

10.4.8Impacts due to vehicle fleet-related pollution

Impact assessment

During the operational phase, a significant number of vehicles will be driving around the site. In addition to this, fuels are stored on site and chemicals are used during normal operational activities. This may result in the following impacts:

- If the vehicles are poorly maintained hydrocarbon spills could cause pollution if washed off roads by storm water.
- Vehicle wash bays are a common source of hydrocarbon pollutants.
- Leaks from fuel depots could result in surface water pollution.
- Spillage and unsafe storage of chemicals could result in surface water contamination.

The affected areas will be the entire extension area. Impacts will be medium term and will cease after the cessation of mining. If soils have become contaminated, this will leach out over a prolonged period.

Mitigation

Mitigation of the impacts should include the following:

- All vehicles should be well maintained and inspected for hydrocarbon leaks weekly.
- Wash bay discharge water should flow through an oil separator.
- Fuel depots and refuelling areas should be bunded.
- Chemicals should be stored in a central secure area. Regular training on the responsible handling of chemicals should be undertaken. If contract plant is being used, responsible handling of chemicals and vehicle maintenance should be a key performance objective of the plant contractor.

Residual impact

If limited soil contamination occurs, the residual impacts will probably be very low.

Cumulative impact

There are potential sources of hydrocarbon pollutants in the study area. However, runoff is low so cumulative impacts will also be low.

10.5 Impacts During the Decommissioning Phase of the Project

10.5.1 Impacts due to the removal of surface infrastructure and rehabilitation

Impact assessment

During the decommissioning phase, most impacts will be associated with the removal of surface infrastructure, and rehabilitation of the RoM and product stockpile footprints. Haul roads will be removed, as will berms, dumps, dams and diversion trenches.

During this process, short-term impacts will be moderate, as heavy earthmoving machinery will disturb large areas. Previously vegetated areas may be disturbed which will increase erosion potential. These short-term impacts will give way to long-term benefits.

Mitigation

Apart from due diligence care while performing decommissioning tasks, no mitigation is necessary. Due diligence care includes the following:

- Plant should be well maintained to ensure that hydrocarbon spills are minimised.
- Existing roads should be used where possible.
- New disturbed areas should be minimised.

Residual impact

The residual impacts will likely be very low as sediments will unlikely be transported into the Ga-Mogara.

Cumulative impact

Topsoil stripping will add to sediment loads produced by erosion from upstream activities. Should sediments reach the Ga-Mogara River, these sediment loads will be small compared to the sediment loads in the Ga-Mogara River.

11. MONITORING PLAN

Based on the impact assessment and surface water baseline water quality data, the following surface water monitoring program is recommended:

- Water quality sampling should be done monthly at the following locations:
  - In the pit (when available),
  - The pollution control dams, and
  - Sedibeng Water's bulk water supply.
- The parameters to be sampled are the same as those listed in Figure 10. Manganese, Iron should be added as well.
- Organic sampling should be done once a quarter in the pit and pollution control dams.
- Should no organic pollution be discovered, the sampling frequency can be reduced to 6-monthly. If pollution is discovered, the frequency should be increased to monthly.

12. REFERENCES

- Midgley, D.C., Pitman, W.V., Middleton, B.J., *Surface Water Resources of South Africa*, 1990. WRC Report No 298/1.1/94, Volume 1.
- Middleton, B.J. and Bailey, A.K., *Water Resources of South Africa*, 2005 study (WR2005), 2009. WRC Report No TT 382/08.

Appendix A: Declaration of Independence

As the specialist compiling the surface water specialist study, I declare that to the best of my knowledge and belief:&

1. I have no vested interests in Tawana Hotazel Mining (Pty) Ltd, or any of their projects. Nor do I stand to benefit in any way from the mining activities at the proposed mine.
2. There are no contraventions of any applicable code of professional conduct in relation to my specialist study.

Appendix B: CV of specialist who prepared the report

Curriculum Vitae - Bruce Randell

EDUCATION AND QUALIFICATIONS

PR Eng

BSc (Civil Engineering) University of Witwatersrand, Johannesburg, 1996
PhD, University of Witwatersrand, Johannesburg, 2002
MDP, Unisa SBL, Johannesburg, 2007
Microsoft Certified Professional (TCP/IP) – NT4, 1998

EXPERIENCE SUMMARY

Water Resources Engineer with over 19 years' experience in mostly mining and heavy industrial projects.

April 2011 to Present

iLanda Water Services CC, Johannesburg, South Africa

Water Resources Engineer, Owner

I started my own consulting practice as a specialist hydrologist, Water Resources Engineer and some Tailings Engineering. My water related work mainly involves water and salt balance determination and modelling. I am also involved in surface water specialist studies and impact assessments, water resources studies, floodline determination, audits and the design of weirs and other hydraulic infrastructure. My tailings related work includes tailings dam surveillance and audits and dam break analysis. I specialise in numerical modelling of tailings storage facility water balances and mine-wide water balance modelling. I predominantly use GoldSim as my modelling tool. I have experience on projects throughout South Africa, Africa and Indonesia.

November 2017 to July 2020

Geo Tail Projects (Pty) Ltd, Johannesburg, South Africa

Tailings Engineer, Director

My mine residue management involves some design work, tailings dam break analysis, tailings storage facility surveillance and auditing. I have experience on projects throughout South Africa, Lesotho and the rest of Africa on gold, copper, diamond, coal, nickel, iron ore and base metal operations.

Reason for leaving: Group restructuring. All my Geo Tail work will be done through iLanda Water Services CC.

January 2008 to March 2011

Golder Associates Africa (Pty) Ltd, Johannesburg, South Africa

Tailings Engineer, Resident Engineer

During my tenure within the tailings division I was involved in feasibility designs for tailings storage facilities and associated infrastructure in South Africa and the Democratic Republic of Congo. The designs included 2-D and 3-D design, drafting using AutoCAD, 3-D modelling, stability and freeboard analysis, surveillance and monitoring of operational tailings storage facilities, and water balance modelling. I completed detailed design projects where I designed silt traps, channels, storm water dams, underdrains and a penstock plug and reverse filter. During the final year of this period I was a resident Engineer on a 380 ha tailings storage facility construction project. My role included quality

assurance on earthworks, reinforced concrete, roads, piping, building, structural steelwork, underdrains, and mechanical works. I was also required to do on-site design work, 3-D modelling, on-site drafting in AutoCAD, running of site meetings, client liaison, client representation and on-site document control.

Reason for leaving: Started iLanda Water Services CC.

August 2002 to December 2007

Golder Associates Africa (Pty) Ltd, Johannesburg, South Africa

Water Resources Engineer, Operations Manager

During the early part of this period my role and experience in Golder Associates Africa was similar to that in Wates, Meiring and Barnard (see next section) but became more involved in the development and running of various water balance models for a wide variety of mining and heavy industrial applications. GoldSim was extensively used for modelling, as was various other mainstream software packages. I was also extensively involved in undertaking surface water specialist studies and impact assessments for EIA projects.

During the latter part of this period my work experience was dominated by water balance modelling and specialist study inputs for EIA's. I was extensively involved in developing and marketing a new product line which included water balance modelling to satisfy the requirements of the ICMI Cyanide Code. My client base was predominantly mining clients with some heavy industrial clients.

My role as Operations Manager of the Surface Water and Closure Division included the management of a merger with another company and the resulting new satellite office. I was again involved in significant staff management – both hiring new staff and managing staff underperformance.

Reason for leaving: Expand engineering and Tailings Engineering skills.

June 2002 to July 2002

Wates, Meiring and Barnard, Johannesburg, South Africa

Water Resources Engineer

I worked for Wates, Meiring and Barnard (WMB) as a hydrologist and modeller. My experience included hydrological studies, flood peak calculation. I was also involved with setting up REMIS applications for data management, general software design and water quality modelling, particularly for mining related pollution control dams. I was also part of the team developing the ISP for the Olifants river catchment in South Africa.

Reason for leaving: Golder Associates bought out WMB in August 2002.

1996 to 2002

Stephenson and Associates, Johannesburg, South Africa

Water Resources Engineer

While reading for my PhD, I was involved with a number of consulting projects. Experience included stream flow modelling, stream flow measuring, software design, water hammer analysis and surge protection design. I was also involved in sediment surveying, sediment modelling, floodline analysis and design of flood protection and alleviation measures. I constructed and tested a number of scale models including river models, pump stations, ogee crests and off channel flood control structures. I also tested the material properties of GRP pipe.

PROJECT RELATED EXPERIENCE

Tailings storage facility water balance modelling:

Custom-built GoldSim models are developed to simulate the water balance around a tailings storage facility. Modelling usually includes return water dam sizing. Rainfall inputs are generally stochastic to allow for scenario analysis, long-term analysis or the statistical analysis for short-duration projects. Tailings storage facility water balances have been completed on mining projects throughout Africa and South Africa on gold, diamond, copper, coal, nickel, base metal, and iron ore mines. Industrial projects have also been completed on power stations (ash dams), iron and steel works.

Mine water balance modelling:

Custom built GoldSim water balance models are developed for scenario analysis and water management decision making purposes on both operational and management levels. Projects completed throughout Africa and South Africa on gold, copper, coal, nickel, and base metal mines.

Open cast pit water balance modelling:

Custom built GoldSim models are used to calculate pit water make in opencast operations, including pits that have concurrent excavation and rehabilitation. Modelling takes into account the dynamics of the working pit configuration and rehabilitation progress during the simulation period. Rainfall inputs are generally stochastic to allow for scenario analysis, long-term analysis or the statistical analysis for short-duration projects. Modelling typically involves final void sizing for closure planning. Projects completed throughout Africa and South Africa on gold, copper, diamond, iron ore, and coal (with concurrent rehabilitation).

EIA surface water specialist studies and impact assessments:

I have conducted specialist surface water studies and impact assessments as part of small and large-scale EIA's and ESIA's. This involved baseline assessments, setup of surface water monitoring programs, general hydrology, hydraulics, hydraulic and hydrological modelling and impact assessments, reporting and attendance and presentations at open house/public meetings. Projects completed in the DRC, Mozambique and throughout South Africa on mining, heavy industrial, municipal and railway projects.

Flood peak and floodline calculation:

I have calculated floodlines on many river reaches in Mali, the DRC and throughout South Africa for housing developers, mining, industrial, municipal, and private clients. Large-scale floodlines have been completed for the entire Umhlatuze municipal area (Richards Bay, Empangeni and surrounds), and the Clover and Blesbokspruit (Benoni, Brakpan, Springs and Heidelberg).

Storm water management plans:

Storm water management plans (concept through to detailed design) have been completed on mining projects in the DRC, Lesotho and throughout South Africa on gold, diamond, copper, nickel, coal, base metal mines. Industrial projects completed throughout South Africa on chrome, steel plants, and aluminium smelters.

Pollution control dam sizing:

Pollution control dams are sized to comply with relevant legislation (e.g. Regulation 704 of the South African National Water Act). In the absence of legislative guidelines, the use of impact assessments on the receiving environment is to determine allowable releases and resultant dam sizing. Mining projects completed throughout Africa and South Africa on gold, diamond, copper, nickel, coal, base metal mines. Industrial projects completed throughout South Africa on power stations, chrome, steel plants, and aluminium smelters.

Tailings dam break analysis:

I have calculated tailings dam breach volumes, flows and floodlines for various typical failure scenarios on tailings dams. Mudflow analysis is performed using Flo2D. Water flow analysis is performed using Flo2D and HEC RAS.

Tailings storage facility surveillance:

In accordance with South African mines' Code of Practice, I conducted tailings storage facility surveillance on numerous mines' tailings storage facilities. I have been the competent person for the Lubambe Copper Mine TSF in Zambia for 3 years. While at Golder, I headed up the surveillance group within the division which consisted of five technical staff and one administrative staff member. I was directly involved in the surveillance of nine tailings dams on two mines. Three of the nine dams were dormant, while the remaining six were active. As part of my surveillance responsibilities I did stability reviews and analysis, freeboard analysis, attended quarterly meetings and inspections and completed annual audit reports and inspections.

Catchment studies and runoff modelling:

Applications include runoff into pollution control dams, diversion canals, silt traps and through various hydraulic structures. Models used include ACRU, WRSM2000, WR90, RAFFLER and purpose-built GoldSim models. I have completed various projects throughout South Africa and Africa.

Infrastructure design:

Detailed design of small dams, silt traps, storm water channels, dissipation structures, Parshall flumes, headwalls, weirs, underdrains, and penstock plugs and reverse filters. The designs included the compilation of tender documents and bills of quantities and construction drawings.

Tailings storage facility feasibility design:

I completed feasibility and bankable feasibility design of tailings storage facility complexes in South Africa and the DRC. This included the tailings storage facility, return water dams, underdrains, storm water channels and other related infrastructure. The designs included the compilation of tender documents and bills of quantities.

Water quality modelling:

The water quality modelling related to pollution control dams involves modelling conservative variables, taking into account the surrounding catchments, dam operating rules, plant inputs and hydrology associated with the system. Daily continuous modelling is used in conjunction with relevant regulations (e.g. Regulation 704 of the South African National Water Act) to formulate solutions for clients.
Water resource projects involve determining the likely impact of process and contaminated storm water discharges from mines and industry. Mining projects completed throughout Africa and South Africa on gold, copper, nickel, coal mines (discard dumps and in pit water quality). Industrial projects completed throughout South Africa on power stations, chrome and steel plants, aluminium smelters, oil producers. Water resource projects completed in the DRC and throughout South Africa. Major rivers include the Olifants and Tugela Rivers in South Africa.

IWMP baseline hydrology and impact assessments:

I have conducted baseline hydrological assessment of the rivers that flow past two paper mills. This included ACRU and other rainfall-runoff modelling. GoldSim was used to do continuous daily modelling of the impacts of effluent from these mills into the receiving waters.

Mine water balance modelling for ICMI Cyanide code compliance:

I developed probabilistic mine-wide water balance models for scenario analysis and water management decision making purposes - a requirement of the ICMI Cyanide code. The models have been extensively audited and accepted as suitable water balance models for ICMI Cyanide code compliance. Project locations include South Africa, Namibia, Ghana, Mali, and Guinea.

Auditing:

I have been involved in GN704, storm water management plan implementation and water use licence auditing for power stations mines and industrial sites. I have experience as a lead auditor and as a specialist in support of a lead auditor.

Flow measuring:

I was involved in flow measuring in the field using both propeller and electromagnetic flow meters in the DRC and throughout South Africa on both small (50 ℓ/s) and large rivers (10 m^3/s).

Sediment surveying and modelling:

I was involved in the sediment surveys that were conducted on the Katse and Muela dams that form part of the Lesotho Highlands Water Project. My experience includes mapping floor profiles using sonar equipment and calculating sediment volumes.

PUBLICATIONS

Prediction model for the Caledon River – presented at the 4th Biennial Congress of the African Division of the International Association of Hydraulic Research, Windhoek, Namibia, 2000. (Co author)

A review of conjunctive use and a proposed model – poster presented at the XXVII IAHR Congress, Graz, Austria, 1999. (Sole author)

Artificial recharge and conjunctive use – Groundwater Hydrology workshop, Bulawayo, Zimbabwe, 1997. (Sole author)

LIST OF PROJECTS

Year	Type of work/Project	Location	Country
1999	Floodlines on the Clover and Blesbokspruit	Benoni, Springs	South Africa
1999	Water hammer analysis for the North South Carrier pipeline	Selibe Pikwe	Botswana
1999-2002	Sediment surveys for the Katse and Muela Dams		Lesotho
2003	Floodlines for all the perennial rivers in the greater Umhlatuze municipal area	Umhlatuze municipal area	South Africa
2003	Floodlines and levee design for Sasol Vanderbijlpark operations	Vandebijlpark	South Africa
2004	Salt balance modelling and impact assessment	Sappi Ngodwana	South Africa
2004	Storm water modelling for Iscor Vanderbijlpark	Vanderbijlpark	South Africa
2004	Hydrology modelling for Khutala colliery's waste discharge charge system	Khutala Colliery	South Africa
2004	Stormwater modelling for Beeshoek Mine	Postmasburg	South Africa
2004	Impact assessment of the Muela Dam	Butha Buthe	Lesotho
2005	ESIA surface water specialist study and impact assessment for the Camden power station return to service	Ermelo	South Africa
2005	Stormwater modelling for the Hillside aluminium smelter	Richards Bay	South Africa
2005	Closure cost modelling for Khutala Colliery	Khutala Colliery	South Africa
2005/6	ESIA surface water specialist study and impact assessment for the Tenke Fungarume Copper Mine	Tenke/Fungarume	DRC
2005/6	Water balance modelling and infrastructure sizing for the Tenke Fungarume Copper Mine	Tenke/Fungarume	DRC
2005-2019	Water balance modelling and infrastructure sizing for the Nkomati Mine	Nkomati Mine	South Africa
2005-2020	Approximately 40 floodlines for various mines in Africa	Various mines in Africa	
2006	ESIA surface water specialist study and impact assessment for the Moatize coal project	Tete	Mozambique
2006	ESIA surface water specialist study and impact assessment for the Heidelberg coal project	Heidelberg	South Africa
2006-8	Water balance modelling for the Highveld steel IWWMP and infrastructure sizing	Witbank	South Africa
2006-2008	Cyanide code compliant water balance modelling for Driefontein Gold Mine	Carletonville	South Africa
2006-2008	Cyanide code compliant water balance modelling for Beatrix Gold Mine	Welkom	South Africa
2006-2008	Cyanide code compliant water balance modelling for Kloof Gold Mine	Carletonville	South Africa
2006-2008	Cyanide code compliant water balance modelling for Sadiola Gold Mine	Kayes	Mali
2006-2008	Cyanide code compliant water balance modelling for Morila Gold Mine	Sanso	Mali
2006-2008	Cyanide code compliant water balance modelling for Yatela Gold Mine	Kayes	Mali

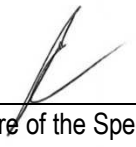
2006-2008	Cyanide code compliant water balance modelling for Siguiri Gold Mine	Siguiri	Guinea
2006-2008	Cyanide code compliant water balance modelling for Iduapriem Mine	Tarkwa	Ghana
2006-2008	Cyanide code compliant water balance modelling for Navachab Gold Mine	Karibib	Namibia
2007	Water balance modelling for the Cullinan TSF	Cullinan	South Africa
2008	Water balance modelling, infrastructure design and storm water management for the DeBeers TCP fines residue deposit	Kimberley	South Africa
2008	Mine wide water balance modelling for Sedibelo Mine	Pilanesberg	South Africa
2008/9	Tailings dam bankable PFS design - Rand Uranium Gelksdal 450Mt TSF	Fochville	South Africa
2008/9	Water balance modelling for Black Mountain Mine	Aggenys	South Africa
2008-2010	TSF surveillance monitoring - Driefontein No1, 2, 3, 4, 5 TSFs	Carletonville	South Africa
2008-2010	TSF surveillance monitoring - Kloof and Leeudoorn TSFs	Fochville	South Africa
2008-2009	TSF surveillance monitoring - Sadiola TSF and Yatela heap leach	Kayes	Mali
2009-2010	TSF surveillance monitoring - Ezulwini TSFs	Westonarea	South Africa
2009	Salt balance modelling at Nkomati Mine	Nkomati Mine	South Africa
2009	Return water dam sizing – Driefontein Gold Mine	Carletonville	South Africa
2009	Impact assessment of Sasol blowdowns	Secunda	South Africa
2010/11	Tailings dam design, Kinsenda mine	Tshinsenda	DRC
2010/11	Resident Engineer for the South Deep TSF construction	Fochville	South Africa
2010/11	Culvert detailed design for the South Deep TSF construction	Fochville	South Africa
2010/11	Resident Engineer for the Kloof underdrain installation	Fochville	South Africa
2011	Sediment survey for the Driefontein return water dams	Carletonville	South Africa
2011-2021	Water balance modelling and infrastructure sizing for over 75 coal mine projects in the Mpumalanga and Northern Kwa Zulu Natal coal fields	Mpumalanga/KZN coal fields	South Africa
2011-2021	Salt balance modelling for over 25 coal mine projects in the Mpumalanga and Northern Kwa Zulu Natal coal fields	Mpumalanga/KZN coal fields	South Africa
2011-2021	EIA surface water specialist studies and impact assessments for over 30 coal mine projects in the Mpumalanga and Northern Kwa Zulu Natal coal fields	Mpumalanga/KZN coal fields	South Africa
2011-2020	Storm water management plans for over 10 mines and 2 aggregate processing operations throughout South Africa		South Africa
2012	Water balance modelling and infrastructure sizing for a new TSF at Bulyanhulu Gold Mine	Bulyanhulu	Tanzania
2012	Surface water monitoring program for Weda Bay Nickel Monitoring Program	Lelilef Sawai	Indonesia

2012	Water balance modelling, infrastructure sizing and PFS design for Phalanndwa Colliery	Delmas	South Africa
2012	Water balance modelling, infrastructure sizing and PFS design for Kangra Colliery	Piet Retief	South Africa
2012	Water balance modelling and infrastructure sizing for Letšeng Diamond Mine	Letšeng	Lesotho
2013-2020	Letšeng storm water management plan an bi-annual updates	Letšeng	Lesotho
2014/15	Water balance modelling and infrastructure sizing for the Liqhobong Diamond Mine	Liqhobong	Lesotho
2018	Mine-wide water and salt balance modelling for Khumani Mine	Kathu	South Africa
2018 and 2020	Water balance modelling and infrastructure sizing for Khumani Mine paste disposal facility, South Africa	Kathu	South Africa
2018-2021	TSF surveillance and EOR for the Lubambe TSF	Chililabombwe	Zambia
2019	TSF closure design and costing for the Lubambe TSF	Chililabombwe	Zambia
2019	Water balance modelling and infrastructure sizing for Khumani Mine	Kathu	South Africa
2019/20	Water balance modelling and infrastructure sizing for the new Two Rivers Platinum Mine TSF	Burgersfort	South Africa
2019	Dam break analysis for the Gloria (old and new) slimes storage facility	Hotazel	South Africa
2019	Dam break analysis for the Nchaning (old and new) slimes storage facility	Hotazel	South Africa
2019	Dam break analysis for the Khumani paste disposal facility	Kathu	South Africa
2020	GISTM Technical Review Panel hydrology specialist for the Sishen tailings storage facility	Kathu	South Africa
2020	Water balance modelling and infrastructure sizing for Paling manganese mine	Postmasburg	South Africa
2020	Water balance modelling and infrastructure sizing for Theta Gold Mine,	Pilgrams Rest	South Africa
2021	Dam break analysis for the Darwendale tailings storage facility	Harare	Zimbabwe
2021	Water balance modelling and infrastructure sizing for the Darwendale TSF	Harare	Zimbabwe
2021	ESIA for Minbos Phosphate Mine	Cabinda	Angola

Declaration of Independence by Specialist

I, _Bruce Randell_____, in my capacity as a specialist consultant, hereby declare that I –

- act as an independent specialist;
  Where **"independent"** in relation **a specialist** means the following, as defined in GN982 of 2014 (*as amended*):
  (a) that such EAP, **specialist** or person has no business, financial, personal or other interest in the activity or application in respect of which that EAP, specialist or person is appointed in terms of these Regulations; or
  (b) that there are no circumstances that may compromise the objectivity of that EAP, specialist or person in performing such work;
  excluding -
  (i) normal remuneration for a specialist permanently employed by the EAP; or
  (ii) fair remuneration for work performed in connection with that activity, application or environmental audit;
- will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- declare that there are no circumstances that may compromise my objectivity in performing such work;
- do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that has 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 National Environmental Management Act, 1998 (Act 107 of 1998);
- have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- based on information provided to me by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional ability; and
- undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered.



Signature of the Specialist

iLanda Water Services CC

Name of Company:

29 August 2021

Date

APPENDIX 13

GROUNDWATER IMPACT ASSESSMENT

Future Flow
GROUNDWATER & PROJECT MANAGEMENT SOLUTIONS

Future Flow Reference: PRE.20.049
Client Reference:

REGISTRATION NO:
2008/094325/23

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M.J. Prinsloo (Pr.Sci.Nat)

TAWANA MANGANESE & IRON ORE MINE

GROUNDWATER STUDY

For

Prime Resources (Pty) Ltd

Future Flow Document: PRE.20.049/Groundwater Assessment_EIA Report
20 December 2021

TAWANA MANGANESE MINE

GROUNDWATER STUDY

For

Prime Resources (Pty) Ltd

Report Issue	DRAFT		
Reference Number	PRE.20.049		
Title	Tawana Manganese Mine – Groundwater Assessment Report		
	Name	**Signature**	**Date**
Author	Martiens Prinsloo (M.Sc.; Pr.Sci.Nat)		21 December 2021
Reviewed			

This report has been prepared by Future Flow Groundwater and Project Management with all reasonable skill, care and diligence within the terms of the contract with the client, and taking into account of the resources devoted to it by agreement with the client. We disclaim any responsibility to the client and any other in respect of any matters outside the scope of the project.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such parties rely on the report at their own risk.

EXECUTIVE SUMMARY

Introduction and terms of reference

Future Flow GPMS cc was contracted by Prime Resources (Pty) Ltd to perform the geohydrological investigation for the proposed Tawana Manganese Mine.

The Department of Mineral Resources and Energy (DMRE) has accepted an application for a Mining Right (MR) made by Tawana Hotazel Mining (Pty) Ltd (THM) in terms of Section 22 of the Mineral and Petroleum Resources Development Act, 2002 (MPRDA). The types of minerals applied for are: all (Code UN); Iron and Iron bearing minerals including hematite, goethite, specularite and limonite (Code (Fe) Type (B)) and Manganese and manganese bearing minerals (Code (Mn) Type (B)).

The THM covers portions of two farms within the Joe Morolong Local Municipality (JMLM) in the Northern Cape Province; Hotazel 280 and York 279 and is located approximately 1 km south-east of the town of Hotazel. The THM largely incorporates the historical Hotazel Manganese Mine (HMM), and the MR area includes the residual opencast void and surface dumps of low-grade material. The mothballed processing plant and rail loadout facility fall outside the MR area. HMM stopped production in 1989. The area was historically mined by both opencast and underground means and yielded high grade manganese ore. All current plans for the project specifically exclude underground mining.

The overall area applied for is approximately 154 Ha (inclusive of the MR application area and access road). Surface infrastructure will include the opencast pit (incorporating the historical HMM void and further expansion of the opencast footprint), in-pit waste dumps (residue material), surface residue handling / storage, vehicle yard, workshop, access and haul roads, offices, stores, processing plant for the crushing and screening of mined ore, product stockpile area, run of mine pad, refuel bay and water management infrastructure.

The ore zone of the various seams is found at depths from 25 to 91 m below the surface and the manganese seam thicknesses varies from 3 to 27 m. Opencast mining methods will be used to a maximum depth of 95 m. RoM ore will be trucked out of the open pit and tipped onto the RoM ore stockpile. From the RoM stockpile, front end loaders (FELs) will feed the ore into the primary crusher (jaw crusher). The primary crusher will feed the screening plant. In the initial stages these will be mobile units.

Residue material (overburden and waste rock) arising from the development and ongoing operation of the opencast mine pit will be disposed back into the existing historical opencast void and the trailing mined out opencast void through backfilling. There will be 3 waste dumps. There will also be a topsoil stockpile and a sand stockpile.

A period of 2 years has been allowed for pre-stripping and mining infrastructure construction. The Life of mine (LoM) indicated by the conversion of the resource to reserve is 30 years for the open pit operation. Backfilling/rehabilitation will commence immediately after the commencement of the

mining operation and its advance will match the depletion rate of the open pit. A period of 3 years is expected for final rehabilitation after closure.

Topography and drainage

Site specific topographical elevations ranges between 1 063 and 1 070 mamsl. The topography within the proposed mining areas is best described as gently sloping from the east (at 1 071 mamsl) towards the Ga-Mogara River west of the proposed mining area (at 1 063 mamsl). The topographical gradient ranges around 1:280.

The study area is located within the D41K quaternary catchment, which forms part of the Vaal Major Water Management Area (WMA). The non-perennial Ga-Mogara River drains the region in a south – north direction and lies approximately 4.8 km west of the mine boundary.

Geology

The project can be described as an erosional relict approximately 2 kilometres to the East of the main KMF basin. The manganese ore seams have been preserved in a north-south orientated fault-bounded graben structure. A prominent vertical Bostonite dyke, 50 meters wide, bisect the lease area along an East-northeast to East-southeast line.

On Tawana-Hotazel all three the manganese seams are present (LMO, MMO and UMO). The UMO is on average 7.61 m thick (Min 0.67 m, Max 27.56 m) and is overlain by a banded iron formation which is on average 10.73 m thick (Min 1.53 m, Max 30.48 m). The LMO is separated from the UMO by a banded iron formation layer on average 17.3 m thick (Min 8.42 m, Max 32.1 m). The LMO varies in thickness from a maximum of 27.92 m to a minimum of 3.35 m (Average 16.72 m). The Hotazel Formation overlies a pillow lava basement of the Ongeluk Formation. The lavas occur on average 12.43 m below the LMO (Min 6.34 m, Max 22.37 m).

Baseline groundwater conditions

<u>Aquifers present on site</u>

Three aquifers occur in the region. These three aquifers are associated with a) the primary sandy gravel material, b) the fractured rock and leached banded iron formation aquifer, and c) the dolomitic aquifers of the Griqualand West Sequence.

The fractured rock aquifers are not high yielding. The dolomitic karst aquifer is well known for its high potential, but note that no dolomite was recorded in the exploration drilling logs; therefore, the dolomitic aquifers are not expected to occur on site. The following is a generalised description of the natural aquifer systems in the area.

The upper sandy gravel aquifer is expected to be dry in large portions of the study area for large parts of the year. The aquifer is seasonal and mostly carries water only during and shortly after

rainfall events when rainfall recharges into the material. The relatively high transmissivity of the sandy gravel material allows the recharging water to migrate quickly through and out of the material. This combined with low annual rainfall (349 mm/a) and the high positive evaporation rate of 2 026 mm/a lays the material dry for large portions of the year. The borehole yield in this aquifer is seasonally variable due to the strong dependence on rainfall recharge.

Groundwater flows in the fractured rock aquifer are associated with the secondary fracturing in the competent rock. As such groundwater flows and contaminant transport will be along discrete pathways associated with the fractures.

Aquifer transmissivity

The site specific aquifer transmissivity is calculated from aquifer tests performed on groundwater monitoring boreholes TMBH1, TMBH2 and TMBH3. These boreholes targeted structures identified from the ground geophysical survey. It could be said that the transmissivities of around 0.08 to 0.16 m^2/day calculated for TMBH1 and TMBH3 represents the fractures present in the area and the transmissivity of 0.04 m^2/day calculated for TMBH2 the general host geology of the area.

Groundwater levels and flow patterns

The regional depth to groundwater level ranges between 20.3 and 32.00 m with an average of 26.76 m. The depth to groundwater level in the boreholes close to the existing pit tends to be greater than that measured in regional boreholes and can be up to be 52.61 m below surface. This is attributed to the previous mine dewatering and the evaporation from the pit lakes.

Regionally, the groundwater flows from the higher lying area to the east of Tawana towards the lower lying Ga-Mogara River west of the mine. Close to the existing pit the groundwater flow patterns are disrupted and are directed towards the pit due to the lower water level in the existing pit.

Groundwater quality

Groundwater samples were collected from:

- Three of the eleven hydrocensus points. Boreholes NG, JB40 and York were sampled;
- The water in the main existing opencast pit (sample HP); and
- Three of the newly drilled groundwater monitoring boreholes (TMBH4 was dry at the time and could not be sampled).

The sample from the church in town (sample NG) and that of monitoring borehole TMBH3 differ notably from the other five samples. None of the elements exceed the SANS241:2015 guideline values in samples NG and TMBH3, while chloride and nitrate exceed the SANS241:2015 guideline value in all five other samples. Sodium and manganese also exceed the guideline values in individual samples. Due to the high chloride and nitrate concentrations the total dissolved solids (TDS) and

electrical conductivity (EC) also exceed the SANS241:2015 guideline values in samples HP, JB40, York, TMBH1 and TMBH2.

Analysis of the water character shows that in terms of cations, the samples are magnesium dominant. Anion analysis shows that the groundwater is chloride dominant with the exception of sample NG, which is bi-carbonate dominant.

Plotting the groundwater qualities on a Piper diagram sows that the water from the area in general shows a high degree of ion exchange having taken place. Only sample NG shows a recently recharged character. Sample TMBH3 indicates a sodium chloride dominant character.

Aquifer vulnerability

For aquifer vulnerability reference is made to the aquifer vulnerability map of South Africa which shows a low aquifer vulnerability for the project area.

Aquifer classification

The aquifers present in the area are classified as minor aquifers. The aquifers are of high importance to the local landowners outside of town as it is their only source of water for domestic, gardening, and agricultural purposes. In Hotazel town the landowners have access to municipal water.

Geochemical characterisation

A geochemical characterisation was done by Prime Resources. A summary of the findings is presented here.

- The waste rock and ore material were non-acid forming and presented a very low risk in terms of acid generation. The waste rock presented a low geochemical risk in terms of metal leaching and can be considered for backfilling into the opencast pit; and
- The samples of high and low grade ore also present a low risk in terms of metal leaching, with the exception of low concentrations of copper which slightly exceed general discharge standards. The fine fraction of material arising from ore stockpiles was found to leach manganese in concentrations which could exceed guidelines.

Geohydrological impacts

Construction phase

Impacts on groundwater volumes

Construction of the surface infrastructure will not impact the groundwater levels which lie between 31 and 53 m depth in the area where the infrastructure will be built.

Dewatering of the existing opencast pit lake and the water contained in the existing underground mine will cause a lowering of the groundwater levels within the surrounding aquifers. The groundwater levels in the area could be reduced by up to 40 m.

Due to the low aquifer transmissivity, the low vertical drawdown in water level, and the relatively short time frame of the construction period, the zone of influence of the groundwater level drawdown cone will be relatively small at less than 400 m from the mine boundary.

No surface streams or privately owned boreholes will be impacted by the drawdown in groundwater level.

Groundwater inflow volumes

Groundwater inflow volumes during the construction phase into the existing mine workings are expected to be on average 170 m^3/day.

Impacts on groundwater qualities

The surface infrastructure that will be constructed all lie close to the existing underground mine and opencast pit and will fall within the existing groundwater level drawdown cone. Any contamination that enters the underlying aquifers will migrate towards the pit where it will be dewatered and directed into the mine water management system.

No contamination is expected to migrate significantly off-site during the construction phase and no surface streams or private boreholes are expected to be impacted.

It should also be taken into account that the groundwater level in this area lies at 31 to 53 m below surface. The aquifers have a low horizontal and even lower vertical permeability. Therefore, there will a significant lag period before contamination entering the soil and eventually reaching the saturated zone. Using a rule of thumb where the vertical hydraulic conductivity is 10 % of the horizontal hydraulic conductivity, it is calculated that it can take up to 600 days for contamination to reach the saturated zone which is near, or past, the end of the construction phase.

Operational phase

Impacts on groundwater volumes

There is an existing drawdown in groundwater level around the existing opencast pit and underground mine due to the previous mine dewatering and ongoing evaporation of water from the pit lake in the opencast pit.

During excavation of the proposed mine pit the existing groundwater level drawdown cone will develop further to become deeper and larger. The groundwater level can be drawn down by 68 m from the current water levels in the aquifer. In the south, where the pit will be the deepest, the groundwater level drawdown cone can extend 1.7 to 1.9 km from the pit boundary, while in the north the zone if influence is expected to reach 1.1 km from the pit boundary.

Boreholes BH1, JB38, JB39, JB41 are expected to fall within the zone of influence of the groundwater level drawdown cone. The boreholes are all monitoring boreholes operated by South32. None of the impacted boreholes are used for private domestic or agricultural purposes.

No surface water streams fall within the zone of influence of the groundwater level drawdown cone.

Feedback from the client indicates concern from local landowners regarding the cumulative impacts from different mining operations (current and proposed) in the region. The concerns from local landowners revolve around the fact that the area is extremely dry and water is scarce. The limited water resources are thus sensitive and extremely vulnerable and obviously underpin the entire ecosystem function. Specific mention is also made of the Korannaberg catchment, which lies approximately 30 to 40 km west of the town of Hotazel, and therefore, also the proposed Tawana mine.

It is difficult to quantify the large scale regional impact on the groundwater environment as part of this study due to no information being available on the other mines in the region and their impact on the regional groundwater resource. However, it can be said that:

- The proposed Tawana mine lies 30 to 40 km from the Korannaberg (the extent of the mentioned sub-catchment is not known), and theoretically, Tawana lies in a different sub-catchment than the Korannaberg catchment due to the presence of the Ga-Mogara River between Tawana mine and Korannaberg (albeit that the river only runs maybe once a decade);
- The zone of influence of Tawana extends at a maximum 1.9 km from the pit boundary; therefore, there is no direct impact on the Korannaberg region.

Groundwater inflow volumes

During the construction phase, and the associated initial dewatering of the water in the existing pit and underground, water currently in storage in the aquifer will enter the excavation. Then, as the

groundwater in storage is depleted inflows will be controlled by regional migration of groundwater towards the pit and the aquifer transmissivities. The average groundwater inflows will reduce to 155 m^3/day for the period 2025 to 2035 after which it will increase again as the pit increase in depth (and depth below the regional groundwater levels). During the period 2035 to 2045 the average daily inflow volumes will be in the order of 180 m^3/day. For the period 2045 to the end of life of mine the average inflows are expected to be in the order of 245 m^3/day.

It is considered that these modelled inflows are high compared to what will enter the mine in reality during the life of mine. Also, with the high evaporation of 2 026 mm/a in the study area can be expected that a large percentage of the water entering the pit from the surrounding aquifers will evaporate before it has to be pumped to surface.

Impacts on groundwater qualities

Fuel will be stored in sealed containers in the refuel area and that the area will be paved. The vehicle yard and workshop will be paved, with appropriate oil traps and other infrastructure in place. Based on this, it is assumed that there will be limited hydrocarbon contamination from these areas.

The water will collect in the pit sump from where it will be pumped to surface and be incorporated into the mine water management system. Due to ongoing dewatering of the pit, no driving head will form that cause contamination to migrate away from the pit. Based on this, it is expected that the pit will not be a notable source of pollution during the operational phase.

The PCD will be lined; therefore, it is assumed that there will be no contamination entering the underlying aquifers from the PCD.

Results from the geochemical assessment show that none of the material that will be mined, processed and stored on site, is likely to be acid forming. In addition, leach testing show that there are no elements that can be said to generally be present in elevated concentrations in the material that will be processed at the plant and stored on the ROM pads and the product stockpiles.

Results from the contaminant migration modelling show that the contaminant plume from the ROM pads and processing plant area, as well as the product stockpiles, will migrate towards and into the pit. No contamination is expected to migrate away from the mining area, and no surface water bodies or privately owned boreholes will be impacted.

<u>Decommissioning phase</u>

Impacts on groundwater volumes

During the decommissioning phase the mining activities, and any dewatering of the pit that takes place, will be stopped. This will allow the groundwater level in the pit area to recover. The recovery rate is expected to be slow and it is not expected that a significant pit lake will form by the end of the 3 year decommissioning phase.

Impacts on groundwater qualities

During the decommissioning phase the ROM pads and the product stockpiles will be removed and the footprint areas rehabilitated. The waste rock and topsoil will be used to finalise backfilling and rehabilitation of the pit.

Contamination that already entered the aquifers underlying the ROM pads and the product stockpile areas during the operational phase will continue to migrate towards the pit. No additional contamination will enter the underlying aquifers in future.

Long term post-closure phase

Recovery of groundwater levels and decant potential

The water level within the rehabilitated pit will continue to recover in the long term. By between 40 and 50 years post closure the water level in the rehabilitated pit is expected to reach 1 040 mamsl, which is the elevation of the natural regional groundwater levels. The natural groundwater levels range between 20.3 and 32.00 m with an average of 26.76 m.

The water level in the rehabilitated pit will then continue to slowly rise above the regional groundwater levels due to the higher recharge from rainfall into the rehabilitated pit than into the surrounding, undisturbed, aquifers. Once the water level in the rehabilitated pit rises above the regional groundwater level water will start to flow from the pit towards the surrounding area.

It is expected that by 100 years post closure the groundwater level in the rehabilitated pit will have risen to around 10 m above the regional groundwater levels. It will not have reached decant elevation and no decant is expected by 100 years post closure.

Impacts on groundwater qualities

During the initial years post closure the contamination that already entered the aquifers from the ROM pads and the processing plant footprint, as well as the product stockpile footprint during the operational phase will continue to migrate towards the pit where the water levels are expected to rise, but remain beneath the regional groundwater levels up to 40 to 50 years post closure. Once the water level in the rehabilitated pit has reached the regional groundwater levels, and start to rise above it due to continuing recharge from rainfall, contaminants can start to migrate away from the opencast pit area.

At 50 years post closure the contamination will mostly be contained within the pit area. Over time the plume will start to migrate radially away from the pit area. The radial spread of the plume is due to the fact that the region has a flat topography and the water level within the rehabilitated pit will rise above the surrounding topographical elevations.

By 100 years post closure it is expected that the plume will not have spread more than 200 m from the pit boundary.

No surface water bodies or privately owned boreholes fall within the expected zone of influence of the plume.

Recommendations

Groundwater monitoring program

Please refer to Section 10 of this report.

Mitigation measures

Please refer to Section 11.3 of this report.

Update of the geochemical assessment

The material sampled for the geochemical assessment has been exposed on surface since the previous mining activities stopped in 1989. It is possible that oxidation and leaching of elements by rainfall has impacted the test results. It is recommended that the geochemical assessment be updated once the mine is operational and fresh material is available.

Update of the numerical groundwater flow and contaminant transport models

It is recommended that the numerical groundwater flow and contaminant transport models be updated on a 2-yearly basis based on time series groundwater level and quality data as obtained from the groundwater monitoring program as well as climatic aspects such as rainfall and evaporation. Re-calibrating the models based on time series data will increase the confidence level of the predictions. Any changes in the mine design, progression plan and surface layouts can also be included and the impact simulations updated.

Reasoned professional opinion

It is recommended that the project be authorized. This recommendation is based on:

- The impact assessment shows that it not expected that there will be a significant impact on the groundwater levels in the area. No privately-owned boreholes around the proposed mine development area will be impacted by the groundwater level drawdown in the fractured rock aquifer;
- It is not expected that there will be a notable impact on the groundwater qualities within the proposed development area.

Conditions for Authorisation

There are no other conditions for authorisation, except commitment to optimal management and monitoring of the expected impacts as described in Sections 10 to 12 of this report.

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1. Introduction

1.1. Background introduction

Future Flow GPMS cc was contracted by Prime Resources (Pty) Ltd to perform the geohydrological investigation for the proposed Tawana Manganese Mine.

The Department of Mineral Resources and Energy (DMRE) has accepted an application for a Mining Right (MR) made by Tawana Hotazel Mining (Pty) Ltd (THM) in terms of Section 22 of the Mineral and Petroleum Resources Development Act, 2002 (MPRDA). The types of minerals applied for are: all (Code UN); Iron and Iron bearing minerals including hematite, goethite, specularite and limonite (Code (Fe) Type (B)) and Manganese and manganese bearing minerals (Code (Mn) Type (B)).

The THM covers portions of two farms within the Joe Morolong Local Municipality (JMLM) in the Northern Cape Province; Hotazel 280 and York 279 and is located approximately 1 km south-east of the town of Hotazel. The THM largely incorporates the historical Hotazel Manganese Mine (HMM), and the MR area includes the residual opencast void and surface dumps of low-grade material. The mothballed processing plant and rail loadout facility fall outside the MR area. HMM stopped production in 1989. The area was historically mined by both opencast and underground means and yielded high grade manganese ore. All current plans for the project specifically exclude underground mining.

The overall area applied for is approximately 154 Ha (inclusive of the MR application area and access road). Surface infrastructure will include the opencast pit (incorporating the historical HMM void and further expansion of the opencast footprint), in-pit waste dumps (residue material), surface residue handling / storage, vehicle yard, workshop, access and haul roads, offices, stores, processing plant for the crushing and screening of mined ore, product stockpile area, run of mine pad, refuel bay and water management infrastructure.

The ore zone of the various seams is found at depths from 25 to 91 m below the surface and the manganese seam thicknesses varies from 3 to 27 m. Opencast mining methods will be used to a maximum depth of 95 m. RoM ore will be trucked out of the open pit and tipped onto the RoM ore stockpile. From the RoM stockpile, front end loaders (FELs) will feed the ore into the primary crusher (jaw crusher). The primary crusher will feed the screening plant. In the initial stages these will be mobile units.

Residue material (overburden and waste rock) arising from the development and ongoing operation of the opencast mine pit will be disposed back into the existing historical opencast void and the trailing mined out opencast void through backfilling. There will be 3 waste dumps. There will also be a topsoil stockpile and a sand stockpile.

A period of 2 years has been allowed for pre-stripping and mining infrastructure construction. The Life of mine (LoM) indicated by the conversion of the resource to reserve is 30 years for the open pit operation. Backfilling/rehabilitation will commence immediately after the commencement of the

mining operation and its advance will match the depletion rate of the open pit. A period of 3 years is expected for final rehabilitation after closure.

1.2. Aim of the investigation

The aim of the groundwater investigation is twofold:

The first phase of the study focuses on characterising the current baseline groundwater environment. This includes aspects such as:

- Identification and characterisation of the aquifers present in the area;
- Aspects that control groundwater flow through the area (e.g. geological structures);
- Groundwater flow patterns;
- Recharge from rainfall;
- Predevelopment groundwater quality; and
- Surface water / groundwater interaction.

The second phase of the study involves a characterisation and quantification of the expected impacts on the surrounding groundwater environment due to the proposed mining activities.

1.3. Timing of the investigation

The initial field investigation, during which a general site overview as well as a hydrocensus was performed, was conducted during November 2020. A follow-up field investigation, which included a ground geophysical survey, drilling of groundwater monitoring boreholes, as well as the aquifer testing of those boreholes was completed during October 2021. Groundwater samples were collected during both the November 2020 and the October 2021 field studies for chemical analysis. Based on this, the collected data is considered to mostly reflect end-of-dry season and early wet season conditions. This will have an impact on the measured groundwater levels and groundwater qualities compared to dry season conditions.

1.4. Potential impacts

The proposed developments could impact on the surrounding groundwater environment. Impacts include:

- Dewatering of the opencast mine area and the associated impacts on the surrounding groundwater environment;
- Contaminant migration away from the mining areas;
- Impacts on surface water flow volumes due to mine dewatering and the possible reduction in baseflow contribution to the streams. It has to be mentioned that there are few non-perennial, and no perennial, surface streams in the region;
- Impacts on the surface water quality due to contaminant migration away from the mining area (opencast and underground mine areas as well as surface infrastructure); and

- Potential decant from the mining area.

1.5. Declaration of independence

We, Future Flow Groundwater & Project Management Solutions cc, act as the independent specialists in the environmental authorisation for the Tawana Hotazel Mining Project. We performed the work relating to the environmental authorisation applications in an objective manner, even if this results in views and findings that are not favourable to the applicant.

We declare that there are no circumstances that may compromise our objectivity in performing such work. We have expertise in conducting the groundwater specialist study and report relevant to the environmental authorisation applications. We confirm that we have knowledge of the relevant environmental Acts, Regulations and Guidelines that have relevance to the proposed activity and my/our field of expertise and will comply with the requirements therein.

We have no, and will not engage in, conflicting interests in the undertaking of the activity.

We undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has, or may have, the potential of influencing any decision to be taken with respect to the application by the competent authority.

Signed

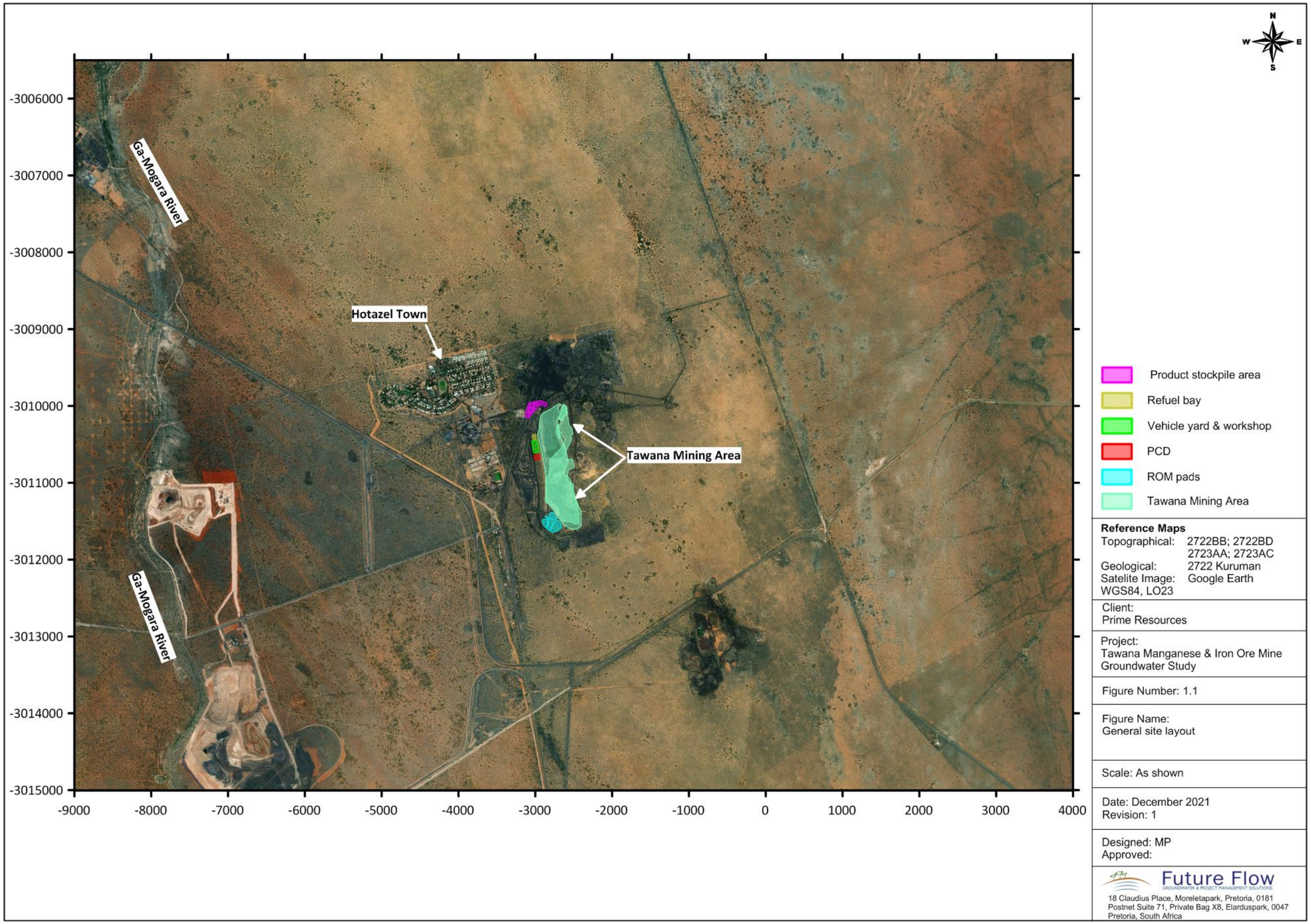
2021/12/20

Date

1.6. Consultation process

The consultation process included:

- Discussion with the client: The client has a working relationship with the surrounding land owners;
- Discussion with local land owners during the hydrocensus.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Ga-Mogara River
Hotazel Town
Tawana Mining Area
Ga-Mogara River
Product stockpile area
Refuel bay
Vehicle yard & workshop
PCD
ROM pads
Tawana Mining Area
Reference Maps
Topographical: 2722BB; 2722BD
2723AA; 2723AC
Geological: 2722 Kuruman
Satelite Image: Google Earth
WGS84, LO23
Client:
Prime Resources
Project:
Tawana Manganese & Iron Ore Mine
Groundwater Study
Figure Number: 1.1
Figure Name:
General site layout
Scale: As shown
Date: December 2021
Revision: 1
Designed: MP
Approved:
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2. Geographical setting

2.1. Site locality

The study area is located directly east to southeast of the town of Hotazel in the Northern Cape Province of South Africa. Maps relevant to the study area include:

- 1:50 000 scale topographical maps (2722BB, 2722BD, 2723AA, and 2723AC);
- 1:250 000 scale geological map (2722 – Kuruman);
- 1:500 000 scale hydrogeological map (Kimberley);
- Satellite image of the area (Google Earth);
- Other published data on the study area.

2.2. Topography and drainage

Site specific topographical elevations ranges between 1 063 and 1 070 metres above mean sea level (mamsl). The topography within the proposed mining areas is best described as gently sloping from the east (at approximately 1 071 mamsl) towards the Ga-Mogara River west of the proposed mining area (at approximately 1 063 mamsl). The topographical gradient ranges around 1:280.

The study area is located within the D41K quaternary catchment, which forms part of the Vaal Major Water Management Area (WMA). The non-perennial Ga-Mogara River drains the region in a south – north direction and lies approximately 4.8 km west of the mine boundary.

2.3. Climate

The project area falls within the summer rainfall region of South Africa, in which more than 80 % of the annual rainfall occurs from October to April. A total of 85 % of the rainfall occur during summer. The closest weather station to the project area is the Olifantshoek weather station. The rainfall data, as obtained from the 2012 groundwater assessment report, is summarised in Table 2.1. The average annual precipitation is 349 mm/a. Annual average evaporation rates are in the order of 2 026 mm/a.

Temperatures in this climate zone are generally moderate to high, although low minima can be experienced during the winter months due to clear night skies. Temperature can vary between 38 degrees (maximum) to 0 degrees (minimum) in summer and 30 degrees (maximum) to -5 degrees in winter.

The annual prevailing wind direction during the day for summer and winter months is from the south.

Table 2.1: Olifantshoek weather station average monthly climatic figures

Month	Precipitation (mm)	Evaporation (mm)	Temperature (°C)
January	70	272	25.1
February	56	220	25.3
March	62	186	20.7
April	33	135	18.2
May	12	112	13.6
June	6	91	10.2
July	2	107	9.2
August	3	143	12.9
September	8	203	17.0
October	23	249	20.5
November	31	265	22.8
December	55	293	24.8
Total	**349**	**2 026**	**-**

3. Scope of work

- Phase 1 - Project initiation:
    - All available data is collected and evaluated including site specific information supplied by the client such as previous groundwater studies done, the geological database, any geotechnical work that was done as well as any information on previous monitoring programs and dewatering requirements. Also included in the desk study is the collection of public domain information (geological and hydrogeological maps etc.); and
    - An initial site visit is performed to visually inspect the study area and evaluate grey areas or data gaps identified during the desk study.
- Phase 2 - Characterisation of the baseline groundwater environment:
    - Perform a hydrocensus of existing boreholes in the area, including depth to groundwater level, groundwater use type and volume. This data is used to calculate groundwater flow directions and patterns, gradients and velocities. Sensitive users in the area are also identified;
    - Ground geophysical investigation: A ground geophysical survey is conducted around the proposed opencast mining area and surface infrastructure in order to identify any geological structures that could act as preferential groundwater flow and contaminant transport pathways;
    - Drilling of groundwater boreholes: This entails drilling of groundwater boreholes during which important information on the baseline groundwater conditions (depth to groundwater level, groundwater strike depth and yields, presence of structures etc.) is collected. The boreholes will also serve as long-term groundwater monitoring boreholes around the mine area;
    - Aquifer testing of the newly drilled boreholes to determine the aquifer parameters for inclusion into the numerical flow and contaminant transport models: These values are

used to specify the aquifer transmissivities in the numerical groundwater flow and contaminant transport calculations and control the plume migration calculations;
    - Laboratory testing of groundwater samples to characterise the current groundwater quality;
- Phase 3 - Groundwater impact assessment using the numerical groundwater flow and contaminant transport models:
    - Simulate the current and pre-mining conditions:
        - Simulate the current groundwater conditions (groundwater levels and qualities) due to the previous mining that was done;
        - Simulate the impact of the dewatering of the existing pit lakes;
    - Simulate the cumulative future impacts:
        - Drawdown in groundwater levels around the mining area due to mine dewatering and the associated impacts on surrounding groundwater users;
        - Impacts on surface water bodies due to reduced baseflow contribution due to mine dewatering;
        - Groundwater recharge from the surface stockpile areas to the underlying aquifers and the associated impacts on the groundwater flow patterns;
        - Contaminant migration through the area and impacts on the surrounding aquifer quality away from the operational area during operations and after closure;
        - Impacts on surface water bodies due to contaminant migration away from contaminant sources within the mining area;
        - Decant potential, points / diffuse zone areas, and volumes;
- Phase 4 - Reporting:
    - The findings of the study are discussed in detail. The report also touches on management recommendations and includes input into any impact mitigation plans, the groundwater monitoring network, and post-closure requirements. The report also includes recommendations on any further work that might be required.

4. Methodology

4.1. Desk study

Available hydrogeological reports, or sections of reports, were reviewed to gain a better understanding of the local geological and hydrogeological characteristics

4.2. Hydrocensus

A hydrocensus of the existing groundwater monitoring boreholes in a 3 km radius of the site was done during this study. A total of 11 boreholes were identified. During the hydrocensus the borehole positions, depth to groundwater level and other information was gathered. Please refer to Table 5.2 for the results of the hydrocensus.

4.3. Ground geophysical survey

A geophysical survey was conducted in the area surrounding opencast pits and surface stockpiles. The aim of the geophysical survey is to identify geological structures that could act as preferential groundwater flow and contaminant migration pathways.

A station spacing of 5 m was used. This is considered to be sufficient to locate and underlying regional geological structures that could control the groundwater flows and contaminant migration in the area.

4.4. Groundwater borehole drilling

A total of 4 groundwater boreholes were drilled. The drilled boreholes include:

- TMBH1 - 1 x 90 m deep borehole to the east of the north-eastern portion of the proposed pit;
- TMBH2 - 1 x 90 m deep borehole to the north of the proposed pit;
- TMBH3 - 1 x 90 m deep borehole to the west of the south-western portion of the proposed pit; and
- TMBH4 - 1 x 30 m deep borehole down-gradient of the proposed crusher and plant area.

4.5. Aquifer testing

Aquifer tests were performed on three (TMBH1, TMBH2, and TMBH3) of the four the newly drilled groundwater monitoring boreholes. Borehole TMBH4 was dry at the time. The aquifer tests were planned to entail:

- 8 hour constant rate pumping phase;
- Recovery measurements.

Due to the low yields of the boreholes, the groundwater levels in the boreholes were drawn down to the pump inlet levels within 30 minutes.

4.6. Sampling and chemical analysis

Groundwater water samples were collected from 3 of the hydrocensus boreholes as well as the main existing opencast pit. Samples were also collected from the newly drilled groundwater monitoring boreholes TMBH1, TMBH2 and TMBH3. Borehole TMBH4 was dry and could not be sampled. The samples were submitted to an ISO17025 accredited laboratory for chemical analysis.

4.7. Groundwater recharge calculations

Groundwater recharge calculations are based on the total area of the D41K sub-catchment covered by the proposed mining activities. Reference is made to the recharge values specified in the

Groundwater Resource Assessment II – Task 3aE Recharge report (Department: Water Affairs and Forestry, 2006). From the GRA II report it can be seen that:

- The area covered by the D41K quaternary catchment is 4 216 km^2;
- The mean annual rainfall is 344 mm/a;
- The average recharge from the main annual rainfall is 1.99 %;
- The average recharge from rainfall is 6.83 mm/a;
- The average recharge from rainfall into the D41K quaternary catchment is 28.803 Mm^3/a.

4.8. Groundwater modelling

The numerical flow model was constructed based on the conceptual groundwater flow model of the study area. The numerical model was constructed using MODFLOW based software, which is an internationally developed, recognised and used software package. The model takes into consideration aspects such as:

- The different aquifers present in the area and their interrelation to each other;
- Recharge from rainfall;
- Aquifer transmissivities, effective porosity, vertical hydraulic conductance etc.;
- Groundwater flow patterns and velocities;
- Geological lithological units and features; and
- Topographical elevations of surface, the contact between weathered material and competent rock.

4.9. Groundwater availability assessment

The groundwater availability was assessed making use of:

- The geology encountered in the area, and the general groundwater potential associated with the lithologies;
- The results from the hydrocensus (borehole yields and groundwater use volumes and types);
- The results from the aquifer testing.

Results from the groundwater monitoring borehole drilling and aquifer testing program show that groundwater yields in the area are low, and there is a limited groundwater availability associated with the Kalahari formation and the Ongeluk lava. Results from the exploration drilling programs do show some notable groundwater strikes associated with faulting and/or fracturing. Groundwater strikes generally occur between 30 and 60 m depth, but can occur up to 110 m below surface.

5. Prevailing groundwater conditions

5.1. Geology

A description of the geology is obtained from the project geologist.

5.1.1. General geological description

The topography varies from flat sand-covered thornveld in the south to a more undulating landscape in the north, characterized by belts of permanent dunes which grade into bushy calcrete covered flats. The only distinct topographic features in the area are a small inselberg at Black Rock mine, the north-south trending Kuruman Hills toward the east and the Korannaberge to the west.

The property is in the northern portion of the Kalahari Manganese Field (KMF). The KMF is an erosional basin spanning approximately 40 km in the North-South dimension and 15 km in the East-West dimension. The regional strike in the study area is 330 degrees with a westward dip of around 7 degrees.

5.1.2. Structural geology

The lithologies in the study area belong to the Griqualand West sequence of the Transvaal Supergroup. The base of the study area is formed by the Ongeluk Lava consisting of an amygdaloidal Andesite. The Hotazel formation overlies the lava and consists of a 40 – 100 m thick Banded Iron Formation (BIF). Intercalated in the BIF a total of 3 Manganese seams can be found. The lowermost of these seams (LMO) is followed by the Manganese Marker seam (MMO) about 2 to 4 metres above it. The upper Manganese seam (UMO) normally occurs about 20 metres above the No 1 seam. The LMO has been extensively exploited in the past

The Hotazel formation is overlain by a sequence of Shales and Quartzites of the Mapedi Formation. Glacial sediments of the Dwyka Formation were observed and is thought to occupy NE – SW trending glacial valleys. The Mapedi Formation is followed by the recent Kalahari Formation consisting of a series of Aeolian sands, clays, and gravels.

Three main structural trends can be observed in the KMF. These are roughly North-South striking normal faults, East-West striking normal faults and a Northeast-Southwest dyke direction. The dykes are termed Bostonite and have virtually the same chemical composition as the Ongeluk Lava.

5.1.3. Project geology

The project can be described as an erosional relict approximately 2 kilometres to the East of the main KMF basin. The manganese ore seams have been preserved in a north-south orientated fault-bounded graben structure. A prominent vertical Bostonite dyke, 50 meters wide, bisect the lease area along an East-northeast to East-southeast line.

Exploration drilling at the project intersected, from top to bottom, the Kalahari Group, Hotazel and Ongeluk Formations. The Kalahari Group is an up to 23 m-thick package consisting of a sequence of sand, calcrete, red clay and gravel units. The sand is on average 13,91 meters thick (min 11.58 m, Max 19 m) and the calcrete is on average 8.33 meters thick (Min 1.52 m, Max 19.51 m). The Hotazel Formation consists of a banded iron formation unit interlayered with manganese layers.

On Tawana-Hotazel all three the manganese seams are present (LMO, MMO and UMO). The UMO is on average 7.61 m thick (Min 0.67 m, Max 27.56 m) and is overlain by a banded iron formation which is on average 10.73 m thick (Min 1.53 m, Max 30.48 m). The LMO is separated from the UMO by a banded iron formation layer on average 17.3 m thick (Min 8.42 m, Max 32.1 m). The LMO varies in thickness from a maximum of 27.92 m to a minimum of 3.35 m (Average 16.72 m). The Hotazel Formation overlies a pillow lava basement of the Ongeluk Formation. The lavas occur on average 12.43 m below the LMO (Min 6.34 m, Max 22.37 m).

In general terms the mines in the KMF normally have one of the two types of manganese mineralization present i.e. the higher-grade oxide ore or the lower grade carbonaceous ore. In the case of Tawana-Hotazel it appears that both a thinner seam of high-grade oxide ore and a thicker seam of lower grade carbonaceous ore seems to be present. The thicker low-grade seam appears to be better developed in the area south of the dyke.

5.2. Aquifer description

Three aquifers occur in the region. These three aquifers are associated with a) the primary sandy gravel material, b) the fractured rock and leached banded iron formation aquifer, and c) the dolomitic aquifers of the Griqualand West Sequence.

The fractured rock aquifers are not high yielding. The dolomitic karst aquifer is well known for its high potential (Van Dyk and Jones, 2006), but note that no dolomite was recorded in the exploration drilling logs; therefore, the dolomitic aquifers are not expected to occur on site. The following is a generalised description of the natural aquifer systems in the area.

5.2.1. Upper primary sandy gravel aquifer

The upper aquifer forms due to the vertical infiltration of recharging rainfall through the primary sandy gravel material being retarded by the lower permeability of the underlying competent rock. In the region this aquifer ranges between 3 and 10 m in thickness. Groundwater collecting above the sandy gravel / competent material contact migrates down gradient along the contact to lower lying areas.

This aquifer is expected to be dry in large portions of the study area for large parts of the year. The aquifer is seasonal and mostly carries water only during and shortly after rainfall events when rainfall recharges into the material. The relatively high transmissivity of the sandy gravel material allows the recharging water to migrate quickly through and out of the material. This combined with low annual rainfall (349 mm/a) and the high positive evaporation rate of 2 026 mm/a lays the material dry for large portions of the year.

The borehole yield in this aquifer is seasonally variable due to the strong dependence on rainfall recharge.

5.2.2. Fractured rock and leached banded iron formation aquifer

Although the lower permeability of the competent rock material will retard vertical infiltration of groundwater some of the water in the upper aquifer will recharge the lower aquifer. The geological map does not show major faults or fractures in the area which will also help recharge the lower aquifers. However, large portions of the area is covered by the sandy gravel, therefore surface mapping of fault and fractures is hampered. The hydrogeological map of the area does show the presence of some regional faults in the Makganyene (Vm) and Danielskuil (Vad) Formations that outcrop 8 to 12 km to the east.

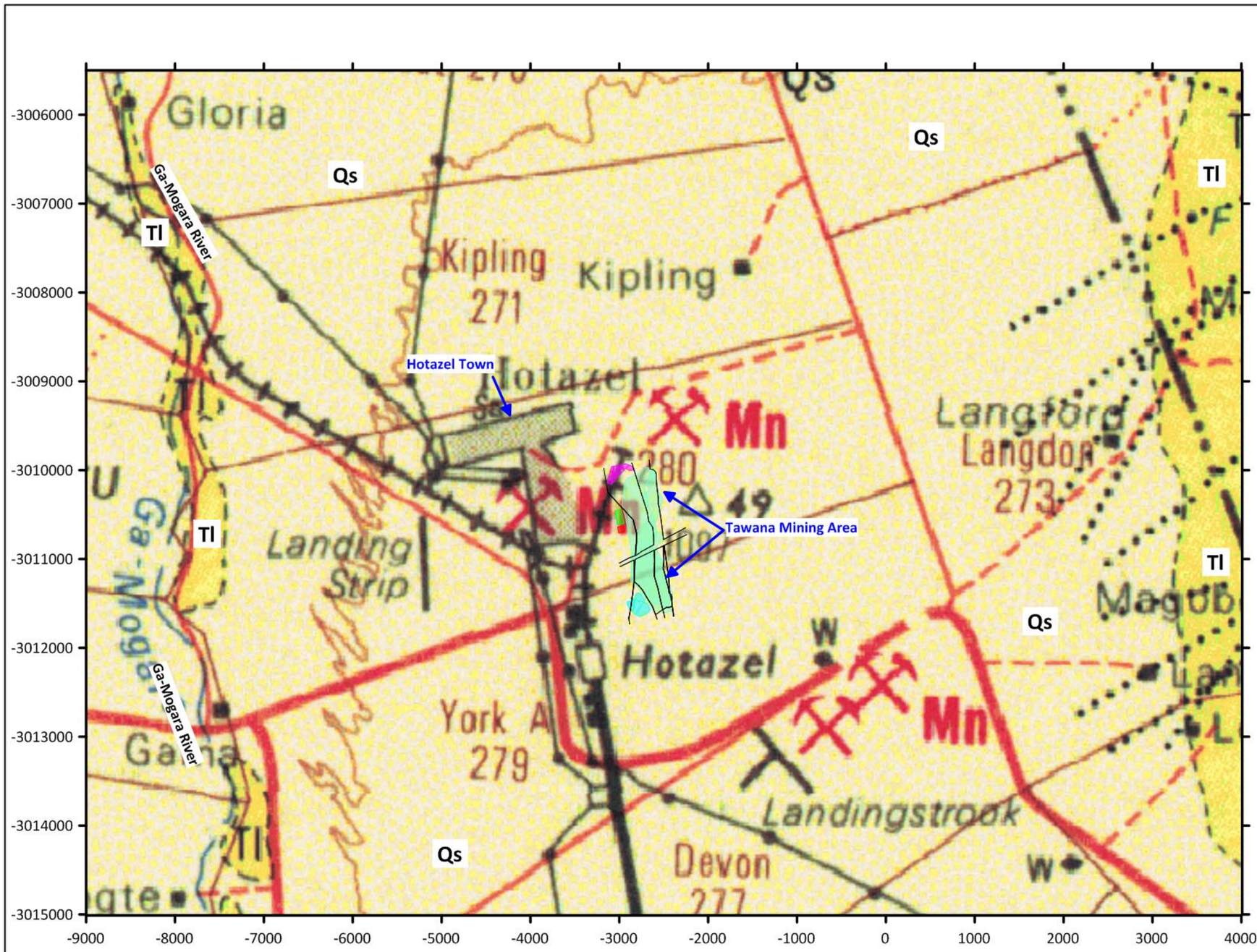
Groundwater flows in the fractured rock aquifer are associated with the secondary fracturing in the competent rock. As such groundwater flows and contaminant transport will be along discrete pathways associated with the fractures.

5.2.3. Dolomitic aquifer

Dolomitic aquifers are recognised to potentially be of concern to mining activities due to the potential large inflow volumes in areas where karstic dolomite is intersected. The dolomitic karst aquifer in the region is well known for its high potential (Van Dyk and Jones, 2006). A number of springs have been mapped in the area (Van Dyk and Jones, 2006) of which the Kuruman, Klein Karoo, and Manyeding are perennial.

Smit (1978) and Wiegmans (2006) defined compartments within the dolomite in separate groundwater management units. Wiegmans (2006) calculated recharge to each of the compartments and the associated management criteria in terms of sustainable abstraction volumes.

Inspection of exploration drilling logs show that no dolomite has been intersected in any of the exploration boreholes. This is confirmed from discussions with the project geologist (A. Pretorius). Therefore, is it expected that the dolomitic aquifer will not be intersected by the proposed Tawana operations.



Geological legend:

QS: Quaternary sand
Tl: Tertiary deposits

- Fault lines
- Product stockpile area
- Refuel bay
- Vehicle yard & workshop
- PCD
- ROM pads
- Tawana Mining Area

Reference Maps
Topographical: 2722BB; 2722BD
2723AA; 2723AC
Geological: 2722 Kuruman
Satelite Image: Google Earth
WGS84, LO23

Client:
Prime Resources

Project:
Tawana Manganese & Iron Ore Mine
Groundwater Study

Figure Number: 5.1

Figure Name:
Regional geology of the study area

Scale: As shown

Date: December 2021
Revision: 1

Designed: MP
Approved:

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5.3. Aquifer transmissivity

The site specific aquifer transmissivity is calculated from aquifer tests performed on groundwater monitoring boreholes TMBH1, TMBH2 and TMBH3 - please refer to Table 5.1 for more details on the aquifer test results. Analysis of the aquifer test data for the boreholes was done using AquiferWin32, which is an internationally developed and used software package.

Three different methods were used to calculate the transmissivity. It can be seen that the transmissivity ranges around 0.04 to 0.12 m^2/day. These boreholes targeted structures identified from the ground geophysical survey. It could be said that the transmissivities of around 0.08 to 0.16 m^2/day calculated for TMBH1 and TMBH3 represents the fractures present in the area and the transmissivity of 0.04 m^2/day the general host geology of the area, but there is not enough information available to confirm such a deduction.

Table 5.1: Aquifer test results

Borehole	Units	TMBH1	TMBH2	TMBH3
SWL	mbgl	47.03	26.65	31.50
Test - pump phase duration	min	12	18	27
Abstraction Rate	L/s	0.3	0.3	0.3
Drawdown achieved	m	31.24	52.61	46.72
Recovery achieved	%	39	91	87
Transmissivity (Theis)	m^2/day	0.16	0.06	0.12
Transmissivity (Cooper-Jacob)	m^2/day	0.12	0.03	0.11
Transmissivity (Recovery)	m^2/day	0.08	0.04	0.11
Transmissivity (Average)	m^2/day	0.12	0.04	0.11

5.4. Groundwater levels

A hydrocensus of the surrounding properties within a 3 km radius from the mine boundary was undertaken during November 2020. The depth to groundwater level was also measured in the newly drilled groundwater monitoring boreholes drilled during October 2021. The results of the hydrocensus and the groundwater monitoring boreholes are summarised in Table 5.2.

The aim of the hydrocensus was to collect information on the current groundwater conditions in the area. During this process privately owned boreholes in the area were identified, the groundwater levels measured, and the groundwater use (type and volume) recorded. A total of 11 boreholes were identified during the hydrocensus. From these 11 boreholes the depth to groundwater level could be measured in 8 boreholes. Borehole BH1 was locked, preventing the depth to groundwater level to be measured, while BH3 was dry to the bottom (26 m) and BH5 has collapsed. Borehole BH2 was pumping at the time of the hydrocensus and the groundwater level that was measured represents a dynamic level and not the true resting groundwater level.

Note that 6 of the boreholes belong to South32, which is a neighbouring mining company, and is used for monitoring purposes. Boreholes BH1 and BH3 are part of these boreholes.

The depth to groundwater level measured during the hydrocensus of November 2020 ranged between 20.3 and 32.00 m with an average of 26.76 m. The depth to groundwater level measured in the groundwater monitoring boreholes TMBH1, TMBH2 and TMBH3 during October 2021 ranged between 26.65 and 47.03 m (please refer to Figure 5.2).

The depth to groundwater level in the new monitoring boreholes tends to be greater than that measured in regional boreholes during the hydrocensus. The depth to groundwater level in TMBH1 is 31.24 m with only boreholes York (31.33 m) and JB39 (32.00 m) having greater depths to groundwater level. In boreholes TMBH2 and TMBH3 the depth to groundwater level is measured to be 52.61 m and 46.72 m respectively. This is attributed to the fact that the new monitoring boreholes are located close to the existing opencast pit where the depth to groundwater level is impacted by the previous mine dewatering and the evaporation from the pit lakes. It is also possible that the groundwater levels in the boreholes had not recovered fully after drilling due to the low aquifer transmissivity.

In areas where there are no large scale external impacts on the groundwater environment, such as the lowering of groundwater level through dewatering, and where the geology and aquifer interactions are not excessively complex it is expected that the groundwater level contours will reflect topographical contours, although at a moderated gradient.

Plotting the depth to groundwater level in the aquifer against topography (excluding the new monitoring boreholes where the groundwater levels could be impacted by external factors) shows a 62.5 % correlation. It has to be cautioned that the correlation is based on only 7 data points and do not necessarily carry any statistical weight.

Bayesian interpolation is used to interpolate the regional groundwater levels throughout the study area. Groundwater level elevation contours are shown in Figure 5.4.

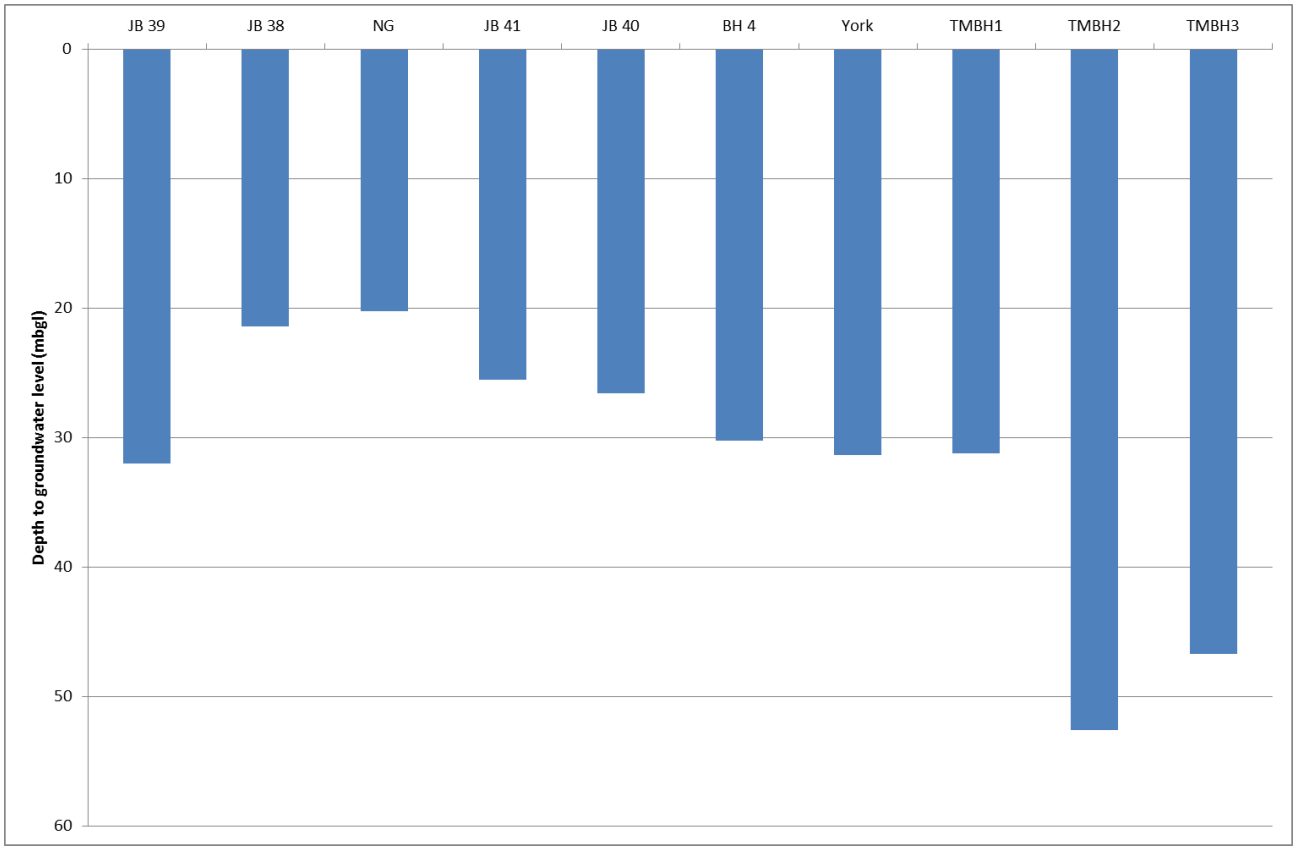


Figure 5.2: Depth to groundwater level

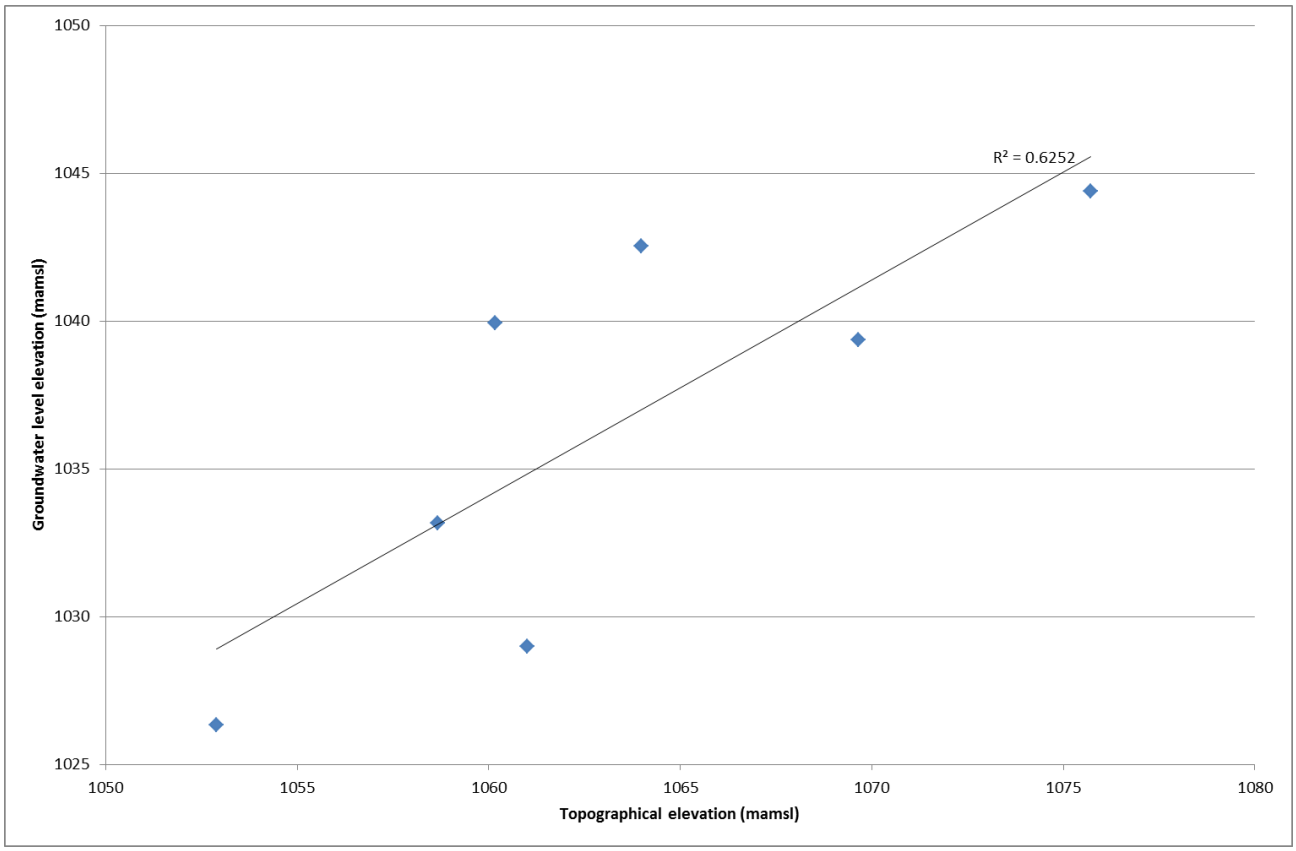
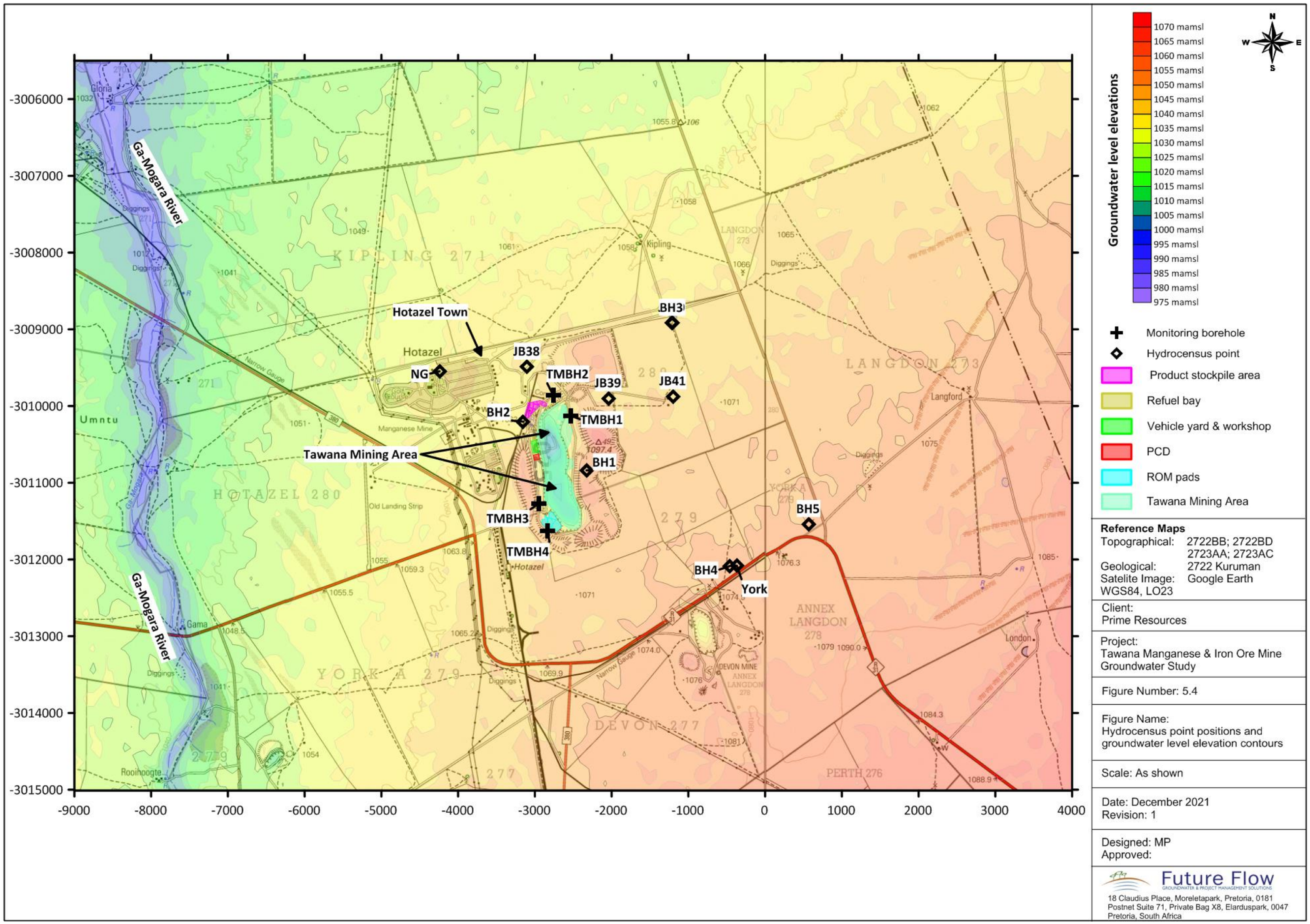


Figure 5.3: Topographical versus groundwater level elevations

Table 5.2: Hydrocensus results

Survey	Point	Owner	East	South	Elevation	SWL		Use type	Comment
			LO27, WGS84		mamsl	mbgl	mamsl		
2020 Hydrocensus	BH1	South 32	-2 328	-3 010 838	1 080.88	N/A		Monitoring	Hole locked. Located on landfill.
	JB 39	South 32	-2 041	-3 009 900	1 061.00	32	1 029.00	Monitoring	Hole located next to landfill.
	JB 38	South 32	-3 101	-3 009 489	1 063.97	21.44	1 042.53	Monitoring	Hole located between sewerage plant and old mine pit.
	NG	NG Church	-4 242	-3 009 547	1 060.17	20.23	1 039.94	Domestic/ garden	Hole located on Church premises.
	BH 2	Olivier Construction	-3 152	-3 010 203	1 052.44	33.74	1 018.70	Industrial	Dynamic water level.
	JB 41	South 32	-1 197	-3 009 874	1 058.67	25.51	1 033.16	Monitoring	Hole located next to old shooting range.
	JB 40	South 32	-1 210	-3 008 916	1 052.90	26.56	1 026.34	Monitoring	Hole located on the farm Hotazel.
	BH 3	South 32	-1 215	-3 008 918	1 063.32	N/A		Monitoring	Hole dry at 26 m.
	BH 4	Pieter Jansen	-463	-3 012 087	1 069.65	30.28	1 039.37	Not in use	Located on the farm York
	York	Pieter Jansen	-369	-3 012 080	1 075.72	31.33	1 044.39	Domestic/York wash bay	Located on the farm York
	BH 5	Pieter Jansen	567	-3 011 539	1 076.08	N/A		Not in use	Hole collapsed.
2021 monitoring boreholes	TMBH1	Tawana Mine	-2 534	-3 010 126	1 067.72	31.24	1 036.48	Monitoring	Hole located to the east of north-eastern portion of the pit
	TMBH2	Tawana Mine	-2 758	-3 009 864	1 069.69	52.61	1 017.08	Monitoring	Hole located to the north of the pit
	TMBH3	Tawana Mine	-2 951	-3 011 273	1 071.26	46.72	1 024.54	Monitoring	Hole located to the west of south-western portion of the pit
	TMBH4	Tawana Mine	-2 832	-3 011 625	1 073.89	31.24	1 036.48	Monitoring	Hole located down gradient of the crusher and plant area

N/A = Not available
mbgl = metres below ground level
mamsl = metres above mean sea level
All coordinates are provided in Transverse Mercator projection, LO23, and WGS84 datum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-7000
-6000
-5000
-4000
-3000
-2000
-1000
0
1000
2000
3000
4000
Ga-Mogara River
Hotazel Town
Hotazel
JB38
NG
TMBH2
JB39
JB41
BH3
BH2
TMBH1
Tawana Mining Area
BH1
TMBH3
TMBH4
BH5
BH4
York
Umntu
Gama
Rooihoogte
Kipling
Langford
London
Manganese Mine
Old Landing Strip
KIPLING 271
HOTAZEL 280
YORKA 279
ANNEX LANGDON 278
LANGDON 273
DEVON 277
PERTH 276
Groundwater level elevations
1070 mamsl
1065 mamsl
1060 mamsl
1055 mamsl
1050 mamsl
1045 mamsl
1040 mamsl
1035 mamsl
1030 mamsl
1025 mamsl
1020 mamsl
1015 mamsl
1010 mamsl
1005 mamsl
1000 mamsl
995 mamsl
990 mamsl
985 mamsl
980 mamsl
975 mamsl
N
W
E
S
Monitoring borehole
Hydrocensus point
Product stockpile area
Refuel bay
Vehicle yard & workshop
PCD
ROM pads
Tawana Mining Area
Reference Maps
Topographical: 2722BB; 2722BD 2723AA; 2723AC
Geological: 2722 Kuruman
Satelite Image: Google Earth
WGS84, LO23
Client:
Prime Resources
Project:
Tawana Manganese & Iron Ore Mine Groundwater Study
Figure Number: 5.4
Figure Name:
Hydrocensus point positions and groundwater level elevation contours
Scale: As shown
Date: December 2021
Revision: 1
Designed: MP
Approved:
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5.5. Groundwater potential contaminants

The opencast mine area and surface stockpiles act as potential sources of contamination to the aquifers in the area. It is assumed that good housekeeping such as storage of potentially hazardous material will be within properly constructed and lined or paved areas. Oil traps will be sized, operated and maintained to contain all discarded oil from working areas.

Residue material (overburden and waste rock) arising from the development and ongoing operation of the opencast mine pit will be disposed back into the existing historical opencast void and the trailing mined out opencast void through backfilling. There will be 3 waste dumps. There will also be a topsoil stockpile and a sand stockpile.

A geochemical assessment of the waste rock and ore material of the Tawana Hotazel Mine was undertaken by Prime Resources (Prime Resources, June 2021). Composite samples representative of the various types of rock material arising at the project were assessed and analysed at an accredited laboratory. It was found that:

- The waste rock and ore material were non-acid forming and presented a very low risk in terms of acid generation. The waste rock presented a low geochemical risk in terms of metal leaching and can be considered for backfilling into the opencast pit;
- The samples of high and low grade ore also present a low risk in terms of metal leaching, with the exception of low concentrations of copper which slightly exceed general discharge standards. The fine fraction of material arising from ore stockpiles was found to leach manganese in concentrations which could exceed guidelines;
- Geochemical modelling of the evaporation of the pit water was undertaken in order to assess the suite of minerals likely to precipitate during a mechanical evaporation process as well as to predict the evolving water quality of the brine solution remaining. It was found that most of the chemical constituents remain in solution until the late stages of the evaporative process resulting in a brine solution with high total dissolved solids.

5.6. Groundwater quality

Groundwater samples were collected from:

- Three of the eleven hydrocensus points. Boreholes NG, JB40 and York were sampled;
- The water in the main existing opencast pit (sample HP); and
- Three of the newly drilled groundwater monitoring boreholes (TMBH4 was dry at the time and could not be sampled).

The samples were submitted to an ISO17025 / SANAS accredited laboratory for chemical analysis. Please refer to Table 5.3 for a summary of the chemical analysis results received. The original laboratory certificate is shown in Appendix A. Note that some element concentrations on the certificate from November 2020 are specified in µg/L while others are specified as mg/L. The electrical conductivity values on the laboratory certificate are given as µS/cm. All parameters in Table 5.3 are given in mg/L and mS/m.

5.6.1. Element concentrations

The water qualities are compared to the SANS 241:2015 drinking water standards. The standard represents a numerical limit of the listed element concentrations that will protect the health of the consumer over a lifetime of consumption. All elements that exceed the guidelines are highlighted.

Please note that nitrate is specified in the laboratory analysis results from November 2020 as Nitrate-NO_3, while the SANS241:2015 guidelines as well as the chemical analysis results for the three monitoring boreholes from October 2021 are specified in Nitrate-N. Therefore, the results from the November 2020 analyses are recalculated from Nitrate-NO_3 to Nitrated-N using the equation:

$$\text{Nitrate-N} = \text{Nitrate-}NO_3 \times 0.2259$$

Similarly, the nitrite concentration results from November 2020 are specified as Nitrite-NO_2, while the SANS241:2015 guideline and October 2021 results are specified as Nitrite-N. For Table 5.3 the November 2020 results are recalculated to Nitrate-N using the equation:

$$\text{Nitrite-N} = \text{Nitrite-}NO_2 \times 0.3045$$

From Table 5.3 it can be seen that the sample from the church in town (sample NG) and that of monitoring borehole TMBH3 differ notably from the other five samples. None of the elements exceed the SANS241:2015 guideline values in samples NG and TMBH3, while chloride and nitrate exceed the SANS241:2015 guideline value in all five other samples. Sodium and manganese also exceed the guideline values in individual samples. Due to the high chloride and nitrate concentrations the total dissolved solids (TDS) and electrical conductivity (EC) also exceed the SANS241:2015 guideline values in samples HP, JB40, York, TMBH1 and TMBH2.

Chloride: The chloride concentrations in boreholes HP (774.9 mg/L), JB40 (748.3 mg/L) York (665.8 mg/L), TMBH1 (728 mg/L) and TMBH2 (515 mg/L) exceed the SANS241:2015 guideline value of 300 mg/L. At concentrations between 200 and 600 mg/L the water will have a distinctly salty taste, but no health effects. There is a likelihood of a noticeable increase in corrosion rates in domestic appliances. At concentrations between 600 and 1 200 mg/L the water will have a salty taste and will not slake thirst. There is a likelihood of rapid corrosion in domestic appliances. (Department of Water Affairs and Forestry, 1996).

Nitrate: The nitrate (NO_3-N) concentrations in boreholes HP (224.3 mg/L), JB40 (119.7 mg/L), York (223.6 mg/L), TMBH1 (260 mg/L) and TMBH2 (235 mg/L) exceed the SANS241:2015 guideline value of 11 mg/L. At concentrations above 20 mg/L methaemoglobinaemia occurs in infants, and an occurrence of mucous membrane irritation in adults can be expected (Department of Water Affairs and Forestry, 1996).

Sodium: The sodium concentration in borehole HP (239.3 mg/L) exceeded the SANS241:2015 guideline value of 200 mg/L. At concentrations between 200 and 400 mg/L the water will have a slightly salty taste and is undesirable for persons on a sodium restricted diet.

Manganese: The manganese concentration in borehole JB40 measured 0.408 mg/L which exceeds the SANS241:2015 guideline value of 0.4 mg/L slightly. At concentrations between 0.15 and 1.0 mg/L there are increasingly severe staining and taste problems. No health effects are expected (Department of Water Affairs and Forestry, 1996).

5.6.2. Groundwater character

The groundwater character is shown at the hand of a Piper diagram in Figure 5.5. The Piper diagram was created using the AQQA program. The Piper diagram, introduced by Arthur Piper in 1944, is one of the most commonly used techniques to interpret groundwater chemistry data. This method proposed the plotting of cations and anions on adjacent tri-linear fields with these points then being extrapolated to a central diamond field. Here the chemical character of water, in relation to its environment, could be observed and changes in the quality interpreted. The cation and anion plotting points are derived by computing the percentage equivalents per million for the main diagnostic cations of calcium, magnesium and sodium, and anions chloride, sulphate and bi-carbonate.

Different waters from different environments always plot in diagnostic areas. The upper half of the diamond normally contains water of static and dis-ordinate regimes, while the middle area normally indicates an area of dissolution and mixing. The lower triangle of this diamond shape indicates an area of dynamic and co-ordinated regimes. Sodium chloride brines normally plot on the right hand corner of the diamond shape while recently recharged water plots on the left-hand corner of the diamond plot. The top corner normally indicates water contaminated with gypsum.

In general the top half of the diamond contains static waters and other unusual waters high in magnesium/calcium chloride and calcium/magnesium sulphate. The lower half contains those waters normally found in a dynamic basin environment. Mixtures of any two waters in any proportion plot along a line joining their respective points in each of these diagrams. Water therefore being invaded by an industrial effluent will plot as a vector towards the analysis of the invading fluid.

Analysis of the water character shows that in terms of cations, the samples are magnesium dominant. Anion analysis shows that:

- In general the groundwater is chloride dominant;
- Sample NG is bi-carbonate dominant.

Figure 5.5 shows that the water from the area in general shows a high degree of ion exchange having taken place. Only sample NG shows a recently recharged character. Sample TMBH3 indicates a sodium chloride dominant character.

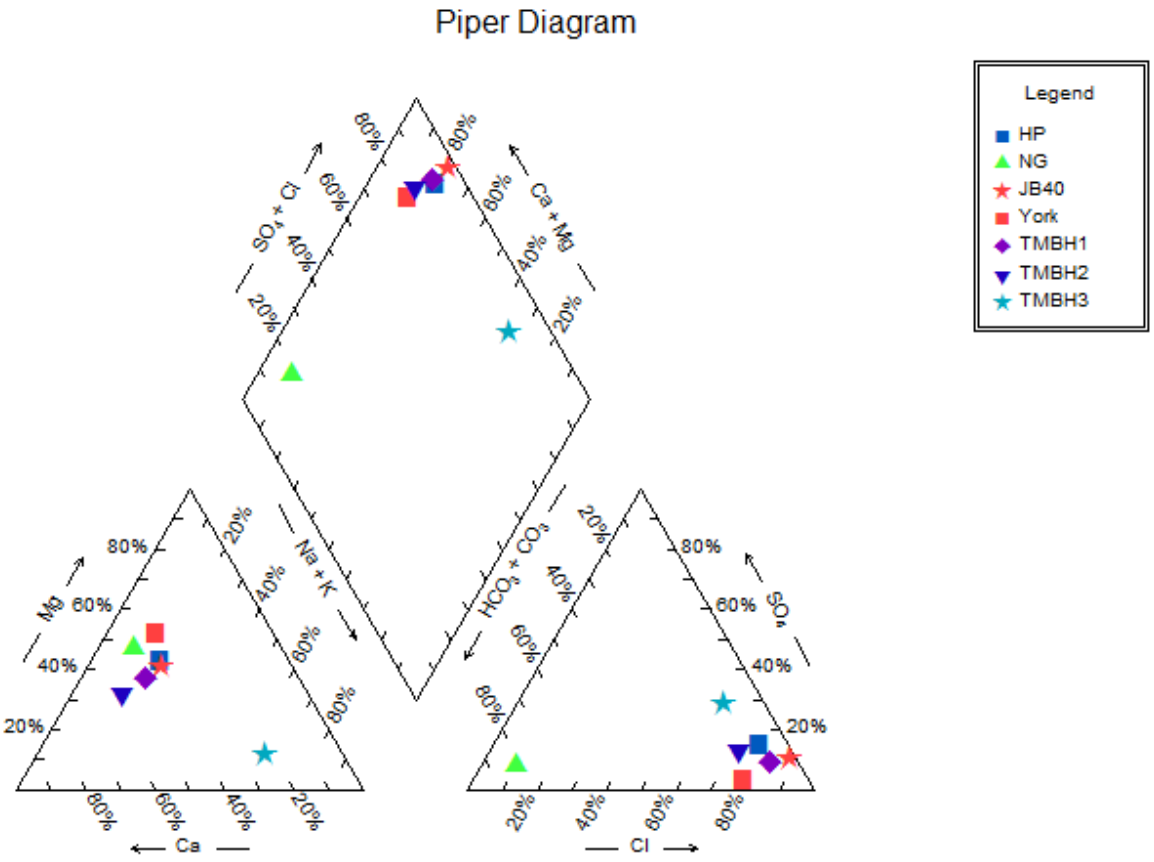


Figure 5.5: Piper diagram

Table 5.3: Groundwater chemical analysis results

Analysis	Units	SANS 241:2015 guideline value	HP	NG	JB40	York	TMBH1	TMBH2	TMBH3
pH		≥5 - ≤9.7	7.84	8.13	7.41	7.58	7.52	7.3	8.53
Electrical Conductivity (EC)	mS/m	≤170	456	73.5	365	394	427	367	86.6
Total Dissolved Solids (TDS)	mg/L	≤1 200	4144	458	3036	3230	2858	2591	488
Total Alkalinity	mg/L $CaCO_3$	N/G	150	316	30	288	130	200	46.9
Total Hardness	mg/L $CaCO_3$	N/G	2080.8	404.1	1454.3	1992	1693	1695	137
Chloride (Cl)	mg/L	≤300	774.9	24	748.3	665.8	728	515	136
Sulphate (SO_4)	mg/L	≤500 (health)	199	23.6	117	35.7	103	121	88.1
Nitrate (NO_3-N)	mg/L	≤11	323.3	4.18	119.7	223.6	260	235	14.1
Nitrite (NO_2-N)	mg/L	≤0.9	0.365	<0.006	0.07	<0.006			
Ammonium (NH_4)	mg/L	N/G	<0.03	<0.03	1.65	<0.03	<0.008	<0.008	<0.008
Phosphate (PO_4)	mg/L	N/G	0.12	0.15	0.24	0.2	<0.005	<0.005	<0.005
Fluoride (F)	mg/L	≤1.5	<0.3	0.3	0.5	<0.3	<0.263	<0.263	<0.263
Bromide	mg/L	N/G	6.95	0.12	7.26	6.31			
Calcium (Ca)	mg/L	N/G	384.6	76.3	277.8	311.6	367	427	36.7
Magnesium (Mg)	mg/L	N/G	266.5	50.8	180.9	288.8	189	153	11
Sodium (Na)	mg/L	≤200	239.3	20.7	182.5	150.5	179	133	122
Potassium (K)	mg/L	N/G	5.4	2.2	3.9	4.4	9.54	7.07	2.26
Aluminium (Al)	mg/L	≤0.3	<0.02	<0.02	<0.02	<0.02	<0.002	<0.002	0.098
Arsenic	mg/L	≤0.01	<0.0025	<0.0025	<0.0025	<0.0025			
Cadmium (Cd)	mg/L	≤0.003	<0.0005	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002
Chromium (Cr)	mg/L	≤0.05	0.002	<0.0015	0.0018	<0.0015	<0.003	<0.003	<0.003
Cobalt (Co)	mg/L	N/G	<0.002	<0.002	<0.002	<0.002	<0.003	<0.003	<0.003
Copper (Cu)	mg/L	≤2	<0.007	<0.007	<0.007	<0.007	0.046	0.043	0.015
Iron (Fe)	mg/L	≤2 (health)	0.08	0.051	0.389	0.034	<0.004	<0.004	<0.004
Lead (Pb)	mg/L	≤0.01	<0.005	<0.005	0.037	<0.005	<0.004	<0.004	<0.004
Manganese (Mn)	mg/L	≤0.4 (health)	0.007	0.003	0.408	<0.002	<0.001	0.168	<0.001
Nickel (Ni)	mg/L	≤0.07	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002
Selenium	mg/L	≤0.04	<0.003	<0.003	<0.003	0.011			

Analysis	Units	SANS 241:2015 guideline value	HP	NG	JB40	York	TMBH1	TMBH2	TMBH3
Vanadium	mg/L	N/G	0.0082	0.0051	0.0015	0.0078			
Zinc (Zn)	mg/L	≤5	0.007	0.183	0.026	0.044	<0.002	0.02	<0.002

Exceed SANS241:2015 guideline value
mS/m = milliSiemens/metre
mg/L = milligram per litre
N/A = Not analysed
N/G = No SANS241:2015 guideline value

6. Aquifer characterisation

6.1. Groundwater vulnerability

For aquifer vulnerability reference is made to the aquifer vulnerability map of South Africa which shows a low aquifer vulnerability for the project area.

6.2. Aquifer classification

The aquifers present in the area are classified as minor aquifers. The aquifers are of high importance to the local landowners outside of town as it is their only source of water for domestic, gardening, and agricultural purposes. In Hotazel town the landowners have access to municipal water.

7. Geochemical characterisation of the rock material present on site

A geochemical assessment of the waste rock and ore material of the Tawana Hotazel Mine was undertaken by Prime Resources (Prime Resources, June 2021). The chemical development of the existing pit lake during mechanical evaporation of the water contained within the historical pit was also simulated. Results from the geochemical assessment are included in the numerical contaminant migration simulations that were done as part of the impact assessment. For ease of reference, and to describe the potential contaminant environment, the most relevant findings are summarised here.

Samples analysed are representative of the material that will be mined, processed and stored on site. A summary of the samples is provided in Table 7.1.

Table 7.1: Geochemical sample description

Sample	Description
TH1	Calcrete composite sample (waste rock)
TH2	Banded ironstone composite sample (waste rock)
TH5	High grade Mn ore. Sampled at the old plant.
TH6	Low grade Mn ore. Sampled from historic waste rock.
TH7	Composite sample of surface waste rock. BIF, calcrete and quartzite.
TH8	Composite sample of fine material. Appears to have been screened or windblown. Occurs on the roads on the site. Comprised of BIF and manganese.

7.1. Acid base accounting tests

Results from the acid-base-accounting testing that were done show that none of the material on site is likely to be acid forming. In addition, the samples have very low abundances of sulphur (<0.01%). Therefore, the samples have insufficient sulphide present that if oxidised, could sustain long term acid generation (Prime Resources, June 2021).

7.2. Metal and sulphate leach testing

Results from the SPLP 1:20 material to solution ratio testing show that copper in the low grade ore sample (TH 6) narrowly exceeded the General Standard for Discharge and manganese in the composite fine sample (TH 8) exceeded the General Standard for Discharge and aesthetic SANS241 drinking water guideline. No other concentrations of the analysed metal and metalloid contaminants of concern have been released in concentrations which exceed water quality guidelines.

The waste rock (represented by TH 1, 2 and 7) and ore samples present a low risk in terms of metal leaching potential. The circum-neutral pH of the solutions resulting from the leach testing as well as the presence of oxyhydroxide iron and manganese minerals within the material inhibits the mobilisation of metal contaminants of concern. The fines material (TH 8) presents a higher risk due to manganese leaching at concentrations exceeding drinking water and discharge standards (Prime Resources, June 2021).

Leach testing was also done using a 1:4 material to solution ratio. Results show that boron exceeded the General Discharge Standard of 1 mg/L in the surface waste rock composite (TH 7). Boron was not leached in detectable concentration in the 1:20 SPLP leach test, and was therefore diluted due to the high leaching ratio. The potential for boron leaching from the waste rock in concentrations exceeding guidelines is therefore dependent on the site-specific rock to water interaction ratio.

Manganese exceeded the General Discharge Standard and aesthetic drinking water standard in the fines composite (TH 8). The concentration of manganese observed in the 1:4 leach test and the 1:20 SPLP test are not markedly different. Given the high abundances of manganese oxide minerals noted in the mineralogy, the concentration of manganese in the solution is not governed by the amount of manganese-bearing mineral present or the water to rock leaching ratio but is more likely to be metered by mineral solubility controls (Prime Resources, June 2021).

7.3. Pit lake quality modelling

A geochemical model was developed to simulate the evolution of water in the existing pit lake during mechanical evaporation of the pit lake water. Results show that the pH of the pit lake water is not expected to become acidic during evaporation. A brine liquid will develop with evaporation with a chemical character dependent on the evaporation percentage. Elements that can be present in elevated concentrations compared to the SANS241:2015 Drinking Water Guidelines include chloride, nitrate and sodium. Calcium and magnesium can also be present in high concentrations, but are not expected to exceed drinking was guidelines (Prime Resources, June 2021).

7.4. Summary of geochemical results

Results from the geochemical assessment show that none of the material is likely to be acid forming. In addition, leach testing show that there are no elements that can be said to generally be present in elevated concentrations in the material that will be mined, processed and stored on site.

Pit lake chemistry is likely to form a brine, with several elements present in concentrations that are expected to exceed drinking water guidelines, including chloride, nitrate and sodium. The final element concentrations will depend on the percentage to which evaporation takes place.

8. Groundwater modelling

8.1. Software model choice

The numerical model was constructed using MODFLOW based software, which is an internationally developed, recognised and used software package. The model includes all parameters discussed in previous sections of this report and takes into consideration aspects such as:

- The different aquifers present in the area and their interrelation to each other;
- Recharge from rainfall;
- Aquifer transmissivities, effective porosity, vertical hydraulic conductance;
- Groundwater flow patterns and velocities;
- Geological lithological units and features such as the extensive faulting that occur in the area; and
- Topographical elevations of surface, the contact between weathered material and competent rock.

8.2. Model setup and boundaries

The model domain is irregularly shaped and defined by the following boundaries:

- On the eastern boundary by the row of north – south striking hills approximately 11 km east of Tawana mine;
- The southern boundary by the Witleegte River;
- On the western boundaries by the Ga-Mogara River; and
- On the northern boundary by the Matlhwaring River / Kuruman River.

8.3. Groundwater elevation and gradient

Groundwater elevations and gradients used in the numerical models were derived from the groundwater levels and flow gradients recorded during the hydrocensus of the area. The data was incorporated as “initial heads” and further consolidated during the calibration process where the groundwater levels and flow contours obtained from the model calculations replicated those measured in the field.

8.4. Geometric structure of the model

The model grid was designed within the delineated model boundary and the proposed developments. The high resolution grid areas overlay the opencast and surface infrastructure areas; with a coarser grid in the far reaches of the model. At the finest resolution the model grid is 12.5 m x 12.5 m, while the coarsest grid size at the outer limits of the model area is 100 m x 100m.

8.5. Groundwater sources and sinks

Groundwater sources include:

- Rainfall recharge (represented by the “recharge” package).

There are no perennial streams indicated in the area. The non-perennial streams do not flow every year. Some streams are recorded to flow less than once every 10 years. Therefore, it is considered that recharge from streams can be omitted.

Groundwater sinks include:

- Evapotranspiration (incorporated in the “recharge” package); and
- Mine dewatering (represented by the “drain” package).

8.6. Conceptual model

8.6.1. Groundwater flows

Three aquifers occur in the region. These three aquifers are associated with a) the primary sandy gravel material, b) the fractured rock and leached banded iron formation aquifer, and c) the dolomitic aquifers of the Griqualand West Sequence. Note that no dolomite was recorded in the exploration drilling logs, therefore, the dolomitic aquifers are not expected to occur on site.

The upper primary sandy gravel aquifer forms due to the vertical infiltration of recharging rainfall through the material being retarded by the lower permeability of the underlying competent rock. In the region this aquifer ranges between 3 and 10 m in thickness. Groundwater collecting above the sandy gravel / competent material contact migrates down gradient along the contact to lower lying areas.

The sandy gravel aquifer is expected to be dry in large portions of the study area for large parts of the year. The aquifer is seasonal and mostly carries water only during and shortly after rainfall events when rainfall recharges into the material. The relatively high transmissivity of the sandy gravel material allows the recharging water to migrate quickly through and out of the material. This

combined with the high positive evaporation rate of 2 026 mm/a lays the material dry for large portions of the year.

The borehole yield in this aquifer is seasonally variable due to the strong dependence on rainfall recharge.

Groundwater flows in the fractured rock aquifer are associated with the secondary fracturing in the competent rock and, as such, will be along discrete pathways associated with the fractures. Faults and fractures in the competent rock can be a significant source of groundwater.

The regional depth to groundwater level ranges between 20.3 and 32.00 m with an average of 26.76 m. The depth to groundwater level in the boreholes close to the existing pit tends to be greater than that measured in regional boreholes and can be up to be 52.61 m below surface. This is attributed to the previous mine dewatering and the evaporation from the pit lakes.

Regionally, the groundwater flows from the higher lying area to the east of Tawana towards the lower lying Ga-Mogara River west of the mine. Close to the existing pit the groundwater flow patterns are disrupted and are directed towards the pit due to the lower water level in the existing pit.

8.6.2. Contaminant transport

Contaminant migration will be controlled by the groundwater flow patterns in the study area. Pollution from sources that fall within the zone of influence of the groundwater level drawdown cone will be directed towards the pit, while pollution outside the zone of influence will migrate in a naturally down gradient direction. Locally, the pollution migration pattern can be impacted by zones of higher transmissivity within the fractured rock aquifer.

The surface stockpiles can act as potential sources of contamination to the aquifers. Both the ROM pads and the product stockpiles are located close to the boundary of the proposed pit, and could therefore fall within the zone of influence of the groundwater level drawdown around the pit during operations. After closure the water level in the rehabilitated pit will rise to near regional levels (20 to 30 m below surface). This could allow contamination to migrate away from the pit in the long term.

9. Geohydrological Impacts

The environmental impact assessment is conducted based on the available information and the numerical model that was constructed. Impacts from the proposed mining activities and the surface infrastructure were evaluated and include impacts on:

- Groundwater levels, flow patterns and volumes;
- Groundwater qualities and plume migration; and
- Surface water qualities due to poor quality groundwater seeping into the surface water bodies in the form of baseflow contribution.

During the risk assessment the risk to the groundwater levels and quality were evaluated. Each of the identified risks was then rated. The following risk assessment model has been used for determination of the significance of impacts:

SIGNIFICANCE = (MAGNITUDE + DURATION + SCALE) X PROBABILITY

The maximum potential value for significance of an impact is 100 points. Environmental impacts can therefore be rated as high, medium or low significance on the following basis:

- High environmental significance 60 – 100 points
- Medium environmental significance 30 – 59 points
- Low environmental significance 0 – 29 points

MAGNITUDE (M)	DURATION (D)
10 – Very high (or unknown)	5 – Permanent
8 – High	4 – Long-term (ceases at the end of operation)
6 – Moderate	3 – Medium-term (2-8 years)
4 – Low	2 – Short-term (0-1 years)
2 – Minor	1 – Immediate
SCALE (S)	**PROBABILITY (P)**
5 – International	5 – Definite (or unknown)
4 – National	4 – High probability
3 – Regional	3 – Medium probability
2 – Local	2 – Low probability
1 – Site	1 – Improbable
0 – None	0 – None

9.1. Construction Phase

The construction phase for the proposed Tawana operations will entail construction of surface infrastructure, including the access roads, offices, loading station, processing plant, product stockpile areas, berms, ROM pad, haul road, and PCD. The water currently present in the existing opencast and underground workings will also be dewatered over a period of approximately 14 months.

9.1.1. Impacts on groundwater volumes

Construction of the surface infrastructure will not impact the groundwater levels which lie between 31 and 53 m depth in the area where the infrastructure will be built.

Dewatering of the existing opencast pit lake and the water contained in the existing underground mine will cause a lowering of the groundwater levels within the surrounding aquifers. Simulations using the 3D numerical groundwater flow model show that the groundwater levels in the area could be reduced by up to 40 m (please refer to Figure 9.1).

Due to the low aquifer transmissivity, the low vertical drawdown in water level, and the relatively short time frame of the construction period, the zone of influence of the groundwater level drawdown cone will be relatively small at less than 400 m from the mine boundary.

No surface streams or privately owned boreholes will be impacted by the drawdown in groundwater level.

9.1.2. Groundwater inflow volumes into the existing excavations

When the existing mine excavations (underground as well as opencast workings) are dewatered during the construction phase, groundwater inflows from the surrounding fractured rock aquifer into the excavations will accelerate as groundwater in storage in the aquifer is released due to the piesometric pressure reduction around the mine area. Then, as the groundwater in storage is depleted inflows will be controlled by regional migration of groundwater towards the pit and the aquifer transmissivities.

Groundwater inflow volumes during the construction phase into the existing mine workings are expected to be on average 170 m^3/day (please refer to Table 9.2).

9.1.3. Impacts on groundwater qualities

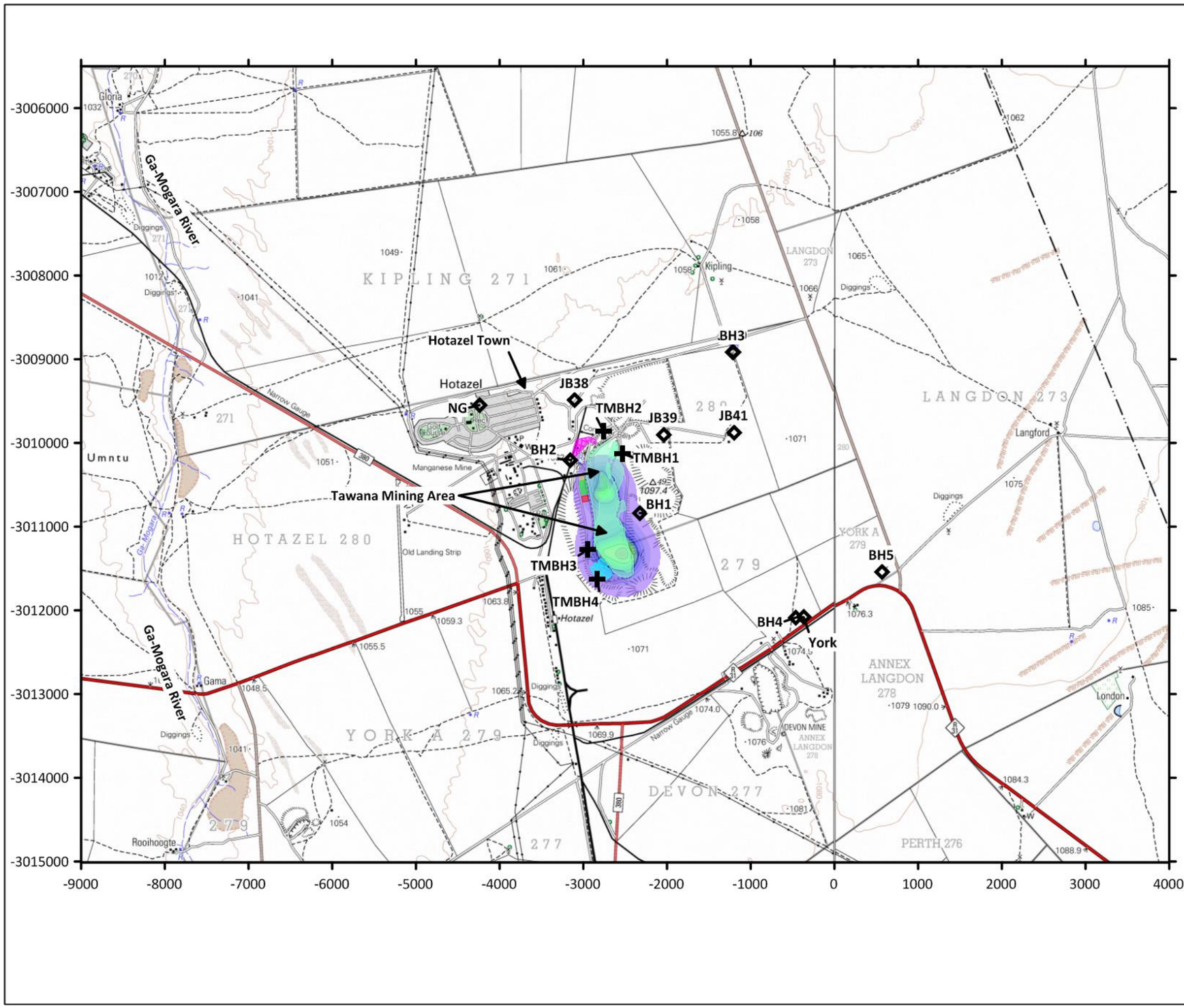
The surface infrastructure that will be constructed all lie close to the existing underground mine and opencast pit. Assessment of the exiting groundwater level drawdown cone and the proposed surface layout shows that the proposed infrastructure all fall within the existing groundwater level drawdown cone. Therefore, any contamination that enters the underlying aquifers will migrate towards the pit where it will be dewatered and directed into the mine water management system. No contamination

is expected to migrate significantly off-site during the construction phase and no surface streams or private boreholes are expected to be impacted.

It should also be taken into account that the groundwater level in this area lies at 31 to 53 m below surface. The aquifers have a low horizontal and even lower vertical permeability. Therefore, there will a significant lag period before contamination entering the soil and eventually reaching the saturated zone. Using a rule of thumb where the vertical hydraulic conductivity is 10 % of the horizontal hydraulic conductivity, it is calculated that it can take up to 600 days for contamination to reach the saturated zone which is near, or past, the end of the construction phase.

Table 9.1: Impact rating – Construction phase

Impact	Status	Magnitude	Duration	Scale	Probability	Significance	Mitigation	Mitigation	Status	Magnitude	Duration	Scale	Probability	Significance
Impacts on groundwater volumes due to active dewatering of the existing pit lake and underground mine	Neg	4	2	2	5	40	Y	Monitor groundwater levels, dewatering volumes, climatic aspects such as rainfall and evaporation.	Neg	2	2	2	5	30
Impacts on surface water volumes due to active dewatering of the existing pit lake and underground mine	Neg	2	2	0	0	0	Y	No surface water bodies fall within the zone of influence						
Impacts on groundwater quality due to poor quality seepage from the mining area and surface infrastructure	Neg	4	2	1	2	14	Y	Monitor the groundwater quality.	Neg	2	2	1	2	10
Impacts on groundwater quality due to accidental chemical and hydrocarbons spills	Neg	4	2	1	2	14	Y	Store fuel in sealed tanks and containing walls around tanks; Proper sizing and operation of oil traps; Safe storage of chemicals.	Neg	2	2	1	2	10
Impacts on surface water quality due to poor quality seepage from the pollution source areas	Neg	1	2	0	0	0	Y	No surface water bodies fall within the zone of influence						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-7000
-6000
-5000
-4000
-3000
-2000
-1000
0
1000
2000
3000
4000
Ga-Mogara River
Hotazel Town
Hotazel
Tawana Mining Area
BH1
BH2
BH3
BH4
BH5
JB38
JB39
JB41
NG
TMBH1
TMBH2
TMBH3
TMBH4
Kipling
York
Gama
Umntu
Rooihoogte
Langford
London
Manganese Mine
Old Landing Strip
Narrow Gauge
Diggings
KIPLING 271
HOTAZEL 280
YORK A 279
LANGDON 273
ANNEX LANGDON 278
DEVON 277
PERTH 276
DEVON MINE
Groundwater level drawdown
42 m
40 m
38 m
36 m
34 m
32 m
30 m
28 m
26 m
24 m
22 m
20 m
18 m
16 m
14 m
12 m
10 m
8 m
6 m
4 m
2 m
N
W
E
S
Monitoring borehole
Hydrocensus point
Product stockpile area
Refuel bay
Vehicle yard & workshop
PCD
ROM pads
Tawana Mining Area
Reference Maps
Topographical: 2722BB; 2722BD
2723AA; 2723AC
Geological: 2722 Kuruman
Satelite Image: Google Earth
WGS84, LO23
Client:
Prime Resources
Project:
Tawana Manganese & Iron Ore Mine
Groundwater Study
Figure Number: 9.1
Figure Name:
Groundwater level drawdown
Zone of influence
End of construction phase
Scale: As shown
Date: December 2021
Revision: 1
Designed: MP
Approved:
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9.2. Operational Phase

The operational phase for the proposed Tawana operations will entail operation of surface infrastructure, including the access roads, offices, loading station, processing plant, product stockpile areas, berms, ROM pad, haul road, and PCD. The existing opencast pit and underground mine will be further excavated as an opencast pit, with a maximum depth of approximately 110 m (minimum pit elevation is planned to lie at 957 mamsl according to the pit shell showing the final pit at the end of life of mine).

9.2.1. Impacts on groundwater volumes

There is an existing drawdown in groundwater level around the existing opencast pit and underground mine due to the previous mine dewatering and ongoing evaporation of water from the pit lake in the opencast pit.

During excavation of the proposed mine pit the existing groundwater level drawdown cone will develop further to become deeper and larger. Results from the numerical groundwater flow model show that the groundwater level can be drawn down by 68 m from the current water levels in the aquifer. In the south, where the pit will be the deepest, the groundwater level drawdown cone can extend 1.7 to 1.9 km from the pit boundary, while in the north the zone if influence is expected to reach 1.1 km from the pit boundary. Please refer to Figure 9.1 for a representation of the expected drawdown cone.

Boreholes BH1, JB38, JB39, JB41 are expected to fall within the zone of influence of the groundwater level drawdown cone. The boreholes are all monitoring boreholes operated by South32. None of the impacted boreholes are used for private domestic or agricultural purposes.

No surface water streams fall within the zone of influence of the groundwater level drawdown cone.

Feedback from the client indicates concern from local landowners regarding the cumulative impacts from different mining operations (current and proposed) in the region. The concerns from local landowners revolve around the fact that the area is extremely dry and water is scarce. The limited water resources are thus sensitive and extremely vulnerable and obviously underpin the entire ecosystem function. Specific mention is also made of the Korannaberg catchment, which lies approximately 30 to 40 km west of the town of Hotazel, and therefore, also the proposed Tawana mine.

It is difficult to quantify the large scale regional impact on the groundwater environment as part of this study due to no information being available on the other mines in the region and their impact on the regional groundwater resource. However, it can be said that:

- The proposed Tawana mine lies 30 to 40 km from the Korannaberg (the extent of the mentioned sub-catchment is not known), and theoretically, Tawana lies in a different sub-catchment than the Korannaberg catchment due to the presence of the Ga-Mogara River

between Tawana mine and Korannaberg (albeit that the river only runs maybe once a decade);

- The zone of influence of Tawana extends at a maximum 1.9 km from the pit boundary; therefore, there is no direct impact on the Korannaberg region.

9.2.2. Groundwater inflow volumes into the mine workings

The expected groundwater inflow volumes into the mine workings as calculated using the numerical groundwater flow model are summarised in Table 9.2. The groundwater inflow volumes are calculated for each pit shell that is available. These include 2025, 2035, 20245 and the final (end of life of mine) pit shells. The pit shell for 2025 is considered to represent the shell as at the end of the construction phase.

It can be seen that during the construction phase, and the associated initial dewatering of the water in the existing pit and underground, water currently in storage in the aquifer will enter the excavation. Then, as the groundwater in storage is depleted inflows will be controlled by regional migration of groundwater towards the pit and the aquifer transmissivities. The average groundwater inflows will reduce to 155 m^3/day for the period 2025 to 2035 after which it will increase again as the pit increase in depth (and depth below the regional groundwater levels). During the period 2035 to 2045 the average daily inflow volumes will be in the order of 180 m^3/day. For the period 2045 to the end of life of mine the average inflows are expected to be in the order of 245 m^3/day.

It has to be stated that these inflows are considered to be high compared to what will enter the mine in reality during the life of mine. Also, with the high evaporation of 2 026 mm/a in the study area can be expected that a large percentage of the water entering the pit from the surrounding aquifers will evaporate before it has to be pumped to surface.

Table 9.2: Groundwater inflow volumes into the mine excavation

Groundwater	**Unit**	**2025**	**2035**	**2045**	**EOM**
inflow volume	m^3/day	170	155	180	245

9.2.3. Impacts on groundwater qualities

The majority of points at Tawana are not expected to act as significant pollution sources.

It is assumed that the fuel will be stored in sealed containers in the refuel area and that the area will be paved. It is also assumed that the vehicle yard and workshop will be paved, with appropriate oil traps and other infrastructure in place. Based on this, it is assumed that there will be limited hydrocarbon contamination from these areas.

Rainfall will recharge into the in-pit stockpiles that is planned will seep from the stockpiles into the pit. The geochemical assessment shows that the material backfilled into the pit is unlikely to be acid forming and element concentrations will comply with discharge and drinking water guidelines. The water will collect in the pit sump from where it will be pumped to surface and be incorporated into

the mine water management system. Any rainfall and groundwater inflows into the pit will also be diverted into the in-pit sump from where it will be pumped to surface and into the mine water management system. Due to ongoing dewatering of the pit, no driving head will form that cause contamination to migrate away from the pit. Based on this, it is expected that the pit will not be a notable source of pollution during the operational phase.

The PCD will be lined; therefore, it is assumed that there will be no contamination entering the underlying aquifers from the PCD.

Potential sources of contamination at Tawana related to the mining activities include the pit, the ROM pads, the processing plant and the product stockpile area.

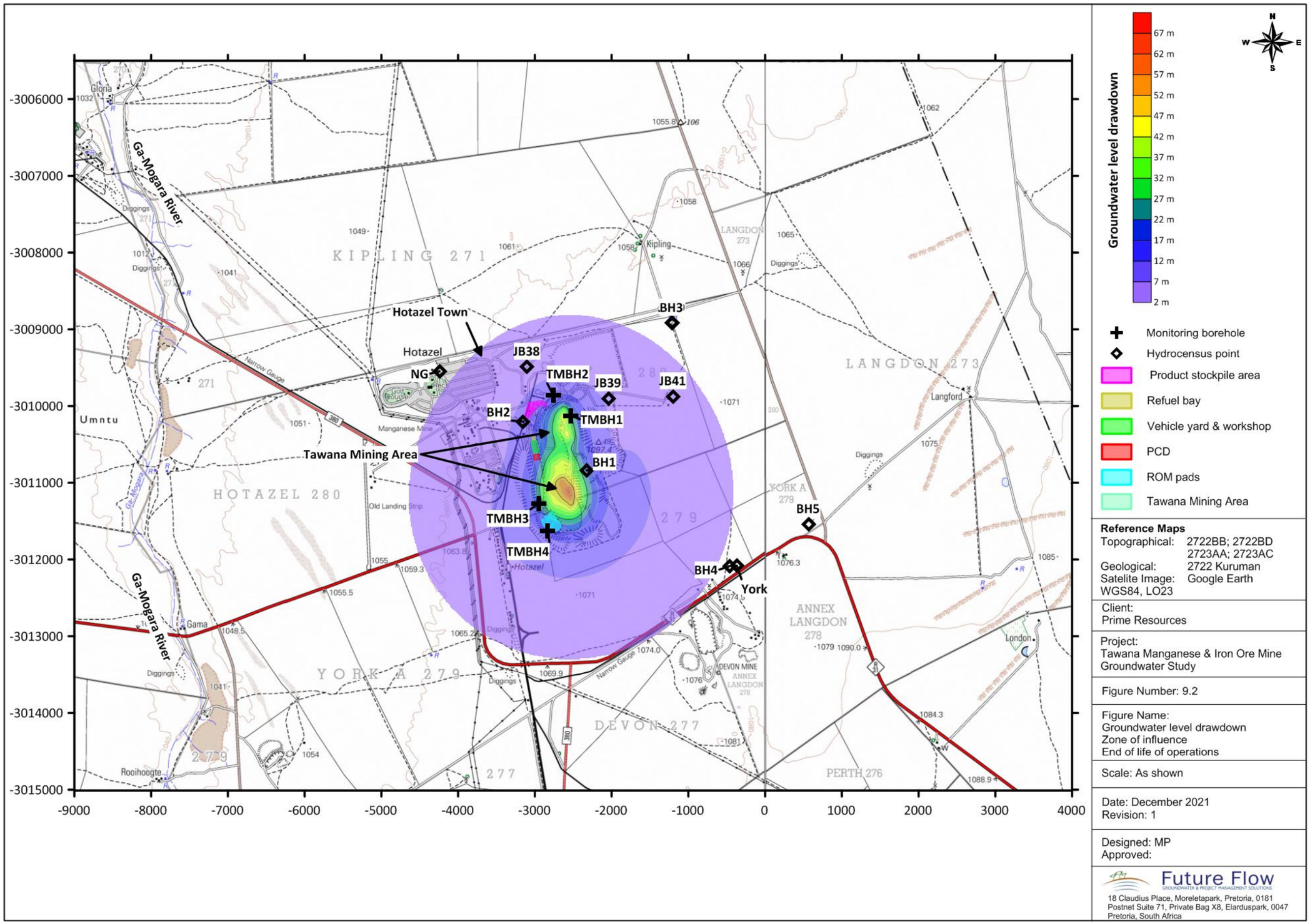
Results from the geochemical assessment show that none of the material that will be mined, processed and stored on site, is likely to be acid forming. In addition, leach testing show that there are no elements that can be said to generally be present in elevated concentrations in the material that will be processed at the plant and stored on the ROM pads and the product stockpiles (please refer to Section 7.2 and 7.4 of this report).

Based on the above, there is no single element that can be identified that can be used as an indication of the plume migration away from the plant area and the ROM pads and the product stockpiles. Therefore, it was decided to apply a generic value of 100 as a starting concentration at the different potential pollution sources when doing the contaminant migration modelling. The resultant simulated plume will then represent any contaminant as a percentage of the source concentration at that specified point and time, e.g. a value of 50 would represent a concentration to the value of 50 % of the source concentration.

Results from the contaminant migration modelling show that the contaminant plume from the ROM pads and processing plant area, as well as the product stockpiles, will migrate towards and into the pit (please refer to Figure 9.3). No contamination is expected to migrate away from the mining area, and no surface water bodies or privately owned boreholes will be impacted.

Table 9.3: Impact rating – Operational phase

Impact	Status	Magnitude	Duration	Scale	Probability	Significance	Mitigation	Mitigation	Status	Magnitude	Duration	Scale	Probability	Significance
Impacts on groundwater volumes due to active dewatering of the opencast mine	Neg	6	4	2	5	60	Y	Monitor groundwater levels, dewatering volumes, climatic aspects such as rainfall and evaporation; Update the numerical groundwater flow model every 2 years in increase the confidence level of the predicted cone of dewatering. Identify boreholes and surface water bodies that will be impacted; Design and implement impact management plans for identified risk and impact areas.	Neg	4	4	2	5	50
Impacts on surface water volumes due to active dewatering of the opencast mine	Neg	2	2	0	0	0	Y	No surface water bodies fall within the zone of influence						
Impacts on groundwater quality due to poor quality seepage from the mining area and surface ROM pads and the product stockpiles	Neg	4	5	2	5	55	Y	Monitor the groundwater quality; Possible update of the geochemical assessment of the waste rock, ROM stockpile, product stockpile once the mine is operational; Update the numerical contaminant migration model every 2 years to increase the confidence level in the predictions; Design and implement impact management plans for identified risk and impact areas.	Neg	2	5	2	5	45
Impacts on groundwater quality due to accidental chemical and hydrocarbons spills	Neg	4	2	1	2	14	Y	Store fuel in sealed tanks and containing walls around tanks; Proper sizing and operation of oil traps; Safe storage of chemicals.	Neg	2	2	1	2	10
Impacts on surface water quality due to poor quality seepage from the pollution source areas	Neg	1	2	0	0	0	Y	No surface water bodies fall within the zone of influence						



Reference Maps
Topographical: 2722BB; 2722BD
2723AA; 2723AC
Geological: 2722 Kuruman
Satelite Image: Google Earth
WGS84, LO23

Client:
Prime Resources

Project:
Tawana Manganese & Iron Ore Mine
Groundwater Study

Figure Number: 9.2

Figure Name:
Groundwater level drawdown
Zone of influence
End of life of operations

Scale: As shown

Date: December 2021
Revision: 1

Designed: MP
Approved:

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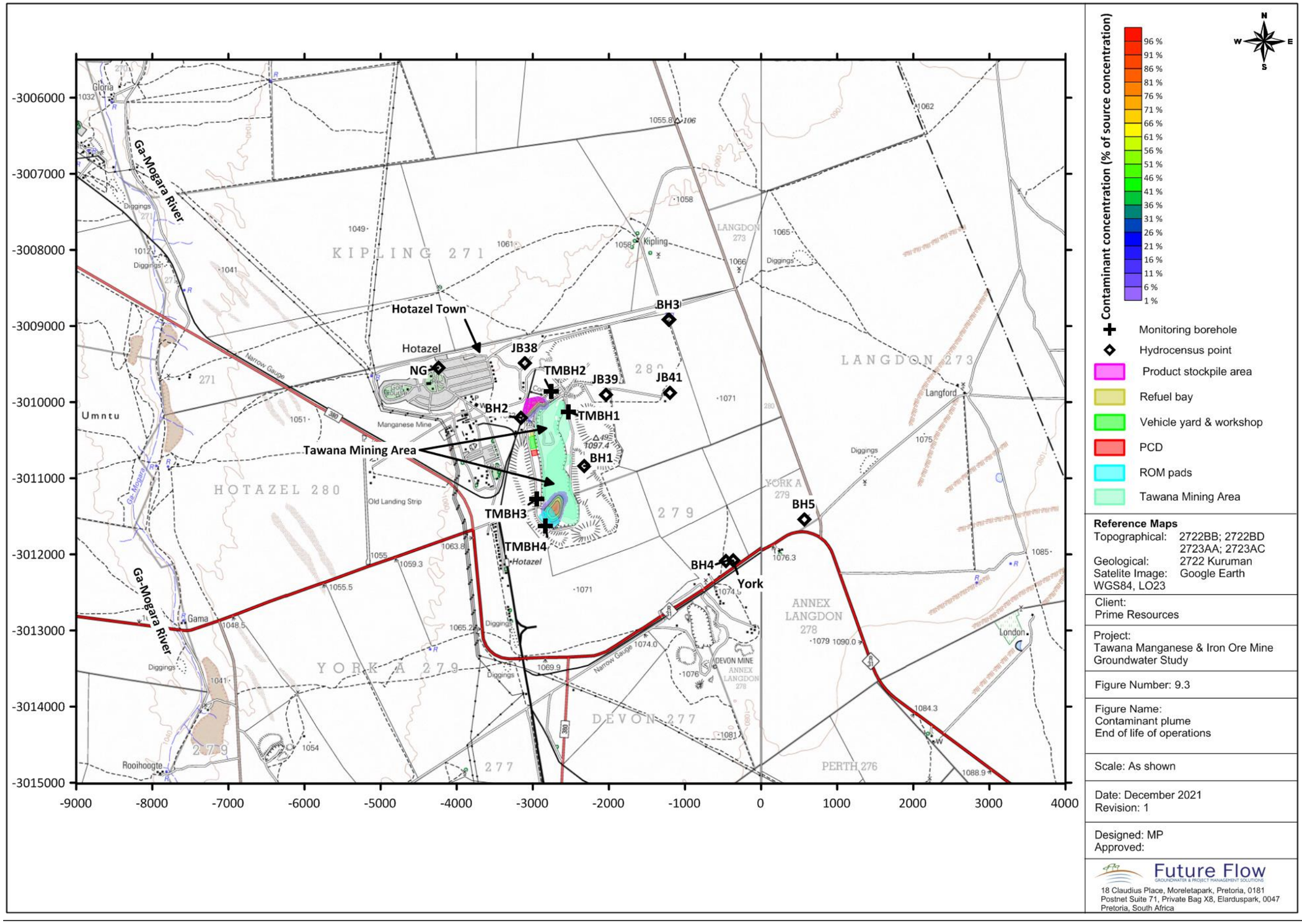
Pretoria, South Africa



Reference Maps
Topographical: 2722BB; 2722BD
2723AA; 2723AC
Geological: 2722 Kuruman
Satelite Image: Google Earth
WGS84, LO23

Client:
Prime Resources

Project:
Tawana Manganese & Iron Ore Mine
Groundwater Study

Figure Number: 9.3

Figure Name:
Contaminant plume
End of life of operations

Scale: As shown

Date: December 2021
Revision: 1

Designed: MP
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9.3. Decommissioning phase

9.3.1. Impacts on groundwater volumes

During the decommissioning phase the mining activities, and any dewatering of the pit that takes place, will be stopped. This will allow the groundwater level in the pit area to recover. The recovery rate is expected to be slow and it is not expected that a significant pit lake will form by the end of the 3 year decommissioning phase.

9.3.2. Impacts on groundwater qualities

During the decommissioning phase the ROM pads and the product stockpiles will be removed and the footprint areas rehabilitated. The waste rock and topsoil will be used to finalise backfilling and rehabilitation of the pit.

Contamination that already entered the aquifers underlying the ROM pads and the product stockpile areas during the operational phase will continue to migrate towards the pit. No additional contamination will enter the underlying aquifers in future.

9.4. Long term post-operational phase

9.4.1. Recovery of groundwater levels and decant potential

The water level within the rehabilitated pit will continue to recover in the long term. It is expected that the water level will rise to near that of the natural regional groundwater levels. The recovery of the water level within the pit will be slow due to the combination of very low groundwater inflow volumes from the surrounding aquifers and the low rainfall in the area.

Rainfall recharge into the rehabilitated pit can be in the order of 8 % of the mean annual rainfall (Hodgson, Usher, Scott, Zeelie, Cruywagen, & de Necker, 2001). Using the average annual rainfall of 349 mm and a total pit area of 452 900 m^2, it is calculated that on average 12 644 m^3 of water will recharge into the rehabilitated pit on an annual basis. This equates to 35 m^3/day.

Groundwater inflows into the pit will decrease over time as the hydraulic gradient between the regional groundwater level and the water level in the rehabilitated pit decreases. Initially, the inflows will be in the order of 245 m^3/day, but as the water level in the rehabilitated pit nears the equilibrium level of around 1 040 mamsl, the groundwater inflows will also decrease to near 0 m^3/day due to the very low groundwater flow gradient.

Using the numerical groundwater flow model it is calculated that by between 40 and 50 years post closure the water level in the rehabilitated pit is expected to reach 1 040 mamsl, which is the elevation of the natural regional groundwater levels. The natural groundwater levels range between 20.3 and 32.00 m with an average of 26.76 m.

The water level in the rehabilitated pit will then continue to slowly rise above the regional groundwater levels due to the higher recharge from rainfall into the rehabilitated pit than into the surrounding, undisturbed, aquifers. Once the water level in the rehabilitated pit rises above the regional groundwater level water will start to flow from the pit towards the surrounding area.

Numerical modelling results show that it is expected that by 100 years post closure the groundwater level in the rehabilitated pit will have risen to around 10 m above the regional groundwater levels. It will not have reached decant elevation and no decant is expected by 100 years post closure.

9.4.2. Impacts on groundwater qualities

During the initial years post closure the contamination that already entered the aquifers from the ROM pads and the processing plant footprint, as well as the product stockpile footprint during the operational phase will continue to migrate towards the pit where the water levels are expected to rise, but remain beneath the regional groundwater levels up to 40 to 50 years post closure. Once the water level in the rehabilitated pit has reached the regional groundwater levels, and start to rise above it due to continuing recharge from rainfall, contaminants can start to migrate away from the opencast pit area.

As discussed previously in this report, the geochemical characterisation of the material stored on the ROM pads and the product stockpiles, as well as the material that will be used to backfill the pit (waste rock, sand and top soil) shows that AMD conditions are not expected to form. In addition, leach testing shows that there are no elements that can be said to generally be present in elevated concentrations in the leachate emanating from the material used to backfill the pit.

In order to be conservative, and to demonstrate plume migration in the post-operational phase, the plume migration up to 100 years post operations was simulated using the 3D contaminant migration model. The obtained plumes at 50 years and 100 years post-closure are shown in Figure 9.4 and Figure 9.5 respectively.

From Figure 9.4 and Figure 9.5 it can be seen that at 50 years post closure the contamination will mostly be contained within the pit area. Over time the plume will start to migrate radially away from the pit area. The radial spread of the plume is due to the fact that the region has a flat topography and the water level within the rehabilitated pit will rise above the surrounding topographical elevations.

The plume migration will be slow due to the combined effect of:

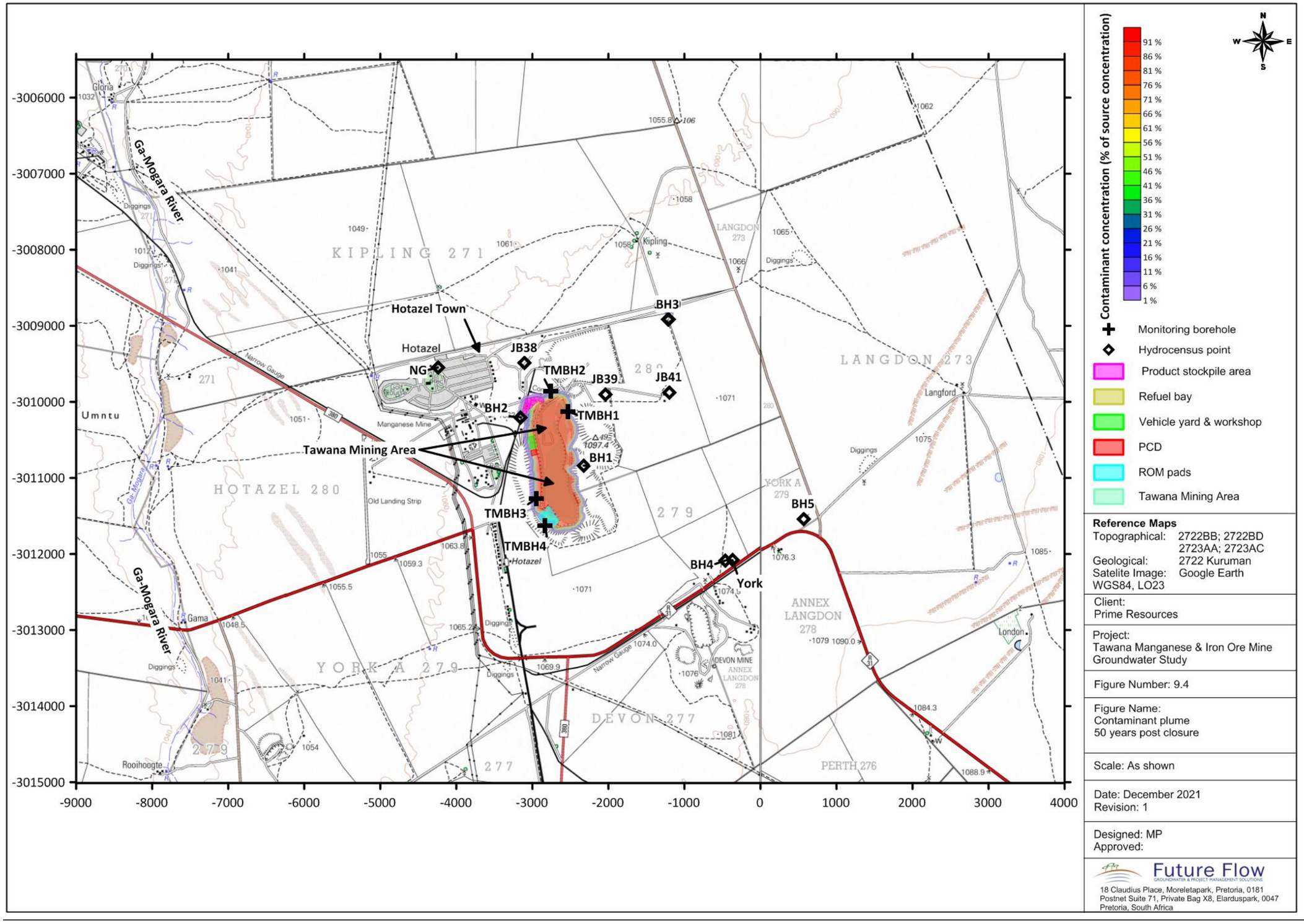
- The low aquifer transmissivity associated with the fractured rock aquifer (the water level I in the rehabilitated pit is not expected to have reached the upper sandy gravel material aquifer); and
- The fact that the water level within the rehabilitated pit will not rise more than approximately 10 m above the regional groundwater level, thereby creating a relatively low driving head.

By 100 years post closure it is expected that the plume will not have spread more than 200 m from the pit boundary.

No surface water bodies or privately owned boreholes fall within the expected zone of influence of the plume.

Table 9.4: Impact rating – Long term post-closure phase

Impact	Status	Magnitude	Duration	Scale	Probability	Significance	Mitigation	Mitigation	Status	Magnitude	Duration	Scale	Probability	Significance
Recovery of groundwater levels	Pos	6	5	2	5	65	Y	Positive impact – no mitigation needed						
Impacts on groundwater quality due to poor quality seepage from the mining area and surface ROM pads and the product stockpiles	Neg	4	5	2	5	55	Y	Monitor the groundwater quality; Remove ROM pads and product stockpiles and rehabilitate footprint area; Backfill and rehabilitate the opencast pit.	Neg	2	5	2	5	45
Impacts on surface water quality due to poor quality seepage from the pollution source areas	Neg	1	2	0	0	0	Y	No surface water bodies fall within the zone of influence						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1000
2000
3000
4000
Ga-Mogara River
Hotazel Town
Hotazel
Tawana Mining Area
Manganese Mine
Old Landing Strip
Kipling
Langford
York
Gama
Umntu
Rooihoogte
London
Gloria
Narrow Gauge
Diggings
KIPLING 271
HOTAZEL 280
LANGDON 273
YORK A 279
DEVON 277
ANNEX LANGDON 278
PERTH 276
BH1
BH2
BH3
BH4
BH5
JB38
JB39
JB41
NG
TMBH1
TMBH2
TMBH3
TMBH4
Contaminant concentration (% of source concentration)
91 %
86 %
81 %
76 %
71 %
66 %
61 %
56 %
51 %
46 %
41 %
36 %
31 %
26 %
21 %
16 %
11 %
6 %
1 %
N
W
E
S
Monitoring borehole
Hydrocensus point
Product stockpile area
Refuel bay
Vehicle yard & workshop
PCD
ROM pads
Tawana Mining Area
Reference Maps
Topographical: 2722BB; 2722BD
2723AA; 2723AC
Geological: 2722 Kuruman
Satelite Image: Google Earth
WGS84, LO23
Client:
Prime Resources
Project:
Tawana Manganese & Iron Ore Mine
Groundwater Study
Figure Number: 9.4
Figure Name:
Contaminant plume
50 years post closure
Scale: As shown
Date: December 2021
Revision: 1
Designed: MP
Approved:
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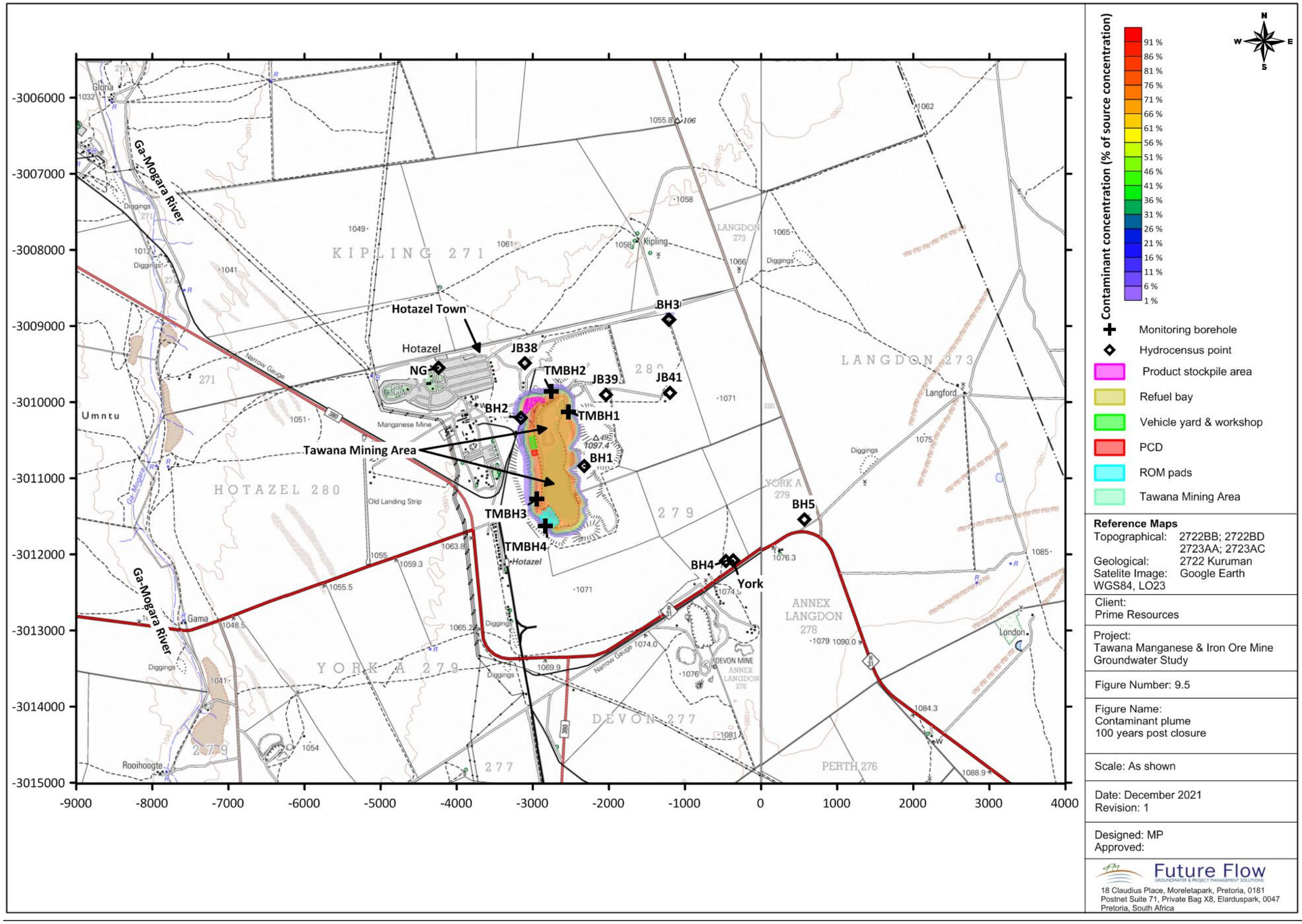
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-4000
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-2000
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1000
2000
3000
4000
Ga-Mogara River
Hotazel Town
Hotazel
Tawana Mining Area
Manganese Mine
Old Landing Strip
Kipling
Langford
York
Gama
Umntu
Rooihoogte
London
Narrow Gauge
Diggings
KIPLING 271
HOTAZEL 280
YORK A 279
DEVON 277
LANGDON 273
ANNEX LANGDON 278
PERTH 276
BH1
BH2
BH3
BH4
BH5
JB38
JB39
JB41
NG
TMBH1
TMBH2
TMBH3
TMBH4
Contaminant concentration (% of source concentration)
91 %
86 %
81 %
76 %
71 %
66 %
61 %
56 %
51 %
46 %
41 %
36 %
31 %
26 %
21 %
16 %
11 %
6 %
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N
W
E
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Monitoring borehole
Hydrocensus point
Product stockpile area
Refuel bay
Vehicle yard & workshop
PCD
ROM pads
Tawana Mining Area
Reference Maps
Topographical: 2722BB; 2722BD
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Prime Resources
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Groundwater Study
Figure Number: 9.5
Figure Name:
Contaminant plume
100 years post closure
Scale: As shown
Date: December 2021
Revision: 1
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Approved:
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10. Groundwater Monitoring System

10.1. Groundwater Monitoring Network

10.1.1. Source, Plume, Impact and Background Monitoring

A water monitoring program that incorporates the proposed operations, with focus on the possible sources of impact, has to be implemented. These sources of impacts include the opencast pit area as well as proposed surface infrastructure areas that could potentially act as pollution sources. These include the ROM pads and processing plant as well as the product stockpile.

Dedicated monitoring boreholes were installed as part of this investigation. The monitoring boreholes covered relevant potential pollution sources at the proposed surface infrastructure points based on the current layout. Please refer to Table 5.2 for the monitoring borehole details (TMBH1 to TMBH4).

10.1.2. Monitoring Frequency

It is recommended that the monitoring program start with a monthly interval for the first year. Ideally, the monitoring program should start a year before mining starts in order to be able to build a database that is not impacted by the mining activities.

Once the monthly database is established the monitoring frequency can change to quarterly.

10.2. Monitoring Parameters

Parameters and elements to be monitored for should comply with the mine the relevant legislature, and also correspond to the parameters suitable to monitor manganese ore mining activities. Recommended parameters and elements are summarised below:

- General chemistry such as pH, TDS and EC;
- Major elements such as calcium, magnesium, sodium, potassium, sulphate, nitrate, fluoride, chloride, phosphate;
- An ICP scan of minor elements including aluminium, arsenic, cadmium, copper, chromium (total), iron, manganese, nickel, lead, antimony, selenium, vanadium and zinc.

10.3. Monitoring Boreholes

The monitoring program should include:

- Dedicated monitoring boreholes TMBH1 to TMBH4 which were installed as part of this study; and
- There are no privately or community owned boreholes which are located close to the proposed mining area. Therefore, none of the privately owned boreholes identified during the hydrocensus have to be included.

11. Groundwater Environmental Management Programme

11.1. Current Groundwater Conditions

Please refer to Section 5 of this report.

11.2. Predicted Impacts of Facility

Please refer to Section 9 of this report.

11.3. Mitigation Measures

11.3.1. Lowering of Groundwater Level during Facility Construction

During the construction phase the existing pit lake and the underground mine will be dewatered, thereby lowering the piesometric pressure level within the existing opencast pit and underground mine. This will cause a lowering of the groundwater levels in the surrounding aquifers due to groundwater being released from the aquifer to flow into the existing mine workings. The zone of influence of the drawdown in groundwater level is expected to extend up to 400 m from the pit boundary. No private boreholes or surface water bodies will be impacted.

Little can be done to reduce the groundwater inflows into the mining area and the associated drawdown in groundwater levels in the surrounding aquifers. It is recommended that the groundwater level around the pit be monitored via the dedicated groundwater monitoring boreholes that were installed as part of this study.

11.3.2. Lowering of Groundwater Levels during Facility Operation

Groundwater that flows into the opencast pit from the surrounding aquifers will be pumped to surface. This ongoing dewatering of the operational pit will cause the existing drawdown in groundwater level that formed due to previous mine dewatering and evaporation from the existing pit lake to increase and the zone of influence of the drawdown cone will expand. In the south, where the pit will be the deepest, the groundwater level drawdown cone can extend 1.7 to 1.9 km from the pit boundary, while in the north the zone if influence is expected to reach 1.1 km from the pit boundary. No surface water bodies or privately owned borehole used for water supply will be impacted; therefore, no man-made post-closure strategies are currently required. Should future assessments show that private boreholes will be impacted, then it might be necessary to provide water of similar quantity and quality to that user.

Impacts of the groundwater level drawdown can be mitigated by:

- Monitoring groundwater levels around the pit;
- Monitoring dewatering volumes;

- Monitoring climate factors such as rainfall and evaporation;
- Using the above information the numerical groundwater flow model can be updated regularly (2 yearly) over the life of mine to increase the model accuracy in predicting the expected groundwater level drawdown cone and the expected impacts on the surrounding environment. This will include identifying boreholes used for private water supply boreholes and surface streams that might be impacted;
- Once boreholes and streams that will be impacted are identified and the impacts quantified using the update numerical groundwater flow model, then further management plans must be put into place where required.

11.3.3. Spread of Groundwater Pollution during Facility Construction

The surface infrastructure that will be constructed all lie close to the existing underground mine and opencast pit. Assessment of the exiting groundwater level drawdown cone and the proposed surface layout shows that the proposed infrastructure all fall within the existing groundwater level drawdown cone. Therefore, any contamination that enters the underlying aquifers will migrate towards the pit where it will be dewatered and directed into the mine water management system. No contamination is expected to migrate significantly off-site during the construction phase and no surface streams or private boreholes are expected to be impacted, therefore, it is not currently foreseen that no man-made post-closure strategies are required. Should future assessments show that private boreholes will be impacted, then it might be necessary to provide water of similar quantity and quality to that user.

The PCD will be lined. Therefore, no impacts on the underlying aquifers from the dam on the underlying groundwater qualities are expected. It is recommended that the dam be sized and constructed correctly and maintained properly.

11.3.4. Spread of Groundwater Pollution during Facility Operation

The ore excavated from the opencast mine will be stored in the ROM pads. After processing in the processing plant the product will be temporarily stored on the product stockpile. Waste will be backfilled into the pit as part of ongoing rehabilitation.

Results from the geochemical assessment show that none of the material that will be mined, processed and stored on site, is likely to be acid forming. In addition, leach testing show that there are no elements that can be said to generally be present in elevated concentrations in the material that will be processed at the plant and stored on the ROM pads and product stockpiles (Prime Resources, June 2021).

The contaminant plume from the ROM pads and processing plant area, as well as the product stockpiles will migrate towards, and into the pit (please refer to Figure 9.3). No contamination is expected to migrate away from the mining area, and no surface water bodies or privately owned boreholes will be impacted. As such, it can be said that placing the ROM pads and product stockpiles

close to the pit boundary, and within the zone of influence of the groundwater level drawdown cone is a mitigatory measure in itself.

Further mitigation aspects that can be implemented include:

- Monitoring groundwater qualities around and down gradient of the pit and surface pollution sources;
- Regular (2 yearly) update of the numerical contaminant migration model over the life of the operations using the monitored groundwater quality, groundwater level and climatic data to increase the model accuracy in predicting the expected contaminant plume migration patterns and the expected impacts on the surrounding environment. This will include identifying boreholes used for private water supply boreholes and surface streams that might be impacted;
- Once boreholes and streams that will be impacted are identified and the impacts quantified using the update numerical contaminant migration model, then further management plans must be put into place where required.

12. Post Closure Management Plan

12.1. Remediation of Physical Activity

Rehabilitation of the opencast pit will commence almost immediately after mining started by placing waste material back into the pit. This rehabilitation will be ongoing for the duration of the life of the operations. Once the mining operations reach and end, the remainder of the pit will be backfilled and the rehabilitation of the pit will be completed during the decommissioning phase, which is currently foreseen to span a 3 year period.

12.2. Remediation of Storage Facilities

Surface storage facilities will be cleared and the footprint areas remediated. This will remove the long-term pollution source associated with the ROM pads, processing plant and product stockpile areas.

12.3. Remediation of Environmental Impacts

The groundwater monitoring program should be continued for a period of at least 5 years after mine closure to monitor the contaminant migration. Based on these results remediation requirements can be identified and a remediation plan put in place.

12.4. Remediation of Water Resources Impacts

The impacts on the water sources include dewatering of the aquifers, as well as contamination of the aquifers.

Dewatering of the aquifers will be remediated after mine closure through natural recharge from rainfall and inflows from the regional aquifers. Currently, it is not foreseen that surface water bodies and/or boreholes that are used for private water supply will be impacted. Therefore, no man-made post-closure strategies are required. Should future assessments show that private boreholes will be impacted in the post closure phase, then it might be necessary to provide water of similar quantity and quality to that user.

Remediation of the impacts on the groundwater qualities will depend on the boreholes and surface water streams being impacted as well as the nature of the impacts and the nature of the sources of the impacts. Currently, it is not foreseen that surface water bodies and/or boreholes that are used for private water supply will be impacted. Therefore, no man-made post-closure strategies are currently recommended. The impacts on groundwater qualities will be naturally attenuated, albeit over very long time periods, through rainfall recharge and mixture with uncontaminated groundwater.

Should future assessments show that private boreholes and/or surface waterbodies will be impacted in the post closure phase by contaminant plume migration, then it might be necessary to provide water of similar quantity and quality to those users.

13. Conclusions and Recommendations

13.1. General Conclusions

- The study area is located directly east to southeast of the town of Hotazel in the Northern Cape Province of South Africa;
- Site specific topographical elevations ranges between 1 063 and 1 070 mamsl. The topography within the proposed mining areas is best described as gently sloping from the east (at 1 071 mamsl) towards the Ga-Mogara River west of the proposed mining area (at 1 063 mamsl). The topographical gradient ranges around 1:280;
- The study area is located within the D41K quaternary catchment, which forms part of the Vaal Major Water Management Area (WMA). The non-perennial Ga-Mogara River drains the region in a south – north direction and lies approximately 4.8 km west of the mine boundary.

13.2. Geology of the study area

- The project can be described as an erosional relict approximately 2 kilometres to the East of the main KMF basin. The manganese ore seams have been preserved in a north-south orientated fault-bounded graben structure. A prominent vertical Bostonite dyke, 50 meters wide, bisect the lease area along an East-northeast to East-southeast line; and
- On Tawana-Hotazel all three the manganese seams are present (LMO, MMO and UMO).

13.3. Baseline Groundwater Conditions

- Aquifer present on site:
    - Three aquifers occur in the region. These three aquifers are associated with a) the primary sandy gravel material, b) the fractured rock and leached banded iron formation aquifer, and c) the dolomitic aquifers of the Griqualand West Sequence;
    - The fractured rock aquifers are not high yielding. The dolomitic karst aquifer is well known for its high potential, but note that no dolomite was recorded in the exploration drilling logs; therefore, the dolomitic aquifers are not expected to occur on site;
    - The upper primary sandy gravel material aquifer forms due to the vertical infiltration of recharging rainfall through the primary sandy gravel material being retarded by the lower permeability of the underlying competent rock. This aquifer is expected to be dry in large portions of the study area for large parts of the year. The aquifer is seasonal and mostly carries water only during and shortly after rainfall events when rainfall recharges into the material. The relatively high transmissivity of the sandy gravel material allows the recharging water to migrate quickly through and out of the material;
    - Groundwater flows in the fractured rock aquifer are associated with the secondary fracturing in the competent rock and, as such, will be along discrete pathways associated with the fractures;
    - Note, that no dolomite was recorded in the exploration drilling logs; therefore, the dolomitic aquifers are not expected to occur on site;

- Aquifer transmissivity:
    - Transmissivity ranges around 0.04 to 0.12 m^2/day. The boreholes which were tested targeted structures identified from the ground geophysical survey. It could be said that the transmissivities of around 0.08 to 0.16 m^2/day calculated for TMBH1 and TMBH3 represents the fractures present in the area and the transmissivity of 0.04 m^2/day the general host geology of the area;
- Depth to groundwater level:
    - The regional depth to groundwater level ranges between 20.3 and 32.00 m with an average of 26.76 m. The depth to groundwater level in the boreholes close to the existing pit tends to be greater than that measured in regional boreholes and can be up to be 52.61 m below surface. This is attributed to the previous mine dewatering and the evaporation from the pit lakes;
    - Regionally, the groundwater flows from the higher lying area to the east of Tawana towards the lower lying Ga-Mogara River west of the mine. Close to the existing pit the groundwater flow patterns are disrupted and are directed towards the pit due to the lower water level in the existing pit;
- Groundwater chemistry:
    - The sample from the church in town (sample NG) and that of monitoring borehole TMBH3 differ notably from the other five samples. None of the elements exceed the SANS241:2015 guideline values in samples NG and TMBH3, while chloride and nitrate exceed the SANS241:2015 guideline value in all five other samples (HP, JB40, York, TMBH1, TMBH2). Sodium and manganese also exceed the guideline values in individual samples;
    - Analysis of the water character shows that in terms of cations, the samples are magnesium dominant. Anion analysis shows that in general the groundwater is chloride dominant, with the exception of sample NG, which is bi-carbonate dominant;
- Aquifer vulnerability: For aquifer vulnerability reference is made to the aquifer vulnerability map of South Africa which shows a low aquifer vulnerability for the project area;
- Aquifer classification: The aquifers present in the area are classified as minor aquifers. The aquifers are of high importance to the local landowners outside of town as it is their only source of water for domestic, gardening, and agricultural purposes. In Hotazel town the landowners have access to municipal water.

13.4. Geochemical characterisation

Geochemical characterisation was done by Prime Resources, as summary is provided here.

13.4.1. Acid-base accounting

- Results from the acid-base-accounting testing that were done show that none of the material on site is likely to be acid forming. In addition, the samples have very low abundances of sulphur (<0.01%). Therefore, the samples have insufficient sulphide present that if oxidised, could sustain long term acid generation.

13.4.2. Metal and sulphide leach testing

- Copper in the low grade ore sample (TH 6) narrowly exceeded the General Standard for Discharge and manganese in the composite fine sample (TH 8) exceeded the General Standard for Discharge and aesthetic SANS241 drinking water guideline. No other concentrations of the analysed metal and metalloid contaminants of concern have been released in concentrations which exceed water quality guidelines;
- The waste rock and ore samples present a low risk in terms of metal leaching potential. The fines material (TH 8) presents a higher risk due to manganese leaching at concentrations exceeding drinking water and discharge standards;

13.5. Environmental Impact Assessment

13.5.1. Construction Phase

13.5.1.1. Impacts on groundwater volumes

- Construction of the surface infrastructure will not impact the groundwater levels which lie between 31 and 53 m depth in the area where the infrastructure will be built;
- Dewatering of the existing opencast pit lake and the water contained in the existing underground mine will cause a lowering of the groundwater levels within the surrounding aquifers. The groundwater levels in the area could be reduced by up to 40 m;
- Due to the low aquifer transmissivity, the low vertical drawdown in water level, and the relatively short time frame of the construction period, the zone of influence of the groundwater level drawdown cone will be relatively small at less than 400 m from the mine boundary; and
- No surface streams or privately owned boreholes will be impacted by the drawdown in groundwater level.

13.5.1.2. Groundwater inflow volumes

- Groundwater inflow volumes during the construction phase into the existing mine workings are expected to be on average 170 m^3/day.

13.5.1.3. Impacts on groundwater qualities

- The surface infrastructure that will be constructed all lie close to the existing underground mine and opencast pit and will fall within the existing groundwater level drawdown cone. Any contamination that enters the underlying aquifers will migrate towards the pit where it will be dewatered and directed into the mine water management system;
- No contamination is expected to migrate significantly off-site during the construction phase and no surface streams or private boreholes are expected to be impacted; and
- It should also be taken into account that the groundwater level in this area lies at 31 to 53 m below surface. The aquifers have a low horizontal and even lower vertical permeability. Therefore, there will a significant lag period before contamination entering the soil and eventually reaching the saturated zone. Using a rule of thumb where the vertical hydraulic conductivity is 10 % of the horizontal hydraulic conductivity, it is calculated that it can take up to 600 days for contamination to reach the saturated zone which is near, or past, the end of the construction phase.

13.5.2. Operational Phase

13.5.2.1. Impacts on groundwater volumes

- There is an existing drawdown in groundwater level around the existing opencast pit and underground mine due to the previous mine dewatering and ongoing evaporation of water from the pit lake in the opencast pit;
- During excavation of the proposed mine pit the existing groundwater level drawdown cone will develop further to become deeper and larger. The groundwater level can be drawn down by 68 m from the current water levels in the aquifer. In the south, where the pit will be the deepest, the groundwater level drawdown cone can extend 1.7 to 1.9 km from the pit boundary, while in the north the zone if influence is expected to reach 1.1 km from the pit boundary;
- Boreholes BH1, JB38, JB39, JB41 are expected to fall within the zone of influence of the groundwater level drawdown cone. The boreholes are all monitoring boreholes operated by South32. None of the impacted boreholes are used for private domestic or agricultural purposes; and
- No surface water streams fall within the zone of influence.

13.5.2.2. Groundwater inflow volumes

- During the construction phase, and the associated initial dewatering of the water in the existing pit and underground, water currently in storage in the aquifer will enter the excavation. Then, as the groundwater in storage is depleted inflows will be controlled by

regional migration of groundwater towards the pit and the aquifer transmissivities. The average groundwater inflows will reduce to 155 m^3/day for the period 2025 to 2035 after which it will increase again as the pit increase in depth (and depth below the regional groundwater levels). During the period 2035 to 2045 the average daily inflow volumes will be in the order of 180 m^3/day. For the period 2045 to the end of life of mine the average inflows are expected to be in the order of 245 m^3/day;

- It has to be stated that these inflows are considered to be high compared to what will enter the mine in reality during the life of mine. Also, with the high evaporation of 2 026 mm/a in the study area can be expected that a large percentage of the water entering the pit from the surrounding aquifers will evaporate before it has to be pumped to surface.

13.5.2.3. Impacts on groundwater qualities

- Fuel will be stored in sealed containers in the refuel area and that the area will be paved. The vehicle yard and workshop will be paved, with appropriate oil traps and other infrastructure in place. Based on this, it is assumed that there will be limited hydrocarbon contamination from these areas;
- The water will collect in the pit sump from where it will be pumped to surface and be incorporated into the mine water management system. Due to ongoing dewatering of the pit, no driving head will form that cause contamination to migrate away from the pit. Based on this, it is expected that the pit will not be a notable source of pollution during the operational phase;
- The PCD will be lined; therefore, it is assumed that there will be no contamination entering the underlying aquifers from the PCD;
- Results from the geochemical assessment show that none of the material that will be mined, processed and stored on site, is likely to be acid forming. In addition, leach testing show that there are no elements that can be said to generally be present in elevated concentrations in the material that will be processed at the plant and stored on the ROM pads and the product stockpiles; and
- Results from the contaminant migration modelling show that the contaminant plume from the ROM pads and processing plant area, as well as the product stockpiles, will migrate towards and into the pit. No contamination is expected to migrate away from the mining area, and no surface water bodies or privately owned boreholes will be impacted.

13.5.3. Decommissioning phase

13.5.3.1. Impacts on groundwater volumes

- During the decommissioning phase the mining activities, and any dewatering of the pit that takes place, will be stopped. This will allow the groundwater level in the pit area to recover. The recovery rate is expected to be slow and it is not expected that a significant pit lake will form by the end of the 3 year decommissioning phase.

13.5.3.2. Impacts on groundwater qualities

- During the decommissioning phase the ROM pads and the product stockpiles will be removed and the footprint areas rehabilitated. The waste rock and topsoil will be used to finalise backfilling and rehabilitation of the pit; and
- Contamination that already entered the aquifers underlying the ROM pads and the product stockpile areas during the operational phase will continue to migrate towards the pit. No additional contamination will enter the underlying aquifers in future.

13.5.4. Long term post-operational phase

13.5.4.1. Recovery of groundwater levels and decant potential

- By between 40 and 50 years post closure the water level in the rehabilitated pit is expected to reach 1 040 mamsl, which is the elevation of the natural regional groundwater levels in that area. The natural groundwater levels range between 20.3 and 32.00 m with an average of 26.76 m;
- The water level in the rehabilitated pit will then continue to slowly rise above the regional groundwater levels due to the higher recharge from rainfall into the rehabilitated pit than into the surrounding, undisturbed, aquifers. Once the water level in the rehabilitated pit rises above the regional groundwater level water will start to flow from the pit towards the surrounding area; and
- It is expected that by 100 years post closure the groundwater level in the rehabilitated pit will have risen to around 10 m above the regional groundwater levels. It will not have reached decant elevation and no decant is expected by 100 years post closure.

13.5.4.2. Impacts on groundwater qualities

- During the initial years post closure the contamination that already entered the aquifers from the ROM pads and the processing plant footprint, as well as the product stockpile footprint during the operational phase will continue to migrate towards the pit where the water levels are expected to rise, but remain beneath the regional groundwater levels up to 40 to 50 years post closure. Once the water level in the rehabilitated pit has reached the regional groundwater levels, and start to rise above it due to continuing recharge from rainfall, contaminants can start to migrate away from the opencast pit area;
- At 50 years post closure the contamination will mostly be contained within the pit area. Over time the plume will start to migrate radially away from the pit area. The radial spread of the plume is due to the fact that the region has a flat topography and the water level within the rehabilitated pit will rise above the surrounding topographical elevations;
- By 100 years post closure it is expected that the plume will not have spread more than 200 m from the pit boundary; and
- No surface water bodies or privately owned boreholes fall within the expected zone of influence of the plume.

13.6. Recommendations

13.6.1. Groundwater monitoring network

Please refer to Section 10 of this report.

13.6.2. Mitigation measures

Please refer to Section 11.3 of this report for recommendations on mitigating the impacts on groundwater levels and qualities.

13.6.3. Update of the geochemical assessment

The material sampled for the geochemical assessment has been exposed on surface since the previous mining activities stopped in 1989. It is possible that oxidation and leaching of elements by rainfall has impacted the test results. It is recommended that the geochemical assessment be updated once the mine is operational and fresh material is available.

13.6.4. Update of the numerical groundwater flow and contaminant transport models

It is recommended that the numerical groundwater flow and contaminant transport models be updated on a 2-yearly basis based on time series groundwater level and quality data as obtained from the groundwater monitoring program as well as climatic aspects such as rainfall and evaporation. Re-calibrating the models based on time series data will increase the confidence level of the predictions. Any changes in the mine design, progression plan and surface layouts can also be included and the impact simulations updated.

13.7. Reasoned Professional Opinion

It is recommended that the project be authorized. This recommendation is based on:

- The impact assessment shows that it not expected that there will be a significant impact on the groundwater levels in the area. No privately-owned boreholes around the proposed mine development area will be impacted by the groundwater level drawdown in the fractured rock aquifer;
- It is not expected that there will be a notable impact on the groundwater qualities within the proposed development area.

13.8. Conditions for Authorisation

There are no other conditions for authorisation, except commitment to optimal management and monitoring of the expected impacts as described in Sections 10 to 12 of this report.

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APPENDIX A:

GROUNDWATER CHEMICAL ANALYSIS CERTIFICATE

Element Materials Technology
Unit D2 & D5
9 Quantum Road
Firgrove Business Park
Somerset West
7130
South Africa

W: www.element.com

Rison Groundwater Consultants
11 Donegal Road
Kenmare
Krugersdorp
Gauteng
South Africa
1739

Attention :	Martiens Prinsloo
Date :	30th November, 2020
Your reference :	Tawana Investment Holdings
Our reference :	Test Report 20/966 Batch 1
Location :	Hotazel Northern Cape
Date samples received :	17th November, 2020
Status :	Final report
Issue :	2

Four samples were received for analysis on 17th November, 2020 of which four were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.
Reason for re-issue: Additional analysis included.

Analysis was undertaken at either Element Materials Technology UK, which is ISO 17025 accredited under UKAS (4225) or Element Materials Technology (SA) which is ISO 17025 accredited under SANAS (T0729) or a subcontract laboratory where specified.

NOTE: Under International Laboratory Accreditation Cooperation (ILAC), ISO 17025 (UKAS) accreditation is recognised as equivalent to SANAS (South Africa) accreditation.

Authorised By:

Debbie van Wyk

Inorganics Laboratory:

Greg Ondrejkovic
Technical Supervisor

Element Materials Technology South Africa (Pty) Limited
Registered Office: Unit D2/D5, 9 Quantum Road, Firgrove Business Park,
Somerset West, Western Cape, 7130, South Africa
Company Registration No: 2015/025446/07

Element Materials Technology

Client Name: Rison Groundwater Consultants
Reference: Tawana Investment Holdings
Location: Hotazel Northern Cape
Contact: Martiens Prinsloo
EMT Job No: 20/966

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=HNO_3

EMT Sample No.	1-3	4-5	6-7	8-9							LOD/LOR	Units	Method No.
Sample ID	HP	NG	JB 40	YORK									
Depth													
COC No / misc													
Containers	HN P	HN P	HN P	HN P									
Sample Date	12/11/2020	12/11/2020	12/11/2020	12/11/2020									
Sample Type	Ground Water	Ground Water	Ground Water	Ground Water									
Batch Number	1	1	1	1									
Date of Receipt	17/11/2020	17/11/2020	17/11/2020	17/11/2020									
Dissolved Aluminium*	<20	<20	<20	<20							<20	ug/l	
Dissolved Arsenic*	<2.5	<2.5	7.8	<2.5							<2.5	ug/l	
Dissolved Cadmium*	<0.5	<0.5	<0.5	<0.5							<0.5	ug/l	
Dissolved Calcium [SA]	384.6$_{AA}$	76.3	277.8$_{AA}$	311.6$_{AB}$							<0.3	mg/l	
Total Dissolved Chromium*	2.0	<1.5	1.8	<1.5							<1.5	ug/l	
Dissolved Cobalt*	<2	<2	<2	<2							<2	ug/l	
Dissolved Copper*	<7	<7	<7	<7							<7	ug/l	
Total Dissolved Iron*	80	51	389	34							<20	ug/l	
Dissolved Magnesium [SA]	266.5$_{AA}$	50.8	180.9$_{AA}$	288.5$_{AB}$							<0.2	mg/l	
Dissolved Potassium [SA]	5.4	2.2	3.9	4.4							<0.1	mg/l	
Dissolved Sodium [SA]	239.3$_{AA}$	20.7	182.5	150.5							<0.1	mg/l	
Dissolved Lead*	<5	<5	37	<5							<5	ug/l	
Dissolved Manganese*	7	3	408	<2							<2	ug/l	
Dissolved Nickel*	<2	<2	3	<2							<2	ug/l	
Dissolved Selenium*	<3	<3	<3	11							<3	ug/l	
Dissolved Vanadium*	8.2	5.1	<1.5	7.8							<1.5	ug/l	
Dissolved Zinc*	7	183	26	44							<3	ug/l	
Total Hardness Dissolved (as CaCO3)	2080.8$_{AA}$	404.1	1454.3$_{AA}$	1992.0$_{AB}$							<1.6	mg/l	
Fluoride [SA]	<0.3	0.3	0.5	<0.3							<0.3	mg/l	
Bromide	6.95	0.12	7.26	6.31							<0.05	mg/l	
Chloride [SA]	774.9$_{AA}$	24.0	748.3$_{AA}$	665.8$_{AB}$							<0.3	mg/l	
Nitrite as NO2 [SA]	1.20$_{AA}$	<0.02	0.23	<0.02							<0.02	mg/l	
Nitrate as NO3 [SA]	992.8$_{AA}$	18.5	529.5$_{AA}$	989.9$_{AB}$							<0.2	mg/l	
Sulphate [SA]	199.0$_{AA}$	23.6	117.0	35.7							<0.5	mg/l	
Ortho Phosphate as PO4	0.12	0.15	0.24	0.20							<0.03	mg/l	
Ammoniacal Nitrogen as NH4 [SA]	<0.03	<0.03	1.65	<0.03							<0.03	mg/l	
Total Alkalinity as CaCO3 [SA]	150	316	30	288							<3	mg/l	
Electrical Conductivity @25C [SA]	4560	735	3650	3940							<2	uS/cm	
Free Chlorine	0.02	0.04	0.02	0.02							<0.02	mg/l	
pH [SA]	7.84	8.13	7.41	7.58							<2.00	pH units	
Total Dissolved Solids [SA]	4144	458	3036	3230							<35	mg/l	

Please see attached notes for all abbreviations and acronyms

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0585

Test Report

Page 1 of 1

Client: Future Flow Cc
Address: 8 Victoria Link, Route 21 Corporate Park, Irene, 0062
Report no: 114640
Project: Future Flow

Date of report: 11 November 2021
Date accepted: 03 November 2021
Date completed: 11 November 2021
Date received: 03 November 2021

Lab no:				63584	63585	63586
Date sampled:				29-Oct-21	29-Oct-21	29-Oct-21
Aquatico sampled:				No	No	No
Sample type:				Water	Water	Water
Locality description:				TMBH1	TMBH2	TMBH3
Analyses		Unit	Method			
A	pH @ 25°C	pH	ALM 20	7.52	7.30	8.53
A	Electrical conductivity (EC) @ 25°C	mS/m	ALM 20	427	367	86.6
A	Total dissolved solids (TDS)	mg/l	ALM 26	2858	2591	488
A	Total alkalinity	mg CaCO3/l	ALM 01	130	200	46.9
A	Chloride (Cl)	mg/l	ALM 02	728	515	136
A	Sulphate (SO4)	mg/l	ALM 03	103	121	88.1
A	Nitrate (NO_3) as N	mg/l	ALM 06	260	235	14.1
A	Ammonium (NH_4) as N	mg/l	ALM 05	<0.008	<0.008	<0.008
A	Orthophosphate (PO4) as P	mg/l	ALM 04	<0.005	<0.005	<0.005
A	Fluoride (F)	mg/l	ALM 08	<0.263	<0.263	<0.263
A	Calcium (Ca)	mg/l	ALM 30	367	427	36.7
A	Magnesium (Mg)	mg/l	ALM 30	189	153	11.0
A	Sodium (Na)	mg/l	ALM 30	179	133	122
A	Potassium (K)	mg/l	ALM 30	9.54	7.07	2.26
A	Aluminium (Al)	mg/l	ALM 31	<0.002	<0.002	0.098
A	Iron (Fe)	mg/l	ALM 31	<0.004	<0.004	<0.004
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.168	<0.001
A	Chromium (Cr)	mg/l	ALM 31	<0.003	<0.003	<0.003
A	Copper (Cu)	mg/l	ALM 31	0.046	0.043	0.015
A	Nickel (Ni)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Zinc (Zn)	mg/l	ALM 31	<0.002	0.020	<0.002
A	Cobalt (Co)	mg/l	ALM 31	<0.003	<0.003	<0.003
A	Cadmium (Cd)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
A	Total hardness	mg CaCO3/l	ALM 26	1693	1695	137
A	Bicarbonate alkalinity	mg CaCO3/l	ALM 26	129	200	45.3
A	Total oxidised nitrogen as N	mg/l	ALM 06	260	235	14.1

A = Accredited N = Non accredited Out = Outsourced Sub = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternativ test report ; Results only apply to the samples as received and tested; Results reported against the limit of detection; Results marked 'Non SANAS Accredited' in thi report are not included in the SANAS Schedule of Accreditation for this laboratory; Uncertainty of measurement available on request for all methods included in the SANAS Schedule of Accreditation; The report shall not be reproduced except in full without approval of the laboratory

M. Swanepoel
Technical Signatory

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APPENDIX B:

CURRICULUM VITAE

Curriculum Vitae MJ Prinsloo

PERSONAL DETAILS

NAME:	Martiens Prinsloo
DATE OF BIRTH:	14 January 1976
NATIONALITY:	South African
MARITAL STATUS:	Married

ACADEMIC QUALIFICATIONS

Year	Qualification & Institution
2008	MBA: Graduate School of Business, University of Cape Town
2005	M.Sc. (Geohydrology): University of the Free State (Bloemfontein)
1997	B.Sc. (Hons) (Geohydrology): University of the Free State (Bloemfontein)
1996	B.Sc. (Earth Sciences): University of Pretoria

PROFESSIONAL REGISTRATION AND AFFILIATIONS

Registered Professional Natural Scientist S.A. (SACNASP Reg. No. 400248/04)
Groundwater Division of the Geological Society of South Africa (Membership no. 234)
International Association of Hydrogeologists (IAH membership no. 122757)
International Mine Water Association (IMWA membership no. 1121)

OTHER COURSES

Course	Institution
PHREEQC (2019)	Short course presented by Kirk Nordstrom
FeFlow (2009)	DHI WASY (Johannesburg)
Geochemical and reactive transport modelling – PHREEQC, MT3DMS and PHT3D (2006)	University of the Western Cape (Cape Town)
Model sensitivity analysis, data assessment, calibration and uncertainty evaluation (2006)	USGS (Cape Town)
Contaminant Site Risk Assessment and Groundwater Modelling (2004)	Waterloo Hydrogeologic Inc. (Johannesburg)
Groundwater Modelling Course (2002)	Summer University of Bremen (Germany)

EMPLOYMENT HISTORY

Date	Company & Position
July 2008 - Present	Future Flow Groundwater & Project Management Solutions cc Founding Member and owner
January 2019 - Present	Rison Groundwater Consulting Owner – bought out company on emigration of previous owner
January 2014 – September 2017	AquaStrata Laboratories (Pty) Ltd (ISO17025 / SANAS accredited testing laboratory) Founding Member and owner
Feb 2007 – June 2008	GCS (Pty) Ltd Manager: Water Resources Unit
Jan 2006 – Jan 2007	GCS (Pty) Ltd Manager: Mining & Modelling Sub-Unit (part of Water Resources Unit)
Apr 2002 – Dec 2005	GCS (Pty) Ltd Hydrogeological modeller / Senior hydrogeologist
Sept 2000 – Mar 2002	GCS (Pty) Ltd Field hydrogeologist
Feb 1998 – Aug 2000	Council for Geoscience Scientific Officer - Hydrogeology

Curriculum Vitae MJ Prinsloo

SCIENTIFIC EXPERIENCE

Mining related hydrogeology:

- Hydrogeological investigations for various types of mines including: coal, gold, platinum, nickel, copper, cobalt, uranium, heavy mineral sands, diamond, zinc, iron ore, magnetite, vanadium, and others. Work experience range from field data collection to data analysis, chemical characterisation, acid base accounting and waste classification, numerical flow and contaminant transport modelling, water balance calculations and compilation of reports;
- Groundwater monitoring and audit reports. The evaluation of groundwater level fluctuation and water quality data. The compilation of monthly, quarterly and annual monitoring reports;
- Groundwater monitoring well field designs. The siting and design of monitoring boreholes for the assessment of the influence of mining activities on the regional groundwater environment;
- Groundwater investigations and numerical modelling of both fractured rock and primary aquifers;
- Hydrogeological assessments for both opencast and underground mines;
- Water supply for mining activities;
- Mine dewatering assessments and dewatering program designs; and
- Tailings and waste storage facility site selection and impact assessments.

Groundwater resource assessment and development:

- Water supply studies and well field design ranging from rural water supply (hand pump) to large scale water supply for construction and irrigation projects (4 000 m^3/hr);
- Assessment of geological controls, geophysical exploration methods and the quantification of groundwater exploitation potential in complex and problematic terrain;
- Hydrogeological mapping investigations and catchment resource analysis; and
- Regional hydrogeological and chemical investigations involving reconnaissance investigations, geophysical surveys, drilling and test pumping for the planning and development and utilisation of groundwater resources in Southern Africa.

Waste disposal management:

- Environmental Impact Assessments for the manufacturing and petroleum industries. Experience includes field data collection, hydrogeological and chemical data analysis and report compilation;
- Environmental Impact Assessments and site suitability assessments for waste disposal sites (including HH classified sites); and
- Characterisation and numerical modelling of contaminant plume migration.

Energy:

- Conventional coal powered power stations, including underground coal gasification: Site selection and risk assessment, environmental impact assessments, geochemical characterisation of fly ash disposal facilities, and impact mitigation;
- CSP and PV renewable energy: Site selection and risk assessment and environmental impact assessments;
- Bio-mass-to-energy (various energy sources from plant matter to biological waste products): Site selection and risk assessment and environmental impact assessments;
- Hydropower: Impact and risk assessment.

PROJECT COUNTRIES

Australia, Azerbaijan, Botswana, Bulgaria, Burkina Faso, Democratic Republic of the Congo (DRC), Guinea, Ivory Coast, Lesotho, Liberia, Madagascar, Mali, Mozambique, Namibia, Senegal, South Africa, Tanzania, Turkey, Zambia, and Zimbabwe.

LANGUAGE PROFICIENCY

English and Afrikaans – Speak, read, write.

TEACHING

- Part time lecturing at the University of Johannesburg (2001 – 2005): Civil Engineering Course – Hydrogeology.
- Ad hock lecturing at the University of the Witwatersrand (2007 – 2008): Postgraduate / Industrial Masters Course: Coal mining extraction and exploitation – Groundwater contaminant transport modelling;
- Annual course lecturing at the University of Pretoria (2009, 2011 – 2020): Postgraduate course: Groundwater Numerical Modelling.

PAPERS AND PUBLICATIONS

- Prinsloo, M.J. (2004). "Characterisation of the dolomitic aquifer in the Copperbelt Province, Northern Zambia". Waternet / WARFSA Symposium, Windhoek, Namibia.
- Prinsloo, M.J. (2006). "Prediction of mine inflow volumes". Mine Water Conference, Johannesburg, South Africa.
- Prinsloo, M.J. (2006). "Prediction of the impact that coal mines have on the environment". Waterberg Coalfield Conference, Lephalale, South Africa.
- Prinsloo, M.J. (2006). "Ruashi Phase II hydrogeological investigation". Mining Review Africa, Issue 2, 2006.
- Wilke, A.R. & Prinsloo, M.J. (2009). "Overview of Malian Geohydrology with focus on Mining Projects and their influence on the environment". GSSA GWD: Groundwater Conference, Somerset West, South Africa.
- Prinsloo, M.J. (2011). "Using groundwater modelling to facilitate your mining operations". Strategic Water Drainage Summit 2011 – Optimising Water Usage and Minimising Impact on Water Quality in Mining Operations. Johannesburg, South Africa.

CONTACT DETAILS

- Mobile phone: +27 83 633 4949
- E-mail: martiens@ffgpm.co.za

Curriculum Vitae MJ Prinsloo

SELECTED RECENT PROJECTS

Project	Description
Filizchay Gold Mine – Azerbaijan Republic (2020)	IFC Performance Standard Gap Analysis.
Wesizwe, Bakubung Platinum Mine – South Africa (2020)	Baseline characterisation and impact assessment.
Kiniero Gold Mine – Guinea (on-going project)	BFS level study. Baseline characterisation and impact assessment.
Akanani Platinum Project – South Africa (2020)	BFS level study. Baseline characterisation and impact assessment.
Ispir Copper-Zinc Mine – Turkey (2020)	Feasibility level study. Baseline characterisation and impact assessment.
Kobada Gold Mine – Mali (2020)	BFS level study. Baseline characterisation and impact assessment.
Breznik Gold Mine – Bulgaria (2020)	BFS level IFC standards gap analysis.
Zandvoort Colliery – South Africa (2020)	Groundwater impact assessment and resource assessment.
Longonjo Rare Earth Project – Angola (project currently on hold)	BFS level study. Baseline characterisation and impact assessment.
Buffelsdoorn Gold Mine – South Africa (on-going project)	BFS level study. Baseline characterisation and impact assessment.
Zelphy Gold Mine – South Africa (2020)	BFS level study. Baseline characterisation and impact assessment.
Dorstfontein Colliery (2020)	Geochemical waste assessment.
National Ceramics Betta Operations (2020)	Industrial water supply
Makoshong & Tweelaagte Villages (2020)	Community water supply.
Rietberg Copper Mine (2019)	Geochemical waste assessment
Northam Platinum Booysendal Mine (2020)	Groundwater assessment update (contaminant source assessment, numerical model update).
Tizert Copper Mine – Morocco (2019)	IFC Standards Gap Analysis.

Page **4** of **4**

APPENDIX 14
TERRESTRIAL BIODIVERSITY IMPACT ASSESSMENT

TERRESTRIAL BIODIVERSITY IMPACT ASSESSMENT REPORT

FOR THE PROPOSED TAWANA HOTAZEL MINE, NORTHERN CAPE PROVINCE

Prepared for:

prime resources (pty) ltd

The Workshop 70-7th Avenue Parktown North 2193
PO Box 2316 Parklands 2121
Tel No: +27 11 447 4888
Fax: +27 86 604 2219
Email: prime@resources.co.za

Prepared by:

Field and Form Landscape Science in collaboration with Malachite Ecological Services
Tel No: +27 82 442 7637 or +27 83 781 8725
Email: michelle@fieldandform.co.za or craig@malachitesa.co.za

November 2021

Declaration of Independence by Specialists

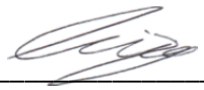
We, **Michelle Pretorius** and **Craig Widdows**, in our capacity as specialist ecological consultants, hereby declare that we -

- Act as independent consultants;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Have and will not have vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that has 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 National Environmental Management Act, 1998 (Act 107 of 1998);
- Will provide the competent authority with access to all information at our disposal regarding the application, whether such information is favourable to the applicant or not;
- Based on information provided to us by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of our professional ability; and
- Undertake to have our work peer reviewed on a regular basis by a competent specialist in the field of study for which we are registered.

_____

Michelle Pretorius
Vegetation Specialist
SACNASP Reg. No. 400003/15

___29 November 2021_____
Date



_____

Dr. Craig Widdows
Faunal Specialist
SACNASP Reg. No. 117852

___29 November 2021_____
Date

EXECUTIVE SUMMARY

Field and Form Landscape Science, in collaboration with Malachite Ecological Services, were appointed by Prime Resources (Pty) Ltd to conduct a baseline (*status quo*) terrestrial biodiversity assessment as part of the environmental authorisation, Water Use Licence Application (WULA) and other requisite permitting processes as part of the overall Mining Right (MR) Application by Tawana Hotazel Mining (Pty) Ltd for the proposed Tawana Hotazel Mine (THM). The project area is located on Portion 1 of the Farm York A 279 and Portion 0 (RE) of the Farm Hotazel 280, within the 2722BB Quarter Degree Square (QDS), approximately 1km southeast of the town of Hotazel in the John Taolo Gaetsewe District Municipality, Northern Cape Province.

The proposed THM largely incorporates the historical Hotazel Manganese Mine (HMM), which stopped production in 1989, and the MR area includes the existing residual opencast void and surface dumps of low-grade material but excludes the mothballed processing plant and rail loadout facility. The area was historically mined by both opencast and underground means and yielded high grade manganese ore. All current plans for the proposed THM project specifically exclude underground mining.

The overall area applied for is approximately 154 hectares (ha) in extent, inclusive of the MR application area and access road towards the northeast. Surface infrastructure will include the opencast pit (incorporating the historical HMM void and further expansion of the opencast footprint), in-pit waste dumps (residue material), surface residue handling/ storage, a vehicle yard, workshop, access and haul roads, offices, stores, a processing plant for the crushing and screening of mined ore, a product stockpile area, run of mine pad, refuel bay and water management infrastructure.

There are two main access roads to the mine, with one road intersecting with Provincial Road D3463 from Kuruman to Severn and entering the mine at the northern easter corner, while the other road is from the town of Hotazel in the west and entering the mine from the north. The main transport route to the northeast will be for Heavy Vehicles (HVs), potentially 80 – 100 trucks per day, and the main entrance to the west (near Hotazel) will be for Light Delivery Vehicles (LDVs).

Two (2) years have been allowed for pre-stripping and mining infrastructure construction and the Life of Mine (LoM) indicated by the conversion of the resource to reserve is 30 years for the open pit operation. Backfilling/ rehabilitation will commence immediately after the commencement of the mining operation and its advance will match the depletion rate of the open pit. A period of three (3) years is expected for final rehabilitation after closure.

Terms of Reference

The terms of reference for the terrestrial biodiversity impact assessment are defined as follows:

- To provide an overview of applicable environmental legislation as well as national and regional planning frameworks to be considered in planning the project;
- To provide a broad description of the biophysical characteristics of the project area and its surroundings as applicable to the terrestrial biodiversity impact assessment;
- To undertake a review of available background information and published literature to broadly describe the baseline environment at a desktop level;
- To categorise and describe the vegetation and habitat present within the project area according to relatively homogeneous habitat units and to provide an overview of vegetation structure, floral species composition (including alien species), predicted faunal associations and the species diversity of each habitat unit;
- To identify floral and faunal Species of Conservation Concern (SCC), National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEMBA) Threatened or Protected Species (TOPS; 2015), nationally or provincially protected species as well as endemic/ near-endemic species that could potentially occur in the project area and surrounds;

- To provide an indication of the conservation importance and ecological sensitivity of each habitat unit identified within the project area and to identify No Go areas where applicable; and
- To assess the potential impacts that may occur as a result of the proposed project and to provide site specific mitigation measures and ongoing management measures that will be required to reduce such impacts should the project be approved.

It is important to note that the faunal component of the study was undertaken as a desktop assessment only.

Desktop Assessment

The results of the desktop assessment in terms of the environmental setting and related conservation characteristics of the project area are summarised in the table below.

Aspect	Conservation Characteristic
Biome	Savanna Biome
Bioregion	Eastern Kalahari Bushveld Bioregion
Quarter Degree Square (QDS)	2722BB
Listed Threatened Ecosystems (2011)	-
Protected and Conservation Areas (PACA; 2021) and National Protected Area Expansion Strategy (NPEAS) Focus Areas (2011)	-
Regions of Floristic Endemism	Griqualand West Centre of Endemism (GWC)
National Biodiversity Assessment (NBA): Terrestrial Remnant Vegetation (2018)	Limited portions along the existing haul roads and access roads are located within remaining extent of Kathu Bushveld [Threat Status: Least Concern (LC); Protection Status: Poorly Protected].
Vegetation Type (2006, 2012; NBA 2018)	Kathu Bushveld (Conservation Status: LC)
Important Bird and Biodiversity Areas (IBA; 2015)	-
Strategic Water Source Areas (SWSA; 2017)	-
Northern Cape Conservation Plan (C-Plan; 2016)	Other Natural Areas (ONAs) indicated along existing haul roads within the opencast void and along the access road in the northeast.

The outcome of the Department of Forestry, Fisheries and Environment (DFFE) National Screening Tool is summarised below.

Environmental Theme	Sensitivity
Terrestrial Biodiversity	Low
Plant Species	Low
Animal Species	Low

No unique floral or faunal species or SCC were identified by the Screening Tool.

Field Assessment

A detailed field assessment of the project area was undertaken over a period of two full days from 23 - 24 November 2020 to determine the ecological condition of the project area and its surrounds. During the field assessment four broad habitat units were identified within the project area. Habitat units were based primarily on floral species composition and vegetation structure, faunal species' habitat provision, the topographical position of the habitat unit in the landscape, as well as the degree of historical and current anthropogenic impact and disturbance within the unit. These habitat units are:

- Existing Infrastructure and Alien Vegetation Communities, which comprise the majority of the project area, specifically occurring within the residual opencast void within the centre of the MR area. This habitat unit is characterised by the absence of vegetation and where vegetation is present, these communities are dominated by alien species;

- The In-Pit Aquatic habitat unit that is associated with the surface water present in the historical opencast workings. Vegetation within this habitat unit is dominated by hydrophytic vegetation, most notably dense stands of *Phragmites australis*;
- The Modified Kathu Bushveld habitat unit, which includes areas that have not previously been cleared for mining and associated activities but mostly occurs in the vicinity of historical disturbance where, although dominated by indigenous species, alteration to the vegetation structure and composition has taken place; and
- The Secondary Thornveld habitat unit that is restricted to historical surface dumps and comprises mostly indigenous vegetation that have re-established on these areas over time. Vegetation in these areas is however dominated by the encroacher species *Senegalia mellifera* subsp. *detinens*, an indigenous pioneer thorn tree/ large shrub species that rapidly establishes on shallow soils and within previously disturbed areas provided that growing medium is available.

The terrestrial ecological sensitivity of each habitat unit was determined and these findings, the expected development implications of the proposed project on each unit as well as key mitigations measures to be considered when developing within each habitat unit, are summarised below.

Habitat Unit	Terrestrial Ecological Sensitivity	Development Implications
Existing Infrastructure and Alien Vegetation Communities	Low	**Habitat** These areas have been significantly impacted by historical mining activities and development within this habitat unit will not lead to the significant loss of natural habitat. The proposed project however has the potential to impact directly on nesting Verreaux's eagles (*Aquila verreauxii*) and their food resources, which include Rock Hyrax (*Procavia capensis*) that utilises this habitat unit in its current degraded state. More information on avifaunal species, and the persistence of *A. verreauxii* within the project area, will form part of the avifaunal assessment undertaken by Feathers Environmental. **SCC, Protected and TOPS-listed species** • No floral SCC, protected or TOPS-listed species were recorded within this habitat unit, and such species have a low probability of occurrence due to past disturbances within this habitat unit. • No nationally protected or TOPS-listed faunal were recorded or are likely to permanently inhabit this habitat unit. One faunal SCC namely Verreaux's eagle (*Aquila verreauxii*) utilises this habitat unit for nesting, breeding and foraging purposes. **Key Mitigation Measures** • Strict management of edge effects, such as erosion and alien vegetation management must take place to prevent impacts on adjacent natural habitat. • All mitigation measures pertaining to the management of potential *A. verreauxii* have to be implemented.
In-Pit Aquatic habitat unit	Medium-Low	**Habitat** Development within this habitat unit will lead to the loss of aquatic habitat that has established within the opencast void over time. Although not considered natural, this habitat unit does provide certain biodiversity and habitat value when considering the semi-arid surrounds and loss thereof is likely to locally reduce faunal diversity specific to this habitat type. **SCC, Protected and TOPS-listed species** • No floral or faunal SCC, protected or TOPS-listed species were recorded within this habitat unit, and such species

Habitat Unit	Terrestrial Ecological Sensitivity	Development Implications
		have a low probability of occurring/ residing within this habitat unit. **Key Mitigation Measures** • Strict management of edge effects, such as erosion and alien vegetation management must take place.
Modified Kathu Bushveld habitat unit	Medium	**Habitat** Development within this habitat unit will lead to the direct loss of reasonably intact bushveld habitat with increased floral and faunal biodiversity, particularly in comparison with the adjacent and surrounding mine-impacted areas. **SCC, Protected and TOPS-listed species** • No floral SCC species were recorded or are likely to occur. One TOPS-listed floral species, namely *Harpagophytum procumbens* was however recorded. • Two nationally protected tree species in terms of the National Forests Act (Act No. 84 of 1998) occur, namely *Vachellia erioloba* in relatively low abundance and *V. haematoxylon* in high abundance. • One provincially protected floral species in terms of Schedule 1 of the Northern Cape Nature Conservation Act (Act No. 9 of 2009), namely *H. procumbens* were recorded, as well as several floral species listed under Schedule 2 of this Act, namely *Plinthus sericeus, Ammocharis coranica, Boophone disticha*, *Crinum* sp., *Orthanthera jasminiflora, Albuca seineri* (=*Ornithoogalum seineri*), *Albuca setosa* (=*Ornithogalum setosum*). The latter species are widespread and occur throughout this habitat unit. • No faunal SCC are likely to occur based on the desktop investigation. Signs of TOPS-listed Aardvark (*Orycteropus afer*) were however noted by the vegetation specialist during the field assessment in the vicinity of the access road. Other faunal TOPS-listed species that may occur are Bat-eared Fox (*Otocyon megalotis*) and Cape Fox (*Vulpes chama*). • The arachnid species *Harpactira* spp. and *Pterinochilus* spp. are provincially protected under Schedule 1 of Northern Cape Nature Conservation Act (NCNCA; Act No. 9 of 2009) and may occur within this habitat unit. **Key Mitigation Measures** • The development footprint must be kept as small as possible within this habitat unit and consideration should be given to conserve existing indigenous trees and associated habitat where possible. • Edge effects from construction and operational activities, such as erosion and alien floral species proliferation should be managed throughout the LoM through the implementation of erosion control measures where required and the implementation of an Alien and Invasive Species Management Programme. • Special attention must be paid to the control of NEMBA Category 1b alien invasive species, as well as *Prosopis glandulosa* var. *torreyana,* specifically also along the MR area boundaries to prevent the spread of such species into adjacent properties and surrounding natural habitat.

Habitat Unit	Terrestrial Ecological Sensitivity	Development Implications
		• No harvesting of firewood or collection of floral species should be allowed. • Where possible, the direct loss of protected and TOPS-listed floral species should be avoided, with specific mention of protected and TOPS-listed plants falling outside of the immediate mine development footprint area. • The establishment of a site nursery where smaller plants with relocation potential, including provincially protected forb species can be kept and propagated should be considered for use in rehabilitation works. • The number of protected and TOPS-listed plants per species should be determined prior to site clearance taking place by means of a site walkthrough of the final proposed development footprint areas. • Where any protected or TOPS-listed species are to be rescued and relocated, this process should be overseen by a suitably qualified botanist or horticulturalist • Permits for the destruction or relocation of nationally and provincially protected tree, shrub and forbs species must be applied for and obtained from the relevant authorities. The conditions contained in the relevant permits, if granted, should be strictly implemented by the mine. • Hunting/ killing of fauna is prohibited. • Any snares or traps found on or adjacent to the project area must be removed and disposed of. • Should any faunal SCC be noted within the project area, the relevant authorities must be notified. Input into the possible relocation of such species must be provided by a suitably qualified ecologist. (Note that avifaunal SCC is discussed in the avifaunal specialist report by Feathers Environmental.)
Secondary Thornveld habitat unit	Medium-Low	**Habitat** This habitat unit is dominated by the encroacher species *Senegalia mellifera* subsp. *detinens*, and development within this habitat unit will not lead to the significant loss of natural habitat. **SCC, Protected and TOPS-listed species** • No floral or faunal SCC, protected or TOPS-listed species were recorded within this habitat unit, and such species have a low probability of occurrence due to past disturbances within this habitat unit. **Key Mitigation Measures** • Bush encroacher species such as *Senegalia mellifera* subsp. *detinens* are expected to further proliferate within Secondary Thornveld areas due to ongoing disturbance and this species should also be controlled where noted within surrounding natural habitat. • Strict management of edge effects, such as erosion and alien vegetation management must take place.

Floral SCC, Protected, TOPS-listed and Endemic/ Near-endemic Floral Species

The occurrence of priority floral species within the project area as recorded during the field assessment, can be summarised as follows:

- IUCN and SANBI threatened floral species and floral SCC: None.
- NEMBA TOPS species: *Harpagophytum procumbens* (Modified Kathu Bushveld habitat unit).
- National Forests Act (Act No. 84 of 1998) protected tree species: *Vachellia erioloba* and *V. haematoxylon* (Modified Kathu Bushveld habitat unit).
- NCNCA (Act No. 9 of 2009) protected floral species: *Harpagophytum procumbens, Plinthus sericeus, Ammocharis coranica, Boophone disticha*, *Crinum* sp., *Orthanthera jasminiflora, Albuca seineri, Albuca setosa* (Modified Kathu Bushveld habitat unit).
- GWC Endemic and Near-endemic species: None.

In terms of priority floral species, it is important to note that although the project area is located within the GWC, the project area is not located within the core geological areas of this centre of floristic endemism, and endemic and near-endemic are unlikely to occur within the project area. From a review of available databases, no floral SCC are known from the region surrounding the project, and threatened floral species are therefore also unlikely to occur.

It should further be noted that most indigenous floral and faunal species in the Northern Cape Province are protected under the NCNCA (Act No. 9 of 2009), and the current assessment highlights those species listed under Schedule 1 (Specially Protected) and Schedule 2 (Protected), for which permits are required from the Northern Cape Department of Environment and Nature Conservation (NC DENC) prior to disturbing such species.

Impact Identification

An impact assessment was undertaken for the proposed project, and the results summarised below.

Development phase	Significance prior to mitigation	Significance post mitigation
Impact: Loss of terrestrial floral and faunal habitat		
Construction	Medium	Low
Operational	Medium	Low
Impact: Reduced floral and faunal diversity		
Construction	Medium	Low
Operational	Medium	Low
Impact: Displacement of faunal species		
Construction	Medium	Medium
Operational	Medium	Medium
Impact: Loss of SCC, protected, TOPS-listed and endemic species Note that no SCC or endemic/ near-endemic species were recorded during the field assessment, and the impact is only applicable to nationally and provincially protected and TOPS-listed species.		
Construction	High	Medium
Operational	High	Medium
Impact: Increased alien invasive species and other detrimental edge effects		
Construction	Medium	Low
Operational	Medium	Low

Alternatives

No site or layout alternatives are available for the proposed project.

Monitoring

A monitoring programme has to be implemented by the proposed mine with emphasis on the following aspects:

- Protected and TOPS-listed species;
- Alien and invasive plant species;
- Erosion; and
- Rehabilitation.

Conclusion

Based on the information gathered during the desktop assessment, it is evident that the proposed THM is not located within an area indicated to be of high ecological importance by any of the databases consulted, and that the project area is not associated with watercourses, valleys or rocky outcrops that may support unique vegetation. Although small, disjunct portions of the project area is associated with Other Natural Areas (ONAs) according to the Northern Cape CBA database (2016), the project area is not located within a CBA, Ecological Support Area (ESA) or a listed threatened ecosystem. The DFFE National Screening Tool furthermore indicates the terrestrial, plant species and animal species environmental themes as Low, and does not indicate the project area to be associated with unique species or SCC. The aforementioned is support by a desktop review of regional floral and faunal species databases.

The findings of the field assessment showed that the majority of the project area comprises the existing infrastructure and alien vegetation communities associated with the residual opencast void and existing access roads, while remnant, remaining Kathu Bushveld vegetation, although present in certain areas and dominated by indigenous species, has been modified in terms of habitat structure and species due to adjacent disturbance. Other areas of limited extent comprise secondary thornveld vegetation dominated by the indigenous bush encroacher species, *Senegalia mellifera* subsp. *detinens.* Loss of the current in-pit aquatic habitat will take place due to proposed dewatering activities, which may lead to a local reduction of faunal diversity in this area, however from a floral perspective, this habitat unit is dominated by dense stands of *Phragmites australis*, together with a number of alien species. No priority species recorded were recorded in this area.

Although no floral or faunal SCC or GWC endemic/ near floral and faunal species were noted from the project area (note that the occurrence and conservation of Verreaux's Eagle (*Aquila verreauxii*) does not form part of this assessment) or are likely to occur within the project area, signs of TOPS-listed Aardvark (*Orycteropus afer*) were noted during the field assessment in the vicinity of the access road, while other faunal TOPS-listed species that may occur are Bat-eared Fox (*Otocyon megalotis*) and Cape Fox (*Vulpes chama*). One floral TOPS-listed species, namely *Harpagophytum procumbens* was recorded along the access road in the northeast and within the Modified Kathu Bushveld habitat unit within the MR area.

Two nationally protected tree species in terms of the National Forests Act (Act No. 84 of 1998) were recorded within the project area, namely *Vachellia erioloba* (Camel Thorn), which occurs in relatively low abundance along the main access road and within the Modified Kathu Bushveld habitat unit within the MR area, while *V. haematoxylon* occurs in these same areas in high abundance. Although common and widespread in the larger region, loss of these species may contribute rewards the cumulative loss of these species, considering the expansion of mining activities in the Eastern Kalahari.

In terms of provincially protected floral species under Schedule 1 of Northern Cape Nature Conservation Act (NCNCA; Act No. 9 of 2009), *H. procumbens* was recorded, as well as several Schedule 2 protected species which occur scattered throughout the project area, mostly within the Modified Kathu Bushveld areas. These species are all listed as having a Least Concern (LC) conservation status. From a faunal perspective, the arachnid species *Harpactira* spp. and *Pterinochilus* spp. are provincially protected and may also occur within the Modified Kathu Bushveld habitat unit.

Although the proposed project is likely to result in the direct loss of certain priority floral species, the proposed mining project will not significantly contribute towards the loss of intact Kathu Bushveld vegetation in region and the overall impact on natural habitat will be significantly lower than that of a greenfields project. It is however recommended, that where possible, remnant Modified Kathu Bushveld vegetation remain conserved due to the abundance of protected and TOPS-listed species occurring within this habitat unit. No areas beyond the approved project footprint should be disturbed and strict management of edge effects such as bush encroachment, erosion and alien invasive species management must take place throughout the LoM to prevent degradation of surrounding natural habitat. Where disturbance to priority species is unavoidable, the required

permits have to be obtained from the relevant Departments prior to commencement of construction, and any conditions attached to such permits have to be implemented. The establishment of a site nursery where plants with relocation potential, including bulbous protected floral species, may be kept and propagated for use during the rehabilitation phase should be considered.

Based on the findings of the assessment, it is the opinion of the specialist that the project be considered favourably, provided that the mitigation measures as outlined in this report be implemented.

The terrestrial ecological sensitivity map developed for the project area is included below as Figure A. Further information pertaining to the terrestrial ecological assessment is included in the main body of this report.

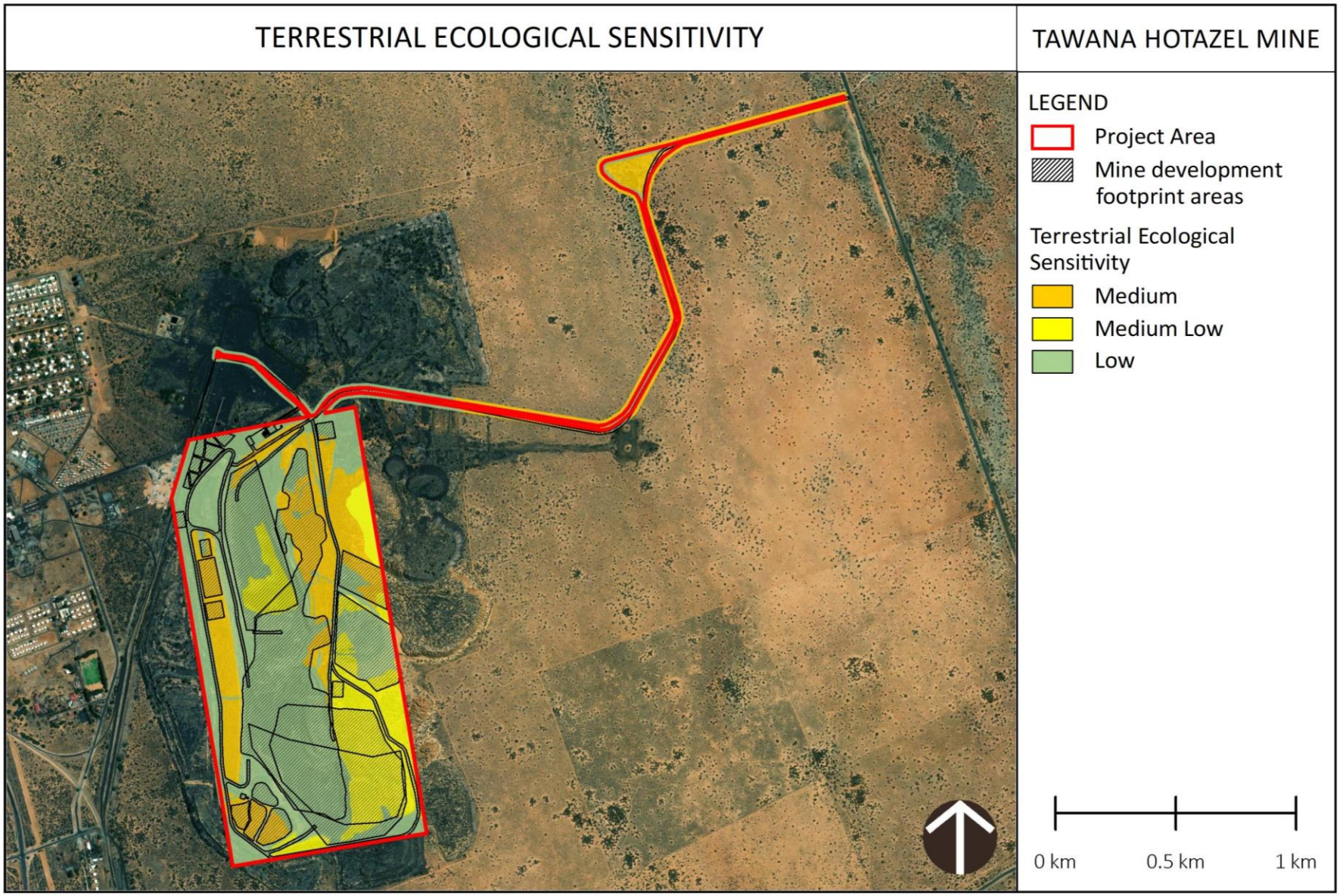


Figure A: Terrestrial ecological sensitivity map

SPECIALIST REPORTING REQUIREMENTS

Specialist reports are required to be undertaken in line with Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(A) and (H) and 44 of the National Environmental Management Act (NEMA; Act No 107 of 1998) when Applying for Environmental Authorisation, dated 20 March 2020. The Protocol for the specialist assessment and impacts on terrestrial biodiversity applies.

Minimum Criteria for the Specialist Assessment and Impacts on Terrestrial Biodiversity

No.	Minimum Report Content Requirements	Relevant Section in Report
2	Terrestrial Biodiversity Species Assessment	
2.1	The assessment must be prepared by a specialist registered with the South African Council for Natural Scientific Professionals (SACNASP) with expertise in the field of terrestrial biodiversity.	Compliant Appendix F
2.2	The assessment must be undertaken on the preferred site and within the proposed development footprint.	Compliant Sections 4.1 and 4.2
2.3	The assessment must provide a baseline description of the site which includes, as a minimum, the following aspects:	
2.3.1	A description of the ecological drivers or processes of the system and how the proposed development will impact these.	Section 6.1
2.3.2	Ecological functioning and ecological processes (e.g. fire, migration, pollination, etc.) that operate within the preferred site.	Section 6.1
2.3.3	The ecological corridors that the proposed development would impede including migration and movement of flora and fauna.	Section 6.1
2.3.4	The description of any significant terrestrial landscape features (including rare or important flora-faunal associations, presence of strategic water source areas (SWSAs) or freshwater ecosystem priority area (FEPA) subcatchments).	Sections 5 and 6
2.3.5	A description of terrestrial biodiversity and ecosystems on the preferred site, including: (a) main vegetation types; (b) threatened ecosystems, including listed ecosystems as well as locally important habitat types identified; (c) ecological connectivity, habitat fragmentation, ecological processes and fine - scale habitats; and (d) species, distribution, important habitats (e.g. feeding grounds, nesting sites, etc.) and movement patterns identified.	Sections 2, 5 & 6
2.3.6	The assessment must identify any alternative development footprints within the preferred site which would be of a low sensitivity as identified by the screening tool and verified through the site sensitivity verification.	No alternatives currently available
2.3.7	the assessment must be based on the results of a site inspection undertaken on the preferred site and must identify:	

No.	Minimum Report Content Requirements	Relevant Section in Report
2.3.7.1	Terrestrial Critical Biodiversity Areas (CBAs), including: (a) the reasons why an area has been identified as a CBA; (b) an indication of whether or not the proposed development is consistent with maintaining the CBA in a natural or near natural state or in achieving the goal of rehabilitation; (c) the impact on species composition and structure of vegetation with an indication of the extent of clearing activities in proportion to the remaining extent of the ecosystem type(s); (d) the impact on ecosystem threat status; (e) the impact on explicit subtypes in the vegetation; (f) the impact on overall species and ecosystem diversity of the site; and (g) the impact on any changes to threat status of populations of species of conservation concern in the CBA.	N/A
2.3.7.2	Terrestrial Ecological Support Areas (ESAs), including: (a) the impact on the ecological processes that operate within or across the site; (b) the extent the proposed development will impact on the functionality of the ESA; and (c) loss of ecological connectivity (on site, and in relation to the broader landscape) due to the degradation and severing of ecological corridors or introducing barriers that impede migration and movement of flora and fauna.	N/A
2.3.7.3	Protected areas as defined by the National Environmental Management: Protected Areas Act, 2004 including- (a) an opinion on whether the proposed development aligns with the objectives or purpose of the protected area and the zoning as per the protected area management plan.	N/A
2.3.7.4	Priority areas for protected area expansion, including- (a) the way in which in which the proposed development will compromise or contribute to the expansion of the protected area network.	N/A
2.3.7.5	SWSAs including: (a) the impact(s) on the terrestrial habitat of a SWSA; and (b) the impacts of the proposed development on the SWSA water quality and quantity (e.g. describing potential increased runoff leading to increased sediment load in water courses).	N/A
2.3.7.6	FEPA sub-catchments, including- (a) the impacts of the proposed development on habitat condition and species in the FEPA sub-catchment.	N/A
2.3.7.7	Indigenous forests, including: (a) impact on the ecological integrity of the forest; and (b) percentage of natural or near natural indigenous forest area lost and a statement on the implications in relation to the remaining areas.	N/A
2.4	The findings of the assessment must be written up in a Terrestrial Biodiversity Specialist Assessment Report.	Compliant
3	Terrestrial Biodiversity Specialist Assessment Report	
3.1	The Terrestrial Biodiversity Specialist Assessment Report must contain, as a minimum, the following information:	
3.1.1	Contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;	Appendix F
3.1.2	A signed statement of independence by the specialist;	Appendix F
3.1.3	A statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 4.2
3.1.4	A description of the methodology used to undertake the site verification and impact assessment and site inspection, including equipment and modelling used, where relevant;	Section 4

No.	Minimum Report Content Requirements	Relevant Section in Report
3.1.5	A description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;	Section 1.3
3.1.6	A location of the areas not suitable for development, which are to be avoided during construction and operation (where relevant);	Section 7
3.1.7	Additional environmental impacts expected from the proposed development;	Section 8
3.1.8	Any direct, indirect and cumulative impacts of the proposed development;	Section 8
3.1.9	The degree to which impacts and risks can be mitigated;	Section 8
3.1.10	The degree to which the impacts and risks can be reversed;	Section 8
3.1.11	The degree to which the impacts and risks can cause loss of irreplaceable resources;	Section 8
3.1.12	Proposed impact management actions and impact management outcomes proposed by the specialist for inclusion in the Environmental Management Programme (EMPr);	Section 8
3.1.13	A motivation must be provided if there were development footprints identified as per paragraph 2.3.6 above that were identified as having a "low" terrestrial biodiversity sensitivity and that were not considered appropriate;	Section 8
3.1.14	A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability, or not, of the proposed development, if it should receive approval or not; and	Section 8
3.1.15	Any conditions to which this statement is subjected.	Section 8
3.2	The findings of the Terrestrial Biodiversity Specialist Assessment must be incorporated into the Basic Assessment Report or the Environmental Impact Assessment Report, including the mitigation and monitoring measures as identified, which must be incorporated into the EMPr where relevant.	Noted, also refer to Sections 8 & 9.
3.3	A signed copy of the assessment must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.	Noted

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ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
ADU	Animal Demographic Unit
BGIS	Biodiversity Geographic Information Systems
BODATSA	Botanical Database of southern Africa
CARA	Conservation of Agricultural Resources Act (Act No. 43 of 1983)
CBA	Critical Biodiversity Area
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CR EX	Critically Endangered, Possibly Extinct
CR	Critically Endangered
DDD	Data Deficient – Insufficient Information
DDT	Data Deficient – Taxonomically Problematic
DEA	Department of Environmental Affairs (now DFFE)
DFFE	Department of Forestry, Fisheries and the Environment (previously DEA)
DMR	Department of Mineral Resources (now DMRE)
DMRE	Department of Mineral Resources and Energy (previously DMR)
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
EN	Endangered
EO	Environmental Officer
ESA	Ecological Support Area
EW	Extinct in the Wild
EWT	Endangered Wildlife Trust
Fe	Iron
FEPA	Freshwater Ecosystem Priority Area
GBIF	Global Biodiversity Information Facility
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
GWC	Griqualand West Centre (of Plant Endemism)
ha	Hectares
HGM	Hydrogeomorphic
HMM	Hotazel Manganese Mine
HV	Heavy Vehicles
IBA	Important Bird and Biodiversity Areas

IUCN	International Union for the Conservation of Nature
LC	Least Concern
LDV	Light Delivery Vehicle
m	Metres
mamsl	meters above mean sea level
MAP	Mean Annual Precipitation
mm	Millimetre
Mn	Manganese
MR	Mining Right
MR Area	Mining Right Area
NBA	National Biodiversity Assessment (2018)
NC DENC	Northern Cape Department of Environmental Affairs and Nature Conservation
NCNCA	Northern Cape Nature Conservation Act (Act No. 9 of 2009)
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NEMBA	National Environmental Management: Biodiversity Act (Act No. 10 of 2004)
NEMPAA	National Environmental Management: Protected Areas Act (Act No. 57 of 2003)
NFEPA	National Freshwater Ecosystem Priority Area (2011)
NPAES	National Protected Areas Expansion Strategy (2008)
NT	Near Threatened
P	Protected (in terms of the NEMBA TOPS Regulations)
PACA	Protected and Conservation Areas
PCD	Pollution Control Dam
POSA	Plants of southern Africa
QDS	Quarter Degree Square
RE	Regionally Extinct
RoM	Run of Mine
SABAP2	Southern African Bird Atlas Project 2
SACAD	South African Conservation Areas Database (2020)
SAFAP	Southern African Frog Atlas Project
SANBI	South African National Biodiversity Institute
SAPAD	South African Protected Areas Database (2020)
SARCA	Southern African Reptile Conservation Assessment
SCC	Species of Conservation Concern
SDF	Spatial Development Framework
SWSA	Strategic Water Source Areas
THM	Tawana Hotazel Mine
TOPS	(NEMBA) Threatened or Protected Species
UNESCO	United Nations Educational, Scientific, and Cultural Organization
VU	Vulnerable
WRC	Water Research Commission
WULA	Water Use Licence Application

1 INTRODUCTION

1.1 Project Locality and Description

Field and Form Landscape Science, in collaboration with Malachite Ecological Services, were appointed to conduct a baseline (*status quo*) terrestrial biodiversity assessment as part of the environmental authorisation, Water Use Licence Application (WULA) and other requisite permitting processes as part of the overall Mining Right (MR) Application for the proposed Tawana Hotazel Mine (THM).

The Department of Mineral Resources and Energy (DMRE) has accepted an application for an MR made by Tawana Hotazel Mining (Pty) Ltd in terms of Section 22 of the Mineral and Petroleum Resources Development Act, 2002 (MPRDA). The types of minerals applied for are: all (Code UN); Iron and Iron bearing minerals including hematite, goethite, specularite and limonite (Code (Fe) Type (B)) and Manganese and manganese bearing minerals (Code (Mn) Type (B)).

The project area is located in the John Taolo Gaetsewe District Municipality and the Joe Morolong Local Municipality in the Northern Cape Province, within the 2722BB Quarter Degree Square (QDS). The project area is located approximately 1km southeast of the town of Hotazel, on Portion 1 of the Farm York A 279 and Portion 0 (RE) of the Farm Hotazel 280, roughly 1km to the east of the R31/ R380 roadway (Figures 1 & 2). The THM largely incorporates the historical Hotazel Manganese Mine (HMM), including the residual opencast void and surface dumps of low-grade material. The mothballed processing plant and rail loadout facility fall outside the MR area. HMM stopped production in 1989. The area was historically mined by both opencast and underground means and yielded high grade manganese ore. All current plans for the project specifically exclude underground mining.

The overall area applied for is approximately 154 hectares (ha) (inclusive of the MR application area and access road). Surface infrastructure will include the opencast pit (incorporating the historical HMM void and further expansion of the opencast footprint), in-pit waste dumps (residue material), surface residue handling/ storage, vehicle yard, workshop, access and haul roads, offices, stores, processing plant for the crushing and screening of mined ore, product stockpile area, run of mine pad, refuel bay and water management infrastructure. The proposed project layout is illustrated in Figure 3.

There are two main access roads to the mine; one intersects with Provincial Road D3463 from Kuruman to Severn and enters the mine at the northeastern corner, while the other road is from Hotazel town in the west and enters the mine from the north. The two roads intersect before entering the mining area. The main transport route to the northeast will be for Heavy Vehicles (HVs), potentially 80 – 100 trucks per day, and the main entrance to the west (near Hotazel) will be for Light Delivery Vehicles (LDV's). In addition, on-site access roads will be required for use by the secondary support fleets and earthmoving haul trucks, with ramps that lead in and out of the pit and haul roads for the transportation of processed products and waste amongst others.

In order to improve mobility around the mine and to potentially reduce road user costs, a ring road (haul road) around the mine pit has been proposed. This road will also intercept stormwater which will be channelled to the stormwater ponds.

The minimum width of all the roads is 10m as they generally have to accommodate large trucks, with sufficient space for surface water flow.

Two (2) years have been allowed for pre-stripping and mining infrastructure construction and the Life of Mine (LoM) indicated by the conversion of the resource to reserve is 30 years for the open pit operation. Backfilling/ rehabilitation will commence immediately after the commencement of the mining operation and its advance will match the depletion rate of the open pit. A period of three (3) years is expected for final rehabilitation after closure.

The purpose of the terrestrial biodiversity baseline report is to define the terrestrial biodiversity and ecology of the project area and immediate surroundings, to identify and map areas of increased terrestrial ecological importance and to determine the perceived impacts and impact significance of the proposed mining activities on the receiving environment from a terrestrial floral and faunal perspective. The objective of this component is furthermore to provide detailed information to the various stakeholders in planning and executing the proposed mining project and in undertaking informed decision-making regarding the need and desirability of such activities. The findings of the assessment must be used in conjunction with other specialist assessments to ensure a holistic understanding of the biophysical attributes associated with the project area.

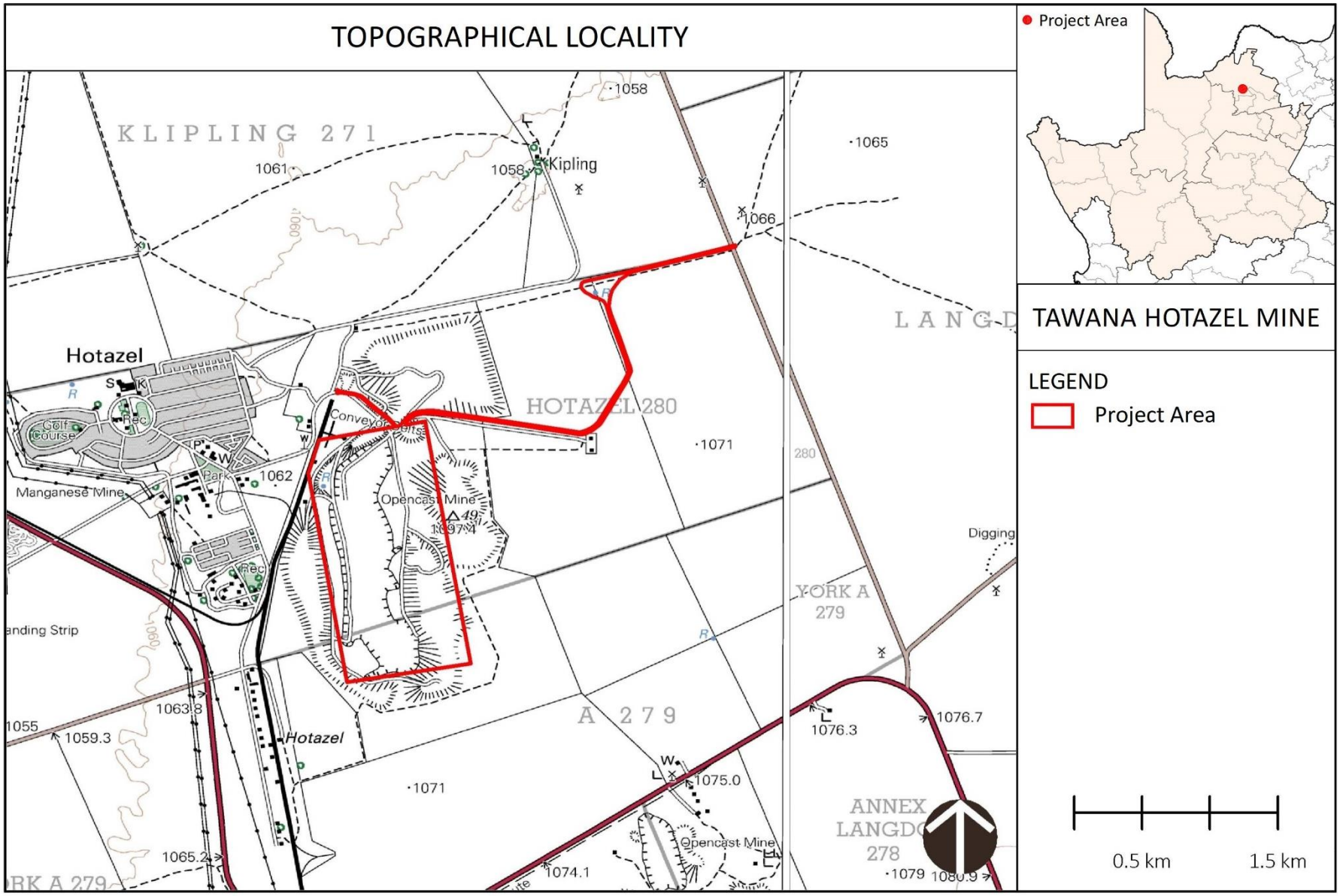

Figure 1: Topographical locality map indicating the location of the project area in relation to the surrounding region

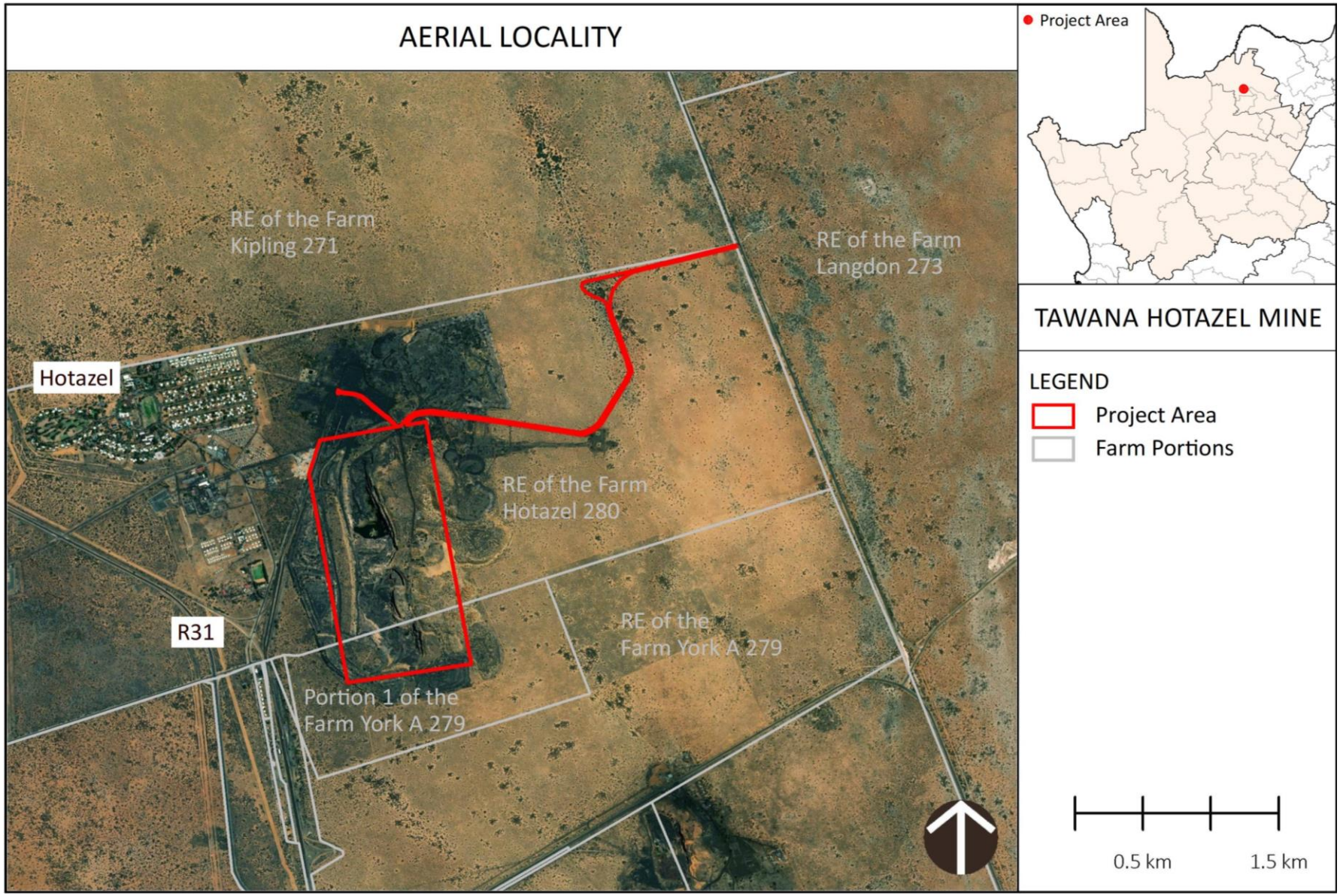

Figure 2: Aerial locality map, including cadastral information, indicating the location of the project area in relation to the surrounding region

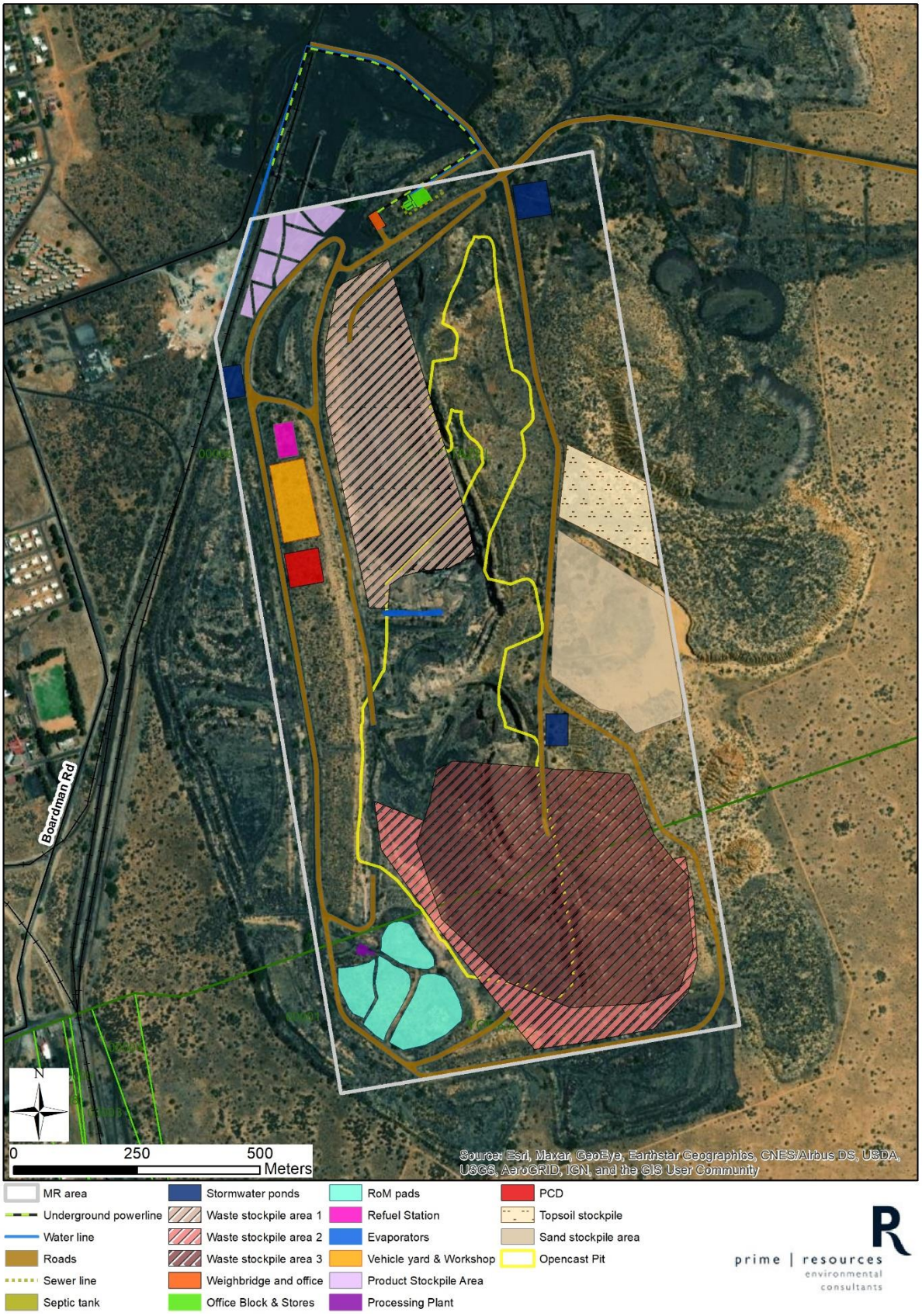

Figure 3: Proposed project layout (Prime Resources, 2021)

1.2 Terms of Reference

The terms of reference of this baseline terrestrial biodiversity component are defined as follows:

- To provide an overview of applicable environmental legislation as well as national and regional planning frameworks to be considered in planning the project;
- To provide a broad description of the biophysical characteristics of the project area and its surroundings as applicable to the baseline terrestrial biodiversity assessment;
- To undertake a review of available background information and published literature to broadly describe the baseline environment at a desktop level;
- To categorise and describe the vegetation and habitat present within the project area according to relatively homogeneous habitat units and to provide an overview of vegetation structure, floral species composition (including alien species), predicted faunal associations and the species diversity of each habitat unit;
- To identify floral and faunal Species of Conservation Concern (SCC), National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEMBA) Threatened or Protected Species (TOPS), nationally or provincially protected species as well as endemic/ near-endemic species that could potentially occur in the project area and surrounds;
- To provide an indication of the conservation importance and ecological sensitivity of each habitat unit identified within the project area and to identify No Go areas where applicable; and
- To assess the potential impacts that may occur as a result of the proposed project and to provide site specific mitigation measures and ongoing management measures that will be required to reduce such impacts should the project be approved.

1.3 Assumptions and Limitations

It is difficult to apply pure scientific methods within a natural environment without limitations or assumptions. The following assumptions and limitations are applicable to this assessment:

- Modelled biodiversity databases have accuracy limitations and as a result, must be ground-truthed for verification. The information obtained from various databases as included in Sections 2, 3 and 5 of this report is however considered to be useful as background to the assessment, and the data have also been used to inform the field assessment, specifically where areas of increased conservation importance are indicated;
- The emphasis of the current baseline phase assessment is on terrestrial biodiversity, and although the hydrological setting of the project area has also been considered, an assessment of freshwater resources including wetlands within the project area falls outside of the scope of this study;
- The results of the field assessment are based on a single site assessment, undertaken over two days on 23 - 24 November, during the wet (Summer) season, under favourable conditions;
- In order to obtain a comprehensive understanding of the dynamics and diversity of the biota on a site, biodiversity studies should ideally include investigations through the different seasons of the year coupled with extensive sampling of the area. As the current assessment relied on information gained during a single season site survey and a field assessment of limited duration, available desktop information for the area, as well as professional judgment and experience were also considered;

- Due to the complexity of natural ecosystems and seasonality of species, it is possible that some aspects pertaining to terrestrial biodiversity, including certain floral species, may have been overlooked during the field assessment. All effort was however made by the consultants to gather and convey accurate information, although the possibility exists that additional information with regard to the project area may come to light at a later stage. It is also important to note that the majority of floral SCC are also known to be extremely seasonal and only flower during specific periods of the year. Prior information on potential threatened flora that may occur in the project area was however known and special emphasis was placed in searching for such species during the field assessment, taking the high level of historical disturbance associated with the project area into consideration;
- The faunal component comprises a desktop assessment only. This component focuses on mammals and herpetofauna (amphibians and reptiles). The field assessment did not include a faunal assessment, and was limited to a floral investigation only; where possible, incidental faunal observations were however noted;
- Information of avian species diversity falls outside of the scope of this assessment and is discussed within the avifaunal assessment compiled by Feathers Environmental; and
- A hand-held Garmin eTrex 20x device were used during the field assessment and this has an accuracy of 3-6m. As a result, potential georeferencing errors, including such limitations in Global Positioning System (GPS) accuracy may result in slight discrepancies in the maps.

1.4 Reporting Conditions

The findings, results, observations, conclusions and recommendations provided in this report are based on the authors' best scientific and professional knowledge as well as information available at the time of compilation. The authors, however, accept no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document. No form of this report may be amended without the prior written consent of the authors.

2 LEGISLATIVE BACKGROUND

2.1 The National Environmental Management: Biodiversity Act (NEMBA; Act No. 10 of 2004)

2.1.1 National List of Ecosystems that are Threatened and in need of Protection (2011)

The NEMBA provides for the listing of threatened or protected ecosystems in one of four categories: 'Critically Endangered (CR)', 'Endangered (EN)', 'Vulnerable (VU)' and 'Protected'. Threatened ecosystems are listed in order to reduce the rate of ecosystem and species extinction by preventing further degradation and loss of structure, function and composition of threatened ecosystems.

According to the National List of Threatened Terrestrial Ecosystems database (2011), the project area is not located within the original or remaining extent of any listed threatened ecosystems.

2.1.2 Alien and Invasive Species Regulations (2020)

The NEMBA Alien and Invasive Species Regulations (2020) aim to:

- Prevent the unauthorised introduction and spread of alien and invasive species to ecosystems and habitats where they do not naturally occur;
- Manage and control alien and invasive species, to prevent or minimise harm to the environment and biodiversity; and
- Eradicate alien and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats.

Alien invasive species categories according to the Alien and Invasive Species Regulations (2020) are as follows:

- Category 1a: Listed Invasive Species which must be combatted or eradicated. If an Invasive Species Management Programme has been developed, this must take place in accordance with such programme.
- Category 1b: Listed Invasive Species must be controlled. If an Invasive Species Management Programme has been developed, this must take place in accordance with such programme.
- Category 2: Invasive species that require a permit to carry out a restricted activity within an area, as specified in the permit.
- Category 3: Listed invasive species subject to certain exemptions and prohibitions. Any plant species identified as a Category 3 Listed Invasive Species that occurs in riparian areas, must, for the purpose of the regulations be considered a Category 1b Listed Invasive Species.

The NEMBA Alien and Invasive Species Lists (2020) include national lists of invasive species to be read together with the Alien and Invasive Species Regulations (2020). A list of alien and invasive floral species noted during the field investigation is included in Section 6.4.

2.1.3 Threatened or Protected Species Regulations (2015)

The NEMBA provides for listing of Threatened or Protected Species (TOPS). If a species is listed as threatened, it must be further classified as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU). In addition to these categories, protected species (P) are defined as "any species which is of such

high conservation value or national importance that it requires national protection". Species listed in this category may include, among others, species listed in terms of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Certain activities, referred to as Restricted Activities, are regulated on listed species using permits by a special set of regulations published under the Act. Restricted activities regulated under the Act are keeping, moving, having in possession, importing and exporting, and selling. Seventeen (17) floral TOPS-listed floral species are indicated to occur in the Northern Cape Province (Appendix C), however based on known species distributions, the majority of these species will not occur within the project area, as most are restricted to the Richtersveld region further west. One TOPS-listed floral species, namely *Harpagophytum procumbens* (P; LC) was recorded during the field assessment within the Modified Kathu Bushveld habitat unit, while *Drimia sanguinea* (P; NT) has an increased probability of occurrence within less modified areas.

Nine faunal TOPS-listed species have sympatric distributions with the project area including South African Python (*Python natalensis*), Brown Hyaena (*Parahyaena brunnea*), Aardvark (*Orycteropus afer*), Temminck's Ground Pangolin (*Manis temminckii*), Black-footed Cat (*Felis nigripes*), Bat-eared Fox (*Otocyon megalotis*) and Cape Fox (*Vulpes chama*). Three TOPS-listed faunal species have increased probability of occurrence within less modified areas, based on distribution and perceived habitat conditions within the project area, namely *O. afer*, *O. megalotis* and *V. chama*.

2.2 National Environmental Management: Protected Areas Act (NEMPAA; Act No. 57 of 2003)

The NEMPAA was promulgated in order to provide for (among other things) the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; for the establishment of a national Register of Protected Areas, and for the management of those areas in accordance with national norms and standards.

2.2.1 South African Protected Areas Database (SAPAD, 2021) and South African Conservation Areas Database (SACAD, 2021)

The primary function of protected areas is to ensure the conservation of habitats, environmental processes and species occurring within these ecosystems. The SAPAD and SACAD are Geographic Information System (GIS) inventories of all Protected and Conservation areas in South Africa. The Protected and Conservation Areas (PACA) database also includes data on privately owned protected areas. This Register comprises of all data required for the Register of Protected Areas (legally declared) as well as data on Conservation Areas (areas responsibly managed for biodiversity conservation but not legally declared as Protected Areas). According to the most recently published SAPAD (2021) and SACAD (2021) databases, the project area is not located within or within 10km of any formally protected areas such as nature reserves or other conservation areas. The closest protected areas are located further than 40km from the project area.

2.3 National Forests Act (Act No. 84 of 1998)

An updated list of protected tree species was published under section 12(1) (d) of the National Forests Act (Act No. 84 of 1998) on 1 March 2021. In terms of section 15(1) of the National Forests Act (Act

No. 84 of 1998), no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any product derived from a protected tree, except under a licence or exemption granted by the Minister of the Environment, Forestry and Fisheries to an applicant and subject to such period and conditions as may be stipulated.

No indigenous forests occur in the project area. Protected tree species in terms of the National Forests Act (Act No. 84 of 1998) that have been recorded with the project area during the field assessment are *Vachellia erioloba* (Camel thorn) and *V. haematoxylon* (Grey camel thorn) where they are restricted to the Modified Kathu Bushvled habitat unit. *Boscia albitrunca* (Shepherd's tree), although known from the region, was not recorded; this does not however exclude its presence from the project area.

2.3.1 The National Protected Areas Expansion Strategy (NPAES; 2010)

Focus areas for land-based protected area expansion are large, intact and unfragmented areas of high importance for biodiversity representation and ecological persistence, suitable for the creation or expansion of large protected areas. The focus areas were identified through a systematic biodiversity planning process undertaken as part of the development of the National Protected Area Expansion Strategy (NPAES, 2008). According to the NPAES database (2010), the project area is not located within an NPAES Focus Area. The closest NPAES Focus Area (the Eastern Kalahari NPAES Focus Area) is located approximately 18km to the northwest and west of the project area.

2.4 Conservation of Agricultural Resources Act (CARA; Act No. 43 of 1983)

The objectives of CARA (Act No. 43 of 1983) are to provide for the conservation of the natural agricultural resources through the maintenance of the production potential of land, through combating and prevention of erosion and weakening or destruction of the water sources, and through the protection of the vegetation and the combating of weeds and invader plants.

Amendments to regulations under the CARA (Act No. 43 of 1983) provide for the declaration of weeds and invader plants, with weeds regarded as alien plants with no known useful economic purpose, while invader plants may serve useful purposes as ornamentals, as sources of timber and may provide many other benefits, despite their aggressive nature. Declared weeds are described as Category 1 plants, while declared invader plants with a commercial or utility value are described as Category 2 plants and ornamental species as Category 3 plants. CARA indicates that Category 1 weeds are prohibited, and that Category 2 and 3 plants must be controlled. A list of alien floral species recorded in the project area, including an indication of the weeds and invader species categories in terms of CARA is included in Section 6.4.

CARA also lists indigenous bush encroacher species that require control. One such species, namely *Senegalia mellifera* subsp. *detinens*, occur in high density within the Secondary Bushveld habitat unit.

2.5 Northern Cape Nature Conservation Act (NCNCA; Act No. 9 of 2009)

The NCNCA (Act No. 9 of 2009) provides for the sustainable utilisation of wild animals, aquatic biota and plants as well as permitting and trade regulations regarding wild fauna and flora within the province.

The Act also lists invasive species in Schedule 6, Specially Protected plant and animal species in Schedule 1, Protected plant and animal species in Schedule 2 and common plant and animal species in Schedule 3. A permit is required to undertake restricted activities involving species listed in Schedule 1 and 2 which include hunting, importing, exporting, transporting, keeping, possessing (unless occurring naturally), breeding or trading in with respect to animal species listed and picking, importing, exporting, transporting, possessing (unless occurring naturally), cultivating and trading in with respect to plant species listed. A permit would therefore be required from the Northern Cape Department of Environmental Affairs and Nature Conservation (NC DENC) to destroy, remove or relocate any provincially listed Specially Protected or Protected species from the project area.

Provincially protected floral species in terms of the NCNCA (Act No. 9 of 2009) recorded within the project area are the Schedule 1 species *Harpagophytum procumbens,* and the Schedule 2 species *Plinthus sericeus, Ammocharis coranica, Boophone disticha*, *Crinum* sp., *Orthanthera jasminiflora, Albuca seineri* (=*Ornithoogalum seineri*), *Albuca setosa* (=*Ornithogalum setosum*). These protected plant species are discussed in Section 6.3 and indicated in the combined floral species list in Appendix A.

From a faunal perspective, the arachnid species *Harpactira* spp. and *Pterinochilus* spp. are provincially protected under Schedule 1 of NCNCA (Act No. 9 of 2009) and may occur within the Modified Kathu Bushveld Habitat Unit.

3 NATIONAL AND PROVINCIAL PLANNING FRAMEWORKS

3.1 National Biodiversity Assessment (NBA; 2018)

The most recent National Biodiversity Assessment (NBA), dated 2018, is a collaborative effort to synthesise the best available science on South Africa's biodiversity. The NBA is used to inform policy in the biodiversity sector and other sectors that rely on or impact on natural resources, such as water, agriculture, mining and human settlements. The NBA provides information to help prioritise resources for managing and conserving biodiversity and provides context and information that underpins biodiversity inputs to land use planning processes (Skowno et al., 2019).

The NBA has seven technical reports (of which only the terrestrial component is discussed within this assessment) and relies on two headline indicators:

- **Threat Status**: Degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function and composition, on which their ability to provide ecosystem services depends. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Least Concern (LC), based on the proportion of each ecosystem type that remains in good ecological condition relative to a series of thresholds (Skowno et al., 2019).
- **Protection Level**: Addresses the extent to which ecosystems and species are protected. Ecosystem types are categorised as Not Protected, Poorly Protected, Moderately Protected or

Well Protected, based on the proportion of each ecosystem type that occurs within a protected area recognised in the NEMPAA (Skowno et al., 2019).

These headline indicators provide important links for data comparison as well as providing a standardised framework that links with policy and legislation. Furthermore, comparing threat status and protection levels for terrestrial ecosystems is useful for identifying ecosystems in particular need of protection (Skowno et al., 2019).

According to the outputs of the NBA (2018) the project area is mostly located outside of the remaining extent of the Kathu Bushveld vegetation type, with only limited portions of remnant vegetation occurring along existing haul roads within the opencast void and along the access road in the northeast where the proposed upgrade of this road may impact on natural vegetation. This implies that the majority of the project area has been previously transformed and that, with the exception of the aforementioned limited portions of remnant vegetation, most of the vegetation present is not regarded as natural habitat. The ecosystem associated with the vegetation type has a threat status of Least Concern (LC) and a poor protection level (Figure 5).

3.2 Mining and Biodiversity Guidelines (2012)

The Mining and Biodiversity Guidelines (2012) enables regulators, industry and practitioners to minimise the impact of mining on biodiversity and ecosystem services by promoting the sustainable development of mineral resources. Biodiversity priority areas (as per the guidelines), are likely to be sensitive to the impacts of mining and as such, should inform and influence spatial land use policies and plans for mining activities (DEA et al., 2013).

The Mining and Biodiversity Guidelines (2012) indicates the project area is not located within any areas of increased biodiversity importance.

3.3 Important Bird and Biodiversity Areas (IBA; 2015)

Various sites within the country have been identified as important for maintaining viable populations of endemic, range restricted and threatened bird species. The primary aim of the IBA programme is to ensure the long-term conservation of important avifaunal habitats. They also provide essential benefits to people, such as food, materials, water, climate regulation and flood attenuation, as well as opportunities for recreation and spiritual fulfilment. According to BirdLife South Africa, one-third of the 112 IBAs located within South Africa are under threat by invasive alien vegetation, habitat modification/ degradation and agricultural expansion (Marnewick et al., 2015). Further to this, 52% of IBAs fall outside formally Protected Areas, further complicating avian habitat conservation.

Based on the current delineation of IBAs in South Africa, the project area is not located within an IBA, with the closest IBA to the project area being the Spitskop Dam IBA (SA028), located approximately 180km to the southeast.

3.4 Regions of Floristic Endemism (2001)

A Centre of Plant Endemism is considered to be a geographical region, typically of relatively small size which harbours a unique assemblage of species and infraspecific taxa, some or many of which have highly restricted distributions, known as endemic or near-endemic species (Van Wyk & Smith, 2001).

The project area is located within the Griqualand West Centre of Endemism (GWC), with the location of the project area in relation to the outer boundaries of the GWC indicated in Figure 6. The GWC is best described in geological terms, with its core area centred on the surface outcrops of the Ghaap Group (notably limestone and dolomite), and those of the Olifantshoek Supergroup (notably quartzite). The figure below indicates the location and extent of the Ghaap Plateau [comprising the Ghaap Group (which includes the Koegas, Asbestos Hills, Campbellrand and Schmidtsdrif Subgroups)] and the Olifantshoek Supergroup (Figure 4; Polteau et al., 2018) in relation to the town of Hotazel, showing that Hotazel and the project area falls outside of these geological boundaries.

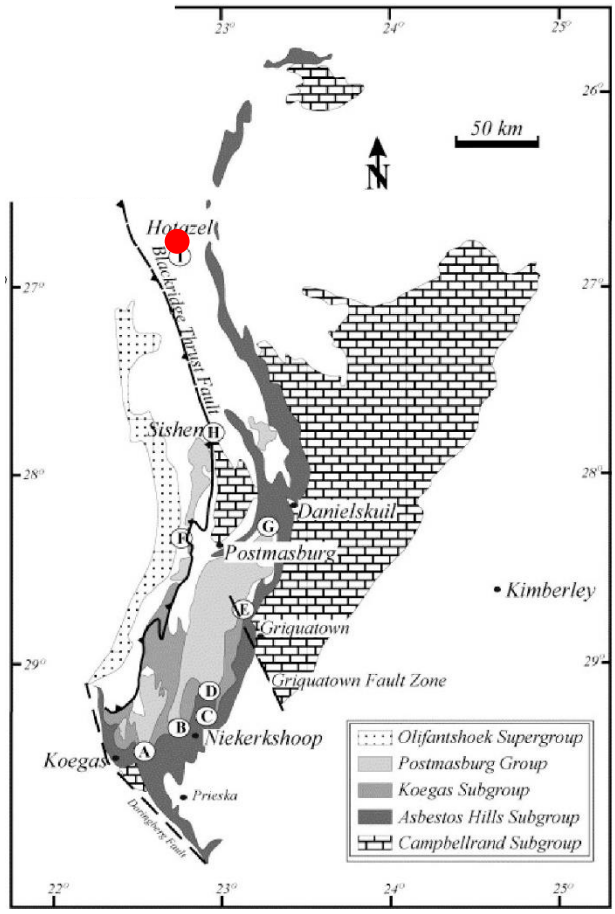

Figure 4: Geological sketch map showing the distribution of the Ghaap and Olifantshoek Groups in relation to Hotazel and the project area, indicated in red (Polteau et al., 2018)

In floristic terms, the GWC boundary is rather diffuse, as several of the GWC floristic elements spill over onto related substrates, especially alkaline ones rich in calcium (Van Wyk & Smith, 2001). The vegetation of Griqualand West can be broadly described as Savanna, specifically forming part of the Eastern Kalahari Bushveld Bioregion (Mucina & Rutherford, 2006). The Savanna Biome is characterized by a herbaceous ground layer dominated by forbs and grasses, and a scattered upper layer comprising of woody vegetation (Frisby et al., 2019). The western parts of the GWC are covered by Kalahari Mountain Bushveld and the eastern plateau is covered by Kalahari Plateau Bushveld, both endemic to the centre. *Tarchonanthus camphoratus* is a particularly common woody species in these two

bushveld types. Pockets of Karoo-type vegetation increase towards the south and west, especially in heavily overgrazed areas (Van Wyk & Smith, 2001).

Some of the important grass species in Griqualand West include *Aristida canescens, A. congesta, Brachiaria nigropedata, B. serrata, Cymbopogon pospischilli, Digitaria eriantha, Enneapogon cenchroides, Eragrostis cylindriflora*, *E. superba, Heteropogon contortus, Melinis repens* and *Themeda triandra* (Mucina & Rutherford, 2006). Important forb species include *Barleria macrostegia, Dicoma capensis, Harpagophytum procumbens, Helichrysum cerastioides, Hermannia tomentosa, Hermbstaedtia odorata, Hibiscus marlothianus* and *Jamesbrittenia aurantiaca* (Mucina & Rutherford, 2006). Other important woody species include *Boscia albitrunca, Dichrostachys cinerea, Ehretia rigida, Euclea crispa, Grewia flava, Gymnosporia buxifolia, Olea europaea, Searsia lancea, Senegalia caffra, S. mellifera, Vachellia erioloba, V. karroo, V. tortilis* and *Ziziphus mucronata* (Mucina & Rutherford, 2006), with typical mountain species including *Searsia tridactyla, Croton gratissimus* and *Buddleja saligna* (Van Wyk & Smith, 2001).

The vegetation of the GWC is still fairly intact, although extremely poorly conserved. Bush encroachment (by e.g. the indigenous *Senegalia mellifera* subsp. *detinens*) due to inappropriate veld management practices (mainly overgrazing by domestic livestock), is a major problem in many parts of the region (Van Wyk & Smith, 2001).

At least 23 plant species have their natural distribution ranges restricted to the Griqualand West region, with these endemics representing 1.4% of the region's flora. Although this is lower than the predicted level of endemism, it matches the trends of endemicity found in other centres in semi-arid savanna of southern Africa (Frisby et al., 2019). Appendix D lists the 23 taxa endemic to the GWC, as well as two near-endemic species, their threat status and habitat requirements. Section 6.3 lists endemic floral species that are known from the vicinity of the project area and are associated with an increased (low) probability of occurrence.

3.5 Northern Cape Critical Biodiversity Areas (2016)

The Northern Cape Critical Biodiversity Areas (CBAs) dataset (2016) identifies biodiversity priority areas, namely CBAs and Ecological Support Areas (ESAs), which, together with protected areas, that are important for the persistence of a viable representative sample of all ecosystem types and species as well as the long-term ecological functioning of a landscape as a whole.

CBAs are areas required to meet biodiversity targets for ecosystems, species and ecological processes, as identified in a systematic biodiversity plan, while ESAs are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of CBAs and/or in delivering ecosystem services. The primary purpose of a map of CBA and ESAs maps is to guide decision-making about where best to locate development and to encourage appropriate land uses that are compatible with the desired state of CBAs and ESAs. It should inform land-use planning, environmental assessment and authorisations, and natural resource management, by a range of sectors whose policies and decisions impact on biodiversity. It is the biodiversity sector’s input into multi-sectoral planning and decision-making processes.

The project area is not associated with CBA or ESA sites, and is mostly located within previously modified areas. Limited portions of natural habitat are indicated to remain along existing haul roads within the opencast void and along the access road in the northeast, with these areas designated as Other Natural Area (ONAs). ONAs are defined as natural or semi-natural areas that are not required to meet biodiversity targets or support natural ecological processes. The desired state of ONAs is best determined through multi-sectoral planning processes and from a biodiversity perspective, these areas can be used for a range of intensive land uses (SANBI, 2018) (Figure 7).

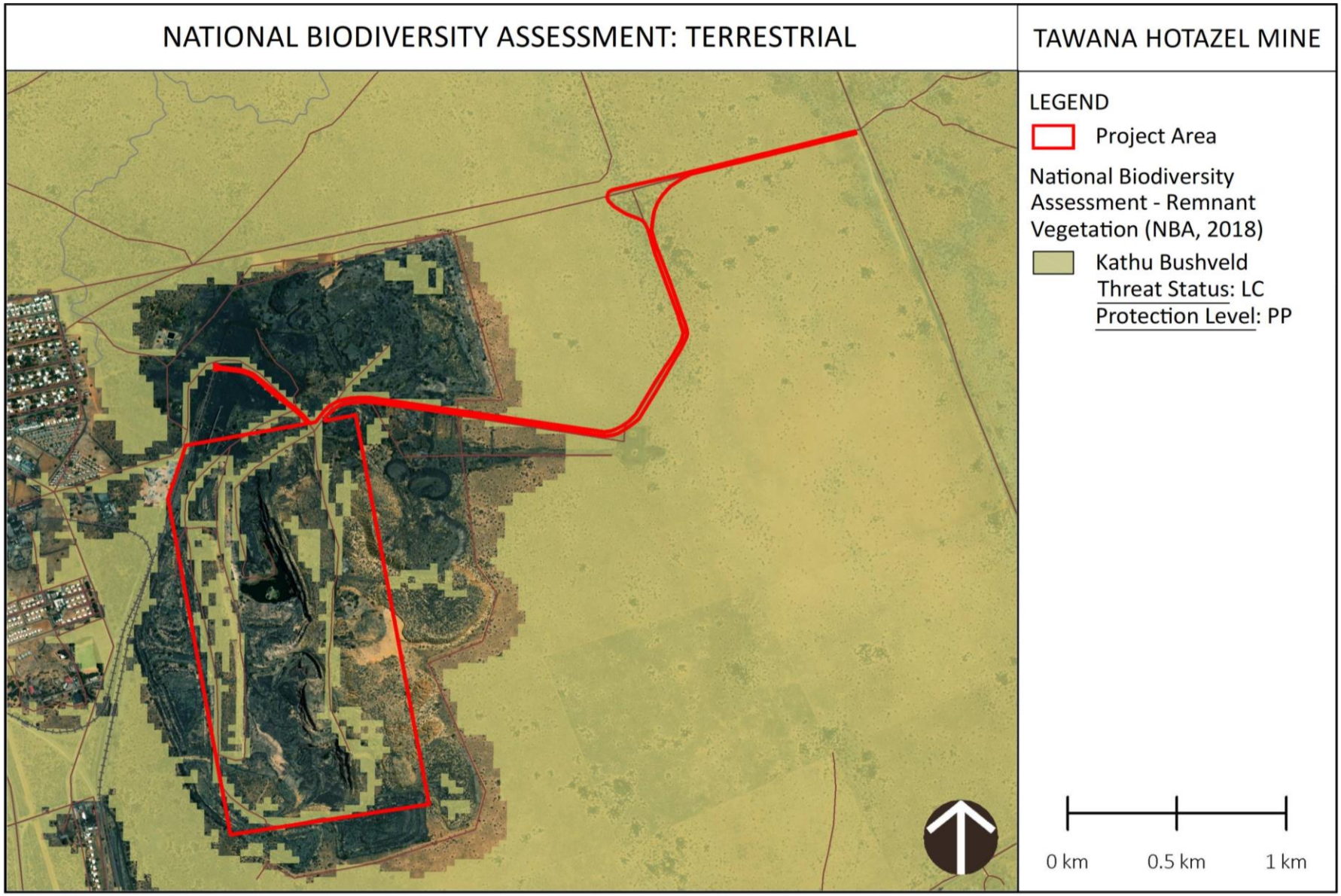

Figure 5: The project area in relation to the remaining extent of terrestrial ecosystems and vegetation types (NBA, 2018) (LC – Least Concern; PP – Poorly Protected)

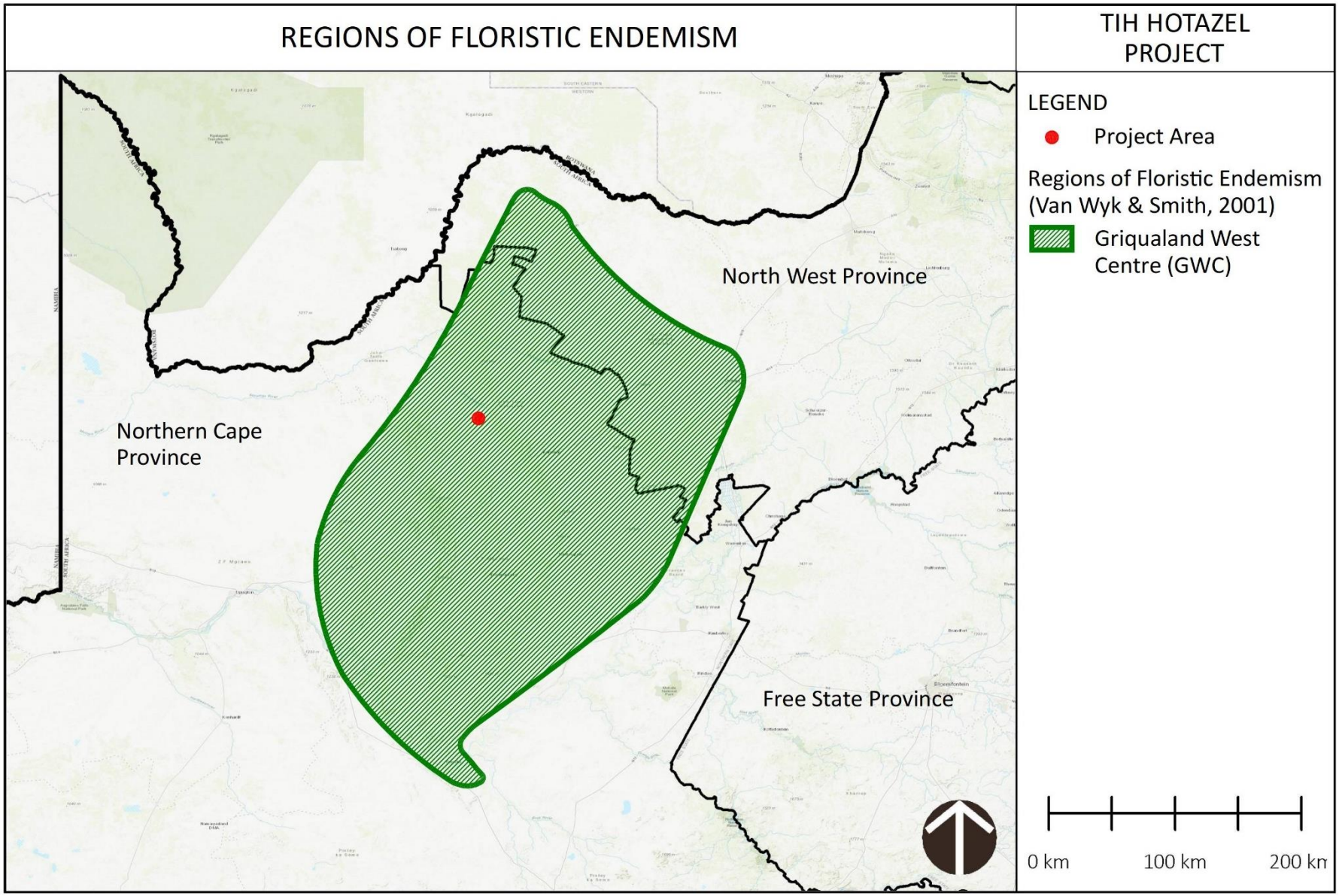

Figure 6: Location of the project area in relation to the GWC

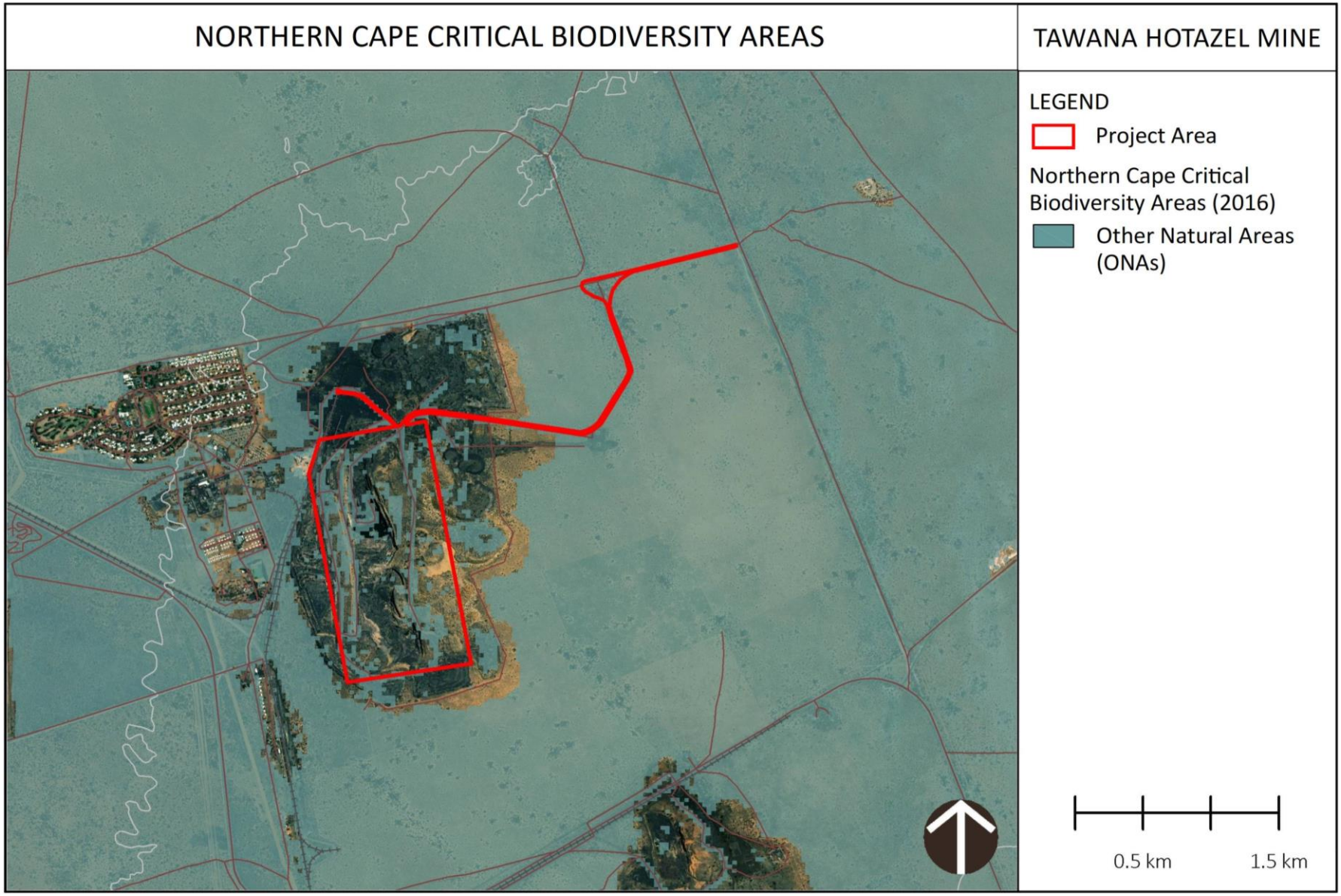

Figure 7: Location of the project area in relation to ONAs indicated by the Northern Cape CBA dataset (2016)

4 METHOD OF ASSESSMENT

There are fundamental differences between the scope and methodologies employed by ecological consultants as opposed to ecological researchers. In consultancy, judgements have to be made and advice provided that is based on the best available evidence, combined with experience and professional opinion. In most instances the available evidence is not ideal, potentially leading to over-simplification of ecological systems, and contain a high degree of uncertainty. This is opposed to ecological research, where evidence needs to be compelling before conclusions are reached (Hill & Arnold, 2012). The below methodologies employed for the baseline terrestrial biodiversity assessment aim to combine available literature and experience to gain an understanding into the broadscale terrestrial biodiversity likely associated with the project area.

4.1 Desktop Assessment

Prior to undertaking the field assessment, a background and literature review was undertaken. Relevant information was obtained from the following sources:

- An overview of the regional vegetation was obtained from relevant literature such Mucina & Rutherford (2006; 2012) and the most recent National Biodiversity Assessment (NBA; 2018), which includes the most recent vegetation classification of South Africa, as well as information contained in general field guides for the region and published literature;
- An overview of the location and extent of potential ecologically sensitive habitat was obtained through consideration of the Listed Threatened Ecosystem (2011), the Northern Cape CBA dataset (2016), and the NBA (2018) terrestrial remnant vegetation databases (refer to Sections 2 and 3 of this report);
- Other national and regional databases such as protected areas (SAPAD, 2020), conservation areas (SACAD, 2020), land use and land cover classes (Department of Environmental Affairs (DEA), 2014), drainage lines and wetlands (National Freshwater Ecosystem Priority Areas (NFEPA), 2011 and NBA National Wetland Map 5, 2018) and relief were also used to identify areas where potential sensitive habitat occur, and also to identify areas where natural/ near-natural and untransformed vegetation are likely to be present that may provide suitable habitat for floral SCC, protected and TOPS-listed species;
- The South African National Biodiversity Institute's (SANBI) Plants of southern Africa (POSA, 2013), the Botanical Database of southern Africa (BODATSA, 2016) and the Global Biodiversity Information Facility (GBIF) were used to determine floral SCC, protected and TOPS-listed floral species, as well as other floral species such as GWC endemics and near-endemics, that have the potential to occur within the project area;
- The SANBI Red List[1] was used to update the conservation status of floral SCC where applicable and provincially protected species as per Appendix B and to confirm any recent taxonomic changes; and
- In addition to the data sources mentioned above, recent aerial photographs were consulted prior to the field assessment in order to determine preliminary broad habitats units prior to defining these during the field assessment.

[1] www.redlist.sanbi.org

The faunal component of the terrestrial biodiversity assessment was undertaken at a desktop level only and utilised the following data sources in order to extrapolate faunal species whose distributions overlap with the project area. Such datasets include:

- Mammals:
    - Stuart's Field Guide to Mammals of Southern Africa (Stuart & Stuart, 2015);
    - Monadjem et al. (2010);
    - International Union for Conservation of Nature (IUCN) distributional data (2017); and
    - MammalMap (Animal Demographic Unit (ADU) Virtual Museum).[2]
- Herpetofauna:
    - FrogMAP (a continuation of the Southern African Frog Atlas Project (SAFAP));
    - A Complete Guide to the Frogs of Southern Africa (du Preez & Carruthers, 2009);
    - ReptileMAP (ADU Virtual Museum and Southern African Reptile Conservation Assessment (SARCA));
    - Atlas and Red List of Reptiles of South Africa, Lesotho and Swaziland (Bates et al., 2014); and
    - A Guide to the Reptiles of Southern Africa (Alexander & Marais, 2007).
- Avifauna:
    - The Southern African Bird Atlas Project 2 (SABAP2) was used to obtain a list of avian species occurring within the larger project area.

4.2 Field Assessment

A detailed field assessment of the project area was undertaken over a period of two days from the 23 - 24 November 2020 to ground-truth the findings of the desktop assessment and to determine the ecological condition of the project area and its surrounds. The following method was followed:

- The vegetation and associated habitat present within the project area were grouped into relatively homogenous habitat units based on aerial photography, different land uses, defined vegetation types and other available information as set out in Section 4.1 above;
- During the field assessment, a walkaround was undertaken for orientation purposes during which time visual observations pertaining to the various ecological attributes of the project area, its surroundings and associated habitat were made;
- The walkaround was following by an on-foot field assessment through subjective placement of sample sites along the steepest environmental gradient possible in order to maximise species detection. During this time vegetation and plant species present within each of the habitat units were identified and inventoried, and the boundaries of each habitat unit refined using a handheld Garmin eTrex 20x GPS device;
- Note was made of the ecological condition and sensitivity of the vegetation present within each habitat unit and existing impacts and disturbances were identified. Any special features considered to be of ecological importance were noted;
- Specific emphasis was placed on the potential occurrence of floral SCC, protected and TOPS-listed species, including those species highlighted by the SANBI POSA and BODATSA databases to occur within the 2722BB QDS, and areas providing suitable habitat for such species;

[2] http://vmus.adu.org.za

- Species encountered were compared with regional species lists available for the expected Kathu Bushveld vegetation type (Mucina & Rutherford, 2006); and
- During the field assessment, incidental faunal species were recorded in the form of direct observations and field signs such as scat, together with observations on broad faunal habitat conditions. It is important to note that these observations do not constitute a full faunal assessment.

4.3 Floral and Faunal SCC, Protected Species and TOPS-Listed Species

A record of floral and faunal SCC and the habitat requirements of these species was acquired from various SANBI, ADU and other databases for the 2722BB QDS. Floral SCC, protected and TOPS-listed species, as well as endemics/ near-endemics known to occur within the region and QDS are listed, together with their habitat requirements, in Section 6.3. Faunal SCC known to occur from the area (historic or recent) or adjacent areas (with similar habitat requirements to those present within the project area) have also been included in Appendix E. Given the relatively low sampling outputs of citizen science projects within the 2722BB QDS, faunal SCC from surrounding QDSs were also included within the assessment.

4.3.1 Species of Conservation Concern (SCC)

South Africa uses the internationally endorsed IUCN Red List Categories and Criteria. This scientific system is designed to measure species' risk of extinction, with the purpose of highlighting those species that are most urgently in need of conservation action.

The assessments contained in the national Red Lists are regional or national assessments, which mean that if a species is not endemic to South Africa, only that part of the species' distribution range falling within South Africa was evaluated in the assessment. Therefore, a species' status on the national Red Lists may differ from its global status on the IUCN Red List. Non-IUCN, national Red List categories for species not in danger of extinction, but considered of conservation concern are also included, with the IUCN equivalent of these categories being Least Concern (LC).

Threatened species are those species that are currently facing a high risk of extinction. Any species classified in the IUCN or SANBI Red List categories Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) is a threatened species.

Species of Conservation Concern (SCC) are species that have a high conservation importance and include Threatened species (CR, EN and VU categories), as well as those species classified in the categories Extinct in the Wild (EW), Regionally Extinct (RE), Critically Endangered, Possibly Extinct (CR PE), Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient – Insufficient Information (DDD) are considered Species of Conservation Concern (SCC). It is important to note that Data Deficient – Taxonomically Problematic (DDT) species and species indicated as LC (decreasing) are not considered floral SCC in line with SANBI Red List definitions.

Descriptions of the various National Red List Categories are included in the table below.

Table 1: National Red List Categories – Version 2020 (SANBI, 2020)

Category	Definition
Extinct (EX)	A species is Extinct when there is no reasonable doubt that the last individual has died.
Extinct in the Wild (EW)	A species is Extinct in the Wild when it is known to survive only in cultivation or as a naturalised population (or populations) well outside the past range.
Regionally Extinct (RE)	A species is Regionally Extinct when it is extinct within the region assessed (in this case South Africa), but wild populations can still be found in areas outside the region.
Critically Endangered, Possibly Extinct (CE PE)	Possibly Extinct is a special tag associated with the category CR, indicating species that are highly likely to be extinct, but the exhaustive surveys required for classifying the species as Extinct has not yet been completed. A small chance remains that such species may still be rediscovered.
Critically Endangered (CR)	A species is CR when the best available evidence indicates that it meets at least one of the five IUCN criteria for CR, indicating that the species is facing an extremely high risk of extinction.
Endangered (EN)	A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
Vulnerable (VU)	A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
Near threatened (NT)	A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable, and is therefore likely to become at risk of extinction in the near future.
***Critically Rare**	A species is Critically Rare when it is known to occur at a single site, but is not exposed to any direct or plausible potential threat and does not otherwise qualify for a category of threat according to one of the five IUCN criteria.
***Rare**	A species is Rare when it meets at least one of four South African criteria for rarity but is not exposed to any direct or plausible potential threat and does not qualify for a category of threat according to one of the five IUCN criteria. The four criteria are as follows: • Restricted range: Extent of Occurrence (EOO) <500 km^2, OR • Habitat specialist: Species is restricted to a specialised microhabitat so that it has a very small Area of Occupancy (AOO), typically smaller than 20 km^2, OR • Low densities of individuals: Species always occurs as single individuals or very small subpopulations (typically fewer than 50 mature individuals) scattered over a wide area, OR • Small global population: Less than 10 000 mature individuals.
***Declining**	A species is Declining when it does not meet or nearly meet any of the five IUCN criteria and does not qualify for CR, EN, VU or NT, but there are threatening processes causing a continuing decline of the species.
Least Concern (LC)	A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.
Data Deficient - Insufficient Information (DDD)	A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.
Data Deficient - Taxonomically Problematic (DDT)	A species is DDT when taxonomic problems hinder the distribution range and habitat from being well defined, so that an assessment of risk of extinction is not possible.

**Categories marked with * are non-IUCN, national Red List categories for species not in danger of extinction, but considered to be of conservation concern. The IUCN equivalent of these categories is Least Concern (LC).*

4.3.2 Protected Species

Protected species are species that are protected by international, national or provincial legislation. The translocation, owning, breeding or trading of faunal species is illegal without the applicable permits or licences in place. Damage or removal of protected floral species and/ or their habitat requires a permit issued by the relevant authorities (usually Provincial). Such a permit will only be issued after the collection of relevant field data and an analysis of the impact associated with the removal (CEN, 2019).

In the Northern Cape Province, provincial environmental legislation in the form of the NCNCA (Act No. 9 of 2009) provides for specially protected and protected species, while national legislation allows for the protection of certain tree species as listed in terms of the National Forests Act (Act No. 84 of 1998).

4.3.3 TOPS-listed Species

TOPS-listed Species are species listed as threatened or protected in terms of Section 56 of NEMBA (Act No. 10 of 2004) under the TOPS Regulations (2015). These species can also be classified as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) or Protected (P).

4.4 Terrestrial Ecological Sensitivity Analysis and Criteria

The terrestrial biodiversity sensitivity analysis has been compiled by assessing the current ecological condition of each identified habitat unit and its associated biodiversity value. This includes the interaction between each habitat unit's ecological sensitivity to the proposed development and the ecological structure of these habitats. The ecological sensitivity classes of each habitat unit identified during the field assessment has been determined by considering aspects such as:

- the occurrence of confirmed or potential floral or faunal SCC, protected or TOPS-listed species, or any other significant species within the habitat unit, such as endemics;
- the presence of unique landscapes and associated faunal habitat, including watercourses, ridges and rocky outcrops, or the presence of an ecologically intact habitat unit or faunal movement corridors within a transformed region;
- the conservation status, threatened status and biodiversity priority values of the ecosystem, vegetation type or provincial conservation plan in which the habitat unit is situated based on local, regional and national databases and the presence of remnant vegetation in line within the recently published NBA (2018);
- floral and faunal diversity compared to that of surrounding areas, and comparison of site conditions with published distribution data, available floristic databases and descriptions of the applicable vegetation types;
- the degree to which habitat integrity is intact, based on observed disturbances, existing impacts and level of habitat transformation;
- the perceived conservation value of the habitat unit; and
- the resilience of the habitat unit and its ability to recover after disturbance.

A conservation and land-use objective has also been assigned to each sensitivity class which aims to guide the responsible and sustainable utilisation or development within each of the defined habitat units. The various sensitivity classes and conservation objectives are presented in the table below.

Table 2: Habitat sensitivity ratings, descriptions and associated conservation objectives

Sensitivity Class	Sensitivity Class Description	Development Implication and Conservation Objectives
High	• Ecologically sensitive habitat with intact or primary vegetation and elevated niche and species diversity. • Intact or primary vegetation occurring within listed Threatened Ecosystems or designated CBA areas. • Confirmed or high potential for floral or faunal SCC or protected species occurrence. • High degree of connectivity with surrounding habitats. • Conservation of habitat unit is vital to achieving conservation targets and maintaining on site biodiversity attributes.	**Implication** • High ecological sensitivity habitat units are often protected by national or provincial legislation and development guidelines and frameworks. • Development within high ecological sensitivity habitat units is undesirable and generally not supported. • Impacts are difficult to mitigate or mitigation is not possible. **Objective** • The biodiversity of the habitat unit must be conserved and implementation of the no-go alternative considered.
Medium High	• Ecologically sensitive habitat that is intact but not unique or of exceptionally high value. • The habitat unit experienced some degree of disturbance, although largely limited in nature. • SCC or protected species may occur, but are not restricted to the habitat unit and occur in the surrounding region. • Conservation of the habitat unit may contribute towards achieving conservation targets and maintaining on site biodiversity attributes.	**Implication** • Development within medium high ecological sensitivity habitat units is undesirable. • Impacts are difficult to mitigate. • The habitat unit must be managed to prevent fragmentation and degradation. **Objective** • The biodiversity of the habitat unit must be conserved as far as possible through limiting development and disturbance.
Medium	• Habitat unit has undergone some disturbance, but is still functional and provide important ecosystem goods and services. • Habitat unit is associated with moderate niche diversity, but does not constitute unique habitat. • The habitat unit is required to ensure the functioning of adjacent habitats and larger ecological corridors.	**Implication** • Low impact development with limited impact on the receiving ecosystem could be considered. • Appropriate mitigation measures must be implemented. • It is still recommended that certain portions of the natural habitat be maintained, particularly where these form part of ecological corridors. • Impacts on adjacent habitat units of increased ecological sensitivity must be prevented. **Objective** • The biodiversity of the habitat unit must be conserved while optimising development potential.
Medium Low	• Habitat unit is mostly disturbed and the area in general has lowered or limited conservation value. • Habitat that is associated with lowered species diversity when compared to surrounds. • Limited suitable habitat for SCC or protected species is present within the	**Implication** • Development within these habitat units could be considered. • Small sections could be considered for conservation or excluded from development, particularly where such areas are connected to unique ecological features.

Sensitivity Class	Sensitivity Class Description	Development Implication and Conservation Objectives
	habitat unit and it is unlikely to contribute to achieving conservation targets.	• Appropriate mitigation measures must be implemented, specifically in managing of edge effects. **Objective** • Development within these habitat units must be optimised while managing edge effects.
Low	• Habitat unit has been significantly impacted with little conservation value and little to no natural habitat remaining. • Species diversity is low or predicted to be low, and dominated by species with generalist and adaptable habitat requirements. • Limited suitable or no permanent habitat for SCC or protected species is present within the habitat unit and the unit does not contribute to achieving conservation targets.	**Implication** • Most types of development can proceed within these habitat units, with little to no impact on habitat with conservation value. • Edge effects must be managed to prevent impacts on surrounding natural habitat. **Objective** • Development must be optimised within these habitat units.

4.5 Impact Assessment

The Prime Resources Impact Assessment Methodology and rationale was used to assess the significance of the potential impacts of the proposed mine layout as presented in Figure 3 on the receiving terrestrial ecological environment.

The objective of the Impact Assessment is to rate the significance of potential impacts of the project prior to and after the implementation of mitigation measures. The methodology encompasses an assessment of the nature, consequence (magnitude, extent, duration) and probability (likelihood) of the identified potential environmental impacts of the project. The reversibility of the impact as well as the cumulative impact are also considered. The impact is assessed prior to and after implementation of potential mitigation measures.

The following risk assessment model has been used for determination of the significance of impacts:

Significance = (Magnitude + Scale + Duration) x Probability

The maximum potential value for significance of an impact is 100 points. Environmental impacts can therefore be rated as high, medium or low significance on the following basis:

High environmental significance	60 – 100
Medium environmental significance	30 – 59
Low environmental significance	0 – 29

Magnitude (M)	
Minor (2)	Change not measurable; or threshold never exceeded. There is no need for people to adapt and will not notice changes to livelihoods and lifestyles.
Low (4)	Low disturbance of degraded areas, which have little conservation value. Minor change in species occurrence or variety. Minor deterioration (nuisance or minor deterioration) or harm to receptors.

	Change to receiving environment not measurable; or identified threshold never exceeded. People are able to adapt and maintain pre-impact livelihoods and lifestyles.
Moderate (6)	Moderate/ measurable deterioration or harm to receptors. Receiving environment moderately sensitive. Identified threshold occasionally exceeded. People are able to adapt with difficulty (with no resettlement). Pre-impact livelihoods and lifestyles can be maintained with difficulty or with support or intervention. Disturbance of areas that have potential conservation value or are of use as resources. Complete change in species occurrence or variety.
High (8)	High, measurable deterioration or harm to receptors. Receiving environment highly sensitive. Identified threshold often exceeded. Pre-impact livelihoods and lifestyles cannot be maintained or resettlement is required.
Very High / Unknown (10)	Loss of ecosystem function. Loss of an irreplaceable natural resource (including cultural and heritage resources). Disturbance of pristine areas that have important conservation value. Human health and or safety is compromised. Receptors of impact are of conservation importance; or identified threshold (such as SANS limits, Resource Quality Objectives, etc.) consistently exceeded. Unknown.
Scale (S)	
Footprint (0)	Occurs only within the footprint of the activity.
Site (1)	Occurs only within the site of the project.
Local (2)	Occurs within approximately 2.5 km of the activity.
Regional (3)	A regional scale as determined by administrative boundaries, habitat type/ecosystem or regional loss of a species population.
National (4)	Nationally important or macro-economic consequences.
International (5)	Internationally important agreements and resources are affected such as areas protected by international conventions, international waters etc. Unknown.
Duration (D)	
Immediate (1)	Completely reversible without management. Impact is instantaneous and ceases imminently.
Short (2)	Naturally reversible or reversible with minimal management. Impact ceases when the activity ceases.
Medium (3)	Impact can be reversed with sufficient management. Impact ceases when project ends.
Long (4)	Impact is potentially irreversible even with management.
Permanent (5)	Impact remains after the life of the project. The impact will continue indefinitely/ ad infinitum. Unknown.
Probability (P)	
Improbable (1)	Improbable, almost impossible.
Unlikely (2)	Low probability, unlikely to occur.
Likely (3)	Medium probability, likely to occur.
Expected (4)	High probability, expected to occur.
Definite (5)	Definite (certain) or unknown.

5 GENERAL CHARACTERISTICS OF THE PROJECT AREA

The biophysical attributes of the project area and surrounding region are discussed in the sections below.

5.1 Climate

The Kalahari region within which the project area is located receives both summer and autumn rainfall and is characterised by very dry winters (Figure 8). The region is semi-arid with a low Mean Annual Precipitation (MAP) of between 220 – 380mm, with significant annual variability and regular drought. Frost is frequent in winter. Mean monthly maximum and minimum temperatures for Sishen are 37.0°C and –2.2°C for December and July, respectively (Mucina & Rutherford, 2006).

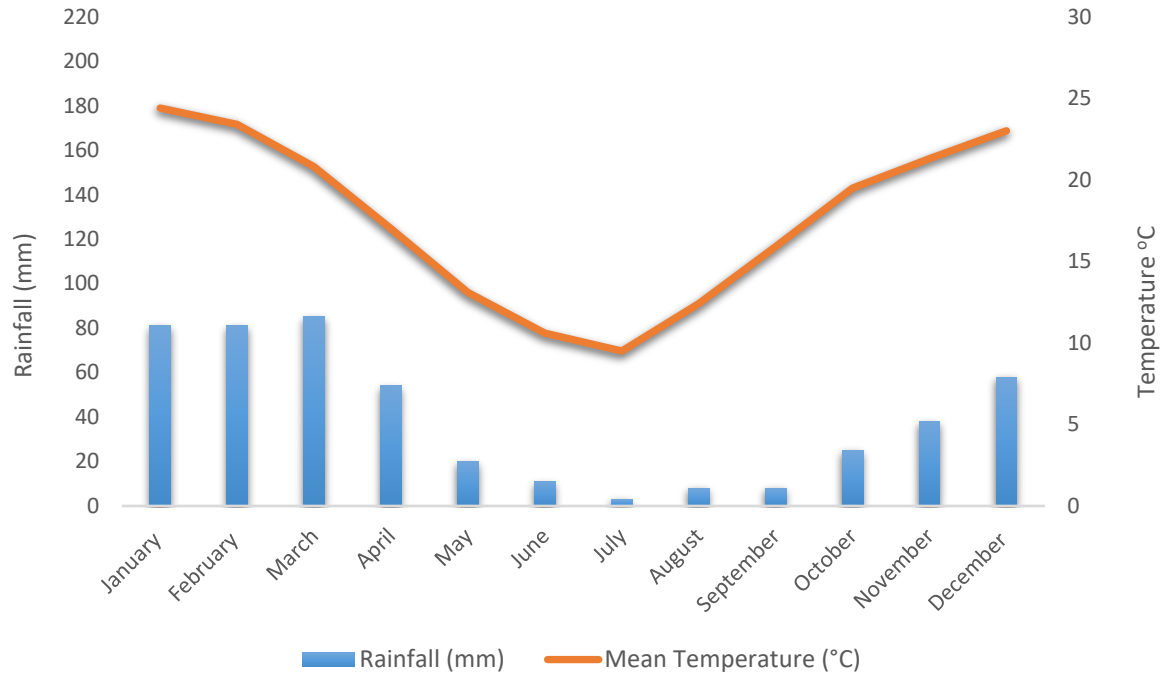

Figure 8: Climate data for the project area

5.2 Geology, Soils and Topographic Setting

The region is characterised by red aeolian sand and surface calcrete, and deep (>1.2 m) sandy soils of Hutton and Clovelly soil forms. Land types are mainly Ah and Ae, with some Ag (Mucina & Rutherford, 2006). The Kalahari sands are underlain by hardpan calcretes of the Mokalanen Formation (Kalahari Group). The relatively deep aeolian Kalahari sand originated in the Kalahari and has over time been blown south and accumulated in depressions between the mountains, hills and koppies. This deep sand reaches high temperatures during the summer months and has poor water retention (Frisby, 2016).

The project area is located in a relative flat area at an elevation of around 1,700 meters above mean sea level (mamsl). With the exception of the existing opencast void and surface dumps in the south and east of the project area, no significant landforms such as hills, valleys or outcrops could be

discerned from available elevation and relief data, although surface mine dumps are present within the east and south of the project area.

5.3 Surface and Ground Water

The project area is situated within Quaternary Catchment D41K, with the main drainage feature in the catchment being the Ga-Mogara River which is located around 4.7km to the west of the project area. The Witleegte River, a tributary of the Ga-Mogara River, runs approximately 8.3km to the south of the project area. The main river of the adjacent quaternary catchment D41L, the Kuruman River runs approximately 7.8km to the north of the project area. No smaller, non-perennial tributaries of any main rivers are indicated to occur in proximity to the project area (Figure 9).

The project area is not located within a surface water or groundwater Strategic Water Source Area (SWSA) (Water Research Commission (WRC), 2018), with the closest SWSA being the Northern Ghaap Plateau groundwater SWSA, approximately 6.5km to the east and the Sishen/ Kathu groundwater SWSA around 10km to the south (Figure 9).

According to the NFEPA (2011) and NBA Wetland Map 5 (2018) databases, no natural or artificial wetland features occur within proximity to the project area. The closest wetland features to the project area, indicated to be depression (pan) wetlands, are shown to occur more than 4km to the east and west.

The NFEPA database indicates the project area to be located within two Class 4 upstream Freshwater Ecosystem Priority Area (FEPA) sub-quaternary catchment associated with the Ga-Mogara and Kuruman Rivers. The management measures stipulated by the hydrologist and freshwater/ wetland ecologist (if applicable) must be complied with in order to manage any potential impacts to water quality and flow characteristics resulting from the proposed project, to ensure that aquatic ecosystems associated with and downstream of the project area are maintained.

5.4 Land Cover

The National Land Cover database (DEA, 2014) indicates a mining land use within the majority of the project area with no to limited vegetation present. The surrounding area, including the proposed access road, are indicated as low shrubland, with urban and industrial land uses associated with the town of Hotazel and surrounds. Scattered areas of woodland are indicated within and around the project area (Figure 10).

5.5 National Vegetation Types

The project area is located within the Savanna Biome (Rutherford & Westfall, 1994; Rutherford, 1997) and within the Eastern Kalahari Bushveld Bioregion (Mucina & Rutherford, 2006). This region is relatively flat, with the exception of mountainous terrain occurring in the southwest such as the Korannaberg, Langeberg and Kuruman Mountain to the southeast. The vegetation comprises an open to dense tree savanna with grassy plains in places (Van Rooyen & Van Rooyen, 2019). Previous national vegetation classifications defined the regional vegetation as the typical, open western form of Kalahari Thornveld (Acocks, 1953) and Kalahari Plains Thorn Bushveld (Low & Rebelo, 1996).

According to the most recent vegetation classification by Mucina & Rutherford (2006), the project area occurs within Kathu Bushveld vegetation type, which is considered to have a conservation status of Least Threatened.

The location of the project area in relation to the Kathu Bushveld and adjacent Gordonia Duneveld vegetation types is illustrated in Figure 11. The main characteristics of the Kathu Bushveld vegetation type are summarised in Table 3 below.

Table 3: Summary of the main characteristics of the Kathu Bushveld vegetation type (Mucina & Rutherford, 2006)

Vegetation Type	**SVk12** **Kathu Bushveld**
Landscape and Distribution	Plains from Kathu and Dibeng in the south, through Hotazel, in the vicinity of Frylinckspan to the Botswana border roughly between Van Zylsrus and McCarthysrus. Occurs at altitudes of 960-1,300m.
Characteristic vegetation	Medium-tall tree layer with *Vachellia* (*Acacia*) *erioloba* in places, but mostly open and including *Boscia albitrunca* as the prominent trees. The shrub layer is generally most important with, for example, *Senegalia mellifera, Diospyros lycioides* and *Lycium hirsutum*. The grass layer is variable in cover.
Conservation Status	**Least threatened,** with a conservation target of 16%. None is conserved in statutory conservation areas. More than 1% already transformed, including the iron ore mining locality at Sishen, one of the biggest open-cast mines in the world. Erosion is very low.
Important taxa (d=dominant)	Tall Tree: *Vachellia* (*Acacia*) *erioloba* (d). Small Trees: *Senegalia* (*Acacia) mellifera* subsp. *detinens* (d), *Boscia albitrunca* (d), *Terminalia sericea*. Tall Shrubs: *Diospyros lycioides* subsp. *lycioides* (d), *Dichrostachys cinerea*, *Grewia flava*, *Gymnosporia buxifolia*, *Rhigozum brevispinosum*. Low Shrubs: *Aptosimum decumbens*, *Grewia retinervis*, *Nolletia arenosa*, *Sida cordifolia*, *Tragia dioica*. Graminoids: *Aristida meridionalis* (d), *Brachiaria nigropedata* (d), *Centropodia glauca* (d), *Eragrostis lehmanniana* (d), *Schmidtia pappophoroides* (d), *Stipagrostis ciliata* (d), *Aristida congesta*, *Eragrostis biflora*, *E. chloromelas*, *E. heteromera*, *E. pallens*, *Melinis repens*, *Schmidtia kalahariensis*, *Stipagrostis uniplumis*, *Tragus berteronianus*. Herbs: *Acrotome inflata*, *Erlangea misera*, *Gisekia africana*, *Heliotropium ciliatum*, *Hermbstaedtia fleckii*, *H. odorata*, *Limeum fenestratum*, *L. viscosum*, *Lotononis platycarpa*, *Senna italica* subsp. *arachoides*, *Tribulus terrestris.* **Biogeographically Important Taxa (Kalahari endemics)** Small Tree: *Vachellia* (*Acacia*) *luederitzii* var. *luederitzii*. Graminoids: *Anthephora argentea*, *Megaloprotachne albescens*, *Panicum kalaharense*. Herb: *Neuradopsis bechuanensis*.

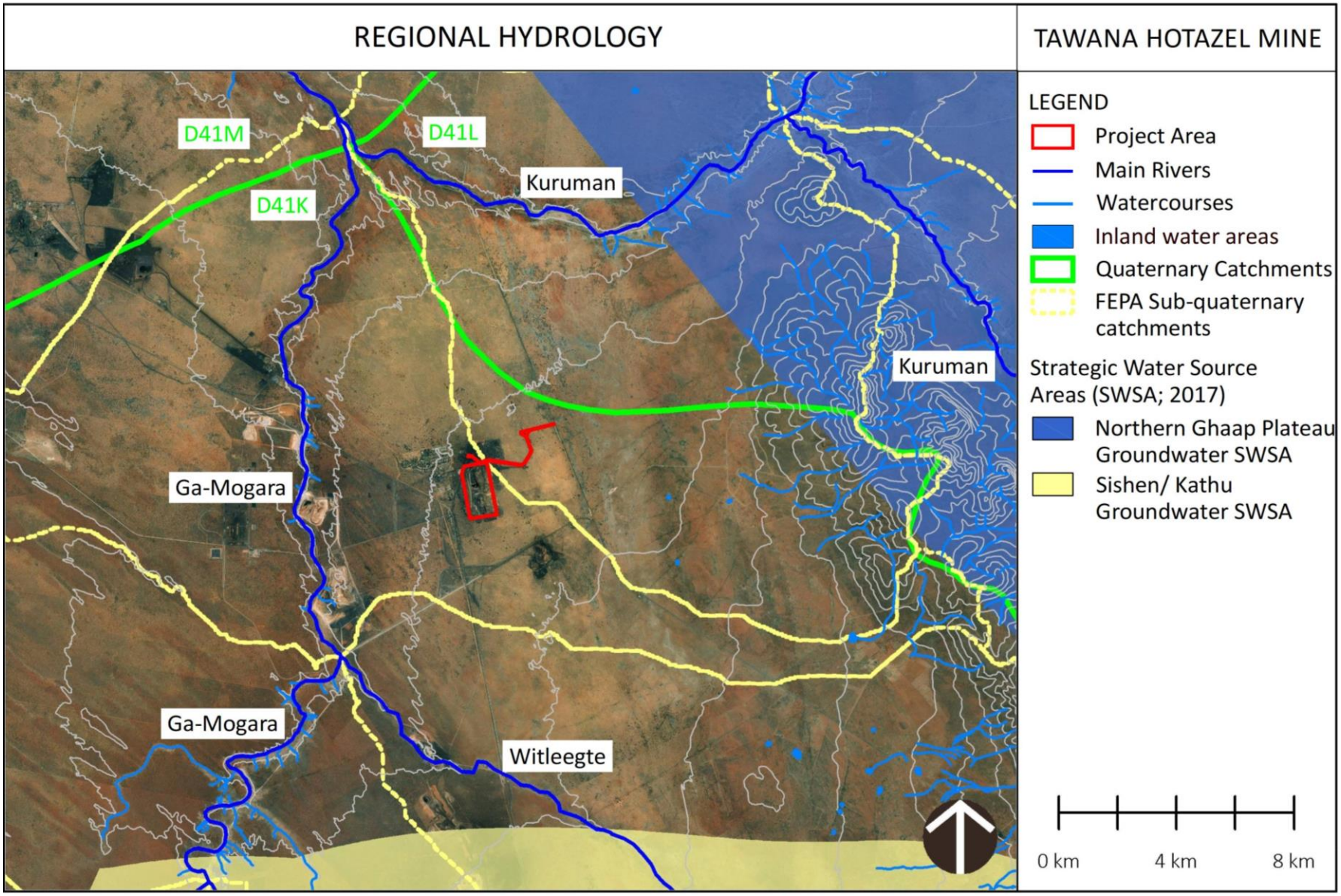

Figure 9: Hydrological setting of the project area

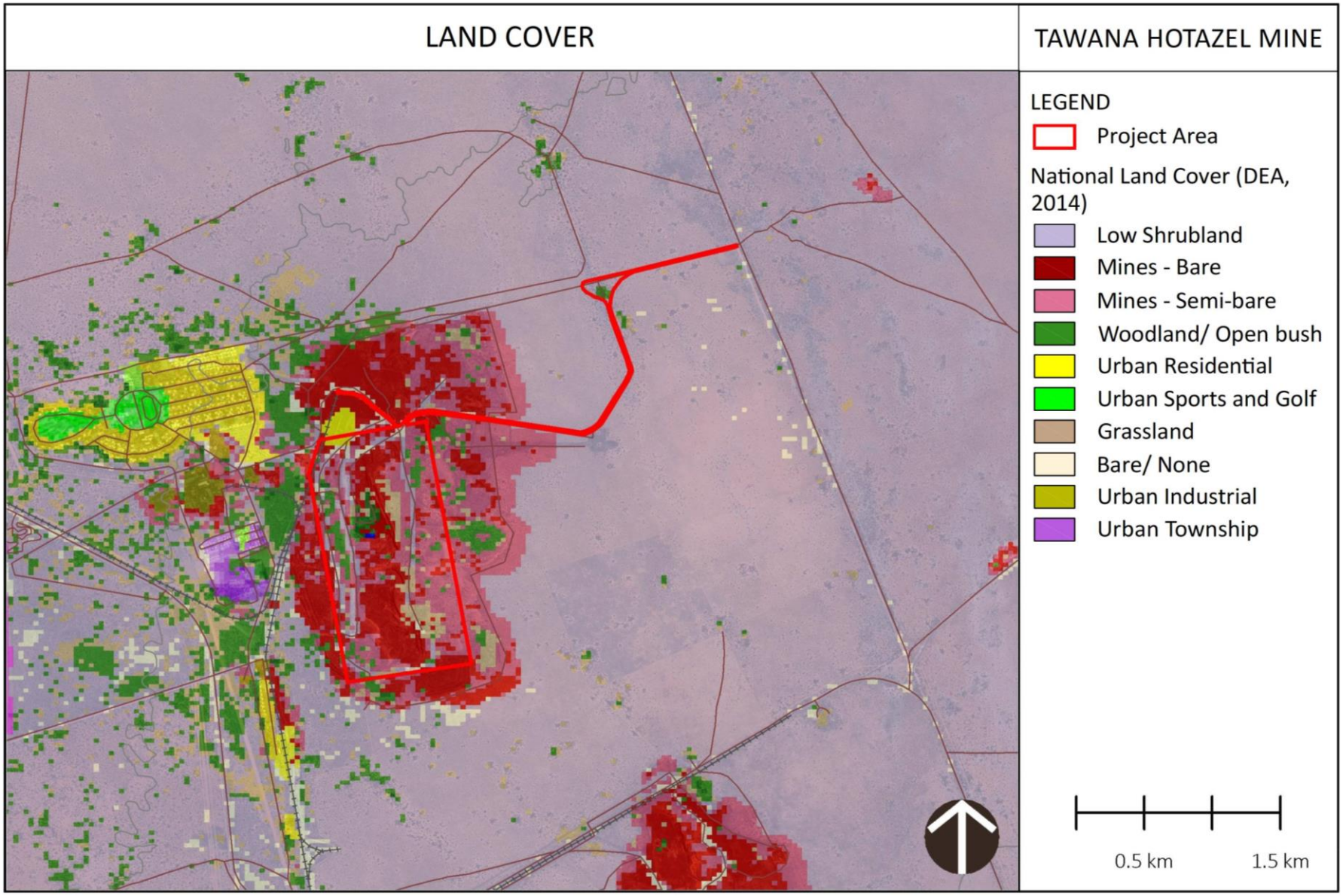

Figure 10: National land cover types associated with the project area

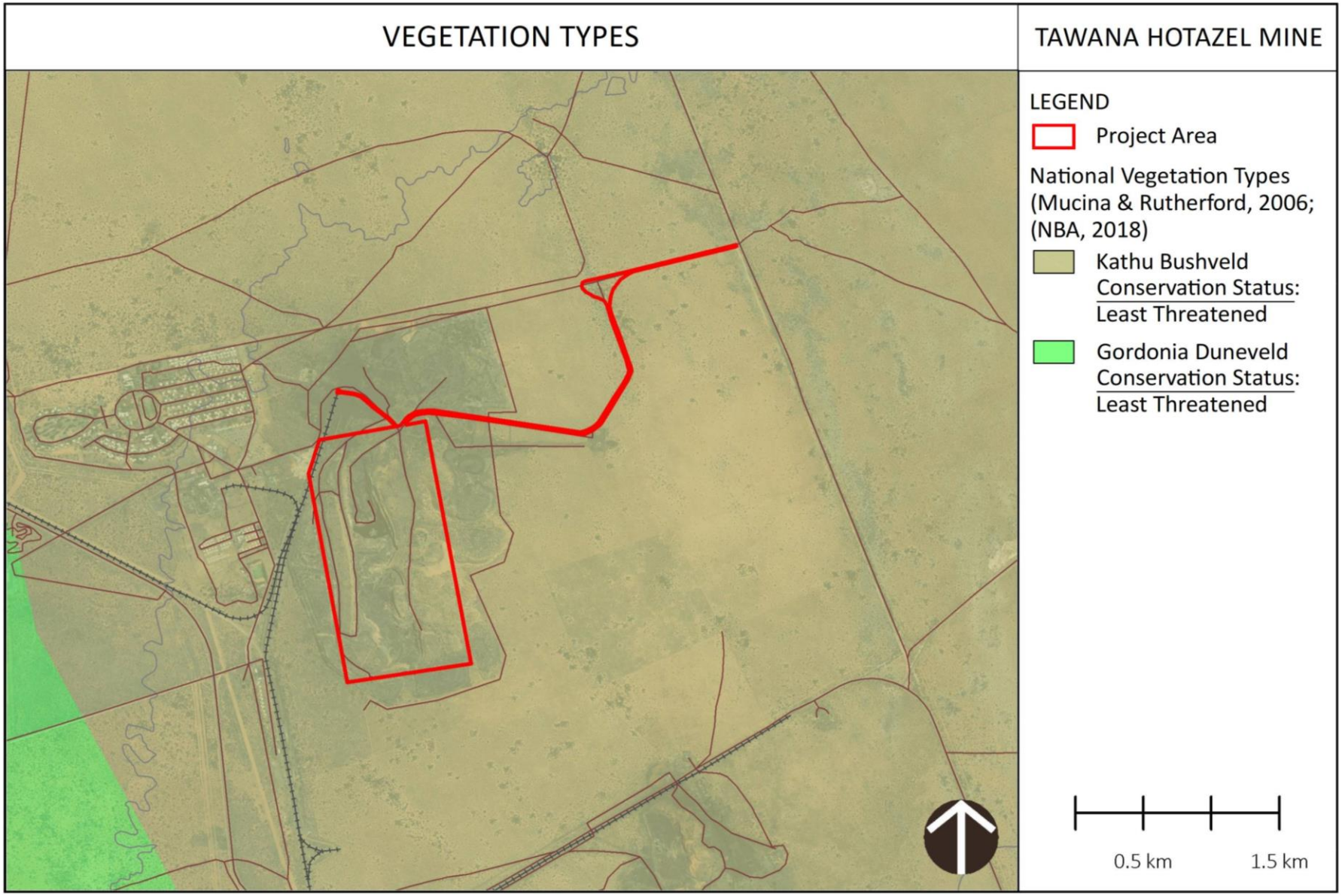

Figure 11: Vegetation types associated with the project area and surrounds

6 RESULTS OF THE BASELINE TERRESTRIAL BIODIVERSITY ASSESSMENT

6.1 Ecological Drivers and Processes

A key event driving the ecology within the majority of the project area is direct disturbance due to the historical construction and operation of mining and related infrastructure. The direct loss of surface vegetation cover, displacement of suitable soils as growing medium and subsequent loss of the indigenous seed bank, have resulted in large areas of the project area being either devoid of vegetation, particularly along steep embankments of the opencast void, or dominated by alien plant species such as *Prosopis glandulosa* var. *torreyana* (mesquite). This alien species was introduced to the Kalahari in the late 1800s as a source of shade and fodder for livestock and has since become a significant invasive species in the region (Henderson & Harding, 1992; Colvin et al., 2007). This and other *Prosopis* spp. are adapted to establishment under suboptimal conditions within disturbed and impacted areas, particularly along water courses and within areas where access to groundwater is assured (Henderson & Harding, 1992). Groundwater-dependent species such as *Prosopis* spp. are also referred to as phraetophytes. In the Kalahari, this species competes with other phraetophytic species such as *Vachellia erioloba* and, as suggested by Shadwell & February (2007), also *V. haematoxylon*, both which occur in the project area, for groundwater resources. These species are deeply rooted, and capable of accessing deep groundwater in aquifers up to 40m - 60m deep during the wet season and are therefore sensitive to changes in the water table (Colvin et al., 2007; Shadwell & February, 2017), and may be outcompeted by invasive *Prosopis* spp. over time. Both *V. erioloba* and *V. haematoxylon* are considered keystone species in the arid and semi-arid savannas of southern Africa due to their importance in providing nesting sites, shade, food resources and soil nutrients for a variety of animal and other plant species.

Other historically disturbed areas within the project area, such as existing surface dumps where improved growing conditions occur, are dominated by the indigenous bush encroacher species, *Senegalia mellifera* subsp. *detinens*, while natural Kathu Bushveld vegetation adjacent to the main access road in the northeast is currently impacted by ongoing grazing, resulting in changes to vegetation structure and the establishment and spread of alien species, including *Prosopis* spp. The loose sandy soils and sparse tuftedness of the grass layer makes this vegetation type particularly vulnerable to grazing pressure (Acocks, 1953). Remnant Kathu Bushveld bordering the opencast void have also been impacted by bush encroachment and the presence of invasive alien species, although to a lesser extent, due to edge effects from surrounding historic mining activities.

It is also important to note that habitat fragmentation, when considering remnant Kathu Bushveld bordering the opencast void specifically, leads to a decline in biodiversity. Ecological processes that are important for ecosystem health often operate at a large spatial scale, which means that in most instances, large, contiguous tracts of habitat is required for ecological processes such as fire, grazing, dispersal and pollination to operate effectively (CEN, 2016).

From the above it is evident that although vegetation re-establishment, one of the key ecological processes taking place within the project area has occurred and continues to take place within disturbed habitats since production ceased in 1989 (Figure 12), this increase in vegetation cover is mainly characterised by invasive alien species encroachment and indigenous bush encroachment. Under natural conditions woody species, grasses and forbs, and faunal species exist in a stable

balance; where this balance is altered due to disturbance, exclusion of fire from the landscape or overgrazing, indigenous bushes and trees could increase in density to such an extent that much other vegetation is excluded. *Senegalia mellifera* subsp. *detinens* is such an aggressive coloniser within semi-arid environments and occur throughout the project area in varying density.

Ecological drivers governing vegetation re-establishment processes within the project area are mainly controlled by climatic conditions, which are characterised by low, variable regional rainfall and seasonal droughts. High temperatures and low surface moisture availability, coupled with generally slow growth rates and episodic recruitment of indigenous species in the region leads to natural indigenous vegetation recovery being slow, allowing opportunity for alien and pioneer woody species, to rapidly establish and persist within disturbed areas. Other drivers include higher CO_2 levels experienced in the historic development of the savanna biome (CEN, 2016) as well as rising CO_2 concentrations due to climate change, that may aggravate bush thickening; as well as fire management, overgrazing, groundwater availability for phraetophytes, and the exclusion of larger browsers from the historical mining area.

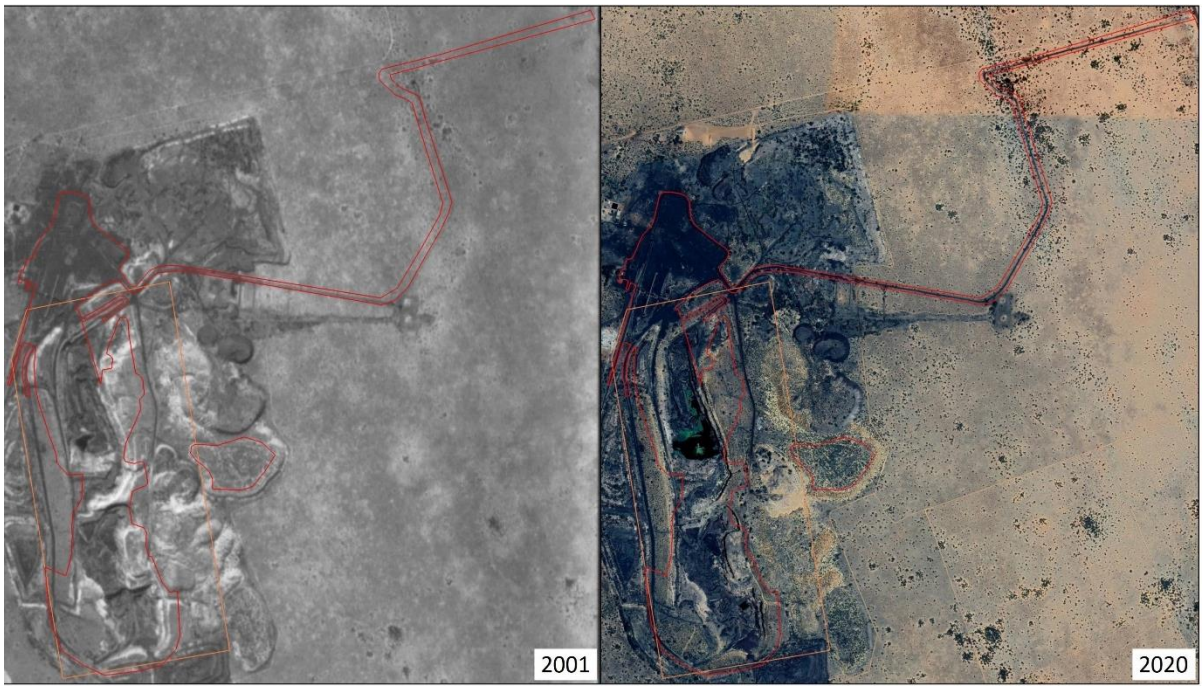

Figure 12: Change in vegetation cover within the project area from 2001 (left) to 2020 (right)

6.2 Habitat Assessment

The structure of the landscape influences vegetation communities which in turn shapes faunal diversity through the provision of food resources, habitat corridors and refugia. Four broad habitat units were identified within the project area, based primarily on floral species composition and vegetation structure, faunal species' habitat provision, the topographical position of the habitat unit in the landscape, as well as the degree of historical and current anthropogenic impact and disturbance within the unit. These habitat units are:

- Existing Infrastructure, which comprises the majority of the project area, specifically occurring within the residual opencast void within the centre of the MR area and historical processing plant and rail loadout facility in the north of the project area. This habitat unit is characterised

by the absence of vegetation and where vegetation is present, these communities are dominated by alien species;

- The In-Pit Aquatic habitat unit that is associated with the surface water present in the historical opencast workings. Vegetation within this habitat unit is dominated by hydrophytic vegetation, most notably dense stands of *Phragmites australis*;
- The Modified Kathu Bushveld habitat unit, which includes areas that have not previously been cleared for mining and associated activities but mostly occurs in the vicinity of historical disturbance where, although dominated by indigenous species, alteration to the vegetation structure and composition has taken place; and
- The Secondary Thornveld habitat unit that is restricted to historical surface dumps and comprises mostly indigenous vegetation that have re-established on these areas over time. Vegetation in these areas is dominated by *Senegalia mellifera* subsp. *detinens*, an indigenous pioneer thorn tree/ large shrub species that rapidly establishes on shallow soils and within previously disturbed areas provided that growing medium is available.

The location and extent of each habitat unit is indicated in the Figure 13, and each habitat unit is broadly discussed in the sections that follow. Each broadscale habitat unit includes micro and niche habitats of varying degrees which in turn influences the associated habitat heterogeneity. These micro-habitats provide benefits to fauna as the structure of the landscape and associated vegetation communities strongly influences faunal diversity through the provision of food resources, habitat corridors and refugia. Furthermore, the degree of connectivity between these broadscale habitats (and subsequently the niche habitats within) also influences the occurrence and movement of fauna through the landscape (degree of landscape permeability) during foraging bouts or dispersal events.

All habitat units have historically been subject to varying degrees of disturbance due to mining activities and construction and operation of associated infrastructure. Ongoing disturbances due to grazing and trampling by livestock, horses and donkeys is taking place along the main access road in the northeast.

A list of floral species, indicating species recorded from each habitat unit is included in Appendix A.

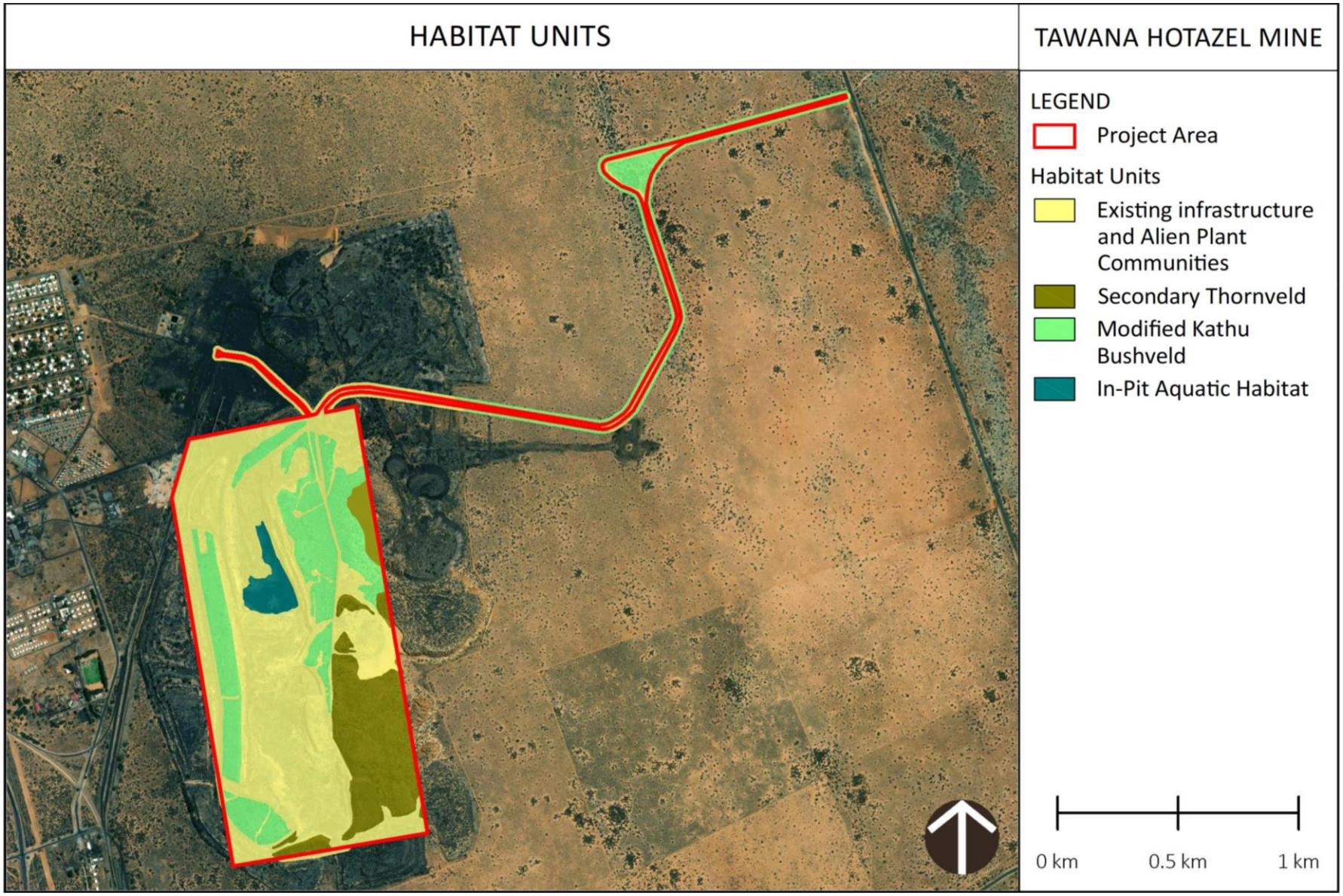

Figure 13: Habitat units identified within the project area

6.2.1 Existing Infrastructure and Alien Vegetation Communities

Existing infrastructure components within the project area most notably include the residual opencast void and associated access roads, the access road entering the MR area from the northeast, and the existing processing plant and rail loadout facility in the north (Figure 14). In-pit water is present within the historic opencast void where aquatic habitat has established (refer to Section 6.2.2).

Due to high levels of historical disturbance, large portions of this habitat unit are devoid of vegetation particularly in areas where waste rock occurs, surfacing has taken place and along the steep embankments of the opencast void. Where vegetation is present, these communities are generally dominated by the invasive alien tree species *Prosopis glandulosa* var. *torreyana* and the invasive alien grass species *Pennisetum setaceum*. Other woody species recorded from this habitat unit include the indigenous trees/ shrubs *Senegalia mellifera* subsp. *detinens*, *Vachellia hebeclada* subsp. *hebeclada* and a low abundance of *Grewia flava* and *Searsia lancea*. Overall forb diversity is low, with several alien species such as *Chenopodium album* and *Argemone ochroleuca* present. Indigenous herbaceous species include *Sida cordifolia* subsp. *cordifolia*, *Ceratotheca triloba* and *Polygala seminuda*. The grass layer is relatively sparse, and in addition to *P. setaceum,* comprises species such as *Melinis repens*, *Stipagrostis uniplumis, Aristida stipitata* and *Schmidtia pappophoroides.*

Figure 14: Representative photographs of the Existing Infrastructure habitat unit

This habitat unit has an overall low indigenous floral and faunal biodiversity and does not provide habitat for floral and faunal SCC, TOPS-listed or endemic species. An exception to the aforementioned, is the known presence of Verreaux's eagle (*Aquila verreauxii*), classified as Vulnerable (VU), with a

breeding pair nesting against the embankment of the opencast void. The persistence of this species has been assessed in detail as part of the avifaunal specialist report.

6.2.2 In-Pit Aquatic Habitat

The In-Pit Aquatic habitat unit is located towards the north-central portion of the opencast void and comprises open water surrounded by dense *Phragmites australis* reedbeds (Figure 15). Approximately 600,000m^3 of water is present in the historical underground and opencast workings which will be dewatered to a new, appropriately sized and lined, surface impoundment for use in the wet-screening process as part of the proposed project. Other floral species recorded in proximity to the aquatic habitat include the indigenous *Searsia lancea* and several woody alien species including *Prosopis glandulosa* var. *torreyana, Schinus molle* and the shrub *Nicotiana glauca.*

Various waterfowl were noted within this habitat unit, while adits surrounding the area provide habitat for swallow and swift species, as well as bats.

Figure 15: Representative photographs of the In-Pit Aquatic habitat unit. Adits are shown in the bottom right image

This habitat unit has an overall low indigenous floral biodiversity and no floral SCC, TOPS-listed, nationally or provincially protected or endemic species were recorded during the field assessment.

6.2.3 Modified Kathu Bushveld

Although the majority of the project area has been directly impacted by past disturbances related to mining activities, remnant Kathu Bushveld occurs within the project area in proximity to the opencast void and adjacent to the main access road entering the MR area from the northeast (Figure 16), which is proposed to be upgraded as part of the proposed project to a final width of approximately 12m. Although less disturbed than the Existing Infrastructure habitat unit, the extent of the Modified Kathu Bushveld habitat unit has been indirectly impacted by edge effects from mining and related infrastructure, which has led to changes in species composition, including an increase in alien species, and changes to the vegetation structure. This is particularly evident along the access road, where grazing and trampling by livestock, horses and donkey continue to take place.

Figure 16: Representative photographs of the Modified Kathu Bushveld habitat unit, indicating the remnant Kathu Bushveld area within the MR area (top) and Modified Kathu Bushveld adjacent to the access road (bottom)

The Modified Kathu Bushveld habitat unit provides habitat for an increased number and diversity of floral and faunal species due to improved habitat quality and heterogeneity when compared with other habitat units in the project area. While this habitat unit, where it is associated with the MR area, is isolated from intact Kathu Bushveld within the larger region due to fencing of the historic mining area, a higher degree of habitat connectivity and landscape permeability exists adjacent to the access roads.

Tree and shrub species characterising the vegetation within Modified Kathu Bushveld habitat unit include the invasive alien species *Prosopis glandulosa* var. *torreyana* and *P. velutina,* indigenous species such as *Vachellia hebeclada* subsp. *hebeclada, Grewia flava* and *Lycium hirsutum,* as well as

the nationally protected tree species *Vachellia erioloba* and *V. haematoxylon*. *Tarchonanthus camphoratus* and *Terminalia sericea* occur in low abundance and were only occasionally encountered during the field assessment. A moderate diversity of forb species is present with prominent species including *Senna italica* subsp. *arachoides,* various *Hermannia* spp., *Hermbstaedtia odorata, Peliostomum leucorrhizum, Crotalaria spartioides, Orthanthera jasminiflora, Geigeria spp., Ipomoea* spp*., Kyllinga alba, Rhynchosia holosericea*, *Pavonia burchellii* and *Acanthosicyos naudinianus,* amongst others. Grasses are relatively sparse, tufted, and dominated by *Aristida* spp., *Eragrostis lehmanniana, Schmidtia* spp*.,* with *Pogonarthria squarrosa* and *Setaria verticillata* also recorded.

Several faunal species were noted during the floral field assessment (either directly, or through discussions with mine personnel) including Rock Hyrax (*Procavia capensis*), Cape Porcupine (*Hystrix africaeaustralis*), Cape Hare (*Lepus capensis*), Ground Squirrel (*Xerus inauris*) and *Gerbilliscus* sp. Given historic disturbances within this habitat unit, modifications to faunal assemblages within this habitat have likely occurred, with species utilising these habitats displaying a high degree of behaviour plasticity. Remaining habitats remain important to fauna present, given the extensive habitat alterations due to historic mining in the surrounding area.

Although no floral SCC were recorded or are likely to be present based on species distribution records and habitat requirements, the TOPS-listed floral species, *Harpagophytum procumbens*, which is also provincially protected in terms of Schedule 1 of the NCNCA (Act No. 9 of 2009) was recorded in the Modified Kathu Bushveld habitat within both the MR area and along the access road. Other confirmed provincially protected floral species recorded within this habitat unit in terms of Schedule 2 of the NCNCA (Act No. 9 of 2009), include species of the provincially protected plant families Aizoaceae (*Plinthus sericeus*), Amaryllidaceae (*Ammocharis coranica*, *Boophone disticha* and *Crinum* sp.), Apocynaceae (*Orthanthera jasminiflora*) and the provincially protected genus *Ornithogalum (Albuca seineri and A. setosa;* both previously taxonomically classified as *Ornithogalum* spp.). Habitat is also suitable for several other provincially protected species known from the region and the nationally protected tree *Boscia albitrunca*; this and other provincially protected species were however not recorded during the field assessment. As mentioned, both *Vachellia erioloba* and *V. haematoxylon* confirmed from the project area are protected in terms of the National Forests Act (Act No. 84 of 1998), with *V. haematoxylon* occurring in very high abundance in this habitat unit within both the MR area and along the access road. If present, GWC endemics and near-endemics are most likely to occur within this habitat unit.

In terms of faunal species, TOPS-listed faunal species Aardvark (*Orycteropus afer*), Bat-eared Fox (*Otocyon megalotis*) and Cape Fox (*Vulpes chama*) may utilise this area.

6.2.4 Secondary Thornveld

The Secondary Thornveld habitat unit comprises vegetated areas on historic surface dumps to the east and south of the opencast void where vegetation has established since mining activities ceased (Figure 17). This vegetation is dominated by *Senegalia mellifera* subsp. *detinens*, an indigenous pioneer species that rapidly establishes on shallow soils and within previously disturbed areas provided that growing medium is available.

Vegetation in this habitat unit has a lowered biodiversity and hosts a high proportion of pioneer forb and grass species, with a low abundance of alien vegetation also present. Forb species recorded include *Ipomoea* spp., *Felicia muricata* and *Senecio inaequidens*, while the most prominent graminoid recorded was *Stipagrotis uniplumis,* a species that plays an important role in soil stabilisation (Van Oudtshoorn, 2004).

Figure 17: Representative photographs of the Secondary Thornveld habitat unit

This habitat unit is unlikely to provide habitat for floral and faunal SCC, protected or TOPS-listed species due to past disturbances and altered habitat conditions, and no such species were recorded.

6.3 Floral SCC, Protected and TOPS-listed and Endemic Species

Floral SCC

An assessment was undertaken considering the occurrence of any IUCN or SANBI threatened floral species or other SCC as defined in Section 4.3.1, including suitable habitat to support such species. According to the POSA dataset, no floral SCC are listed for the 2722BB QDS, and no floral SCC are indicated by the BODATSA and GBIF databases to occur in the surrounding region. It is therefore unlikely that floral SCC will occur in the project area or immediate surroundings, and no such species were recorded during the field assessment.

Protected Floral Species

The protected tree species listed in Table 4 below have been identified within the project area or have an increased likelihood of occurrence. *Vachellia erioloba* and *V. haematoxylon* were confirmed within the Modified Kathu Bushveld habitat unit. *Boscia albitrunca* is known to occur in the region, but was not recorded in the project area.

Table 4: Protected tree species in terms of the National Forest Act (Act No. 84 of 1998) confirmed to occur in the project area.

Species	SANBI threat status	Conservation status	Habitat	Habitat Unit
Vachellia erioloba	LC	Nationally Protected	Savanna, semi-desert and desert areas with deep, sandy soils and along drainage lines in very arid	Confirmed from the Modified Kathu Bushveld habitat unit.

Species	SANBI threat status	Conservation status	Habitat	Habitat Unit
			areas, sometimes in rocky outcrops.	
Vachellia haematoxylon	LC	Nationally Protected	Occurs in rid regions with deep red Kalahari sands, either on sandy flats between dunes or on the dune crests. It is also found along dry river beds.	Confirmed from the Modified Kathu Bushveld habitat unit.

LC – Least Concern

A number of plant families and genera are protected in terms of the NCNCA (Act No. 9 of 2009) (Appendix B), with those taxa listed in Schedule 1 being mostly threatened and those listed in Schedule 2 generally common and widespread. During the field assessment, one Schedule 1 NCNCA (Act No. 9 of 2008) species, namely *Harpagophytum procumbens*, was recorded from the Modified Kathu Bushveld habitat unit in high abundance, with several Schedule 2 also recorded from this habitat unit. A list of confirmed provincially protected species is included in Table 5. Although provincially protected, none of the species indicated are considered to be national conservation priority species, with all species listed having a conservation status of Least Concern (LC). *H. procumbens* is also a TOPS-listed floral species due ongoing and unsustainable harvesting of this species for medicinal purposes.

Based on data obtained from the BODATSA and GBIF databases, several other Schedule 2 provincially protected floral species are also known to occur in the region within which the project area is located. Although not recorded during the field assessment, other common and widespread species from the Aizoaceae and Apocynaceae plant families, species from the Apiaceae, Asphodelaceae, Euphorbiaceae, Iridaceae, Capparaceae (e.g. *Boscia albitrunca*) and Celastraceae (e.g. *Gymnosporia buxifolia*) plant families, as well as *Jamesbrittenia atropurpurea* subsp. *atropurpurea,* amongst others, have a possibility of also occurring, most likely within the Modified Kathu Bushveld habitat unit.

Table 5: Protected floral species in terms of the NCNCA (Act No. 9 of 2009) confirmed to occur within the project area

Species	SANBI threat status	Habitat Unit
Schedule 1: Specially Protected Species		
Harpagophytum procumbens	LC	Confirmed from the Modified Kathu Bushveld habitat unit.
Schedule 2: Protected Species		
Family Mesembryanthemaceae (=Aizoaceae) – All Species *Plinthus sericeus*	 LC	Confirmed from the Modified Kathu Bushveld habitat unit.
Family Amaryllidaceae – All species except those listed in Schedule 1 *Ammocharis coranica* *Boophone disticha* *Crinum* sp.	 LC LC LC	Confirmed from the Modified Kathu Bushveld habitat unit.
Family Apocynaceae – All species except those listed in Schedule 1 *Orthanthera jasminiflora*	 LC	Confirmed from the Modified Kathu Bushveld habitat unit.

Species	SANBI threat status	Habitat Unit
Genus Ornithogalum (Family Hyacinthaceae) *Albuca seineri* (=*Ornithogalum seineri*) *Albuca setosa* (=*Ornithogalum setosum*)	 LC LC	Confirmed from the Modified Kathu Bushveld habitat unit.

LC – Least Concern

TOPS-listed Floral Species

Based on a review of the distribution and habitat requirements of TOPS-listed floral species known to occur in the Northern Cape Province (refer to Appendix B), the majority of these TOPS-listed species are floral SCC occurring in the Richtersveld and succulent Karoo (refer to Appendix C), with no distribution overlap with the project area. One Protected (P) TOPS-listed floral species, as indicated in Table 6, has however been confirmed to occur in high abundance within the project area where it is restricted to the Modified Kathu Bushveld habitat unit. One other TOPS species, namely *Drimia sanguinea* (P; with a national threat status of Neat Threatened (NT)), has an increased likelihood of occurrence, with its preferred habitat known to be open veld and scrubby woodland. This species but was not recorded from the project area, but if present, will also occur within the Modified Kathu Bushveld habitat unit where available habitat has been less severely impacted.

Table 6: TOPS-listed floral species confirmed to occur within the project area

Species	SANBI threat status	TOPS status	Habitat	Habitat Unit
Harpagophytum procumbens	LC	P	Well drained sandy habitats in open savanna and woodlands.	Confirmed from the Modified Kathu Bushveld habitat unit.

LC – Least Concern ; **P** – Protected

Endemic/ Near-endemic Floral Species

A review of the distribution and habitat requirements of endemic and near-endemic floral species of the GWC (Appendix D) was undertaken, together with data obtained from the BODATSA and GBIF databases. The findings indicate that five endemic species, namely *Glossochilus burchellii, Justicia puberula, Putterlickia saxatilis, Searsia tridactyla* and *Tarchonanthus obovatus* are known to occur in the region surrounding the project area. The habitat available within the project area does however not correspond with the habitat requirements and distribution patterns of these species, and it is unlikely that these, or other endemics and near-endemics, occur within the project area, although outlier populations may occur.

It is further important to note that the project area is not with located within the GWC core area (Frisby, 2016), where high concentrations of GWC endemics occur. These areas are mainly associated with distinct higher-lying areas such as the Ghaap Plateau, and surface outcrops of the Ghaap Group (notably limestone and dolomite), and those of the Olifantshoek Supergroup (notably quartzite) (refer to Section 4.3). As per Appendix D, core locations for GWC endemics in addition to the Ghaap Plateau, include the Langberg, Kuruman Hills and Asbestos Hills. The approximate locations of these landforms are indicated in Figure 18, none of which are located in proximity to the project area. Several endemics and near-endemics are also associated with river valleys, of which none are present within the project area.

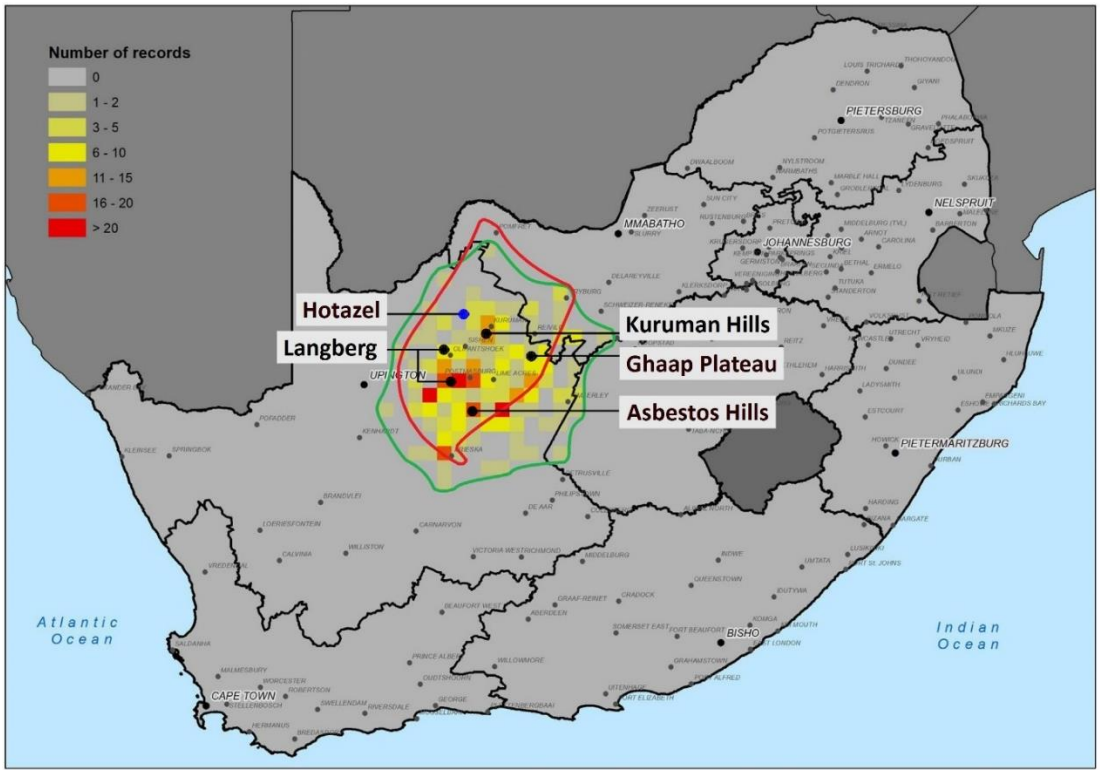

Figure 18: Combined distribution of the GCW endemic and near-endemic species, including the number of such species per QDS. The green polygon demarcates the total distribution of endemic species as defined by Frisby (2016), while the red polygon represents the boundaries of the GWC as proposed by Van Wyk and Smith (2001) (Frisby et al., 2019). Core locations for endemics referred to in Appendix D are also indicated, and Hotazel is shown in blue

Summary

The occurrence of priority floral species within the project area as recorded during the field assessment, can be summarised as follows:

- IUCN and SANBI threatened floral species and floral SCC: None.
- NEMBA TOPS species: *Harpagophytum procumbens* (Modified Kathu Bushveld habitat unit).
- National Forests Act (Act No. 84 of 1998) protected tree species: *Vachellia erioloba* (Modified Kathu Bushveld habitat unit) and *V. haematoxylon* (Modified Kathu Bushveld and Secondary Thornveld habitat units) (Figure 19).
- NCNCA (Act No. 9 of 2009) protected floral species: *Harpagophytum procumbens* (Figure 20), *Plinthus sericeus, Ammocharis coranica, Boophone disticha*, *Crinum* sp., *Orthanthera jasminiflora, Albuca seineri, Albuca setosa* (Modified Kathu Bushveld habitat unit).
- GWC Endemic and Near-endemic species: None.

Should any of the above nationally or provincially protected or TOPS-listed floral species be disturbed, destroyed, removed or relocated during the construction or operation of the proposed mine, the required permits must be obtained from the relevant Departments in order to destroy, remove or relocate such species. In the case of nationally protected tree species and TOPS-listed floral species, the licensing authority will be the Department of Forestry, Fisheries and Environment (DFFE), while the NC DENC will be the licensing authority in the case of provincially protected species.

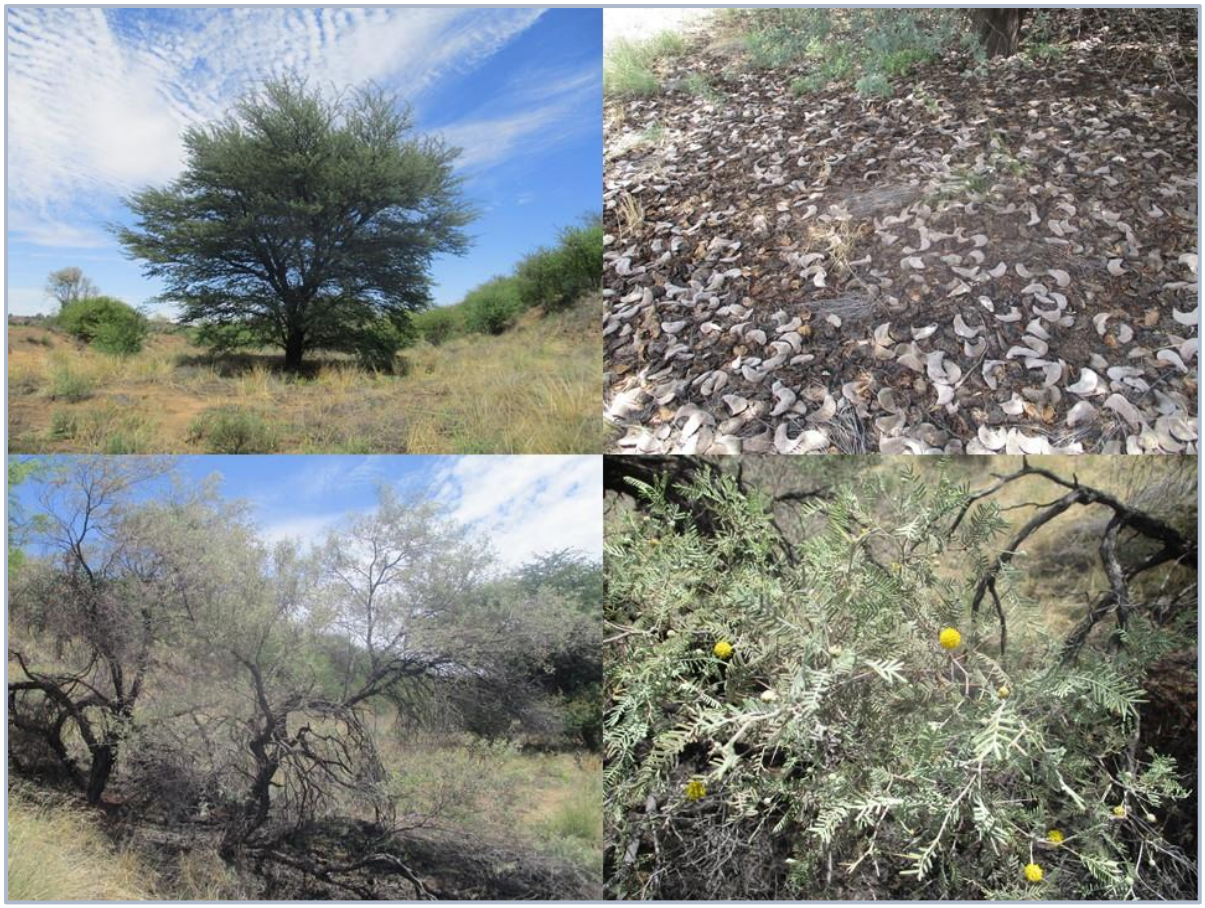

Figure 19: Photographs of the protected tree species Vachellia erioloba (top), and V. haematoxylon (bottom)

Figure 20: Photographs of the TOPS-listed floral species, Harpagophytum procumbens

6.4 Alien and Invasive Floral Species

Alien and invasive floral species lead to degradation of the ecological integrity of an area, which in turn may lead to, amongst others, a decline in indigenous species diversity and potential local floral species' extinction, an ecological imbalance, and the decreased productivity of land (Bromilow, 2010). In the Kalahari, *Prosopis glandulosa* var. *torreyana,* which occurs in high abundance within the Existing Infrastructure habitat unit, and to a lesser extent within the other habitat units, and other *Prosopis* spp. compete with *Vachellia erioloba and V.haematoxylon* for groundwater resources, having a potential detrimental impact on these protected species populations.

Alien and invasive floral species encountered during the field assessment within the boundaries of the project area are listed in Table 7. The various listed invasive species' categories as indicated by the NEMBA Alien and Invasive Species Lists (2020) are shown, as well as the categories as per CARA (Act No. 43 of 1983). Schedule 6 of the NCNCA (Act No. 9 of 2009) also lists invasive species, none of which were recorded within the project area, which the exception of those species listed under CARA.

Table 7: Alien floral species identified during the field assessment across all habitat units

Species	Common name	NEMBA Category*	CARA Category*
Argemone ochroleuca	White-flowered Mexican poppy	1b	1
Boerhavia diffusa var. *diffusa*	Red spiderling	N/L	N/L
Chenopodium album	White Goosefoot	N/L	N/L
Hypochaeris radicata	False dandelion	N/L	N/L
Nicotiana glauca	Wild tobacco	1b	1
Opuntia ficus-indica	Sweet prickly pear	1b	1
Pennisetum setaceum	Fountain grass	1b	1
Prosopis glandulosa var. *torreyana*	Honey mesquite	3	2
Prosopis velutina	Velvet mesquite	3	2
Schinus molle	Pepper tree	N/L	N/L
Verbesina enceloides	Wild sunflower	N/L	N/L
Washingtonia robusta	Washington fan palm	N/L	N/L

***N/L** – Not Listed

NEMBA

Category 1b – Invasive species that must be controlled.

Category 3 – Ornamentally used plants that may no longer be planted. Existing plants may remain, except within the flood line of watercourses and wetlands, as long as all reasonable steps are taken to prevent their spread.

CARA

Category 1 – Declared weeds that are prohibited.

Category 2 – Invader plants with a commercial value that must be controlled.

When considering the above table, it is evident that a relatively low diversity of alien species is present within the project area. Four of the species listed in Table 7 are NEMBA listed invasive species that require mandatory control, while spreading or allowing the spread of *Prosopis* spp. is prohibited.

6.5 Faunal Assemblages

Through the use of available tools and datasets (discussed in Section 4.1), faunal occurrence within the 2722BB QDS and more specifically, within the project area is discussed below.

6.5.1 Mammals

The project area lies within the distributional range of 61 mammals from ten orders (IUCN, 2017). According to MammalMap (ADU, 2019) 10 species have been recorded within the 2722BB QDS with a further 11 species likely to occur. The larger project area and surrounds is seemingly understudied, given the lack of recent ADU reports, therefore presented richness is likely an underestimate. The relative proportions of reported families are displayed in Figure 21.

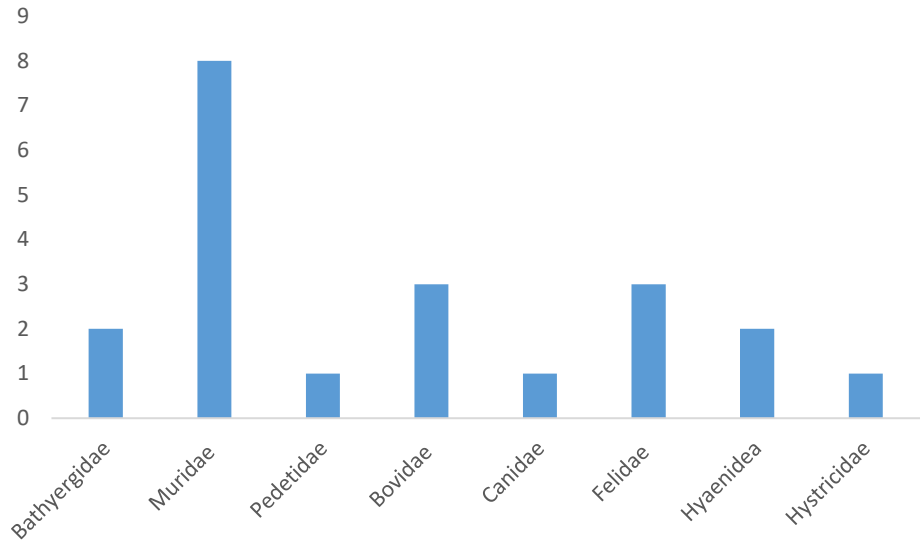

Figure 21: Reported mammalian families in proximity to the project area (ADU, 2020)

Habitat transformation and fragmentation due to historic mining activities, coupled with increased human presence and associated impacts (persecution, hunting, trapping and intensification of land management) have had a negative impact on species composition (particularly true for large ungulates and carnivores, with their presence in most cases largely restricted to conservation (informal and formal) areas.

Based on analysis of aerial imagery a high degree of habitat transformation has occurred within the project area (discussed in Section 6.2) during the construction of the Manganese and Iron Ore Mine and associated operations of the facility. Within the project area a number of anthropogenic impacts were observed including a residual opencast void, surface dumps and a disused rail layout facility. Habitat modification and continued ecological disturbance during the mining operations have likely impacted the mammal community structure within the project area, with surrounding surface dumps and historical opencast activities in particular resulting in a decline in species richness.

Small to medium sized mammals are likely to account for a large portion of mammals potentially occurring within the project area and surrounds (where suitable habitat exists) including species which display a high degree of behavioural plasticity such as Southern African Mastomys (*Mastomys coucha*), Bushveld Gerbil (*Gerbilliscus leucogaster*) and Yellow Mongoose (*Cynictis penicillata*). Discussions with

mine personnel as well as field signs noted during the floral investigation confirmed the presence of several faunal species including Rock Hyrax (*Procavia capensis*), Cape Porcupine (*Hystrix africaeaustralis*), Black-backed Jackal (*Canis mesomelas*), South African Ground Squirrel (*Xerus inauris*), Cape Hare (*Lepus capensis*), Steenbok (*Raphicerus campestris*) and Kudu (*Tragelaphus strepsiceros*). Based on the desktop findings, further species likely utilising the larger project area include Grey African Climbing Mouse (*Dendromus melanotis*), Xeric Four-striped Mouse (*Rhabdomys pumilio*), Namaqua Rock Mouse (*Micaelamys namaquensis*) and Pouched Mouse (*Saccostomus campestris*). Habitats associated with the more intact Modified Kathu Bushveld habitat unit likely represent the most important mammal habitat (foraging sites, refugia and reduced predation risk) within the project area, given the extensive impacts associated with historic mining.

The existing adits within the mining area also provide habitat for Chiropteran (bat) species and this was confirmed through discussions with mine personnel.

No mammalian SCC have been reported within the 2722BB QDS (ADU MammalMap) however several additional species have distributions which overlap with the project area and are discussed below (Table 8). Habitat requirements of each species listed were obtained from Endangered Wildlife Trust (EWT) Red Data List[3], Stuart & Stuart (2015) and IUCN datasets. Given the desktop nature of the faunal assessment, the Precautionary Principle was applied.

Table 8: Mammal SCC with sympatric distributions and likelihood of occurrence within the project area

Species	Threat status	Habitat
Carnivora		
Parahyaena brunnea Brown Hyaena	NT TOPS	Widespread, utilising open woodland and scrub habitats. Resting up in rocky bushveld areas. *P. brunnea* are known to occur outside of formally protected areas.
Felis nigripes Black-footed Cat	VU TOPS	Specialist, inhabits dry, open savannah, grasslands and Karoo semi-desert with sparse shrub and tree cover and a mean annual rainfall of between 100 and 500 mm.
Panthera pardus Leopard	VU TOPS	Wide habitat tolerance. Preference for well-wooded habitats.
Otocyon megalotis Bat-eared Fox	LC TOPS	Short grass plains, open scrub and open arid savanna.
Vulpes chama Cape Fox	LC TOPS	Open country grassland with scattered thickets, and lightly wooded areas.
Eulipotyphla		
Atelerix frontalis Southern African Hedgehog	NT	Scrub brush, grasslands and suburban gardens. Require ample cover and insect food resources. Geographic distribution includes the project area.
Tubulidentata		
Orycteropus afer Aardvark	LC TOPS	Broad range of habitats including open savanna, shrubland, grassland and thickets.
Pholidota		
Smutsia temminckii Temminck's Ground Pangolin	VU TOPS	Woodland and savanna habitats, preferring arid and mesic savanna and semi-arid environments at lower altitudes, often with thick undergrowth.
Chiroptera		

[3] https://www.ewt.org.za/resources/resources-mammal-red-list/

Species	Threat status	Habitat
Rhinolophus denti Dent's Horeshoe Bat	NT	Savannah habitats with suitable roosting sites. Typically restricted to broken country with rocky outcrops or suitable caves (crevices in rocky outcrops and abandoned mines.

NT – Near Threatened; **VU** – Vulnerable; **TOPS** – Threatened or Protected Species (2015)

Given the historic and current impacts occurring within the project area, resident populations of the discussed mammal SCC within the MR area are unlikely. Several Aardvark (*Orycteropus afer*) burrows were noted within the Modified Kathu Bushveld habitat unit adjacent to the access road. A possibility therefore exists for this and several other TOPS-listed mammal species, such as Bat-eared Fox (*Otocyon megalotis*) and Cape Fox (*Vulpes chama*), to occur within proximity to the road upgrade route where relatively intact Kathu Bushveld is present.

6.5.2 Herpetofauna

6.5.2.1 Amphibians

The class Amphibia is represented in South Africa only by the Anura with a total of 117 species. Amphibians are globally the most threatened vertebrate group and approximately 29% of amphibians within South Africa are listed as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) (Tarrant & Armstrong, 2013). Suitable environmental conditions, particularly breeding sites, are critical for amphibians, as some species are often restricted to specific habitats. In a biogeographical context, the project area falls within the interface between the grasslands and arid savanna macro-habitat.

Based on data extrapolated from the ADU (FrogMap), six amphibians from four families are confirmed to occur within the 2722BB QDS. A further four species were reported from surrounding QDSs, with members of the Pyxicephalidae dominating. The majority of the reported species have wide distributions and are tolerant of varying habitat/environmental conditions. Most amphibians are dependent on suitable aquatic habitat (perennial or ephemeral) for breeding. Based on available aerial imagery in combination with findings from the floral field investigation limited intact amphibian habitat occurs within the project area and species present will likely comprise of those with a wide distribution and the ability to utilise suboptimal water resources. Amphibian species, if present, will likely include Red Toad (*Schismaderma carens*), Power's Toad (*Sclerophrys poweri*) and Boettger's Caco (*Cacosternum boettgeri*).

No amphibian SCC have been reported within the 2722BB QDS and a further search of surrounding QDSs also did not reveal any SCC.

6.5.2.2 Reptiles

Southern Africa has a high diversity of reptile species which are generally secretive and extremely sensitive to habitat destruction, fragmentation and modification, anthropogenic disturbances and degradation of habitats due to pollution (Bates et al., 2014). The Kalahari Bushveld Bioregion has a high diversity of reptiles comprised of a high diversity of southern African endemics. Based on the findings of ReptileMAP (2019), only seven species, belonging to six families have been confirmed to occur within the 2722BB QDS however over 30 species are likely to utilise suitable available habitats

within the QDS. Species likely to utilise intact habitats within the project area include Southern Rock Agama (*Agama atra*), Western Ground Agama (*Agama aculeata aculeata*), Namaqua Sand Lizard (*Pedioplanis namaquensis*), Spotted Sand Lizard (*Pedioplanis lineoocellata lineoocellata*), Kalahari Tree Skink (*Trachylepis spilogaster*), Puff Adder (*Bitis arietans*), Cape Cobra (*Naja nivea*) and Forked-marked Sand Snake (*Psammophis trinasalis*). Discussion with mine personnel confirmed the presence of *B. arietans* and *N. nivea* within the project area, while several *P. namaquensis* were noted during the floral field investigation within the Modified Kathu Bushveld habitat unit, both within the MR area and along the access road in the northeast.

No reptile SCC have been reported within the 2722BB QDS. Based on distributional data, the South African Python (*Python natalensis*) is the only SCC whose distribution includes the project area and historically would have occurred within wooded communities with rocky elements. Although regionally listed as Least Concern (LC), *P. natalensis* is a registered TOPS-listed species.

Sundevall's Shovel-snout (*Prosymna sundevallii*) is a near-endemic reptile species with an overlapping distribution with the project area and may occur in more intact Kathu Bushveld along the access road.

6.5.3 Avifauna

A total of 94 avian species have previously been recorded within the 2710_2255 pentad[4] based on the SABAP2[5]. These species are presented in Table 9.

Table 9: Avian species recorded within the 2710_2255 pentad by SABAP2

Scientific Name	Common Name	Habitat
Passeriformes		
Turdoides bicolor	Southern Pied Babbler	Savanna habitats and riparian thickets.
Batis pririt	Pririt Batis	Semi-arid woodlands.
Pycnonotus nigricans	African Red-eyed Bulbul	Arid and semi-arid woodlands.
Emberiza impetuani	Lark-like Bunting	Arid and semi-arid shrublands.
Crithagra atrogularis	Black-throated Canary	Semi-arid savanna, dry woodland.
Crithagra flaviventris	Yellow Canary	Semi-arid shrublands, dry savanna.
Cercomela familiaris	Familiar Chat	Grasslands, rocky hillsides, road margins.
Myrmecocichla formicivora	Ant-eating Chat	Open grasslands and semi-arid shrublands.
Cisticola aridulus	Desert Cisticola	Desert grassland and open croplands.
Cisticola rufilatus	Tinkling Cisticola	Semi-aid savanna.
Sylvietta rufescens	Long-billed Crombec	Dry savanna with shrub understory.
Corvus albus	Pied Crow	Wide range of habitats.
Dicrurus adsimilis	Fork-tailed Drongo	Range of wooded habitats.
Eremomela icteropygialis	Yellow-bellied Eremomela	Arid and semi-arid shrublands and woodlands.
Amadina erythrocephala	Red-headed Finch	Arid and semi-arid grassland/savanna.
Sporopipes squamifrons	Scaly-feathered Finch	Dry savanna and shrublands.
Lanius collaris	Southern Fiscal	Open savanna.
Sigelus silens	Fiscal Flycatcher	Open woodland.
Bradornis infuscatus	Chat Flycatcher	Arid *Acacia* savanna and desert shrublands.

[4] A pentad is a 5 minute x 5 minute coordinate grid super-imposed over the continent for spatial reference.
[5] http://sabap2.birdmap.africa

Scientific Name	Common Name	Habitat
Bradornis mariquensis	Marico Flycatcher	*Acacia* savanna and mixed woodlands.
Calendulauda africanoides	Fawn-coloured Lark	Shrublands, savanna and open woodlands.
Riparia paludicola	Brown-throated Martin	Rivers, dams and sewage works.
Ptyonoprogne fuligula	Rock Martin	Rocky hills and cliffs.
Ploceus velatus	Southern Masked Weaver	Open savanna and suburbia.
Acridotheres tristis	Common Myna	Suburbia.
Cisticola fulvicapilla	Neddicky	Understory of light woodlands.
Anthoscopus caroli	Cape Penduline-tit	Semi-arid shrublands and arid savanna.
Prinia flavicans	Black-chested Prinia	Shrublands and open savanna.
Cercotrichas paena	Kalahari Scrub Robin	Semi-arid shrublands and savanna.
Quelea quelea	Red-billed Quelea	Semi-arid savanna and dry grasslands.
Laniarius atrococcineus	Crimson-breasted Shrike	Kalahari thornveld, semi-arid savanna.
Lanius minor	Lesser Grey Shrike	Arid and semi-arid savanna
Lanius collurio	Red-backed Shrike	Semi-arid, open woodland.
Passer melanurus	Cape Sparrow	Arid and semi-arid woodlands.
Passer domesticus	House Sparrow	Suburban habitats.
Passer diffusus	Southern Grey-headed Sparrow	Dry woodlands, gardens and parks.
Plocepasser mahali	White-browed Sparrow-Weaver	Semi-arid savanna.
Eremopterix verticalis	Grey-backed Sparrow-lark	Arid and semi-arid grasslands and shrublands.
Lamprotornis nitens	Cape Glossy Starling	Savanna, gardens and parks.
Onychognathus nabouroup	Pale-winged Starling	Arid and semi-arid mountains and rocky hills.
Cinnyris fuscus	Dusky Sunbird	Arid shrubland and drainage lines.
Cinnyris mariquensis	Marico Sunbird	Dry *Acacia* savanna and riparian woodlands.
Cecropis cucullata	Greater Striped Swallow	Montane grassland and cultivated area.
Tchagra australis	Brown-crowned Tchagra	Semi-arid woodlands, riverine thickets.
Turdus litsitsirupa	Groundscraper Thrush	Open woodlands, parks and gardens.
Sylvia subcoerulea	Chestnut-vented Tit-Babbler	Semi-arid woodland and shrublands.
Melaniparus cinerascens	Ashy Tit	Arid and semi-arid *Acacia* woodlands.
Uraeginthus granatinus	Violet-eared Waxbill	Semi-arid and arid savanna.
Zosterops pallidus	Orange River White-eye	Riverine woodland, thicket and scrub.
Vidua regia	Shaft-tailed Whydah	Semi-arid and arid savanna.
Charadriiformes		
Vanellus armatus	Blacksmith Lapwing	Wide habitat tolerance.
Vanellus coronatus	Crowned Lapwing	Short grasslands and open habitats.
Anseriformes		
Alopochen aegyptiaca	Egyptian Goose	Inland wetlands and cultivated lands.
Columbiformes		
Oena capensis	Namaqua Dove	Semi-arid and arid savanna.
Spilopelia senegalensis	Laughing Dove	Savanna and urban landscapes.
Streptopelia capicola	Cape Turtle Dove	Woodland, savanna and farmlands.
Streptopelia semitorquata	Red-eyed Dove	Wooded habitats.
Columba guinea	Speckled Pigeon	Mountainous areas and suburbia.
Pelecaniformes		
Bostrychia hagedash	Hadeda Ibis	Grasslands, wooded areas and suburbia.
Galliformes		
Numida meleagris	Helmeted Guineafowl	Widespread.
Pternistis adspersus	Red-billed Spurfowl	Dry savanna and woodland.
Coliiformes		
Colius colius	White-backed Mousebird	Arid savanna.
Urocolius indicus	Red-faced Mousebird	Savanna and dry woodlands.
Piciformes		
Dendropicos fuscescens	Cardinal Woodpecker	Most woodland types.

Scientific Name	Common Name	Habitat
	Golden-tailed Woodpecker	
Tricholaema leucomelas	Acacia Pied Barbet	Semi-arid savanna.
Accipitriformes		
Elanus caeruleus	Black-winged Kite	Open savanna, grassland, croplands.
Circaetus pectoralis	Black-chested Snake Eagle	Savanna, woodlands, shrublands.
Aquila verreauxii	Verreaux's Eagle	Mountainous and rocky areas.
Micronisus gabar	Gabar Goshawk	*Acacia* savanna, often around water.
Melierax canorus	Southern Pale Chanting Goshawk	Arid and semi-arid shrublands as well as dry, open woodlands.
Bucerotiformes		
Upupa africana	African Hoopoe	Open woodlands
Lophocerus nasutus	African Grey Hornbill	Dry savanna.
Tockus leucomelas	Southern Yellow-billed Hornbill	Thornveld and dry savanna.
Rhinopomastus cyanomelas	Common Scimitarbill	Dry savanna.
Otidiformes		
Afrotis afraoides	Northern Black Korhaan	Arid shrublands, open savanna, grasslands.
Lophotis ruficrista	Red-crested Korhaan	Dry dense woodland and Kalahari dune grassland.
Coraciiformes		
Merops apiaster	European Bee-eater	Range of woodlands and shrublands.
Merops hirundineus	Swallow-tailed Bee-eater	
Coracias caudatus	Lilac-breasted Roller	Dry savanna and open woodland.
Coracias naevius	Purple Roller	Dry woodland and savanna.
Cuculiformes		
Cuculus clamosus	Black Cuckoo	Dense woodland and thickets.
Chrysococcyx caprius	Diderick Cuckoo	Riparian woodlands.
Clamator jacobinus	Jacobin Cuckoo	Dry savanna.
Falconiformes		
Falco biarmicus	Lanner Falcon	Desert, pen savanna, mountains and farmlands.
Falco rupicoloides	Greater Kestrel	Dry grassland, arid savanna, agricultural lands.
Falco rupicolus	Rock Kestrel	Grassland, karoo shrubland and light savanna.
Apodiformes		
Cypsiurus parvus	African Palm Swift	Wooded regions. Especially palms.
Apus affinis	Little Swift	Wide range of habitats.
Apus caffer	White-rumped Swift	Wide range of habitats.
Pterocliformes		
Pterocles burchelli	Burchell's Sandgrouse	Arid and semi-arid savanna.

The avifauna component has been studied and reported on in more detail as part of the avifaunal assessment undertaken by Feathers Environmental. Of specific importance is the known occurrence of Verreaux's eagle (*Aquila verreauxii*), classified as VU, nesting against the embankment of the opencast void.

6.5.4 Faunal Summary

Based on the historic disturbances to the project area, coupled with the condition of existing habitats, resident populations of faunal SCC occurring specifically within the project area are unlikely, with the exception of Verreaux's eagle (*Aquila verreauxii*). The majority of faunal activity is likely associated with the more intact Modified Kathu Bushveld which provides relatively functional bushveld habitats. These habitats have experienced fewer impacts and offers a wider mosaic of foraging and refuge

opportunities. Faunal TOPS-listed species Bat-eared Fox (*Otocyon megalotis*) and Cape Fox (*Vulpes chama*) may occur within this habitat, while signs of Aardvark (*Orycteropus afer*) were noted during the field survey in the vicinity of the access road in the northeast of the project area.

Although the commissioned faunal component of this assessment largely deals with vertebrates, care must be taken to ensure no disturbance to arachnids of the Theraphosidae family occur during the mining project. Members of the Theraphosidae family are particularly sensitive to threats such as habitat loss and collection for the pet trade, as they have low reproductive rates, with some species occupying restricted geographic ranges and having specific habitat requirements. *Harpactira* spp. and *Pterinochilus* spp. are provincially protected under Schedule 1 of NCNCA (Act No. 9 of 2009), and individuals, as well as burrow sites must not be impacted during the project.

7 TERRESTRIAL ECOLOGICAL SENSITIVITY ASSESSMENT

The results of the sensitivity analysis of each habitat unit according to the method described in Section 4.4 identified are outlined in the table below.

Table 10: Results and development implications of the terrestrial ecological sensitivity analysis

Habitat Unit including approximate area	Terrestrial Ecological Sensitivity	Development Implications
Existing Infrastructure and Alien Vegetation Communities	Low	**Habitat** These areas have been significantly impacted by historical mining activities and development within this habitat unit will not lead to the significant loss of natural habitat. The proposed project will however impact directly on nesting Verreaux's eagle (*Aquila verreauxii*) and their food resources, which include Rock Hyrax (*Procavia capensis*) that utilises this habitat unit in its current degraded state. More information on avifaunal species will form part of the avifaunal assessment to be undertaken by Feathers Environmental. **SCC, Protected and TOPS-listed species** • No floral SCC, protected or TOPS-listed species were recorded within this habitat unit, and such species have a low probability of occurrence due to past disturbances within this habitat unit. • No nationally protected or TOPS-listed faunal were recorded or are likely to permanently inhabit this habitat unit. One faunal SCC namely Verreaux's eagle (*Aquila verreauxii*) utilises this habitat unit for nesting, breeding and foraging purposes.
In-Pit Aquatic habitat unit	Medium-Low	**Habitat** Development within this habitat unit will lead to the loss of aquatic habitat that has established within the opencast void. Although having certain faunal biodiversity and habitat value when considering the semi-arid surrounds, this habitat unit is not considered natural, and hosts an overall low floral diversity. **SCC, Protected and TOPS-listed species** • No floral or faunal SCC, protected or TOPS-listed species were recorded within this habitat unit, and such species have a low probability of occurring/ residing within this habitat unit.

Habitat Unit including approximate area	Terrestrial Ecological Sensitivity	Development Implications
Modified Kathu Bushveld habitat unit	Medium	**Habitat** Development within this habitat unit will lead to the direct loss of reasonably intact bushveld habitat with increased floral and faunal biodiversity, particularly in comparison with the adjacent and surrounding mine-impacted areas. **SCC, Protected and TOPS-listed species** • No floral SCC species were recorded or are likely to occur. One TOPS-listed floral species, namely *Harpagophytum procumbens* was recorded. • Two nationally protected tree species in terms of the National Forests Act (Act No. 84 of 1998) occur, namely *Vachellia erioloba* in relatively low abundance and *V. haematoxylon* in high abundance. • One provincially protected floral species in terms of Schedule 1 of the Northern Cape Nature Conservation Act (Act No. 9 of 2009), namely *H. procumbens,* and several floral species listed under Schedule 2 of this Act, namely *Plinthus sericeus, Ammocharis coranica, Boophone disticha*, *Crinum* sp., *Orthanthera jasminiflora, Albuca seineri* (=*Ornithoogalum seineri*), *Albuca setosa* (=*Ornithogalum setosum*) were recorded. • No faunal SCC were noted during the vegetation field assessment or are likely to occur based on the desktop investigation. Signs of TOPS-listed Aardvark (*Orycteropus afer*) were however noted during the field assessment in the vicinity of the access road. Other faunal TOPS-listed species that may occur are Bat-eared Fox (*Otocyon megalotis*) and Cape Fox (*Vulpes chama*). • The arachnid species *Harpactira* spp. and *Pterinochilus* spp. are provincially protected under Schedule 1 of NCNCA (Act No. 9 of 2009) and may occur within this habitat unit.
Secondary Thornveld habitat unit	Medium-Low	**Habitat** Development within this habitat unit will not lead to the significant loss of natural habitat. **SCC, Protected and TOPS-listed species** • No floral or faunal SCC, provincially protected or TOPS-listed species were recorded within this habitat unit, and such species have a low probability of occurrence due to past disturbances within this habitat unit.

The terrestrial ecological site sensitivity map developed for the proposed project is included as Figure 22 below, with Figure 23 including the mine development footprint overlaid onto the sensitivity map.

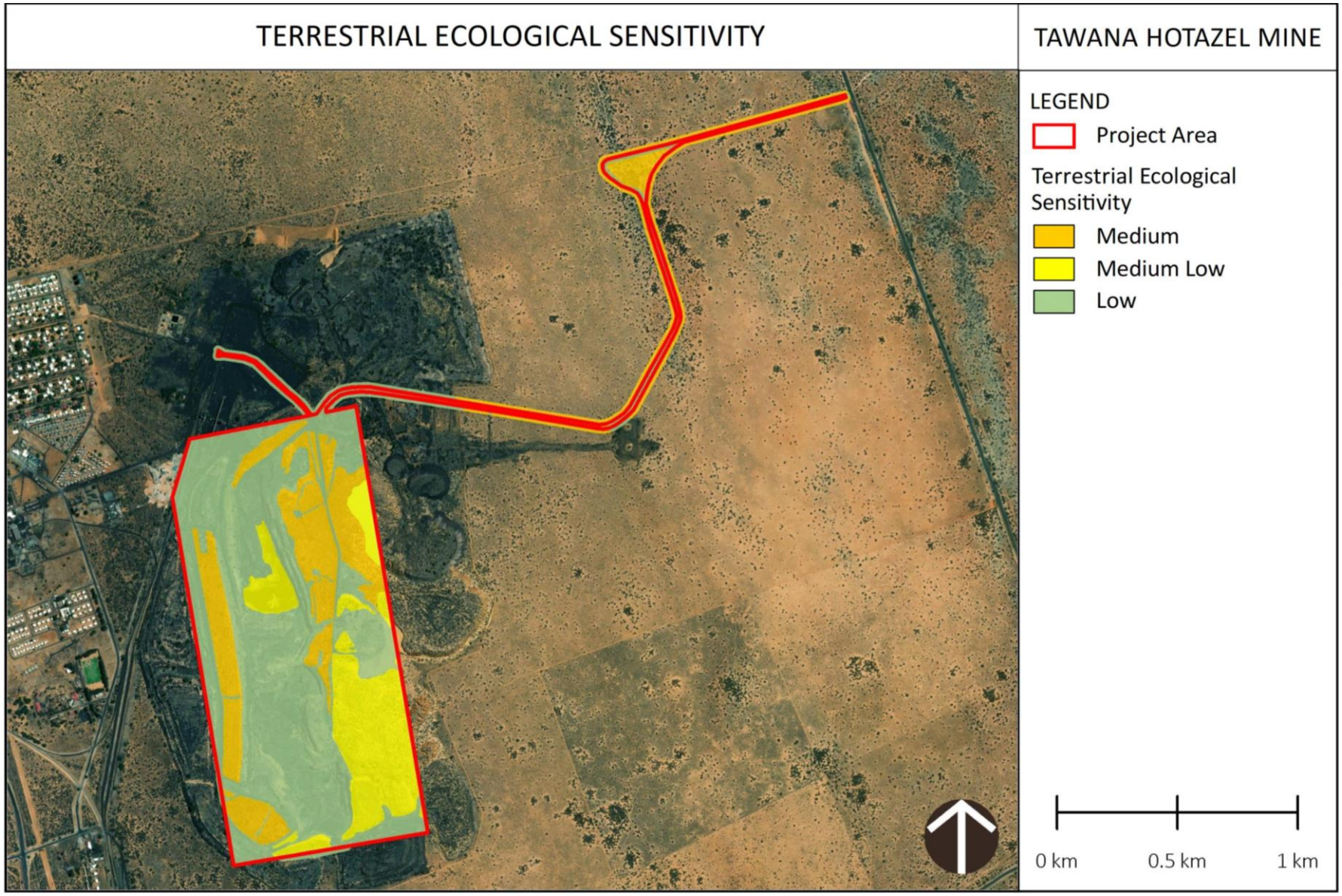

Figure 22: Terrestrial ecological sensitivity map for the project area

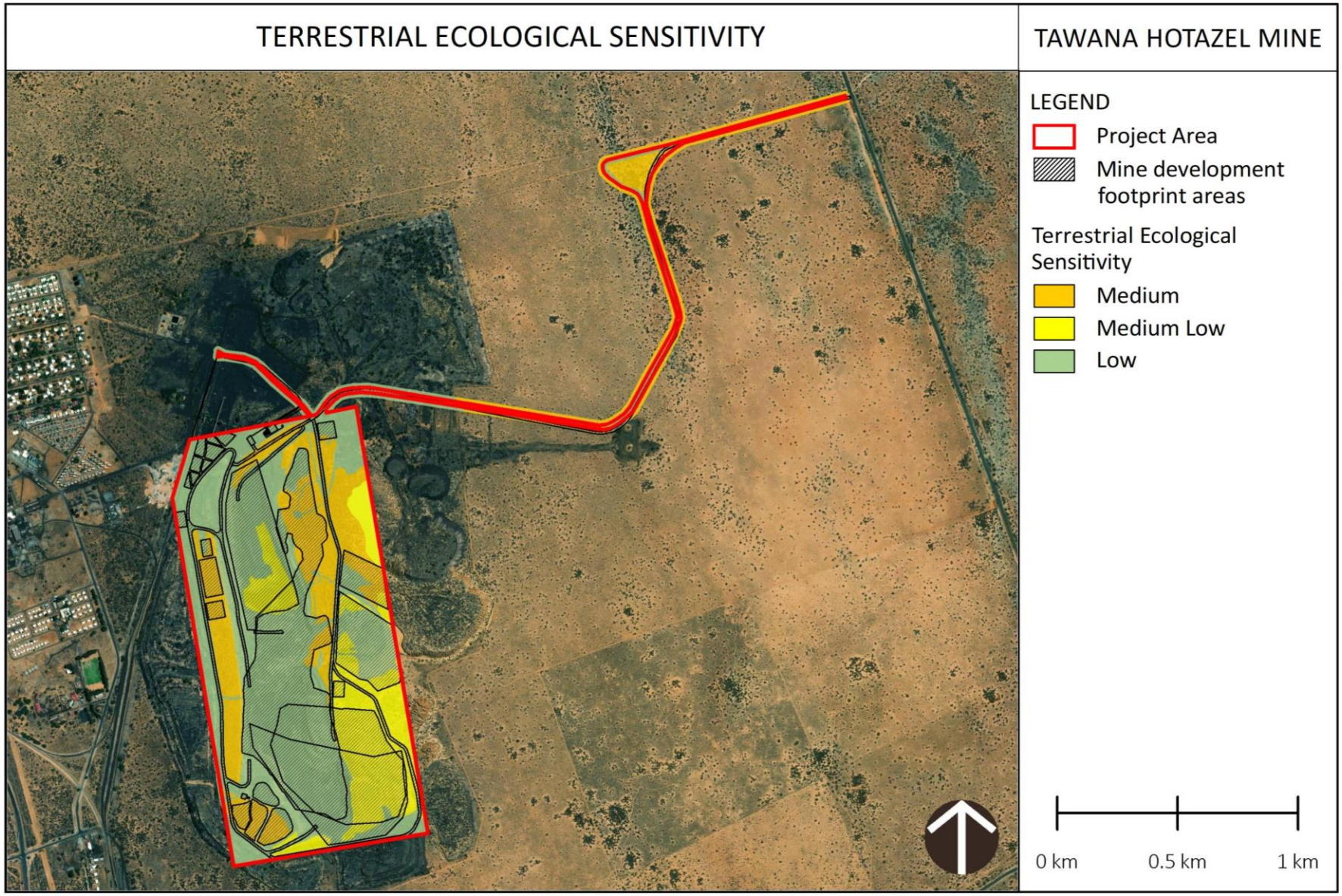

Figure 23: Terrestrial ecological sensitivity map for the project area in relation to the proposed mine development footprint areas

8 RESULTS OF THE IMPACT ASSESSMENT

Anthropogenic activities and developments will negatively impact the receiving natural environment. As part of the terrestrial biodiversity assessment undertaken for the proposed project, perceived impacts on the receiving natural environment have been identified. Such impacts are expected to include the following:

- Direct impacts: Impacts directly associated with the project. These impacts can be temporary or remain as residual impacts, i.e. the clearing of natural vegetation within the mining and associated infrastructure footprints.
- Indirect impacts: Impacts that are not a direct result of the project and often extend beyond the project boundary, i.e. encroachment of invasive alien vegetation outside of the project area.
- Residual impacts: Impacts that remain following the implementation of mitigation measures, and that may remain after the project has been completed.
- Cumulative impacts: Impacts occurring from the project combined with impacts from past, existing and future projects that will affect the same natural resources e.g. a number of impacts occurring in the same ecosystem.

The section below provides an indication of potential impacts associated with the development and operation of the proposed mining project. Perceived impacts on the terrestrial ecology within the project area are discussed in Tables 11– 15 below, with significance ratings provided for the envisioned pre- and post-mitigation scenarios, provided that suitable management and mitigation measures be implemented. It must be noted that given the scope of works, the faunal component (prescribed mitigation measures and perceived impact ratings) is based on a desktop assessment.

For the purposes of the impact assessment, a period of two (2) years has been allowed for pre-stripping and mining infrastructure construction, while the operational phase will continue over the LoM of the open pit operation, which is expected to last for 30 years.

8.1 Summary of Impacts

8.1.1 Loss of terrestrial floral and faunal habitat

Although it is evident from the desktop and field assessment that significant levels of habitat modification have occurred within the project area, remnant, modified Kathu Bushveld occur within the MR area and along the main access road within the north-eastern portion of the project area. Areas of secondary thornveld have also established on surface dumps in the south and east where adequate growing medium is present. The proposed mining activities and upgrades to the access road will likely lead to loss of relatively intact habitat in these areas, while further disturbances may occur during the construction phase as a result of dust, unauthorised vehicles access, and edge effects. Although the majority of habitat associated with the project area has an altered vegetation structure and composition when compared with reference state Kathu Bushveld, the Modified Kathu Bushveld habitat unit in particular provides improved habitat for floral and faunal species, while the In-Pit Aquatic habitat unit has allowed for aquatic communities to establish within the historical void.

Direct habitat loss and a reduction in habitat quality will take place during both the construction/ pre-mining and operational phases due to clearance of vegetation and impacts of construction and operational vehicles, which may also lead to indirect impacts such as increased runoff and erosion, an increase in dust as well as the fragmentation of habitat. Indirect loss of floral and faunal habitat within areas adjacent to the development footprint may also occur as a result of edge effects such as alien vegetation proliferation and encroachment and a decline in faunal refugia and food resources which has the potential to continue during the operational phase of the project if edge effects are not managed. Ineffective backfilling and rehabilitation may lead to exposed and impacted areas beyond the clearance footprint.

The current proposed rehabilitation strategy includes concurrent rehabilitation measures, whereby as much material as available will be used to re-fill the opencast void, which at closure will be revegetated and covered. Backfilling/ rehabilitation will commence immediately after the commencement of the mining operation and its advance will match the depletion rate of the open pit. The establishment of vegetation within the existing infrastructure areas that are currently devoid of vegetation may contribute towards improved habitat conditions in these areas.

Table 11. Loss of Floral Habitat: Impact Ratings

Issue	Project Phase	Impact Rating Criteria					Significance
		Nature	Magnitude	Scale	Duration	Probability	
Without mitigation measures							
Loss of Floral and Faunal Habitat	Construction	Negative	Moderate 6	Local 2	Medium 3	Expected 4	44 Medium
	Operational	Negative	Moderate 6	Local 2	Long 4	Expected 4	48 Medium
With mitigation measures							
Loss of Floral and Faunal Habitat	Construction	Negative	Low 4	Site 1	Short 2	Likely 3	21 Low
	Operational	Negative	Low 4	Site 1	Medium 3	Likely 3	24 Low
Mitigation Measures	The following mitigation measures are proposed in order to limit or reduce the impact of the proposed project on the terrestrial ecology within the project area: • No areas should be cleared of natural vegetation if not required for construction and operation of the proposed mining operation and related infrastructure, and the overall clearance footprint should be kept as small as possible. • The boundaries of the designated and approved clearance footprint should be clearly demarcated on site prior to commencement of site clearance. • Due to the occurrence of a high abundance of priority floral species adjacent to the existing access road, the widths of proposed road upgrades should be kept to a minimum. • The location and extent of areas of increased ecological importance and sensitivity (notably the remnant Kathu Bushveld habitat indicated as being of Medium ecological sensitivity) should be considered during the pre-construction and planning phases. Consideration should be given to conserve these relatively intact remnant habitats as part of the mine and access road upgrades as far as possible. • Construction and operational vehicles should be restricted to travelling on designated roadways only and vehicle access beyond the designated and approved clearance footprint areas should be prohibited.						

	• Construction camps, contractors' laydown areas and other temporary infrastructure are to be placed within areas that have already been modified and existing roads and tracks should be used during the construction and mine development process as far as possible. • No littering or dumping of waste and construction or waste material within natural areas beyond the clearance footprint may be allowed. All excess and waste material must be removed from the construction areas once works have been completed. • Edge effects from construction and operational activities, such as erosion and alien floral species proliferation and spread within disturbed areas, should be managed throughout the LoM through the implementation of erosion control measures where required and the implementation of an Alien and Invasive Species Management Programme. Special attention must be paid to the control of NEMBA Category 1b alien invasive species, as well as *Prosopis glandulosa* var. *torreyana,* specifically also along the MR area boundaries to prevent the spread of such species into adjacent properties and surrounding natural habitat. • Bush encroacher species such as *Senegalia mellifera* subsp. *detinens* are expected to further proliferate within Secondary Thornveld areas due to ongoing disturbance and this species should also be controlled where noted within surrounding natural habitat. • Construction and operational vehicles should be maintained to a high standard to reduce the likelihood of spills and other pollution. • Should excessive dust on unpaved roads in the vicinity of the project area be evident during dry and windy conditions, appropriate dust control measures should be put in place. • Adequate storm water management measures must be put in place to limit increased runoff. • Excessive erosion where noted should be rectified immediately making use of soft engineering techniques. A soil management strategy must be in place. • Backfilling and rehabilitation should take place concurrently as proposed. Prolonged exposure of bare soils should be avoided. • Any disturbed and compacted areas outside of the project footprint must be ripped, reprofiled and self-succession of indigenous grass and forb species allowed. Where self-succession does not occur over a period of one growing season, active revegetation by means of applying an indigenous veld grass mixture is recommended. • Should a final void remain open at closure, it must be ensured that engineered slopes and water-management measures are in place to prevent ongoing deterioration of habitat.

8.1.2 Reduced floral and faunal diversity

Although a relatively low diversity of alien and invasive floral species is present within the project area, a large proportion of the vegetation, particularly considering the Existing Infrastructure and Secondary Thornveld habitat units, are alien or bush encroacher species. As a result, the overall floral and faunal species assemblages have an overall reduced biodiversity (based on historic habitat transformation and mining activities) when compared to intact natural habitat in the region and reference state Kathu Bushveld. Direct impacts on remaining species and local diversity within the project area will however occur as a result of initial site clearance activities and construction/ pre-mining activities, which may also result in inadvertent burial or mortalities of faunal species (including the potential provincially protected arachnid species *Harpactira* spp. and *Pterinochilus* spp).

During the operational phase of the project, species diversity may be further reduced as mining activities progress and should operational vehicle movement extend beyond the designated access

roads and mine works areas; should infrastructure exceed the approved development footprint areas, this would further exacerbate this impact. An influx of people and associated increased human activity during the construction/pre-mining and operational phases of the project may lead to negative human-faunal interactions in more intact habitats, including increased poaching and trapping of faunal species within the project area and immediate surroundings, while the potential harvesting of plants, including species with medicinal or human use value, may also take place.

Table 12. Reduced Floral and Faunal Diversity: Impact Ratings

Issue	Project Phase	Impact Rating Criteria					Significance
		Nature	Magnitude	Scale	Duration	Probability	
Without mitigation measures							
Reduced Floral and Faunal Diversity	Construction	Negative	Moderate 6	Local 2	Medium 3	Expected 4	44 Medium
	Operational	Negative	Moderate 6	Local 2	Long 4	Expected 4	48 Medium
With mitigation measures							
Reduced Floral and Faunal Diversity	Construction	Negative	Low 4	Site 1	Short 2	Likely 3	21 Low
	Operational	Negative	Low 4	Site 1	Medium 3	Likely 3	24 Low
Mitigation Measures	The following mitigation measures are proposed in order to limit or reduce the impact of the proposed project on the terrestrial ecology within the project area: • All mitigation measures as presented in Section 8.1.1 should be implemented. • Construction and site personnel should receive environmental awareness and biodiversity education training and site induction procedures should include a discussion of key ecological aspects (such as the necessary procedures for working in proximity to sensitive habitats). • Areas of increased ecological sensitivity and floral species diversity within natural habitat bordering the project area, as well as the main access road, should be off limits to construction vehicles and workers. • Harvesting of plant material within the project area and natural areas bordering the project area should be prohibited. • Consideration should be given to rescue and relocation of bulbous species for use in landscaping or in rehabilitation of disturbed areas. This should include provincially protected species such as *Crinum* sp., *Ammocharis coranica* and *Boophone disticha.* • Any fires made by workers and site personnel, if unavoidable, should be restricted to designated areas, where accidental spread thereof can be avoided. • All vehicles accessing the project must adhere to a 30km/hr speed limit and vigilant driving techniques. • No wild animals may under any circumstance be tampered with or removed by construction workers. • Hunting/ killing of fauna is prohibited. • Any snares or traps found on or adjacent to the project area must be removed and disposed of.						

8.1.3 Displacement of faunal species due to disturbance

In addition to the direct loss of faunal species, displacement of faunal species will likely take place during the various phases of the proposed project. It is postulated that the HMM has been largely

inactive which may have resulted in some species re-establishing where adequate habitat exists. During the construction/ pre-mining phase, faunal displacement may result from initial vegetation clearing and movement of construction and mining vehicles through areas of increased faunal sensitivity. This will result in a localised decline in biodiversity as certain species are more sensitive to disturbances. During the construction phase impacts associated with increased human activity, drilling, blasting, movement of heavy machinery, noise pollution, vibrations and excessive dust will also have a disturbance impact on faunal populations.

However, it must be borne in mind that species present are likely already adapted to living within mining areas. Historical disturbances have likely already resulted in some degree of change to species composition within the project area. Disturbance impacts on fauna are likely to be the highest surrounding the access road to the northeast and within remnant Kathu Bushveld within the MR area. Furthermore, the drilling and blasting will also likely have some degree of disturbance extending outside of the project area (noise and vibrations).

Table 13. Displacement of Faunal Species due to Disturbance: Impact Ratings (at a desktop level)

Issue	Project Phase	Impact Rating Criteria					Significance
		Nature	Magnitude	Scale	Duration	Probability	
Without mitigation measures							
Displacement of Faunal Species	Construction	Negative	High 8	Local 2	Long 4	Expected 4	56 Medium
	Operational	Negative	High 8	Local 2	Long 4	Expected 4	56 Medium
With mitigation measures							
Displacement of Faunal Species	Construction	Negative	Moderate 6	Site 1	Medium 3	Likely 3	30 Medium
	Operational	Negative	Moderate 6	Site 1	Medium 3	Likely 3	30 Medium
Mitigation Measures	The following mitigation measures are proposed in order to limit or reduce the impact of the proposed project on the terrestrial ecology within the project area: • All mitigation measures as presented in Section 8.1.1 and 8.1.2 should be implemented. • Disturbance to sensitive habitats must be avoided and the project footprint (including all surface infrastructure) must be clearly demarcated. • The extent of construction/ pre-mining activities (site clearance) and operational activities (drilling, blasting and hauling) must be limited to the approved development footprint area. • In order to reduce noise pollution, proper maintenance of equipment is required, and the implementation of low noise techniques is recommended. • Light pollution must be kept to a minimum. Any lighting require must be directed away from sensitive habitats and the use of sodium vapour lights are recommended so as to not impact nocturnal faunal-invertebrate dynamics, through the attraction of species to these artificially lit areas. • No dumping of waste (domestic or mining) may take place outside of the project area. All Non-hazardous waste must be stored temporarily within a covered bins / skip. • The placement of the proposed refuelling station must occur outside of any delineated sensitive habitat and take into consideration potential buffers imposed within other specialist studies.						

8.1.4 Loss of SCC, protected, TOPS-listed and endemic species

The probability of floral and faunal SCC occurring within the project area is low or unlikely (with the exception of Verreaux's eagle (*Aquila verreauxii*), however certain TOPS-listed species, nationally or provincially protected species, including protected tree species in terms of the National Forests Act (Act No. 84 of 1998), and protected species in terms of the NCNCA (Act No. 9 of 2009), are known to occur within the Modified Kathu Bushveld habitat unit, with protected tree species also occurring within the Secondary Thornveld habitat unit. The proposed project is likely to result in the direct loss of such species during site clearance activities, and therefore the necessary permit applications for the destruction, removal or relocation of such species should be obtained prior to commencement of any activities within the project area. Increased human activity during the construction/ pre-mining phase of the project in particular also increases the risk of floral and faunal species being collected or harvested. Although the nationally and provincially protected floral species recorded within the project area are locally relatively common, and not restricted to the project area, the ongoing cumulative loss of these species within the larger region, mostly due to the establishment of new mines in the area, could however become significant over time.

Although located within a centre of endemism, the GWC, no endemic species were recorded within the project area. The proposed project is therefore unlikely to significantly impact on the extent and biodiversity value of the GWC, and the distribution and occurrence of such species.

Table 14. Loss of Floral and Faunal SCC, Protected, TOPS-listed and Endemic Species: Impact Ratings

Issue	Project Phase	Impact Rating Criteria					Significance
		Nature	Magnitude	Scale	Duration	Probability	
Without mitigation measures							
Loss of Species of Conservation Importance	Construction	Negative	High 8	Local 2	Permanent 5	Expected 4	60 High
	Operational	Negative	High 8	Local 2	Permanent 5	Expected 4	60 High
With mitigation measures							
Loss of Species of Conservation Importance	Construction	Negative	Moderate 6	Site 1	Medium 3	Likely 3	30 Medium
	Operational	Negative	Moderate 6	Site 1	Medium 3	Likely 3	30 Medium
Mitigation Measures	The following mitigation measures are proposed in order to limit or reduce the impact of the proposed project on the terrestrial ecology within the project area: • No harvesting of firewood or collection of floral species by construction workers or mine personnel from the project area or natural areas surrounding the project footprint should be allowed. • The location and extent of the remnant Kathu Bushveld habitat along the main access road and within the MR area should be considered during the pre-construction and planning phases due to this habitat harbouring the majority of priority floral species. Consideration should be given to conserve these relatively intact remnant habitats as part of the mine and access road upgrades as far as possible. • Where possible, the direct loss of protected and TOPS-listed species should be avoided, with specific mention of protected and TOPS-listed plants falling outside of the immediate mine development footprint area. It is recommended that trees located in proximity to the development footprint be clearly marked by means of danger tape or						

	similar for the duration of the construction phase. Large, prominent *V. erioloba* trees in proximity to mining operations could be mapped by means of GPS coordinates and indicated on mine plans to promote their conservation. • The establishment of a site nursery where smaller plants with relocation potential, including *V. erioloba* seedlings and saplings, can be kept and propagated during the construction and operational phases should be considered. These plants could be used in the rehabilitation works. • The estimated number of protected and TOPS-listed plants per species should be determined prior to site clearance taking place by means of a site walkthrough of the final proposed development footprint areas. Priority floral species are confined the Modified Bushveld habitat unit as per Figure 23, which includes areas adjacent to the existing access road. • Where any protected or TOPS-listed species are to be rescued and relocated, this process should be overseen by a suitably qualified botanist or horticulturalist • Permits for the destruction or relocation of nationally and provincially protected tree, shrub and forbs species must be applied for and obtained from the relevant authorities: o For the destruction, removal or relocation of *Vachellia erioloba* and *V. haematoxylon* trees that are protected in terms of the National Forests Act (Act No. 84 of 1998), the required permit must be applied for and obtained from the Department of Fisheries, Forestry and the Environment (DFFE). o For the destruction, removal or relocation of the TOPS-listed species *Harpagophytum procumbens*, the required permit must be applied for and obtained from the DFFE. o For the destruction or removal of plant species that are protected in terms of the NCNCA (Act No. 9 of 2009), including *H. procumbens*, a permit should be applied for and obtained from the NCDENC after consultation with the relevant authorities. o Any conditions attached to tree and plant removal permits issued should be strictly implemented. This may require the planting of additional trees, shrubs and/ or forbs species in proportion to the number of plants lost, as specified by the relevant Departments. • Any removed trees could be mulched and used as soil moisture protection during concurrent rehabilitation or made available to local communities as firewood. • No wild animals may under any circumstance be handled or be interfered with by construction workers or any personnel. • Should any faunal SCC (avifauna is discussed within the avifaunal assessment) be noted within the project area, the relevant authorities must be notified. Input into the possible relocation of such species must be provided by a suitably qualified ecologist.

8.1.5 Increased alien invasive species, and other detrimental edge effects

A high proportion of alien invasive floral species, mostly attributed to *Prosopis glandulosa* var. *torreyana* occurs within the project area at present, due to historical and ongoing disturbances within the area. Further disturbance within the project area is likely to lead increased proliferation of such species, may introduce additional alien species to the project area, and may lead to alien invasive species encroachment into adjacent areas. An increase in alien invasive species could continue during the operational phase should eradication and control measures not be implemented. Alien and invasive floral species have the potential to outcompete indigenous vegetation and reduce faunal habitat quality.

Edge effects such as alien vegetation proliferation and encroachment, changes to runoff patterns, erosion and compaction resulting from disturbances to soils, as well a decline in faunal refugia and food resources may occur during the construction and operational phases of the project. Altered ecosystem processes resulting from the proposed project may also lead to changes to the community composition within adjacent areas. Edge effects will continue during the operational phase of the project if not managed.

Table 15. Increased alien invasive species and impacts from other detrimental edge effects: Impact Ratings

Issue	Project Phase	Impact Rating Criteria					Significance
		Nature	Magnitude	Scale	Duration	Probability	
Without mitigation measures							
Alien Invasive Species and other Detrimental Edge Effects	Construction	Negative	Moderate 6	Local 2	Long 4	Likely 3	36 Medium
	Operational	Negative	Moderate 6	Local 2	Long 4	Likely 3	36 Medium
With mitigation measures							
Alien Invasive Species and other Detrimental Edge Effects	Construction	Negative	Low 4	Site 1	Medium 3	Likely 3	24 Low
	Operational	Negative	Low 4	Site 1	Medium 3	Likely 3	24 Low

Mitigation Measures	The following mitigation measures are proposed in order to limit or reduce the impact of the proposed project on the terrestrial ecology within the project area:
	• An Alien and Invasive Plant Species Management Programme, including consideration of the bush encroacher species, *Senegalia mellifera* subsp. *detinens* should be developed for the mine, based on the species listed under in Section 6.4 and updated to include any additional species that may be noted during the mining operations. Such as plan should include the following:
	  ○ Staff training and safety requirements.
	  ○ Prioritising control areas.
	  ○ Development of control programme schedules.
	  ○ Description of preferred control methods per species.
	  ○ Follow-up control requirements.
	  ○ Aftercare and rehabilitation requirements within areas where alien and invasive plant species have been removed.
	• Special attention must be paid to the control of NEMBA Category 1b alien invasive species, as well as *Prosopis glandulosa* var. *torreyana,* specifically also along the MR area boundaries to prevent the spread of such species into adjacent properties and surrounding natural habitat.
	• It is important that bare soils be avoided, and adequate indigenous grass cover be achieved on any exposed slopes, and that rehabilitation takes place concurrently, as alien species tend to proliferate within bare, disturbed soils.
	• Excessive erosion where noted should be rectified immediately making use of soft engineering techniques. Where required topsoil and hessian material must be placed over such areas in order to encourage the establishment of indigenous grass cover.						

	Should indigenous grass cover not establish successfully after one growing season, active reseeding will be required. • Adequate storm water management measures must be put in place to limit increased runoff and sedimentation of water resources.

8.2 Residual Impacts

Latent or residual impacts associated with the floral and faunal ecology within the project area and surrounds are likely to occur. Once vegetation is lost to site clearance, it is highly unlikely that vegetation communities and associated faunal micro-habitats will be restored, even if revegetation and concurrent rehabilitation measures are implemented. Certain residual edge effects, such as the proliferation and spread of alien and invasive plant species, including ruderal weeds, and potential erosion within areas adjacent to active mining activities as a result of loss of basal cover, may also remain over the long term, and further contribute to regional sub-optimal habitat for terrestrial floral and faunal species, particularly faunal SCC, and floral and faunal TOPS-listed and protected species.

8.3 Cumulative Impacts

Cumulative impacts are those impacts from the project combined with the impacts from past, existing and reasonably foreseeable future projects that would affect the same biodiversity or natural resources (e.g. a number of development projects in the same catchment or ecosystem type collectively affecting water quality or flow, or impacting the same endemic species). Due to various similar mining projects being active in the immediate region, further mining and loss of habitat within the project area is likely to contribute towards a reduction in local *Vachellia erioloba* and *V. haematoxylon* communities, either directly or through lowering of the groundwater table, as well as regional ecosystem functioning and connectivity.

9 TERRESTRIAL ECOLOGICAL MONITORING

Terrestrial ecological monitoring should take place during both the construction and operational phases of the proposed mining project in order to identify and address unforeseen negative impacts, and to ensure the efficacy of mitigation measures. These monitoring measures should be incorporated into the Environmental Management Programme (EMPr) for the project, together with the mitigation measures proposed in this report. An Environmental Officer (EO) should be appointed to undertake the necessary monitoring and include the findings in regular reports submitted to the relevant authorities as required.

The following activities should be undertaken <u>once off</u> prior to commencement of construction:

- It must be ensured that relevant permits are obtained for any protected tree species such as *Vachellia erioloba* and *V. haematoxylon,* provincially protected plant species or TOPS-listed species that will be destroyed, removed or relocated during the construction and operational phases of the project.
- It must be ensured that an Alien and Invasive Plant Species Management Plan is in place prior to commencement of construction and mining activities.
- It must be ensured that a Rehabilitation Plan is in place prior to commencement of mining activities. Management of soils throughout the LoM should also be addressed.

The following monitoring activities should be undertaken during the construction and operational phases of the proposed project by the EO on a monthly basis.

- It must be ensured that the mine development footprint areas do not exceed approved project boundaries.
- Natural areas surrounding the project area must be inspected to ensure that these remain in a natural state and that no clearing, dumping or excavations that may obstruct faunal movement, occur.
- Should the presence of any floral or faunal SCC not recorded during the current study be confirmed within the project area, rescue and relocation of these species must take place under the supervision of a suitable qualified botanist or faunal specialist and with the required permits in place if necessary, and the existing management strategy must be adapted to protect such species.
- It must be ensured that any protected plant species (particularly large of prominent *V. erioloba* trees) located in proximity to the mining footprint area and earmarked to remain intact, remain protected for the duration of the project.
- Where applicable, monitoring should include the successful implementation of conditions attached to permits obtained for the disturbance or removal of protected and TOPS-listed species.
- It must be ensured the Alien and Invasive Species Management Plan, together with management measures indicated in the EMPr, is implemented to a high standard for the duration of the project.
- Any snares or traps found on or adjacent to the study area must be recorded. The date as well as GPS location of the snare/trap must be recorded, and this record document must be readily available on the mine premises. Furthermore, if the snare/trap has been activated, the trapped species must be noted. Identified snares must be removed and disposed of.
- Recording any faunal involved in vehicle collisions within the study area.

The following monitoring activities should be undertaken during the rehabilitation and post-rehabilitation phases of the proposed project according to the time frames indicated:

- It must be ensured that the Rehabilitation Plan, together with management measures indicated in the EMP, is implemented to a high standard.
- Implementation of the Alien and Invasive Species Management Plan should continue during the rehabilitation phase. In areas where rehabilitation work has been completed, invasive species monitoring, and eradication must continue biannually (every six months) for a period of two years.
- All rehabilitated areas should be monitored for erosion, and where encountered, immediate rectification must take place. In areas where rehabilitation work has been completed, erosion monitoring and rectification thereof, must continue biannually (every six months) for a period of two years.
- Where any protected species are to be rescued and relocated, this process should be overseen by a qualified botanist or horticulturalist and the EO or external environmental specialist must be appointed to monitor the reestablishment success of relocated species every six months (biannually) for a period of two years after relocation.
- Areas that have been revegetated (either through succession or reseeding) as part of the rehabilitation process, must be monitored biannually for a period of two years once

rehabilitation has been completed to ensure that adequate vegetation cover (as defined in the rehabilitation plan) has been achieved. Where large bare areas are noted, reseeding must take place at the beginning of the following rainy season and where tree mortalities are noted, these must be replaced.

- It must be ensured that the post-mining landscape is self-sustaining, and in line with future land use of the project area.

10 ALTERNATIVES

No site or layout alternatives are available for the proposed project. The no-go alternative has however been considered, which would be the option of not undertaking the development of the proposed project. Should the no-go alternative be adopted, no further impacts on the floral and faunal communities within the project area, other than those impacts currently taking place, will occur.

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APPENDIX A – LIST OF FLORAL SPECIES RECORDED IN THE PROJECT AREA

Floral Species recorded within the two main habitat units within project area

* - Alien species (note that alien species recorded in the Modified Grassland and Existing Infrastructure habitat units within the project area are listed under Section 6.2.3)

NEMBA – National Environmental Management: Biodiversity Act (Act. No 10 of 2004)

NFA – protected in terms of the National Forests Act (Act No. 84 of 1998) (indicated in bold)

NCNCA – protected in terms of the Northern Cape Nature Conservation Act (Act No. 9 of 2009) (indicated in bold)

LC – Least Concern in terms of the SANBI Red List

TOPS – SANBI Threatened or Protected Species (2015)

Table 16: Floral species recorded during the field assessment

SPECIES	Conservation Status	Habitat Unit				
		Modified Kathu Bushveld (MR area)	Modified Kathu Bushveld (access road)	Existing Infrastruc-ture	Secondary Thornveld	In-pit Aquatic Habitat
Aizoaceae						
Plinthus sericeus	**NCNCA - Schedule 2**	**X**				
Amaranthaceae						
Hermbstaedtia odorata	LC	X				
Pupalea lappacea var. *lappacea*	LC			X		
Sericocoma avolans	LC			X		
Amaryllidaceae						
Ammocharis coranica	**NCNCA - Schedule 2**		**X**			
Boophone disticha	**NCNCA - Schedule 2**		**X**			
***Crinum* sp.**	**NCNCA - Schedule 2**		**X**			
Anacardiaceae						
**Schinus molle*	Alien					X
Searsia lancea	LC			X		X
Searsia pendulina	LC					X
Anacampserotaceae						
Talinum crispatulum	LC	X	X	X		
Apocynaceae						
Orthanthera jasminiflora	**NCNCA - Schedule 2**	**X**	**X**			
Arecaceae						
**Washingtonia robusta*	Alien					X
Asparagaceae						
Asparagus laricinus	LC	X				
Asteraceae						
**Hypochaeris radicata*	Alien			X		

SPECIES	Conservation Status	Habitat Unit				
		Modified Kathu Bushveld (MR area)	Modified Kathu Bushveld (access road)	Existing Infrastruc-ture	Secondary Thornveld	In-pit Aquatic Habitat
**Verbesina enceloides*	Alien		X			
Chrysocoma obtusata	LC	X				
Felicia muricata	LC	X			X	
Foveolina dichotoma	LC		X			
Geigeria ornativa subsp. *ornativa*	LC	X				
Geigeria pectidea	LC	X				
Helichrysum argyrosphaerum	LC	X				
Tarchonanthus camphoratus	LC	X				
Senecio inaequidens	LC			X	X	
Pegolettia retrofracta	LC			X		
Boraginaceae						
Ehretia alba	LC	X				
Heliotropium ciliatum	LC		X	X		
Cactaceae						
**Opuntia ficus-indica*	NEMBA Category 1b listed invasive			X	X	
Caryophyllaceae						
Pollichia campestris	LC	X	X			
Chenopodiaceae						
**Chenopodium album*	Alien			X	X	
Combretaceae						
Terminalia sericea	LC	X				
Commelinaceae						
Commelina erecta	LC		X			
Convolvulaceae						
Ipomoea bolusiana	LC	X				
Ipomoea obscura	LC	X	X			
Merremia verecunda	LC	X	X			
Xenostegia tridentata subsp. *angustifolia*	LC			X		
Cucurbitaceae						
Acanthosicyos naudinianus	LC	X	X			
Cucumis africanus	LC	X	X			
Momordica balsamina	LC		X			
Cyperaceae						
Kyllinga alba	LC		X			
Fabaceae						

SPECIES	Conservation Status	Habitat Unit				
		Modified Kathu Bushveld (MR area)	**Modified Kathu Bushveld (access road)**	**Existing Infrastruc-ture**	**Secondary Thornveld**	**In-pit Aquatic Habitat**
**Prosopis glandulosa* var. *torreyana*	NEMBA Category 1b listed invasive	X	X	X	X	X
**Prosopis velutina*	NEMBA Category 1b listed invasive	X		X		
Crotalaria spartioides	LC	X	X			
Elephantorrhiza elephantina	LC		X			
Listia sp.	LC	X				
Pomaria burchellii	LC	X	X			
Requienia sphaerosperma	LC					
Rhynchosia holosericea	LC	X				
Senegalia mellifera subsp. *detinens*	LC	X	X	X	X	
Senna italica subsp. *arachoides*	LC	X	X			
Tephrosia rhodesica	LC		X			
Vachellia erioloba	**NFA**	**X**	**X**			
Vachellia haematoxylon	**NFA**	**X**	**X**		**X**	
Vachellia hebeclada subsp. *hebeclada*	LC	X	X		X	
Hyacinthaceae						
***Albuca seineri* (=*Ornithogalum seineri*)**	**NCNCA - Schedule 2**	**X**				
***Albuca setosa* (=*Ornithogalum seineri*)**	**NCNCA - Schedule 2**	**X**				
Dipcadi vaginatum	LC	X	X		X	
Dipcadi viride	LC	X				
Ledebouria leptophylla	LC	X				
Lamiaceae						
Leonotis pentadentata	LC	X	X	X	X	
Loranthaceae						
Tapinanthus oleifolius	LC	X	X	X	X	
Malvaceae						
Grewia flava	LC	X		X		X
Hermannia burchellii	LC	X	X			
Hermannia tomentosa	LC	X				
Pavonia burchellii	LC		X			

SPECIES	Conservation Status	Habitat Unit				
		Modified Kathu Bushveld (MR area)	Modified Kathu Bushveld (access road)	Existing Infrastruc-ture	Secondary Thornveld	In-pit Aquatic Habitat
Sida cordifolia subsp. *cordifolia*	LC		X	X		
Waltheria indica	LC			X		
Molluginaceae						
Limeum aethiopicum	LC			X		
Nyctaginaceae						
**Boerhavia diffusa* var. *diffusa*	Alien			X		
Papaveraceae						
**Argemone ochroleuca*	NEMBA Category 1b			X		
Pedaliaceae						
Ceratotheca triloba	LC		X	X		
Dicerocaryum eriocarpum	LC	X				
Harpagophytum procumbens	**NCNCA - Schedule 1 TOPS**	**X**	**X**			
Phyllanthaceae						
Phyllanthus parvulus subsp. *parvulus*	LC	X				
Poaceae						
**Pennisetum setaceum*	NEMBA Category 1b	X		X	X	
Aristida congesta subsp. *congesta*	LC	X	X	X	X	
Aristida stipitata	LC		X	X	X	
Cenchrus ciliaris	LC			X	X	
Centropodia glauca	LC	X	X	X	X	
Chrysopogon serrulatus	LC	X	X	X		
Coelachyrum yemenicum	LC			X		
Cymbopogon pospischilii	LC	X		X	X	X
Cynodon dactylon	LC	X	X	X		X
Enneapogon cenchroides	LC	X	X	X	X	
Eragrostis chloromelas	LC	X	X		X	X
Eragrostis echinochloidea	LC	X	X	X		
Eragrostis lehmanniana	LC	X	X	X		
Eustachys paspaloides	LC		X			
Heteropogon contortus	LC	X	X	X	X	
Melinis repens	LC			X	X	
Panicum maximum				X	X	

SPECIES	Conservation Status	Habitat Unit				
		Modified Kathu Bushveld (MR area)	Modified Kathu Bushveld (access road)	Existing Infrastruc-ture	Secondary Thornveld	In-pit Aquatic Habitat
Phragmites australis	LC					X
Pogonarthria squarrosa	LC		X		X	
Schmidtia kalahariensis	LC	X	X	X	X	
Schmidtia pappophoroides	LC	X	X	X	X	
Setaria verticillata	LC		X	X		
Stipagrostis hirtigluma	LC	X		X		
Stipagrostis uniplumis	LC	X	X	X		
Themeda triandra	LC	X			X	
Tragus berteronianus	LC	X	X	X		
Tricholaena monachne	LC	X	X			
Polygalaceae						
Polygala seminuda	LC			X		
Polygala leptophylla var. *leptophylla*	LC	X	X			
Polygonaceae						
Oxygonum delagoense	LC		X			
Rhamnaceae						
Ziziphus mucronata	LC		X	X		
Scrophulariaceae						
Peliostomum leucorrhizum	LC	X				
Solanaceae						
**Nicotiana glauca*	NEMBA Category 1b					X
Lycium hirsutum	LC		X			
Vahliaceae						
Vahlia capensis subsp. *vulgaris*	LC	X	X	X		
Zygophyllaceae						
Tribulus terrestris	LC			X		

APPENDIX B – NORTHERN CAPE NATURE CONSERVATION ACT (ACT NO. 9 OF 2009) SPECIALLY PROTECTED AND PROTECTED FLORAL SPECIES

The floral species included in the table below are those indigenous species specified in Schedules 1 and 2 of the NCNCA (Act No. 9 of 2009) that are declared to be Specially Protected and Protected plants.

Table 17: Specially Protected and Protected floral species in terms of the NCNCA (Act No. 9 of 2009).

Schedule 1: Specially Protected Plants	
Species	**Common Name**

Amaryllidaceae	
Clivia mirabilis	Oorlogskloof bush lily / Clivia
Haemanthus graniticus	April fool
Hessea pusilla	-
Strumaria bidentata	-
Strumaria perryae	-
Anacardiaceae	
Ozoroa spp.	All species
Apiaceae	
Centella tridentata	-
Chamarea snijmaniae	-
Apocynaceae	
Hoodia gordonii	-
Pachypodium namaquanum	Elephants' trunk
Asphodelaceae	
Aloe buhrii	-
Aloe dabenorisana	Cliff aloe
Aloe erinacea	-
Aloe meyeri	Cliff aloe
Aloe pearsonii	Pearson's aloe
Aloe pillansii	Giant quiver tree
Aloidendron dichotomum (=*Aloe dichotoma*)	Quiver tree
Aloidendron ramosissimum (= *Aloe dichotoma* var. *rumosissima*)	Maiden quiver tree
Trachyandra prolifera	-
Asteraceae	
Athanasia adenantha	-
Athanasia spathulata	-
Cotula filifolia	-
Euryops mirus	-
Euryops rosulatus	-
Euryops virgatus	-
Felicia diffusa subsp. *khamiesbergensis*	-
Othonna armiana	-
Crassulaceae	
Tylecodon torulosus	-
Dioscoreaceae	
Dioscorea spp.	Elephant's foot, all species
Eriospermaceae	
Eriospermum erinum	-
Eriospermum glaciale	-
Fabaceae	
Amphithalea obtusiloba	-
Lotononis acutiflora	-
Lotononis polycephala	-
Lessertia spp.	-
Sceletium tortuosum	-
Sutherlandia spp.	Cancer Bush, all species
Wiborgia fusca subsp. *macrocarpa*	-
Geraniaceae	
Pelargonium spp.	Pelargonium, all species
Hyacinthaceae	
Drimia nana	-
Ornithogalum bicornutum	-
Ornithogalum inclusum	-
Iridaceae	
Babiana framesii	-

Ferraria kamiesbergensis	-
Freesia marginata	-
Geissorhiza subrigida	-
Hesperantha minima	-
Hesperantha oligantha	-
Hesperantha rivulicola	-
Lapeirousia verecunda	-
Moraea kamiesensis	-
Moraea namaquana	-
Romulea albiflora	-
Romulea discifera	-
Romulea maculata	-
Romulea rupestris	-
Molluginaceae	
Kewa trachysperma (=*Hypertelis trachysperma*)	-
Psammotropha spicata	-
Orchidaceae	
Disa macrostachya	Disa
Pterygodium ingeanum (=*Corycium ingeanum*)	-
Oxalidaceae	
Oxalis pseudohirta	Sorrel
Pedaliaceae	
Harpagophytum spp.	Devil's claw
Poaceae	
Pentameris dentata (=*Secale strictum* subsp. *africanum*)	Wild rye
Prionanthium dentatum	-
Proteaceae	
Leucadendron meyerianum	Tolbos
Mimetes spp.	All species
Orothamnus zeyheri	-
Rosaceae	
Cliffortia arborea	Sterboom
Scrophulariaceae	
Charadrophila capensis	Cape Gloxinia
Stangeriaceae	
Stangeria spp.	Cycads, all species
Zamiaceae	
Encephalartos spp.	Cycads, all species
Schedule 2: Protected Plants	
Species	**Common Name**
	All indigenous plants, except those listed in Schedules 1, 3 and 6.
Acanthaceae	
Barleria papillosa	-
Justicia saxatilis (=*Monechma saxatile*)	-
Dicliptera spp. - certain speciess (=*Peristrophe* spp.)	All species
Adianthaceae	
Adiantum spp.	Maidenhair Fern, all species
Agapanthaceae	
Agapanthus spp.	All species
Aizoaceae (Mesembryanthemaceae)	
All species	-
Amaryllidaceae	
All species except those listed in Schedule 1	-
Anthericaceae	
All species	-

Apiaceae	
All species except those listed in Schedule 1	-
Apocynaceae	
All species except those listed in Schedule 1	-
Aquifoliaceae	
Ilex mitis	-
Araceae	
Zantedeschia spp.	Arum lilies, all species
Araliaceae	
Cussonia spp.	Cabbage trees, all species
Asphodelaceae	
All species except those listed as Schedule 1, and the species *Aloe ferox.*	-
Asteraceae	
Helichrysum jubilatum	-
Felicia deserti	-
Gnaphalium simii	-
Lopholaena longipes	-
Senecio albopunctatus	-
Senecio trachylaenus	-
Ifloga lerouxiae (=*Trichogyne lerouxiae*)	-
Osteospermum pinnatilobatum (=*Tripteris pinnatilobata*)	-
Troglophyton acocksianum	-
Vellereophyton lasianthum	-
Burmanniaceae	
Burmannia madagascariensis	Wild Ginger
Burseraceae	
Commiphora spp.	All species
Capparaceae	
Boscia spp.	Shepherd's trees, all species
Caryophyllaceae	
Dinanthus spp.	All species
Celastraceae	
Gymnosporia spp.	All species
Colchicaceae	
Androcymbium spp.	All species
Gloriosa spp.	All species
Combretaceae	
Combretum spp.	All species
Crassulaceae	
All species except those listed in Schedule 1	-
Cupressaceae	
Widdringtonia spp.	Wild cypress, all species
Cyatheaceae	
Cyathea spp.	Tree ferns, all species
Cyathea capensis	Tree Ferns
Cyperaceae	
Carex acocksii	--
Droseraceae	
Drosera spp.	Sundew, all species
Dryopteridaceae	
Rumohra spp.	Seven Weeks Fern, all species
Ericaceae	
Erica spp.	Erica, all species
Euphorbiaceae	
Alchornea laxiflora	Venda Beadstring

Euphorbia spp.	All species
Fabaceae	
Argyrolobium petiolare	-
Aspalanthus spp.	Tea bush, all species
Caesalpinia bracteata	-
Calliandra redacta	-
Crotalaria pearsonii	-
Erythina zeyheri	Plougbreaker
Indigofero limosa	-
Polhillia involucrata	-
Rhynchosia emarginata	-
Wiborgiella bowieana (=*Lebeckia bowieana*)	-
Wiborgiella humilis (=*Wiborgia humilis*)	-
Hyacinthaceae	
Daubenya spp.	Daubenya, all species
Eucomis spp.	Pineapple flower, all species
Lachenalia spp.	Viooltjie, all species
Ornithogalum filicaule (=*Neopatersonia namaquensis*)	-
Ornithogalum spp.	All species
Veltheimia spp.	Forest Lily, all species
Iridaceae	
All species except those listed in Schedule 1	
Lauraceae	
Ocotea spp.	Stinkwood, all species
Meliaceae	
Nymania capensis	Chinese Lantern
Oleaceae	
Olea europaea subsp. *africana*	Wild olive
Orchidaceae	
Orchids, all species except those species listed in Schedule 1	-
Orobanchaceae	
Harveya spp.	Harveya, all species
Oxalidaceae	
Oxalis spp.	Sorrel, all species except those species listed in Schedule 1
Plumbaginaceae	
Limonium namaquanum (=*Afrolimon namaquanum*)	-
Poaceae	
Brachiaria dura var. *dura*	-
Dregeochloa calviniensis	-
Pentameris lima (=Pentaschistis lima)	-
Podocarpaceae	
Podocarpus spp.	Yellowwoods, all species
Portulacaceae	
Anacampseros spp.	All species
Avonia spp.	All species
Portulaca foliosa	-
Proteaceae	
All species except those listed in Schedule 1	
Restionaceae	
All species	
Rhamnaceae	
Phylica spp.	All species
Rutaceae	
Agathosma spp.	Buchu, all species

Scrophulariaceae	
Chaenostoma longipedicellatum	-
Diascia spp.	All species
Halleria spp.	All species
Jamesbrittenia spp.	All species
Manulea spp.	All species
Nemesia spp.	All species
Phyllopodium spp.	All species
Polycarena filiformis	-
Strelitziaceae	
Strelitzia spp.	All species
Tecophllaeaceae	
Cyanella spp.	All species
Thymelaeaceae	
Gnidia leipoldtii	
Zingiberaceae	
Siphonochilus aethiopicus	Wild Ginger

APPENDIX C – NEMBA TOPS-LISTED FLORAL SPECIES KNOWN FROM THE NOTHERN CAPE PROVINCE

Table 18: NEMBA TOPS-listed floral species known to occur in the Northern Cape Province

Species	**NEMBA TOPS Threat Status**	**SANBI Threat Status**	**Habitat[6]**
Aizoaceae (Mesembryanthemaceae)			
Cheiridopsis peculiaris	CR	CR	Namaqualand Shale Shrubland near Steinkopf on gravels and shale derived from metamorphic rocks of the Namaqualand Complex.
Conophytum bachelorum	VU	CR	Southern Richtersveld between Steinkopf and Port Nolloth, in the Northern Cape Province, on quartz outcrops, ridges and cliffs in Namaqualand Heuweltjieveld.
Conophytum herreanthus subsp. *herreanthus*	CR	EW	Richtersveld, near Umdaus north of Steinkopf on quartz patches.
Conophytum ratum	VU	CR	Bushmanland Inselbergs near Aggeneys, in the Northern Cape, South Africa.
Lithops dorotheae	EN	EN	From Pella to Pofadder on fine-grained, sheared, feldspathic quartzite.
Sceletium tortuosum	P	LC	In the succulent Karoo in the Eastern Cape, Northern Cape, Western Cape Provinces.
Asphodelaceae			
Aloe krapohliana	P	LC	This species is endemic to the Richtersveld and Namaqualand region of South Africa, where it occurs from the lower Gariep Valley to Vanrhynsdorp and Calvinia. It occurs on sandy flats and rocky slopes in arid succulent shrubland, from sea level to 1,500m.
Aloidendron dichotomum	VU	VU	From Nieuwoudtville east to Olifantsfontein and northwards to the Brandberg in Namibia.
Aloidendron pillansii	EN	EN	Richtersveld and southern Namibia.
Amaryllidaceae			

[6] www.sanbi.redlist.org

Species	NEMBA TOPS Threat Status	SANBI Threat Status	Habitat[6]
Brunsvigia herrei	VU	VU	Southern Namibia to Springbok. Succulent karoo shrubland, granitic soils on flats and sometimes in deposits of fairly large stones.
Brunsvigia josephinae	VU	VU	Nieuwoudtville to Baviaanskloof in heavy clay soils.
Cyrtanthus herrei	P	NT	Central mountains of the Richtersveld and southern Namibia on deeply shaded rock ledges on south-facing rocky slopes.
Gethyllis grandiflora	VU	LC	Richtersveld Mountains to Komaggas in sandy and or stony soils in arid karroid shrubland.
Gethyllis namaquensis	VU	LC	Richtersveld and southern Namibia coastal dunes and gravelly mountain slopes in succulent karoo shrubland.
Haemanthus graniticus	EN	EN	Springbok to Kamiesberg. Namaqualand Klipkoppe Shrubland or Namaqualand Granite Renosterveld.
Hyacinthaceae			
Drimia sanguinea	P	NT	Northern Cape and across to Limpopo and Mpumalanga Provinces, Namibia, Botswana and Zimbabwe. Open veld and scrubby woodland in a variety of soil types.
Pedaliaceae			
Harpagophytum procumbens	P	LC	Within South Africa this species occurs in the Northern Cape, North West, Free State, and Limpopo Provinces and the largest populations are found in the communally owned areas of the North West Province and the north eastern parts of the Northern Cape. Well drained sandy habitats in open savanna and woodlands.

APPENDIX D – ENDEMIC AND NEAR-ENDEMIC FLORAL SPECIES OF THE GWC

Table 19: Endemic and near-endemic floral species of the GWC (Frisby et al., 2019)

Species	SANBI Threatened Status	Habitat (www.sanbi.redlist.org; Frisby et al., 2019)
Acanthaceae		
Barleria media	VU (endemic)	Occurs in the Kalahari region near Kuruman, possibly on rocky slopes or koppies. Found on the Ghaap Plateau, Kuruman Hills and in river valleys in the Northern Cape and North-West.
Blepharis marginata	LC (endemic)	Kathu to Griekwastad and Warrenton. It occurs in cracks in limestone rocks, or red sand over limestone in Kalahari thornveld. found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills, Langberg and in river valleys in the Northern Cape.
Glossochilus burchellii	LC (endemic)	Kuruman to Griekwastad. Gravelly slopes of low hills in low shrubland and Kalahari thornveld. Found on the Ghaap Plateau, Kuruman Hills and Asbestos Hills in the Northern Cape.
Justicia puberula	LC (endemic)	Kloofs, in rock crevices and under shrubs. Found on the Ghaap Plateau, Kuruman Hills, Langberg and in river valleys in the Northern Cape.
Justicia thymifolia	LC (near-endemic)	Found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills, Langberg and in river valleys in the Northern Cape.

Species	SANBI Threatened Status	Habitat (www.sanbi.redlist.org; Frisby et al., 2019)
Aizoaceae		
Antimima lawsonii	Rare (endemic)	Kimberley district in limestone soils. found on the Asbestos Hills, Ghaap Plateau and Kuruman Hills in the Northern Cape.
Hereroa wilmaniae	DDT (endemic)	Found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills, Langberg and river valleys in the Northern Cape.
Lithops aucampiae subsp. *euniceae*	VU (endemic)	Hopetown, on fine-grained, brown sandstone with some amygdaloidal lava. Found on the Asbestos Hills and river valleys in the Northern Cape.
Lithops bromfieldii	LC (endemic)	Found in the Langberg region in the Northern Cape.
Lithops lesliei subsp. *burchellii*	NT (endemic)	Kimberley, on calcareous, well-drained soil in areas that receive 250-400mm rainfall per year. found on the Asbestos Hills and Ghaap Plateau of the Northern Cape
Prepodesma orpenii	LC (endemic)	Found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills and Langberg in the Northern Cape.
Anacardiaceae		
Searsia tridactyla	LC (endemic)	Found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills, Langberg and in river valleys in the Northern Cape.
Apiaceae		
Deverra rapaletsa	Not yet assessed – species first described in 2019 (endemic)	Found on the Ghaap Plateau near Postmasburg and Danielskuil in the Northern Cape. found along the Asbestos Hills, Langberg and Ghaap Plateau in the Northern Cape.
Asteraceae		
Amphiglossa tecta	Critically Rare (endemic)	Postmasburg, in basins among white sand dunes. found along the Asbestos Hills, Langberg and Ghaap Plateau in the Northern Cape.
Cineraria exilis	DDT (endemic)	Near the source of the Moshaweng River, Kuruman district. Possibly occurring in the low shrub or herbland vegetation of the dry riverbed and banks, known as Southern Kalahari Mekgacha. found on the Ghaap Plateau and Kuruman Hills in the Northern Cape and North-West.
Dicoma kurumanii	Rare (endemic)	This species occurs from Kuruman in the Northern Cape to the Molopo River on the border with Botswana. Its specific habitat requirements are unknown. Found on the Ghaap Plateau and Kuruman Hills in the Northern Cape.
Eriocephalus ericoides subsp. *griquensis*	LC (endemic)	Found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills, Langberg and in river valleys in the Northern Cape.
Gnaphalium englerianum	LC (endemic)	Found on the Ghaap Plateau, Kuruman Hills and in river valleys in the Northern Cape.
Pentzia stellata	NT (endemic)	Postmasburg to Vryburg in seasonally waterlogged calcrete pans. found on the Ghaap Plateau, primarily next to unweathered calcrete pans in the Northern Cape and North-West.
Tarchonanthus obovatus	LC (endemic)	Restricted to Gordonia district, in the Northern Cape Province. This species occurs in pockets of sandy soils on rocky hill slopes and flats. found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills, Langberg and in river valleys in the Northern Cape.
Celastraceae		
Maytenus ilicina	LC (endemic)	Found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills and Langberg in the Northern Cape.

Species	**SANBI Threatened Status**	**Habitat (www.sanbi.redlist.org; Frisby et al., 2019)**
Putterlickia saxatilis	LC (endemic)	Found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills, Langberg and valleys in the Northern Cape.
Fabaceae		
Calobota cuspidosa	LC (endemic)	Found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills, Langberg and valleys in the Northern Cape.
Poaceae		
Brachiaria dura var. *pilosa*	DDT (endemic)	Found in the Langberg region in the Northern Cape.
Stilbaceae		
Nuxia gracilis	LC (near-endemic)	Found on the Asbestos Hills, Ghaap Plateau, Kuruman Hills and valleys in the Northern Cape.

APPENDIX E – FAUNAL ASSEMBLAGES

Table 20: Mammalian species known from records within the 2722BB QDS (MammalMAP, 2017) and surrounds. Mammal SCC are indicated in bold.

(LC – Least Concern; NT – Near Threatened; VU – Vulnerable; EN – Endangered; TOPS – NEMBA Threatened or Protected Species (2015))

Scientific Name	Common Name	Conservation Status	Habitat
Bathyergidae			
Fukomys damarensis	Damaraland Mole-rat	LC	Semi-arid regions consisting of red Kalahari sands and sandy soils, occupying habitats including grassland, savannah, thorn-scrub and woodland.
Pedetidae			
Pedetes capensis	South African Spring Hare	LC	Relatively flat and open habitats with short grass and little to no woody vegetation.
Bovidae			
Sylvicapra grimmia	Common Duiker	LC	Variety of habitats with sufficient cover. Also in anthropogenically modified habitats.
Aepyceros melampus melampus	Impala	LC	Ecotones species preferring light woodland with little undergrowth and grassland.
Tragelaphus strepsiceros	Greater Kudu	LC	Mixed scrub woodland, *Acacia*, and *Mopane* bush on lowlands and mountains.
Raphicerus campestris	Steenbok	LC	Variety of grasslands, shrublands and savannah habitats.
Alcelaphus buselaphus caama	Red Hartebeest	LC; TOPS	Open Savanna and woodlands.
Oryx gazella	Gemsbok	LC	Semi-arid and arid grass, shrub and woodland savannahs of the Kalahari, Karoo and adjacent regions.
Hippotragus equinus	**Roan Antelope**	**EN; TOPS**	Savannah woodlands and grasslands within the bushveld and Lowveld of southern Africa.
Antidorcas marsupialis	Springbok	LC	Dry grasslands and shrublands and are mixed feeders.
Hippotragus niger niger	**Sable Antelope**	**VU, TOPS**	**Woodland/grassland ecotones and are selective feeders.**
Erinaceidae			
Atelerix frontalis	**Southern African Hedgehog**	**NT**	**Scrub brush, grasslands and suburban gardens. Require ample cover and insect food resources.**
Canidae			
Canis mesomelas	Black-backed Jackal	LC	Wide habitat tolerance including savanna, shrubland and grasslands.
Otocyon megalotis	Bat-eared Fox	LC; TOPS	Short grass plains, open scrub and open arid savannah.
Vulpes chama	Cape Fox	LC; TOPS	Open country grassland with scattered thickets, and lightly wooded areas, particularly
Hyaenidae			
Parahyaena brunnea	**Brown Hyaena**	**NT, TOPS**	**Desert, semi-desert, open scrub and open woodland savanna.**

Scientific Name	Common Name	Conservation Status	Habitat
Proteles cristata	Aardwolf	LC	Open grassy plains, karroid scrub and open woodlands. Feed primarily on Trinervitermes.
Felidae			
Caracal caracal	Caracal	LC	Wide habitat tolerance. Savanna, scrubland, moist woodland and evergreen forest.
Panthera pardus	**Leopard**	**VU, TOPS**	**Wide habitat tolerance. Preference for well-wooded habitats.**
Felis nigripes	**Black-footed Cat**	**VU; TOPS**	Specialist, inhabits dry, open savannah, grasslands and Karoo semi-desert with sparse shrub and tree cover and a mean annual rainfall of between 100 and 500 mm.
Felis silvestris	African Wildcat	LC	Variety of habitats, require some cover and protection such as rocky hillsides, bushes, dwarf shrubs and tall grass.
Herpestidae			
Cynictis penicillata	Yellow Mongoose	LC	Variety of habitats, savanna, shrubland, grassland and arid environments.
Herpestes sanguineus	Slender Mongoose	LC	Forest to open savanna, as long as there is suitable cover. Can persist in urban areas.
Suricata suricatta	Suricate	LC	Arid, open country, characterised by short grasses and sparse woody growth.
Hystricidae			
Hystrix africaeaustralis	Cape Porcupine	LC	Wide habitat tolerance occurring in cultivated/greenfield areas. Also urban landscapes.
Mustelidae			
Mellivora capensis	Honey Badger	LC, CITES III, TOPS	Variety of habitat types but generally absent from the more open and central Grassland and Nama Karoo biomes.
Muridae			
Thallomys nigricauda	Black-tailed Tree Rat	LC	Arid savannahs, *Acacia* bushland and Kalahari thornveld.
Micaelamys namaquensis	Namaqua Rock Mouse	LC	Wide range of habitats. Must contain patches of rocky areas.
Gerbilliscus leucogaster	Bushveld Gerbil	LC	Variety of habitats, including bushveld and grasslands, as well as transformed habitats.
Gerbilliscus brantsii	Highveld Gerbil	LC	Wooded grassland with sufficient cover.
Desmodillus auricularis	Cape Short-tailed Gerbil	LC	Hard soils of arid plains and pans, with a sparse cover of grass or low karroid shrubs.
Gerbilliscus paeba	Hairy-footed Gerbil	LC	Sandy soils, or sandy alluvium associated with grass, scrub or thin woodland in savannah, desert and dune field habitats.
Mastomys coucha	Southern African Mastomys	LC	Wide habitat tolerance.
Rhabdomys sp.	Xeric Four-striped Mouse	LC	Widespread. Only consistent requirement appears to be presence of grass.
Mus minutoides	Pygmy Mouse	LC	Habitat generalist preferring grasslands also found in including savannah and fynbos.
Soricidae			
Crocidura cyanea	Reddish-grey Musk Shrew	LC	In western parts of the country, it has been collected from scrub on Kalahari sand and reedbeds around waterholes.

Scientific Name	Common Name	Conservation Status	Habitat
Manidae			
Smutsia temminckii	**Temminck's Ground Pangolin**	**VU; TOPS**	**Woodland and savanna habitats, preferring arid and mesic savanna and semi-arid environments at lower altitudes, often with thick undergrowth.**
Suidae			
Phacochoerus africanus	Common Warthog	LC	Open habitats as well as lightly wooded savanna habitats.
Procaviidae			
Procavia capensis	Rock Hyrax	LC	Wide range of habitats. Mainly Rocky outcrops, cliffs, or piles of boulders with bushes.
Macroscelididae			
Elephantulus myurus	Eastern Rock Elephant Shrew	LC	Rocky outcrops or koppies with sufficient cracks and holes for shelter and nesting sites.
Elephantulus intufi	Bushveld Sengi	LC	Arid terrain including dry savannah woodlands, bushveld, steppe, and semi-deserts.
Nesomyidae			
Dendromus melanotis	Grey African Climbing Mouse	LC	Variety of habitats in grassland and savanna habitats as well as Kalahari scrub.
Saccostomus campestris	Pouched Mouse	LC	Generalist. Inhabits savannah woodland areas across its range.
Orycteropodidae			
Orycteropus afer	Aardvark	LC; TOPS	Broad range of habitats including open savanna, shrubland, grassland and thickets.
Leporidae			
Lepus capensis	Cape Hare	LC	Variety of grassland and open habitat, preferring dry, open habitats
Pronolagus rupestris	Smith's Red Rock Hare	LC	Rocky areas, krantzes, hillsides and koppies.
Cercopithecidae			
Papio ursinus	Chacma Baboon	LC (CITES II)	Wide range of habitats including anthropogenically modified habitats.
Sciuridae			
Xerus inauris	South African Ground Squirrel	LC	Open terrain with little bush cover, occurring on in open grassland or karroid areas, with suitable burrowing substrate.

Table 21: Amphibian species known from records within the 2722BB QDS (FrogMAP) and surrounds.

(LC – Least Concern)

Scientific Name	Common Name	Conservation Status	Habitat
Bufonidae			
Sclerophrys gutturalis	Guttural Toad	LC	Open pools, dams, vleis and other semi-permanent or permanent water bodies.
Sclerophrys poweri	Power's Toad	LC	Vlei and pans in thornveld.
Pyxicephalidae			
Amietia delalandii	Common River Frog	LC	Banks of slow-moving streams/ permanent bodies of water in a wide variety of wetlands.
Cacosternum boettgeri	Boettger's Caco	LC	Variety of habitats in Nama Karoo, succulent Karoo, grassland and thickets.
Amietia poyntoni	Poynton's River Frog	LC	Banks of slow-moving streams/ permanent bodies of water in a wide variety of wetlands.
Tomopterna cryptotis	Tremelo Sand Frog	LC	Savanna and grassland habitats with standing water at the edges of dams and pans.
Hyperoliidae			
Kassina senegalensis	Bubbling Kassina	LC	Grassland around vleis and pans. Breeds in temporary and permanent water bodies.
Pipidae			
Xenopus laevis	Common Platanna	LC	Restricted to aquatic habitats but opportunistic and can be found in any form of wetland.
Brevicipitidae			
Breviceps adspersus	Bushveld Rain Frog	LC	Sandy to sandy-loam soils in semi-arid habitats in savanna and grassland habitats.

Table 22: Reptile species known from record within the 2722BB QDS (SARCA; Bates et al., 2014) and surrounds.

(LC – Least Concern; NE- Near Endemic; TOPS – NEMBA Threatened or Protected Species (2015))

Scientific Name	Common Name	Conservation Status	Habitat
Chameleonidae			
Chamaeleo dilepis	Common Flap-neck Chameleon	LC	Variety of habitats usually found high up in bushes and woody vegetation.
Agamidae			
Agama aculeata aculeata	Common Ground Agama	LC	Largely terrestrial. Dry sandy areas. Shelters under bushes and in burrows.
Agama atra	Southern Rock Agama	LC	Rocky habitats.
Amphisbaenidae			
Monopeltis mauricei	Maurice's Worm Lizard	LC	Fossorial. Digs deep burrows in sparsely vegetated Kalahari sand.
Zygaspis quadrifrons	Kalahari Dwarf Worm Lizard	LC	Kalahari sands.
Gekkonidae			
Pachydactylus capensis	Cape Gecko	LC	Wide range of habitats with suitable refugia.
Chondrodactylus bibronii	Bibron's Gecko	LC	Rock outcrops throughout the Karoo region. Commensal in farm buildings and outhouses.
Chondrodactylus angulifer angulifer	Common Giant Ground Gecko	LC	Terrestrial. Burrows in loosely compacted sand in the sparsely vegetated, sandy valleys of the western arid region.
Colopus wahlbergii wahlbergii	Kalahari Ground Gecko	LC	Dune and savanna habitats in the central Kalahari and adjacent regions.
Ptenopus garrulus garrulus	Common Barking Gecko	LC	Dune and savanna habitats in the central Kalahari and adjacent regions.
Lacertidae			
Nucras intertexta	Spotted Sandveld Lizard	LC	Sandy substrates in arid savanna and open scrubland.
Heliobolus lugubris	Bushveld Lizard	LC	Low-lying savanna, often overlying Kalahari sands.
Pedioplanis lineoocellata lineoocellata	Spotted Sand Lizard	LC	Prefers dry, open vegetation.
Pedioplanis namaquensis	Namaqua Sand Lizard	LC	Open sandy areas in karroid veld, arid savanna and semi-desert.
Lamprophiidae			
Pseudaspis cana	Mole Snake	LC	Variety of habitats. Common in sand, scrub-covered areas and in grassland.
Boaedon capensis	Brown House Snake	LC	Range of terrestrial habitats and tolerant to considerable habitat transformation.

Scientific Name	Common Name	Conservation Status	Habitat
Lycophidion capense capense	Cape Wolf Snake	LC	Under rocks and logs or in old termitaria.
Psammophis brevirostris	Short-snouted Grass Snake	LC	Grassland and savanna habitats. Shelters in holes in the ground, under rocks and in old termitaria.
Atractaspis bibronii	Bibron's Stiletto Snake	LC	Fossorial. Found in termitaria or on soil under logs or rocks, in a variety of habitat types.
Psammophis trinasalis	Fork-marked Sand Snake	LC	Arid savannas and grasslands often in old termitaria and occasionally under rocks.
Xenocalamus bicolor bicolor	Bicoloured Quill-snouted Snake	LC	Kalahari sands at altitudes of 1 000–1 200 m.
Prosymna sundevallii	Sundevall's Shovel-snout	LC; NE	Moist and dry savanna and karroid areas, often found in old termitaria/under rocks.
Colubridae			
Dasypeltis scabra	Rhombic Egg-eater	LC	Variety of habitats, sheltering in moribund termitaria, under rocks and crevices.
Dispholidus typus viridis	Boomslang	LC	Arboreal in a variety of habitats.
Philothamnus semivariegatus	Spotted Bush Snake	LC	Moist savanna, lowland forest and riverbanks as well as vegetated rocky areas.
Telescopus semiannulatus semiannulatus	Eastern Tiger Snake	LC	Arid and moist savanna, sheltering under bark and in rock crevices.
Scincidae			
Trachylepis punctatissima	Speckled Rock Skink	LC	Rocky outcrops and trees in savannah and grassland systems.
Acontias kgalagadi kgalagadi	Kgalagadi Legless Skink	LC	Fossorial, found in sandy soils in areas of Kalahari dunes and open savanna.
Trachylepis occidentalis	Western Three-striped Skink	LC	Arid scrub and karroid veld, Uses tree clumps and bushes for refuge.
Trachylepis punctulata	Speckled Sand Skink	LC	Arid regions mainly on deep, sandy soils and occasionally on rocky outcrops.
Trachylepis spilogaster	Kalahari Tree Skink	LC	Arboreal in arid savanna. Also uses urban landscapes.
Trachylepis sulcata sulcata	Western Rock Skink	LC	Rupicolous found in groups on rock outcrops in arid savanna, karroid veld and desert.
Trachylepis variegata	Variegated Skink	LC	Rocky areas but also in sandy gravel habitat.
Varanidae			
Varanus albigularis albigularis	Rock Monitor	LC	Savanna and arid areas. Affinity for rocky areas.
Testudinidae			
Stigmochelys pardalis	Leopard Tortoise	LC	Wide distribution.
Psammobates oculifer	Serrated Tent Tortoise	LC	Undulating sandy plains with open tree cover and well- developed grass and shrub layers in arid region.

Scientific Name	Common Name	Conservation Status	Habitat
Elapidae			
Naja annulifera	Snouted Cobra	LC	Savanna habitats. Uses holes in the ground, old termite mounds and rocky outcrops.
Aspidelaps scutatus scutatus	Speckled Shield Cobra	LC	Semi-fossorial found primarily in stony and sandy areas at altitudes of 500–1 300 m.
Naja nigricincta woodi	Black Spitting Cobra	LC	Arid rocky regions throughout range.
Naja nivea	Cape Cobra	LC	Generalist. Arid karoo, open fynbos and grassland habitats throughout its range.
Viperidae			
Bitis arietans arietans	Puff Adder	LC	Wide habitat preference. Absent from alpine habitats, dense forests and deserts.
Pythonidae			
Python natalensis	Southern African Python	LC, TOPS	Wide variety of habitats. Usually in riverine or rocky areas.

APPENDIX F – CURRICULUM VITAE OF SPECIALISTS

CURRICULUM VITAE – MICHELLE PRETORIUS

Personal Details

Identity Number: 8210050124087
Telephone Number: 0824427637
Marital Status: Married
Drivers Licence Code: 08
Languages: English, Afrikaans

Academic qualifications

MSc (Environmental Ecology) – University of Pretoria	in progress
BSc (Hons) Plant Science Cum Laude – University of Pretoria	2008
BSc (Landscape Architecture) – University of Pretoria	2006
BSc (Botany) – University of Pretoria	2003

Professional Membership

Professional Natural Scientist (Ecological and Botanical Science) - South African Council for Natural Scientific Professions (SACNASP) Registration number: 400003/15.
Professional Landscape Architectural Technologist - South African Council for the Landscape Architectural Profession (SACLAP) Registration number: 20253
Member of the Botanical Society of South Africa (BotSoc) since 2011
Member of the Grassland Society of southern Africa (GSSA) since 2018
Member of the Land Rehabilitation Society of southern Africa (LaRSSA) since 2018

Snapshot of Project Experience - Flora

- Floral Assessment as Part of the Environmental Authorisation Process for the Proposed Bryanston Ext. 3B Housing Project Located in the City of Johannesburg Metropolitan Municipality, Gauteng Province (2020).
- Floral Assessment as Part of the Environmental Assessment Process for the Proposed Bryanston Ext. 3C Housing Project Located in the City of Johannesburg Metropolitan Municipality, Gauteng Province (2020).
- Terrestrial Biodiversity Assessment as Part of the Environmental Assessment Process for the Extension of the South African Nuclear Energy Corporation (NECSA) Pipe Storage Facility, North West Province (2020).
- Floral Assessment as Part of the Environmental Authorisation Process for the Proposed Rietfontein Housing Project Located in the City of Johannesburg, Gauteng Province (2020).
- Vegetation assessment for the proposed subdivision and development of residential units on Portion 551 (a portion of Portion 43) of the Farm Witpoort 406JR, Gauteng province (2019).
- Floral ecological assessment as part of the Environmental Impact Assessment Process for the proposed Driefontein Mining Project near Middelburg, Mpumalanga Province (2019).
- Floral ecological assessment for the proposed Lower Maguga Hydropower Project, Kingdom of Eswatini (2019).

- Floral biodiversity assessment for the proposed R573 road upgrade: Baviaanspoort Road to Stormvoël Road, City of Tshwane, Gauteng Province (2019).
- Floral species diversity assessment report for Vele Colliery, located in the Vhembe District, Mucina Local Municipality, Limpopo Province (2019).
- Floral Species of Conservation Concern Assessment for the Proposed Development of Distance Measuring Equipment for the O.R. Tambo International Airport Terminal Manoeuvering Area, Gauteng Province – FAOR3 (Magaliesberg) (2018).
- Floral Species of Conservation Concern assessment for the proposed development of distance measuring equipment for the O.R. Tambo International Airport Terminal Manoeuvering Area, Gauteng Province – FOAR 3: Magaliesberg and FASJ 4: Donkerhoek (2018).
- Vegetation assessment for the proposed Wildealskloof mixed-use development, Mangaung Local Municipality, Bloemfontein, Free State Province (2018).
- Proposed Mixed-Use Development on Part of Portion 29 of the Farm Hatherley No. 331 – JR, City of Tshwane, Gauteng Province Vegetation Assessment (2018).
- Eco-Conditional Requirements (Eco-0) Assessment for Green Star South Africa Rating Purposes, of an Office Building at the VSAD Reatile Bulk Petroleum Products Storage and Distribution Facility, Heidelberg, Gauteng Province (2018).
- Floral Species of Conservation Concern rescue and relocation plan for the proposed outfall sewer line from German Development to Eastdene, Middelburg, Mpumalanga (2018).
- Vegetation assessment for the proposed construction of the Thusanang Powerline and Substations in Westonaria, Gauteng Province (2017).
- Wetland rehabilitation and management plan for the proposed Hyde Park Country Estate, near KwaDukuzu (Stanger), KwaZulu-Natal Province (2017).

CURRICULUM VITAE – CRAIG WIDDOWS

Personal Details

Identity Number: 8810235028085
Telephone Number: 0837818725
Marital Status: Married
Drivers Licence Code: 08
Languages: English

Academic qualifications

PhD (Ecology) – University of KwaZulu-Natal	2016
MSc (Ecology) – University of KwaZulu-Natal	2014
BSc (Biological Sciences) Cum Laude – University of KwaZulu-Natal	2012
BSc (Biological Sciences) – University of KwaZulu-Natal	2011

Professional Membership

Professional Natural Scientist (Ecology and Zoology) - South African Council for Natural Scientific Professions (SACNASP) Registration number: 117852.
Member of the South African Wetland Society (Membership No. 826080)

Member of the Zoological Society of Southern Africa (Membership No. 199)
Member of the Field Guides Association of Southern Africa (Membership No. 22691)

Snapshot of Project Experience - Fauna

- Nkomati Nickle Mine, Mpumalanga. Terrestrial and Aquatic Biodiversity Baseline Assessment. (2020).
- Proposed Eskom Aloe 132 kV Substation and Loop-in-Loop-out Powerlines. Terrestrial Biodiversity Assessment (2020).
- Biodiversity assessment as part of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) Section 24G retroactive environmental authorisation process for the unlawful construction of a dam on the Farm South Downs No. 17934. Biodiversity Assessment (2019).
- Pongola Substation Battery Energy Storage System, Zululand District Municipality, KwaZulu-Natal. Biodiversity Assessment (2019).
- Proposed Bhokwe Community Sanitation Project, Abaqulusi Local Municipality, KwaZulu-Natal: Biodiversity Assessment (2019).
- Proposed Zwelibomvu Pipeline Project, eThekwini Metropolitan Municipality: Preliminary Ecological Assessment (2019).
- Subdivision and Rezoning of Erf 15990, Ladysmith Township, KwaZulu-Natal. Ecological and Wetland Assessment (2019).
- Proposed upgrade and construction activities outside of the National Route 2 Wild Coast Toll Highway road reserve. Eastern Cape: Faunal Assessment (2019).
- Faunal ecological assessment for the proposed Lower Maguga Hydropower Project, Kingdom of Eswatini (2019).
- Proposed construction of a dam and irrigation pipeline on the farm compensation, within the Matatiele Local Municipality, Eastern Cape: Ecological Assessment (2018).
- Rezoning for Portion 204 (of 184) of the Farm Mt. Albert No. 2074 in Pennington, Umdoni Municipality: Ecological Sensitivity Assessment (2018).
- Mulberry Park, eThekwini Metropolitan Municipality: Ecological Sensitivity Assessment (2018).
- Proposed Khoto Residential Development, eThekwini Metropolitan Municipality, KwaZulu-Natal: Ecological Sensitivity Assessment (2017).
- Elandspruit Colliery Mining Pan Amendment Plan, Middleburg: Ecological Assessment (2017).
- Ayesha Avenue internal access road and residential parking lot development, eThekwini Metropolitan Municipality, KwaZulu-Natal: Faunal Assessment (2015).
- PeaceValley III Road Upgrade Project, uMsunduzi Local municipality: Faunal and Vegetation Assessment (2015).
- Proposed development of the Eskom Agulhas 400/132Kv 2x500 MVA Transmission Substation and loop-in loop-out lines, Swellendam Local Municipality, Western Cape Province: Avifaunal Assessment (2015).

Declaration of Independence by Specialist

I, _Craig Widdows_____, in my capacity as a specialist consultant, hereby declare that I –

- act as an independent specialist;
  Where **"independent"** in relation **a specialist** means the following, as defined in GN982 of 2014 (*as amended*):
  (a) that such EAP, **specialist** or person has no business, financial, personal or other interest in the activity or application in respect of which that EAP, specialist or person is appointed in terms of these Regulations; or
  (b) that there are no circumstances that may compromise the objectivity of that EAP, specialist or person in performing such work;
  excluding -
  (i) normal remuneration for a specialist permanently employed by the EAP; or
  (ii) fair remuneration for work performed in connection with that activity, application or environmental audit;
- will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- declare that there are no circumstances that may compromise my objectivity in performing such work;
- do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that has 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 National Environmental Management Act, 1998 (Act 107 of 1998);
- have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- based on information provided to me by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional ability; and
- undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered.

Signature of the Specialist

Malachite Specialist Services

Name of Company:

25 August 2021

Date

Declaration of Independence by Specialist

I, _____Michelle Pretorius__, in my capacity as a specialist consultant, hereby declare that I –

- act as an independent specialist;
  Where **"independent"** in relation **a specialist** means the following, as defined in GN982 of 2014 (*as amended*):
  (a) that such EAP, **specialist** or person has no business, financial, personal or other interest in the activity or application in respect of which that EAP, specialist or person is appointed in terms of these Regulations; or
  (b) that there are no circumstances that may compromise the objectivity of that EAP, specialist or person in performing such work;
  excluding -
  (i) normal remuneration for a specialist permanently employed by the EAP; or
  (ii) fair remuneration for work performed in connection with that activity, application or environmental audit;
- will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- declare that there are no circumstances that may compromise my objectivity in performing such work;
- do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that has 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 National Environmental Management Act, 1998 (Act 107 of 1998);
- have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- based on information provided to me by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional ability; and
- undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered.

Signature of the Specialist

Michelle Pretorius t/a Field & Form Landscape Science

Name of Company:

2021-08-26

Date