Soils

According to a study undertaken by SRK (2009) the Gamsberg area is characterised by an extensive peneplain and the soils present in the peneplain are predominantly shallow and stony. The soils present on the peneplain are generally characterised by reddish sandy topsoil that is shallow in nature. However, a 10 cm thick red sandy surface layer is present along the northern section of the site. The western and southern part of the site is characterised with deeper red soils, varying in depth from 30 cm to 60 cm. Along the south western portion of the site, deeper red soils occur. Eleven individual soil units (types) were identified and mapped during soil investigations (Table 6-4).

Table 6-4 Soil Types Identified in the Project Area (Source: SRK Consulting, 2009)

Soil Units	Dominant Soils		Brief Description of the Soils	Land Form	Land Capability Class
	Soil Form	Family			
Kn1	Knersvlakte Coega	1000	Shallow red sand on dorbank or calcrete	Peneplain	VI
Kn2	Knersvlakte	2000	Shallow gravelly red sand on gravelly dorbank	Gentle lower slopes	VII
Gr1	Garies	1000	Moderately deep to shallow red sand to loamy sand on dorbank with calcrete deeper down	Peneplain	VI
Gr2	Garies	1000	Moderately deep red sand on dorbank	Wide, non-incised, gently sloping drainages	VI
Gr3	Garies Knersvlakte	1000	Moderately deep to shallow red sand to loamy sand on dorbank with calcrete deeper down	Peneplain	VI
Hu1	Hutton	3100	Deep red sand	Sand dune	VI
Hu2	Hutton	3100	Moderately deep red sand on rock or gravelly material	Gently sloping pediments	VI
Ms1	Mispah Hutton	1100 3100	Shallow stony to rocky sloping soils	Lower scree slopes	VII
Ms2	Mispah	1100	Dominantly shallow stony soils	Dissected Gamsberg basin	VII
R1	Rock Mispah	1100	Outcrop and rocky shallow soils	Scarps and very steep scree slopes	VIII
R2	Mispah	1100	Very shallow rocky soils and outcrop	Level to convex crest of Gamsberg	VIII

Land Capability

Land capability was also assessed by SRK Consulting in December 2009. Land capability is generally measured in terms of agricultural potential. Land capability in the study area (assessed using the System of Land Capability Classification for Agriculture in South Africa) ranged from low (Class VI) to very low (Class VIII), largely as a result of the arid climate of the area and the sandy nature of soils found there. According to the Chamber of Mines land capability classification system, the affected area may only be used as a 'wilderness' area, i.e. it cannot be used for any alternative agricultural purpose.

Groundwater

No regional aquifers are developed in the area and groundwater occurs mainly in secondary fractured-rock aquifers (SRK, 2010). Primary weathered zone aquifers are rare and localised because soils are thinly developed.

Highly permeable scree, talus and intensively weathered bedrock occur to a depth of 20 to 30 m. This zone is, however, thought to be of restricted extent with limited groundwater potential, due to low rainfall and runoff with a high evaporation rate resulting in very low and sporadic recharge (ERM, 2013a).

The highly fractured and weathered hard rock terrain of the white quartzite unit, the schist, and the gneiss, are considered to be water-bearing units, or secondary fractured-rock aquifers. The primary control on permeability is taken as structures and weathering (related to depth from surface), rather than rock type, appreciating that unweathered units at depth can also be water bearing, and that fracturing around major faults will increase hydraulic conductivity. Pump test information interpreted by ERM (2013a) indicated similar ranges of hydraulic conductivities in gneiss, schist, and quartzite lithology, and indicated a broadly confined character in the pump test curves.

Hydraulic Conductivity

Aquifer units in the Gamsberg area generally have very low to low permeability and increased groundwater occurrence is only associated with secondary structures such as faults and fractures (SLR, 2020).The TSF, smelter complex and secured landfill facility are all located on basal gneiss of the Gladkop Group and no regional scale lineaments are located within the footprint of these facilities.

Groundwater Levels and Flow Direction

The Gamsberg Zinc Mine currently has an existing groundwater monitoring network and monitoring is conducted and reported by GHT Consulting Scientists on a quarterly basis. This monitoring network consists of 22 "farm" boreholes on surrounding privately-owned farm areas and 31 mine property boreholes (Figure 6-4).

The average groundwater levels measured during the Golder (2007), SRK (2010), and ERM (2013a) hydrocensus investigations were 31.7 metres below ground level (mbgl), 28.1 mbgl, and 29.4 mbgl respectively. The groundwater levels ranged between artesian conditions and 178.8 mbgl.

Farm borehole groundwater levels ranged between 8.6 mbgl and 78.9 mbgl with an average groundwater level of 30.8 mbgl (as measured in April 2019). The mine borehole groundwater levels ranged between 11.6 mbgl and 52.3 mbgl with an average groundwater level of 30.6 mbgl and .

In general, water levels in the Gamsberg area mimic the surface topography (based on April 2019 measured groundwater levels). Figure 6-5 shows an inferred groundwater level contour map of the area and the monitoring boreholes in which groundwater levels were measured. Groundwater levels were contoured to groundwater elevation above mean sea level. The groundwater contour map indicates that groundwater flow is radially to the northeast and southwest away from the Gamsberg Inselberg.

Groundwater Quality

Results from the previous hydrocensus investigations by Golder (2007), SRK (2010), and ERM (2013a) showed that pH ranged between 5.81 and 8.67 with an average value of 7.49. The electrical conductivity (EC) ranged

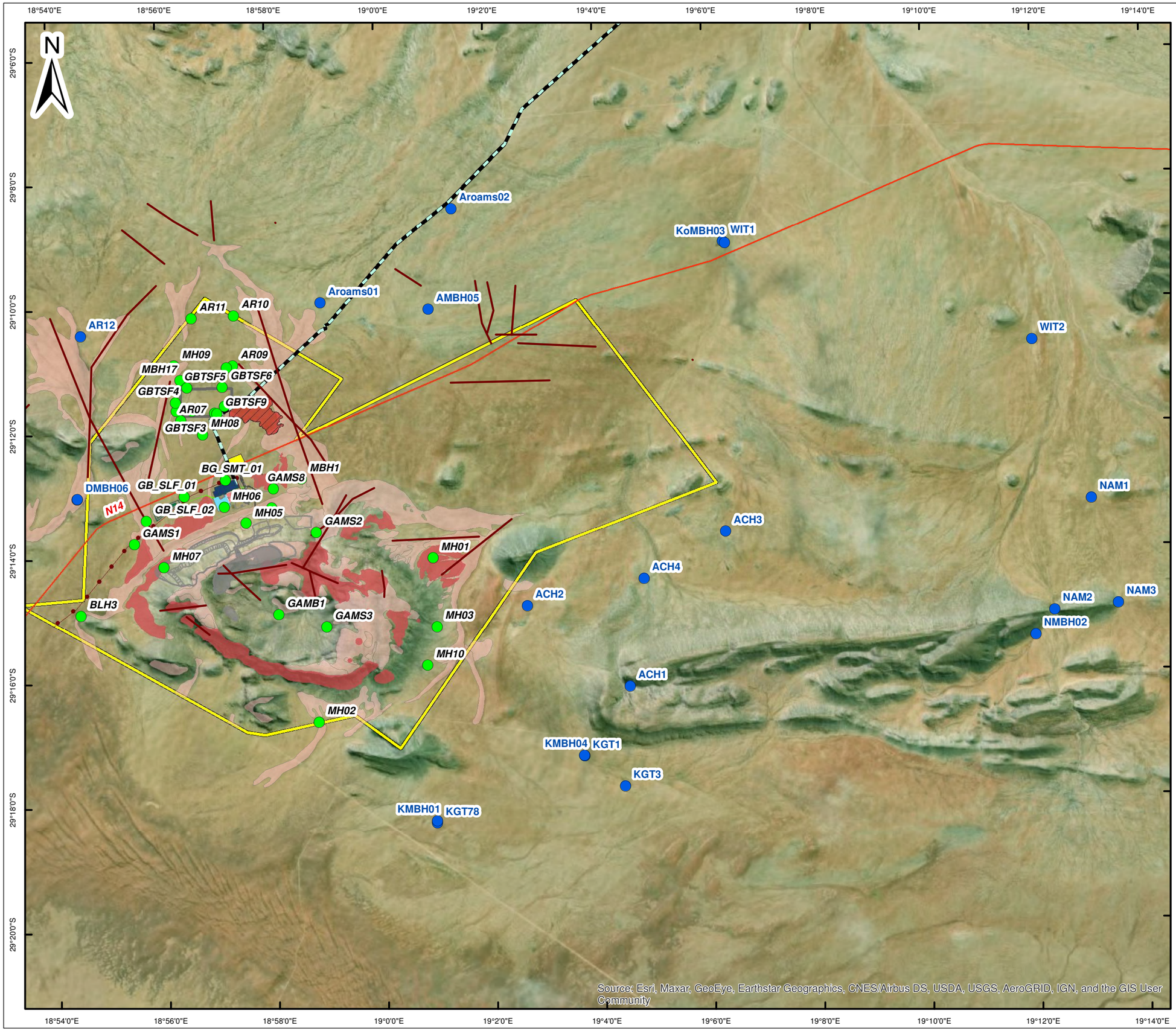
between 16 mS/m and 1 626 mS/m with an average value of 161 mS/m. The sulphate concentrations ranged between 14.6 mg/L and 1 706 mg/L with an average concentration of 163.9 mg/L.

In addition, groundwater monitoring results conducted between November 2017 and April 2019 indicated the pH of the groundwater samples ranged between 6.57 and 8.44 with an average value of 7.51. The EC ranged between 33 mS/m and 1 141 mS/m with an average value of 229 mS/m and sulphate concentrations ranged between 28.5 mg/L and 2 324 mg/L with an average concentration of 289.3 mg/L.

The previous hydrocensus investigations and groundwater monitoring results showed several constituents that were elevated above relevant guideline limits. Parameters included EC, total dissolved solids (TDS), sodium, calcium, magnesium, chlorine, sulphate, fluoride, nitrate, arsenic, lead, iron, manganese, and uranium.

The processes of evaporation and long-residence time or the host rock mineralogy (apatite-bearing rocks) may result in elevated fluoride concentrations which is a characteristic feature of the Northern Cape. SRK (2010) concluded that the chemical composition of the water from the area under investigation has undergone natural base-exchange and precipitation processes. The hydrochemistry of the Gamsberg area was interpreted by SRK (2010) to be indicative of a mature hydrochemical environment with very limited recharge, which generally only takes place in years of exceptionally high precipitation. Analysis of the April 2019 sampling of the Gamsberg Zinc Mine and farm monitoring boreholes confirmed the SRK (2010) findings that the groundwater is indicative of a mature hydrochemical environment with very limited recharge.

GHT Consulting concluded that between November 2017 and April 2019 there was no indication of pollution emanating from the Gamsberg Zinc Mine site that could affect the groundwater quality of the surrounding farm boreholes.



Legend

- Gamsberg Zinc Mine MRA
- Laydown Area - Area: 15
- Business Partner Camp - Area 12 Ha
- Contractors Camp
- Main Road
- Existing Infrastructure

Proposed Infrastructure

- Proposed Bulk Water Pipeline
- Access Road
- Transmission Line
- Secured Landfill Site
- Smelter Complex Footprint

Botanical Sensitivity

- Irreplaceable
- Irreplaceable (S Todd, 2020)
- Constrained

Monitoring Network

- Mine Monitoring Boreholes
- Farm Monitoring Boreholes
- Lineaments

0 1 000 2 000 Meters

Scale: 1:109 800 @ A3
WGS_1984

Gamsberg Smelter Project

Figure 6-4

Gamsberg Groundwater Monitoring Network – Mine and Farm Boreholes

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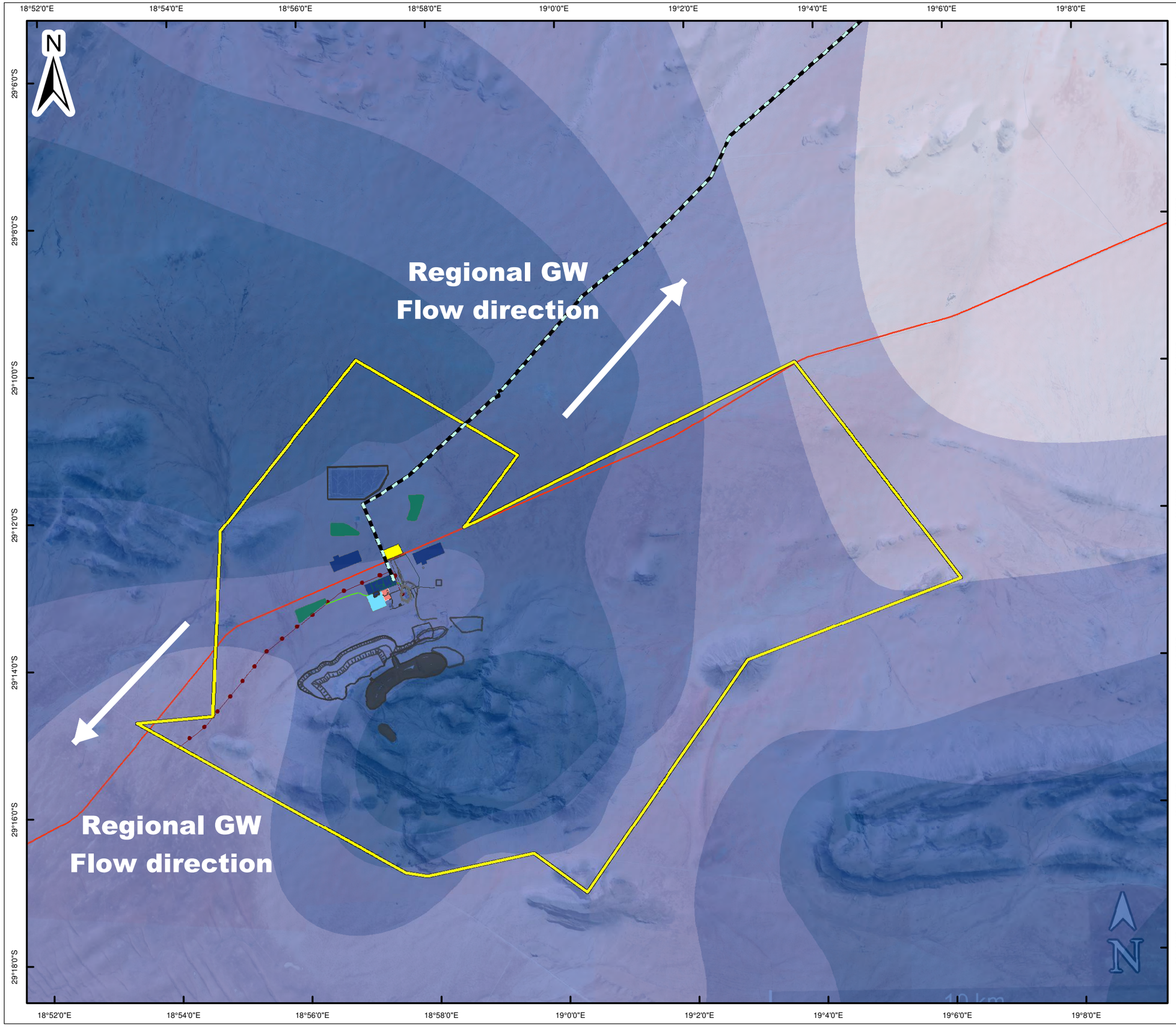

Legend

- Gamsberg Zinc Mine MRA
- Laydown Area - Area: 15 Ha
- Business Partner Camp - Area 12 Ha
- Contractors Camp
- Main Road
- Existing Infrastructure

Proposed Infrastructure

- Proposed Bulk Water Pipeline
- Access Road
- Transmission Line

Alternatives

- Alternative Secured Landfill Site
- Alternative Smelter Complex Locations

Groundwater Elevations (mamsl)

- 721 - 770
- 771 - 819
- 820 - 860
- 861 - 891
- 892 - 922
- 923 - 1 006

0 1 000 2 000 Meters

Scale: 1:92 500 @ A3
WGS_1984_UTM_Zone_34S

Gamsberg Smelter Project

Figure 6-5

Gamsberg Groundwater Elevation and Inferred Groundwater Flow Direction

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Aquifer Characterisation

Groundwater Vulnerability

Groundwater vulnerability gives an indication of how susceptible an aquifer is to contamination. Based on the national scale results (Parsons & Conrad, 1998), the aquifer underlying the project area has a low vulnerability rating indicating a low tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some surface location above the uppermost aquifer.

SRK (2010) determined the local-scale groundwater vulnerability and concluded that approximately 58 % of the study area had a medium high vulnerability, mostly occurring on the plains surrounding the Gamsberg. The mountainous regions were predominantly of medium low to very low vulnerability. In the south to southeast, in the region of the windblown sand and dune sand, the vulnerability was classified as high. The mine infrastructure is situated in areas of medium high vulnerability.

Aquifer Classification

No regional aquifers are developed in the area and groundwater occurs mainly in secondary fractured-rock aquifers (SRK, 2010). Primary weathered zone aquifers are rare and localised because soils are thinly developed. Based on the aquifer classification map the aquifer system underlying the site is regarded mainly as a poor groundwater region. A poor groundwater region consists of a low to negligible yielding aquifer system of moderate to poor water quality.

The recommended level of groundwater protection based on the Groundwater Quality Management (GQM) Classification is <1 and therefore a limited to low-level groundwater protection is required for the aquifer within the study area.

Surface Water

Hydrological Setting

The Gamsberg Zinc Mine MRA is influenced by four quaternary catchments D81G, D82A, D82B and D82C (Figure 6-6). The Gamsberg inselberg is situated within quaternary catchment D81G, which drains in a northerly direction towards the Orange River some 35km away. The D82C catchment is an interior drainage basin that does not drain into the other catchments. Most of the water courses in the area are ephemeral but the small catchment area on top of the Gamsberg inselberg contains a spring and can experience seasonal flows. The most significant watercourse for the Gamsberg Smelter Project is a drainage line running parallel to the N14 at the base of the northern side of the Gamsberg inselberg, and its tributaries from the north. The regional hydrology is presented in Figure 6-6.

Runoff

The naturalized runoff for quaternary catchments D81G, D82A, D82B and D82C was simulated using the WRSM2000 hydrological model (SLR, 2020) at a unit runoff of 0.28 mm per annum. The runoff is 0.5% when it is expressed as a percentage of rainfall. The monthly runoff for quaternary catchments D81G, D82A, D82B and D82C is presented in Table 6-5. The low flows of the areas can be attributed to high evaporation rates within the region.

Table 6-5: Mean Annual Runoff (mm) for Catchment D81G, D82A, D82B and D82C

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.02	0.09	0.04	0.02	0.01	0.28

Surface Water Quality

The water quality assessment for this study was limited as there is no database of water quality data for surface run off for the Gamsberg Zinc Mine site. However, a review was undertaken of an existing one-year record of

water quality data (SRK, 2010). The existing baseline water quality analysed in this study was undertaken prior to the start of mining at Gamsberg Zinc Mine.

The results have been compared to the South African National Standards (SANS) for drinking water quality (SANS241:2006) and the Department of Water Affairs Guidelines for Livestock Watering (DWAF, 1996) since these are the two most likely water uses for the springs and farm dams in the area. All parameters were within the limits of the SANS241: 2006. The Livestock Watering Guidelines showed exceedances in barium noted at the monitoring points GAMS 1SW and GAMS 3SW.

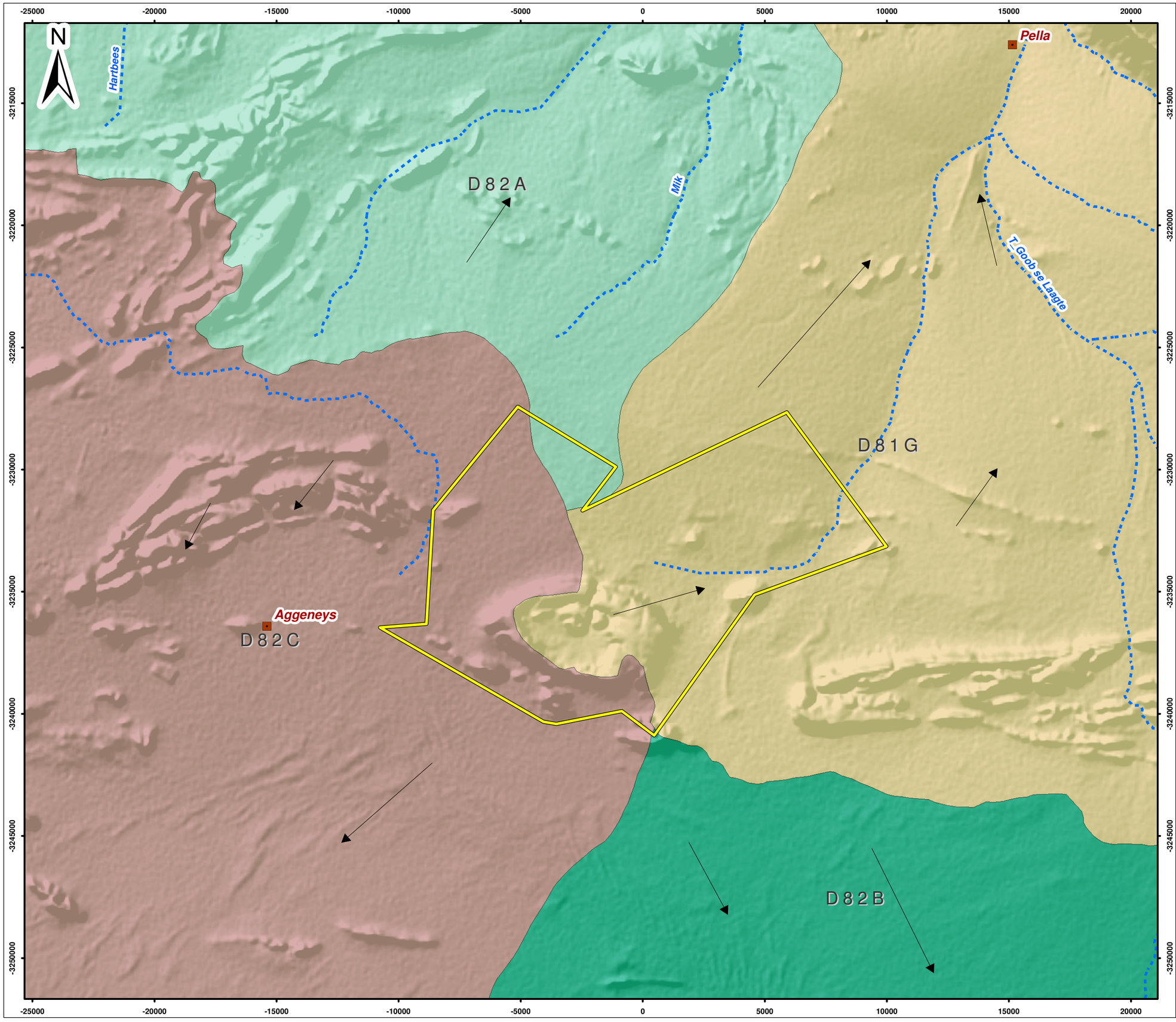
According to SRK Consulting (2010), the water emerging as springs from the Gamsberg Inselberg was fit for domestic use and livestock watering. However, it must be noted that although the barium values comply on average over the monitoring period there were instances where certain samples did not comply with the WHO guideline concentration level for drinking water. These exceedances could be due to historical barite mining activities north of the site.

The results were consistent between consecutive months over the monitoring period for the majority of parameters monitored with the most notable exception being nitrate in GAMS 1SW. Nitrate in July and August was ten times greater than that in May and June although still within the SANS for Class I drinking water quality. This high concentration in nitrate was considered likely to be related to fertilizer, livestock or sanitation impacts (SRK Consulting, 2010).

Some seasonal variation during the higher rainfall months of February and March may be anticipated with an initial peak in concentrations due to constituents that have built up on surfaces being washed into runoff or infiltrating into the groundwater, followed by dilution effects once these first flush constituents have been removed. These effects are likely to be less evident in the natural springs due to the filtering effects of the soil and the time lag for recharge to groundwater (SRK Consulting, 2010).

Flood Line Determination

Flood lines for the 1:50-year and 1:100-year recurrence intervals were determined for the current river network passing through the project site and with the 100m buffer from the watercourses. These flood lines are presented in Figure 6-7.



Legend

- Towns / Villages
- Rivers
- Mining Right Area
- Flow Direction

Sub-Catchments

- D81G
- D82A
- D82B
- D82C

0 1 000 2 000 Meters

Scale: 1:69 700 @ A3

Projection: Transverse Mercator
Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-6

Regional Hydrology around the Gamsberg Zinc Mine

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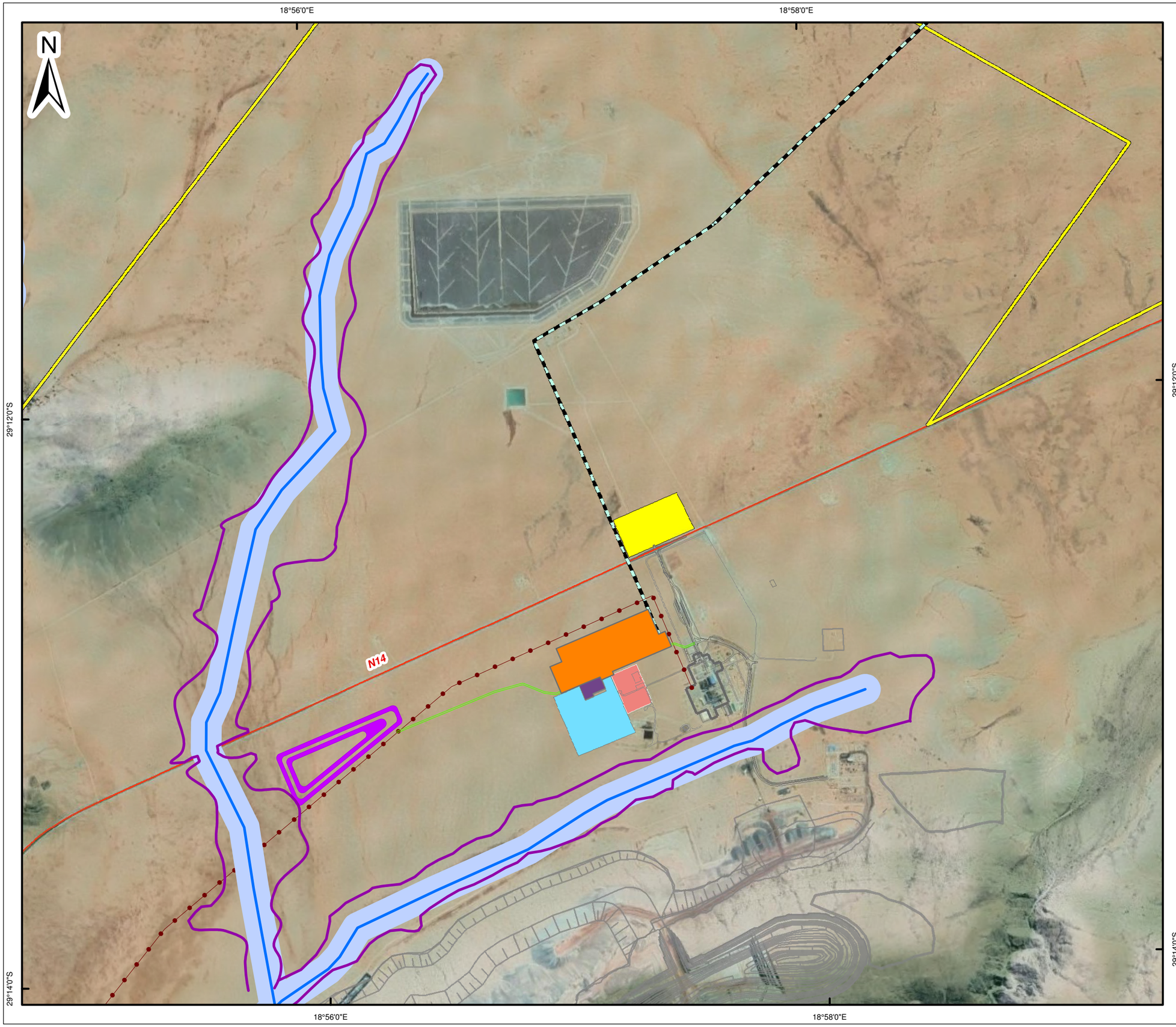

Legend

- Gamsberg Zinc Mine MRA
- Laydown Area
- Business Partner Camp
- Existing Contractors Camp
- Main Road
- Existing Infrastructure
- 100-Year Floodline
- Watercourses
- 100m Watercourse Buffer

Proposed Infrastructure

- Bulk Water Pipeline
- Access Road
- Transmission Line
- Secured Landfill Site
- Smelter Complex Footprint
- Switch Yard

0 500 1 000 Meters

Scale: 1:24 000 @ A3
Projection: Transverse Mercator
Datum: Lo 23 WGS 84

Gamsberg Smelter Project

Figure 6-7

1:100-Year Flood Lines for the Streams Adjacent to the Project Site

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Terrestrial Biodiversity

Vegetation Types & Plant Communities

Broad-Scale Vegetation Types

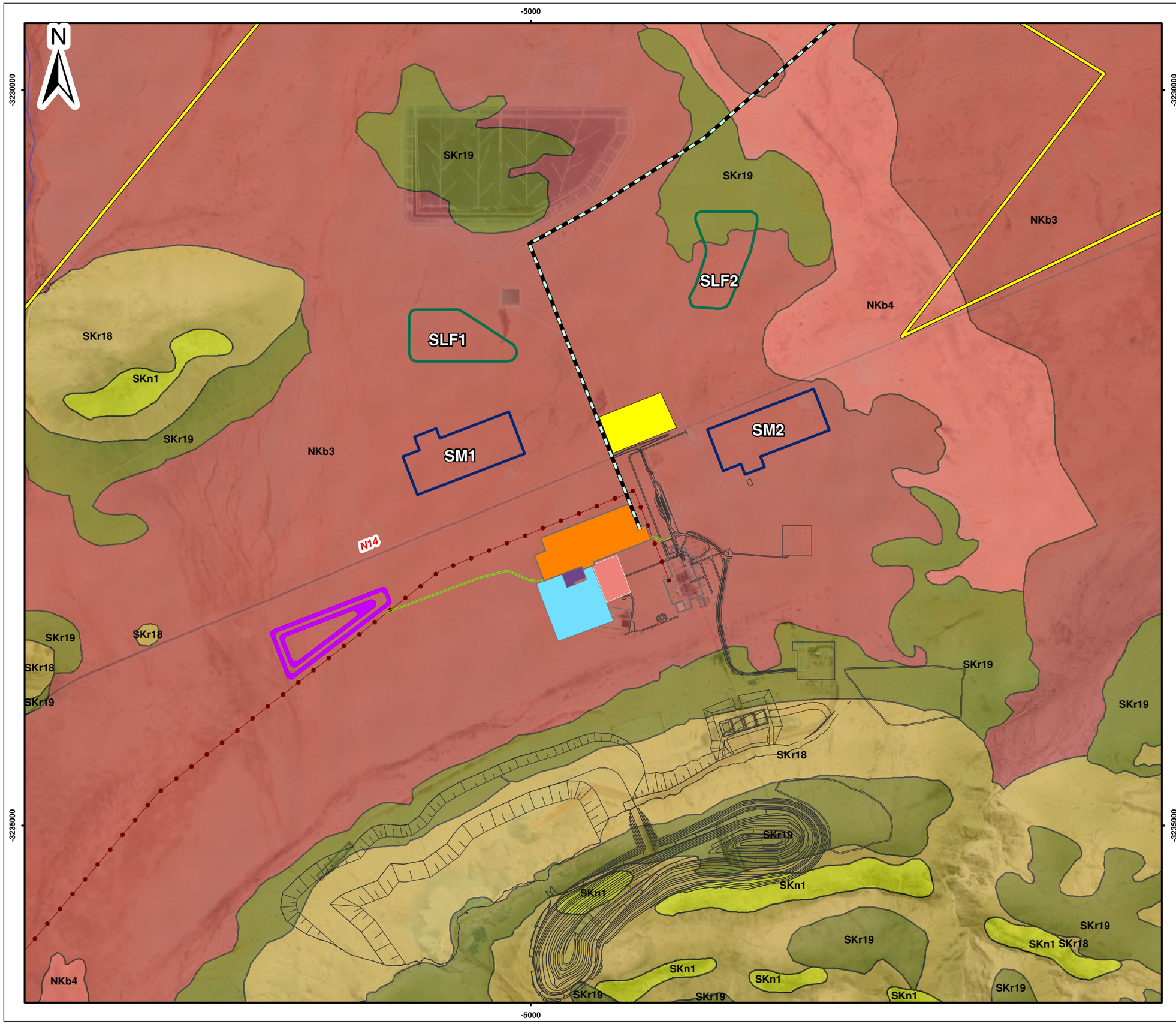
There are several national vegetation types in the broader study area (Figure 6-8), however, only Bushmanland Arid Grassland and Aggeneys Gravel Vygieveld fall within the Gamsberg Smelter Project's area of influence. Bushmanland Arid Grassland is an extensive vegetation type; the second most extensive vegetation type in South Africa, occupying an area of 45,478 km^2. Due to the arid nature of the unit, which receives between 70 and 200 mm annual rainfall, it has not been significantly impacted by intensive agriculture and more than 99% of the original extent of the vegetation type is still intact. Mucina and Rutherford (2006) list six endemic species for the vegetation type, which is a relatively low number given the extensive nature of the vegetation type.

Aggeneys Gravel Vygieveld occurs on the foothills and peneplains of inselbergs in northern Bushmanland scattered between Pofadder and Aggeneys and a little further westwards to the edges of the Namaqualand granite hill ridges. This unit occurs on flat or slightly sloping plains with a distinctly white surface layer of quartz pebbles on reddish soils. It supports sparse low-growing vegetation dominated by small to dwarf leaf-succulents of the families *Aizoaceae*, *Crassulaceae*, *Euphorbiaceae*, *Portulaceae* and *Zygophyllaceae*. Although this is not a threatened vegetation type, it has an extent of only 62 km^2 and reportedly (Mucina & Rutherford 2006) has 17 endemic species which is a very high number for such a small vegetation unit. Due to the presence of numerous endemic and specialised species associated with this vegetation type, it is considered to represent irreplaceable habitat. The presence of these local endemic flora species is a key basis for the identification of the entire Gamsberg area as a Critical Biodiversity Area (CBA).

Fine-Scale Habitats and Plant Communities

Desmet (2013) identified and delineated a number of habitat units as depicted in Figure 6-9. In the Aggeneys Gravel Vygieveld vegetation type, six habitat units were mapped: four occurring in the Gamsberg Zinc Mine study area are Mountain Plateau, Plains Quartz Gravel patches; Plateau Quartz Gravel patches and Plains Intermediate Quartz Gravel patches. Two additional units that occur to the east of the study area include Feldspar Gravel patches and Rocky Plains.

The Plains Quartz Gravel patches habitat occurs in the vicinity of the Gamberg Smelter Project although the smelter site itself comprises sandy plains habitat (Figure 6-9). According to Desmet (2013) the surface of quartz gravel patches is characterised by a fairly uniform and dense layer (lag) of small quartz pebbles with rock and boulders absent or in low density. Quartz patches can be divided into plateau patches or fine-grained quartz patches with a dense pebble covering of often very small (<5 mm diameter) and brilliant white pebbles. Plains Quartz patches occur mainly on the lower foot slopes of larger inselbergs; and Intermediate Quartz patches appear physically similar to the other quartz patches but are devoid of any of the characteristic plant species. Quartz Gravel patches are always found in association with quartz or quartzite rocks. While a number of succulent plant species occur in this habitat unit, the only species restricted to plains Quartz Gravel patches and which do not occur on the plateau are the diminutive annual succulent, *Mesembryanthemum inachabense*, and *Conophytum angelicae* (Desmet 2013).



Legend

- Gamsberg Zinc Mine MRA
- Existing Infrastructure
- Business Partner Camp
- Laydown Area
- Existing Contractors Camp

Proposed Infrastructure

- Proposed Bulk Water Pipeline
- Access Road
- Transmission Line
- Switch Yard
- Smelter Complex Footprint (Preferred)
- Secured Landfill Site (Preferred)

Alternatives

- Alternative Secured Landfill Site
- Alternative Smelter Complex Locations

Vegetation Areas (2018)

- NKb 3 Bushmanland Arid Grassland
- NKb 4 Bushmanland Sandy Grassland
- SKn 1 Namaqualand Klipkoppe Shrubland
- SKr 18 Bushmanland Inselberg Shrubland
- SKr 19 Aggeneys Gravel Vygieveld

0 400 800 Meters

Scale: 1:23 500 @ A3

Projection: Transverse Mercator
Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-8

Broad-Scale overview of the Vegetation In and Around the Gamsberg Zinc Mine. The Vegetation map is Based on the 2018 National Vegetation Map. (SANBI, 2018)

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-5000

-3230000

N

SLF1

SLF2

SM1

SM2

N14

-3235000

-5000

Fine Scale Vegetation Types

- Calcrete Patch - S Todd, 2020

Aggeneys Gravel Vygieveld
- Mountains Plateau
- Rocky Plains
- Plains Quartz Gravel Patches
- Plateau Quartz Gravel Patches
- Plains Intermediate Quartz Gravel Patches

Bushmanland Inselberg Shrubland
- Mountains

Bushmanland Inselberg Succulent Shrubland
- Bushmanland Inselberg Succulent Shrubland

Bushman Arid Grassland
- Hummocky Sandy Plains
- Flat Sandy Plains
- Calcrete Gravel Patches

Azonal
- Wash
- Kloof

Legend
- Gamsberg Zinc Mine MRA
- Existing Infrastructure
- Business Partner Camp
- Laydown Area
- Existing Contractors Camp

Proposed Infrastructure
- Proposed Bulk Water Pipeline
- Transmission Line
- Access Road
- Switch Yard
- Smelter Complex Footprint (Preferred)
- Secured Landfill Site (Preferred)

Alternatives
- Alternative Secured Landfill Site
- Alternative Smelter Complex Locations

0 400 800 Meters

Scale: 1:23 500 @ A3

Projection: Transverse Mercator
Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-9

Fine Scale Vegetation Types in the Gamsberg Area (Note the hatched Calcrete Gravel patches to the east and west of the Smelter)

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Desmet (2013) identified three different habitat units within the Bushmanland Arid Grassland vegetation type namely, Plains Sand Flats (Bushmanland Flat Arid Grassland), Plains Hummocky (Bushmanland Hummock Arid Grassland) and Plains Gravel Calcrete. Apart from the Plains Gravel Calcrete, these habitat units do not have diverse plant communities and generally contain few Species of Conservation Concern (SCC).

The Plains Gravel Calcrete patches (Figure 6-10) are considered unique and contain several taxa not found elsewhere including *Brownanthus divaricata, Drosanthemum hispidum, Kleinia longiflora, Pteronia divaricata, Cucumis rigidus, Euphorbia gariepina, Euphorbia mauritanica, Euphorbia spinea, Sarcocaulon crassicaule, Avonia albissima, Ceraria fruticulosa, Zygophyllum cf. decumbens* as well as several endemic species restricted to these Calcrete Gravel patches such as *Titanopsis hugo-schlechteri, Crassula mesembrianthemopsis, Anacampseros bayeriana, Lithops julii subsp. fulleri var. fulleri,* and *Ruschia aff. divaricata* (Desmet 2013).

Figure 6-10 Plains Gravel Calcrete patch north of the N14, in the vicinity of secured landfill facility Alternative 2

Indigenous Flora Species

Typical and dominant species in the smelter complex footprints include *Eriocephalus* sp., *Pteronia unguiculata*, *Rhigozum trichotomum*, *Stipagrostis brevifolia*, *S.obtusa* and *Ebracteola fulleri*. Notable species confirmed during the January 2020 survey comprised six species, all of which are protected in the Northern Cape (Table 6-6, Figure 6-10 and Figure 6-11). Several individuals of three of these species were commonly found in the selected smelter complex and secured landfill facility footprints: *Euphorbia braunsii, Hoodia gordonii,* and *Aloidendron dichotomum* (Quiver Tree), none of which are considered uncommon or rare in the Project Area.

Table 6-6: Plant species confirmed during the January 2020 survey in the Gamsberg Smelter Project area and alternative sites

Species	Status	Habitat Unit	Location
Titanopsis hugo-schlechteri	NC Protected	Calcrete Gravel Plains	SLF 2
Avonia papyracea subsp. *papyracea*	NC Protected	Calcrete Gravel Plains	SLF 2
Boscia foetida subsp. *foetida* (Stink Shepherd's Tree)	NC Protected	Calcrete Gravel Plains	SLF 2
Euphorbia braunsii	NC Protected	Flat Sandy Plains	SLF 3, SM 3
Hoodia gordonii	Data Deficient NC Protected	Flat Sandy Plains	SLF 3
Aloidendron dichotomum (Quiver Tree)	Vulnerable NC Protected	Flat Sandy Plains	SLF 3 (many) SLF 1 (few)
Titanopsis hugo-schlechteri	NC Protected	Calcrete Gravel Plains	SLF 2

Figure 6-11 *Titanopsis hugo-schlechteri* and *Avonia papyracea* subsp. papyracea observed at SLF Alternative 2 (SLF2)

Figure 6-12 Notable species observed within Secured Landfill Facility Alternative 3 includes *Hoodia gordonii*, *Euphorbia braunsii* and *Aloidendron dichotomum* (VU)

Earlier surveys in the Calcrete Gravel patches to the south of the preferred secured landfill facility and to the east of the proposed location of the smelter complex by Desmet (2013) recorded the following floral species: *Titanopsis hugo-schlechteri, Crassula mesembrianthemopsis,* and *Lithops julii* subsp. *fulleri;* all endemic to the region and restricted to Calcrete Gravel patches. Additional species confirmed in the vicinity of the smelter complex to the east include *Avonia quinaria subsp alstonii* in quartz gravel plains*,* and *Euphoriba friedrichiae. Titanopsis hugo-schlechteri* and *Crassula mesembrianthemopsis* are considered Vulnerable and have an estimated distribution range of less than 1 000 km^2. Calcrete Gravel patches are considered to be of high conservation concern and evaluated as irreplaceable due to the presence of restricted-range species.

Alien Plants

Alien plant species abundance at the site was low. This can partly be ascribed to the prevailing drought conditions as well as an actual low abundance of such species within the site. The major species of concern in this regard is the alien invasive tree *Prosopis glandulosa* and its' various hybrids which is common in the area and tends to invade along drainage lines and more generally in areas with deeper soils. This species is not seen as a current threat in the immediate area of the Gamsberg Zinc Mine.

Faunal Communities

Mammals

The mammalian community at the project site is likely to be of moderate diversity. Although more than 50 species of terrestrial mammals are known from the wider area, the habitat diversity of the project site is low and would not support a very wide range of mammals. Species that can be confirmed present in the proposed Gamsberg Smelter Project area based on camera trapping and previous site visits to the area include Leopard (*Panthera pardus*), Caracal (*Caracal caracal*), Black-backed Jackal (*Canis mesomelas*), African Wildcat (*Felis silvestris*), Cape Fox (*Vulpes chama*), Chacma Baboon (*Papio ursinus*), Rock Hyrax (*Procavia capensis*), South African Ground Squirrel (*Xerus inauris*), Steenbok (*Raphicerus campestris*), Common Duiker (*Sylvicapra grimmia*), Springbok (*Antidorcas marsupialis*), Gemsbok (*Oryx gazella*), Cape Porcupine (*Hystrix africaeaustralis*), Yellow Mongoose (*Cynictis penicillata*), Cape Grey Mongoose (*Herpestes pulverulentus*), Small-spotted Genet (*Genetta genetta*), Striped Polecat (*Ictonyx striatus*), Cape Hare (*Lepus capensis*), Smiths's Red Rock Rabbit (*Pronolagus rupestris*), Springhare (*Pedetes capensis*), Aardvark (*Orycteropus afer*), Aardwolf (*Proteles cristata*), Round-eared Elephant Shrew (*Macroscelides proboscideus*), Western Rock Elephant Shrew (*Elephantulus rupestris*), Namaqua Rock Mouse (*Aethomys namaquensis*), Pygmy Rock Mouse (*Petromyscus collinus*) and Hairy-footed Gerbil (*Gerbillurus paeba*). The open plains which characterise the majority of the proposed Gamsberg Smelter Project area are likely to be dominated by species associated with open hard or sandy ground such as various gerbils including the Hairy-footed Gerbil, Cape Hare, Steenbok, Cape Fox, Bat-eared Fox (*Otocyon megalotis*), Aardvark and Aardwolf. There are also burrows of Ground Squirrels and Yellow Mongoose at the site and these appear to be the most common fauna within the affected area.

No bats were observed during the January 2020 survey. A previous survey by GroundTruth (2013) which included mist-netting and bat acoustic monitoring detected only one bat - Darling's Horseshoe Bat (*Rhinolophus darling*) - classed as Least Concern by IUCN (IUCN 2017). Bats are likely to be restricted to the vicinity of the inselberg where they can shelter in rock crevices or caves and have access to water while some individuals may only fly over the gravel plains area for foraging.

Three Red-listed species have been confirmed or may occur in the broader area, the Black-footed cat (*Felis nigripes*) (Vulnerable), Brown Hyaena (*Hyaena brunnea*) (NT) and Leopard (*Panthera pardus*) (Vulnerable). Given the existing levels of anthropogenic disturbance at the site, it is not likely that these three species will remain active in close proximity to the mine and the proposed Smelter Project footprint. However, leopard have been recorded at the Gamsberg kloof and Achab farm.

Reptiles

Although reptile diversity in the broader area is high with as many as 60 species known from the area[5], a much smaller subset of these is likely to be present within the site. A total of 24 species have previously been recorded from the site according to the previous studies conducted for the Gamberg Zinc Mine ESIA. Species observed during the current field assessment or within the study area previously, are typical of the area and include Verrox's Tent Tortoise (*Psammobates tentorius verroxii*), Western Rock Skink (*Trachylepis sulcata sulcate*), Western Three-striped Skink (*Trachylepis occidentalis*), Namaqua Sand Lizard (*Pedioplanis namaquensis*), Spotted Desert Lizard (*Meroles suborbitalis*), Southern Rock Agama (*Agama atra*) and Plain Sand Lizard (*Pedioplanis inornata*).

No snakes were observed during the January 2020 site visit, although species likely to occur include Black Spitting Cobra (*Naja nigricincta*) and Cape Cobra (*Naja nivea*). The Desert Mountain Adder (*Bitis xeropaga*) was confirmed in 2012 and is a range-restricted endemics confined to the lower Gariep River and adjacent regions, and is restricted to rocky, mountainous habitat and therefore unlikely to occur on the flat sandy plains. Conditions at the time of the site visit were relatively poor for reptiles as a result of the prolonged drought and the depressing effect this is likely to have had on local reptile populations. There are only two Red-listed species recorded from the area, Good's Gecko (*Pachydactylus goodi*) (VU) and the Speckled Padloper (*Homopus signatus*) (VU).

Amphibians

Eight frog species are known from the area around the site (Appendix 6). This is likely an overestimate of the number of amphibian species present within the Gamsberg Inselberg where there is a spring and kloof. However, there is no natural perennial water in or near the open plains which characterise the current potential development areas of the proposed Gamsberg Smelter Project. The only species likely to be present within the affected area would be species that are relatively independent of water such as the Karoo Toad (*Vandijkophrynus gariepensis*) and the Paradise Toad (*Vandijkophrynus robinsoni*). The ephemeral drainage lines present in the area are likely to be the most important areas for amphibians, but given the extreme drought conditions which characterise the area, there are not likely to be any parts of the site that are of high importance for amphibians.

Avifauna

The most commonly recorded species at the site includes the Chat Flycatcher (*Melaenornis infuscatus*), Karoo Chat (*Cercomela schlegelii*), and Anteating Chat (*Myrmecocichla formicivora*). Other typical and characteristic species include Spike-heeled Lark (*Chersomanes albofasciata*) and Tractrac Chat (*Emarginata tractrac*). Although the near-threatened Karoo Korhaan (*Eupodotis vigorsii*) was observed in the area, it was not observed in close proximity to the proposed Gamsberg Smelter Project footprint. The near-threatened Sclater's Lark *Spizocorys sclateri* is also present in the area, but no observations were made in the vicinity of the current site. Raptors observed in the general area include the Endangered Martial Eagle *Polemaetus bellicosus,* Black-chested Snake-eagle *Circaetus pectoralis*, Verreaux's Eagle *Aquila verreauxii* and Jackal Buzzard *Buteo rufofuscus*, suggesting that large raptors are still relatively common in the area and are likely using the affected plains of the site for foraging. Although the endemic Red Lark *Calendulauda burra* (Red-listed as Vulnerable), is present in the wider area, it was not observed in close proximity to the site due to the lack of suitable red dune habitat near the Project Area.

Red-listed species which occur in the wider area include Martial Eagle (*Polemaetus bellicosus*) (Endangered), the endemic Red Lark (*Calendulauda burra*) (Vulnerable), Verreaux's Eagle (*Aquila verreauxii*) (Vulnerable), Lanner Falcon (*Falco biarmicus*) (Vulnerable), Secretarybird (*Sagittarius serpentarius*) (Vulnerable), and the near-endemic Sclater's Lark (*Spizocorys sclateri*) (Near-threatened). The Lanner Falcon (*Falco biarmicus*) has a high probability of occurring within the affected area, while Secretarybird has a low probably of occurrence, based on SABAP2 reporting. Verreaux's Eagles (*Aquila verreauxii*) are confirmed present on the Gamsberg Plateau with nesting sites present on the cliffs along the kloof. These species, including the Secretarybird (*Sagittarius*

[5] ReptileMap 2020 http://sarca.adu.org.za/

serpentarius), have large home ranges and are thus unlikely to be affected by the proposed Gamsberg smelter complex and secured landfill facility.

Critical Biodiversity Areas

CBAs are areas required to meet biodiversity targets for ecosystems, species and ecological processes, as identified in a systematic biodiversity plan[6]. Most provinces have developed, or are in the process of developing, maps of CBAs and Ecological Support Areas (ESAs) in the form of provincial spatial biodiversity plans. A map of the Critical Biodiversity Areas (CBAs) in the proposed Gamsberg Smelter Project area is depicted in Figure 6-13. CBAs are areas that have been identified as being essential for meeting biodiversity targets for the protection or retention of specific ecosystems. Two categories of CBAs are defined (CBA1 and CBA2), as well as ESAs and Other Natural Areas (ONAs).

CBA1 sites are considered 'irreplaceable' and are required for meeting South Africa's biodiversity targets and there are no or few other options for meeting biodiversity targets for features associated with these areas. As such, development within such areas is likely to result in an irreplaceable loss of biodiversity, contrary to the NEMA principles. Development within CBA1 which may impact on the ecological features, processes or condition should be avoided. CBA2 units are also required to meet conservation targets for biodiversity features or ecological processes but offer more flexibility for development than CBA1 units.

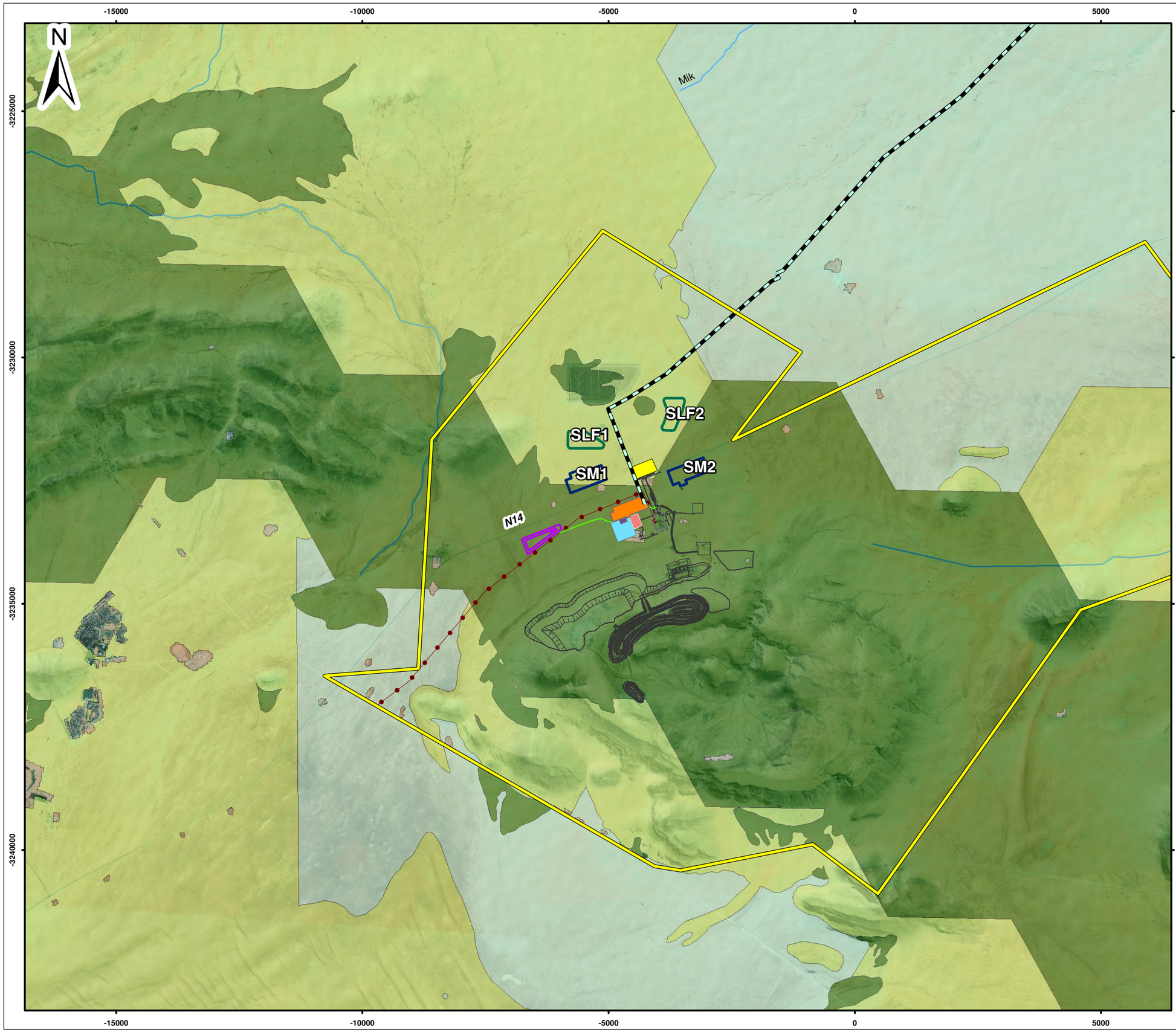
The proposed Gamsberg Smelter Project development footprint and the existing Gamsberg Zinc Mine lies almost entirely within an area designated as a CBA1 while the area to the north of the N14 is designated as CBA2. The designation of the Gamsberg area as a CBA1 is largely based on the presence of localised habitat types and range-restricted flora. Within the CBA1 unit around Gamsberg there are specific habitat units, such as the calcrete gravel patches, that are of higher conservation importance (and considered 'irreplaceable') than the adjacent extensive areas of flat sandy plains.

Although the mine has had to implement a biodiversity offset, habitats such as the calcrete gravel patches are considered irreplaceable and not-offsettable as species of high conservation concern in these habitats are not well-represented elsewhere.

Habitat Modification

Habitats within the footprint of the proposed Gamsberg Smelter Project components are considered largely natural, affected mainly by historical grazing and more recently by dust from the adjacent mining operations on the Gamsberg Inselberg. It is possible that succulent plants in the wider area around Aggeneys may be targeted for illegal collection. Future threats to habitats are expected to occur in the wider area from the expansion of renewable energy projects which may have a significantly greater footprint of between 2 000 and 6 000 ha over time, considerably increasing the risk of cumulative negative impacts.

[6] http://biodiversityadvisor.sanbi.org/industry-and-conservation/biodiversity-in-the-urban- economy/understand/definitions-related-to-urban-land-use-planning/critical-biodiversity-areas-and-ecological-support-areas/ - Accessed 17 September 2020



Legend

- Gamsberg Zinc Mine MRA
- Existing Infrastructure
- Business Partner Camp
- Laydown Area
- Existing Contractors Camp

Proposed Infrastructure

- Proposed Bulk Water Pipeline
- Transmission Line
- Access Road
- Switch Yard
- Smelter Complex Footprint (Preferred)
- Secured Landfill Site (Preferred)

Alternatives

- Alternative Secured Landfill Site
- Alternative Smelter Complex Locations

Critical Biodiversity Areas

- Critical Biodiversity Area (CBA1)
- Critical Biodiversity Area (CBA2)
- Ecological Support Area (ESA)
- Other Natural Areas (ONA)

0 600 1 200 Meters

Scale: 1:75 200 @ A3

Projection: Transverse Mercator
Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-13

Critical Biodiversity Areas (Holness & Oosthuysen 2016) Map for the Study Area, Showing that the Majority of Infrastructure Lies Within Areas Classified as CBA1

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Air Quality

Air Quality Sensitive Receptors

Potential sensitive receptors within the project area include individual homesteads, residential areas (i.e. Aggeneys), areas of industrial activities, recreational areas and sensitive biodiversity as discussed in previous section (Figure 6-14).

Ambient Air Quality within the Region

Ambient Particulate Concentrations

Ambient PM_{10} sampling was undertaken at the site during 2018 and 2019 by the mine. The location of the PM_{10} sampling points is provided in Table 6-7. A summary of ambient PM_{10} concentrations measured at the GB Mining Offices, GB South Access, Aggeneys Highschool, GB Camp and GB NW is provided in Table 6-7.

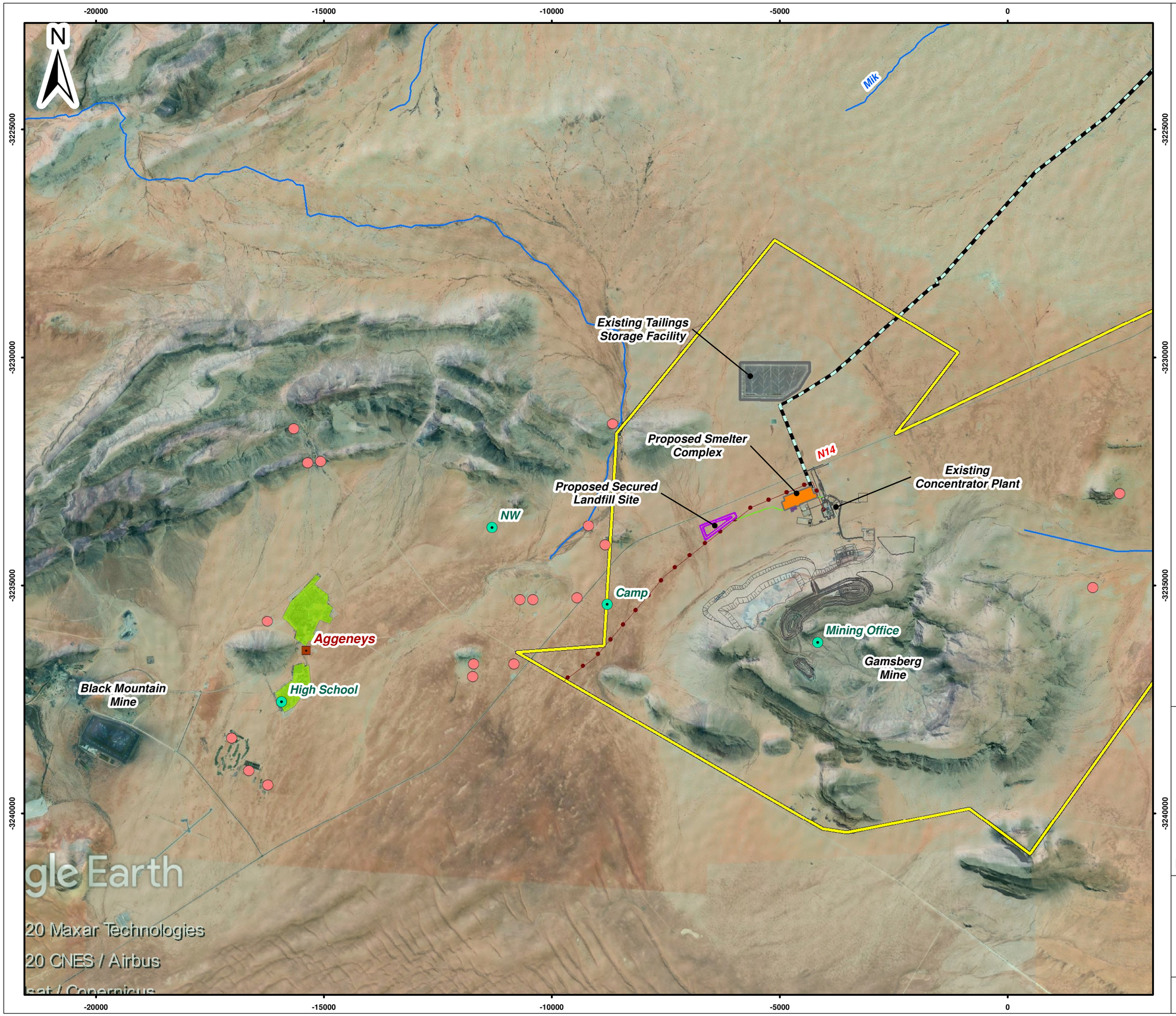
The GB NW site could be classified as a background site (representative of natural desert windblown dust). The daily PM_{10} concentrations were 21 µg/m³ (99th percentile). It should be noted that the daily PM_{10} National Ambient Air Quality Standards (NAAQS) at this site was exceeded three times during the sampling period and the data availability was only 58%.

Table 6-7 Summary of the Ambient Particulate Measurements in the Study Area (Units: µg/m^3)

Pollutant	Availability (%)	Daily				No of recorded exceedances
		Max	99th Percentile	90th Percentile	50th Percentile	
GB Mining Offices (January - May 2018)						
PM_{10}	100	273.5	39.0	11.3	2.2	12
GB South Access (January - June 2018)						
PM_{10}	96	50.6	7.4	2.1	0.3	0
Aggeneys High School, South Village (January - September 2019)						
PM_{10}	97	564.5	23.0	9.0	2.7	5
GB Camp (January - September 2019)						
PM_{10}	98	337.0	27.8	11.5	3.5	7
GB NW (January - September 2019)						
PM_{10}	58	498.0	21.0	8.5	0.0	3

Dust Fallout

Sampled dust fallout data for 14 single dust buckets was provided for the assessment by Black Mountain Mining (Pty) Ltd (2020). The dustfall classification and location (where available) is given in Table 6-8. The measured dust fallout for the period January 2018 to April 2019 is provided in Figure 6-15 and Table 6-8.



Legend

- Towns / Villages
- Rivers
- Gamsberg Zinc Mine MRA
- Existing Infrastructure

Proposed Infrastructure

- Bulk Water Pipeline
- Transmission Line
- Access Road
- Secured Landfill Site
- Switch Yard
- Smelter Complex Footprint

Sensitive Receptors

- Residential Developments
- Individual Households/ Recreational areas/ Industries
- PM10 Sampling Locations

0 1 000 2 000 Meters

Scale: 1:69 700 @ A3

Projection: Transverse Mercator
Datum: WGS1984, Lo23

Gamsberg Smelter Project

Figure 6-14

Location of Potentially Sensitive Human Receptors to Air Quality Impacts

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