INTEGRATED REHABILITATION & CLOSURE REPORT FOR SAND, AGGREGATE AND ALLUVIAL DIAMOND MINING ON THE REMAINING EXTENT OF PORTION 1-, REMAINING EXTENT- AND PORTION 3 OF THE FARM WOODLANDS 407, PARYS DISTRICT, FREE STATE.
MINING RIGHT APPLICATION – (FS 30/5/1/2/2/10048 MR)

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KEY ROLE PLAYERS

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Property owner	Goosebay Farm (Pty) Ltd formerly known as Winners Point 117 Trading (Pty) Ltd
Main consultant	Greenmined Environmental

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Mr. Mader van den Berg graduated, with distinction, in November 2004 at the University of Pretoria and achieved a Masters Degree in Landscape Architecture. He has working experience since 2005 in the fields of Landscape Rehabilitation, Landscape Design and Visual Impact Assessments. In 2010, Mr. van den Berg joined Skets Architects and Planning CC, previously known as I-Dot Design Studios CC. The company's core business skills include Landscape Architectural services, Environmental Planning & Consulting and Architecture.

Signature of the specialist:

Skets Architects and Planning CC

Name of company:

2019-07-11

Date of first draft report:

2021-03-18

Date of final report:

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

bgl	Below Ground Level
DMR	Department of Mineral Resources
EMP	Environmental Management Plan
HGM	Hydrogeomorphic
MAMSL	Meters Above Mean Sea Level
MAP	Mean Annual Precipitation
MPA	Mining Permit Area
MPRDA	Mineral and Petroleum Resources Development Act
NEMA	National Environmental Management Act
NEMBA	National Environmental Management: Biodiversity Act
ROM	Run of Mine
SABAP	South African Bird Atlas Project
SCC	Species of Conservation Concern
TMM	Trackless Mobile Machine
ToR	Terms of Reference
WULA	Water Use Licence Application

1 INTRODUCTION

i. Mine rehabilitation and closure have received increasing global attention in recent years in response to mining practices that resulted in extensive ecological disturbances and long-term socio-economic detriment. The challenges facing the rehabilitation of these historic mining landscapes are diverse, complex and costly, prompting the need for integrative, regenerative and sustainable strategies for future mining. It has become progressively more evident that rehabilitation planning must go hand-in-hand with the feasibility, design and operations of a mining project. The conventional engineering concept of ***mine optimisation*** narrowly focuses on the operational aspects, but a ***holistic optimisation*** is required over the lifetime of the mine, commencing at pre-feasibility and only ending at the closure phase.

ii. The closure phase is regarded as the lengthiest phase of the mine and should deal with all the residual environment impacts. Therefore, it is paramount that a holistic, integrated approach to mine planning and operation is required in order to align the various phases with sustainable closure objectives and minimal residual impacts. Such an integrated approach requires multi-disciplinary input from ecological, social and engineering sciences, to name a few.

iii. A redefinition of the term "***mining***" is suggested. The conventional use of the term places emphasis on the extraction of a valuable sub surface resource from an ore body, vein, seam, reef or deposit. This action usually requires the removal of various types of material (overburden) to access the subsurface resource. The economic balance between energy input versus the value of the extracted resource, is what makes such a mining project feasible or not. Limited emphasis is given to the "value" of the post-mining landscape within this economic model. The item that deals with this aspect is usually labelled ***rehabilitation and closure*** on the balance sheet, and although minimum standards are suggested by the legislative frameworks, the mining company has a wide choice as to how rehabilitation and closure will be implemented.

iv. In light of the above definition, one can argue that mining is also a landform altering exercise that often moves large volumes of material and reshapes the biophysical characteristics of the landscape (***transformative action***). To a typical mining enterprise, only two types of materials exist, namely; that which is referred to as the ***resource,*** and other, which is partly classified as ***waste***. The resource is sold and removed off the mining site. That which remains as a waste component, has to be dealt with accordingly and requires some form of rehabilitation. From a rehabilitation perspective, the remaining material becomes the "resource" that has to be worked with in order to achieve closure objectives.

v. An advanced waste management and landform design strategy, dovetailed to integrated rehabilitation and closure planning, should redirect mining operations to align with predetermined closure objectives. This approach implements holistic optimisation principles and is believed to achieve more resilient, regenerative and capable post-mining landscapes.

vi. This study explores opportunities while addressing the above-mentioned concerns and aims to implement a strategy that focuses greatly on the post-mining landscape, while directing responsible mining practices.

2 TERMS OF REFERENCE

i. Skets Architects and Planning (herein after referred to as *Skets*), an independent consultant, has been appointed by Monte Cristo Commercial Park (Pty) Ltd (herein after referred to as the *Applicant*) to compile an integrated rehabilitation and closure plan for the mining of sand, aggregates and alluvial diamonds on Remaining Extent of Portion 1-, Remaining Extent- and Portion 3 of the farm Woodlands 407 (herein after referred to as the ***Application Area***) (Figure 1). The study area is located on a privately-owned farm, bordering the Vaal River approximately 20km north east of the town of Parys in the Ngwathe Local Municipality, Free State Province.

ii. The Applicant applied for a mining right over the above-mentioned properties. When and if such application is successful, several areas will be earmarked for open pit sand, aggregate and alluvial diamond mining over a 30 year period. The rehabilitation and closure plan will encompass all the open pit mining areas as well as the associated infrastructure that will be constructed in support of the mining activities.

iii. The terms of reference and applied study methodology are set out below:

- Provide a contextual analysis of the biophysical and social environment;
- Discuss the post-mining vision for the application area;
- Describe the mining methods and mining schedule;
- Identify closure objectives and targets for all the domains relating to infrastructure, pits/quarries, etc.;
- Provide closure and rehabilitation actions;
- Provide a preliminary monitoring program; and
- Establish relinquishment criteria.

iv. The information sources that are utilised to inform the rehabilitation report, include but are not limited to:

- The studying of the available specialist reports submitted for the Environmental Impact Assessment;
- Research on the best practices in the rehabilitation of quarries and pit mines;
- Experience gained through the involvement with the rehabilitation of the mining permits on the same properties;

- Information gathered during several site investigations over a five-year period; and
- Information gathered during engagement with the Applicant and mine manager that is deemed applicable to this mining right application.

3 ASSUMPTIONS AND LIMITATIONS

i. The Integrated Rehabilitation and Closure study is considered a working document, that should be adjusted according to the monitoring of progressive rehabilitation and/or the procedures of mining. It is imperative that clear objectives are made to set the course for proper implementation, but uncertainties in the pre-mining stage may prompt adjustments in the future. This section provides a clear understanding of the limitations and assumptions that influences the accuracy of the rehabilitation strategy and closure planning:

- Many of the specialist studies' findings were incorporated into this document to inform the rehabilitation strategy and develop an integrated plan. Although some of the studies were still in draft format at the time of the compilation of this report, the extracted information is regarded accurate and factual. If at any stage, the specialist studies are revised, it is recommended that a review of this report is also done to reflect factual information and maintain integrity and accuracy;
- The resource statement presented by the Applicant is considered accurate within reasonable limits. The potential for alluvial diamonds has not been accurately assessed and assumptions on the location of the diamonds are based on a specialist report from Marshall (2018). As a result, the procedure for diamond extraction is conceptual and has not been geographically positioned on the application area. Therefore, the rehabilitation methodology will remain conceptual until such time more accurate information becomes available;
- No detailed engineering drawings and specifications have been provided for the plant infrastructure that are specific to the site. The layout of the processing plant is preliminary and has not been signed off by a qualified engineer. Images of the plant infrastructure are provided by suppliers and are assumed applicable to this operation with minor adjustments to its specific requirements. The description of the infrastructure under Section 6 is based on information provided by the suppliers as well as information provided by the Applicant;
- The management of stormwater, extraction of water from underground or surface resources as well as the storage of water is subject to the success of the Water Use License Application (WULA), which, at this point, is still in progress. The Integrated Rehabilitation and Closure study deals with this on a conceptual level as if the application is successful. Amendments are required once a point of certainty is reached.

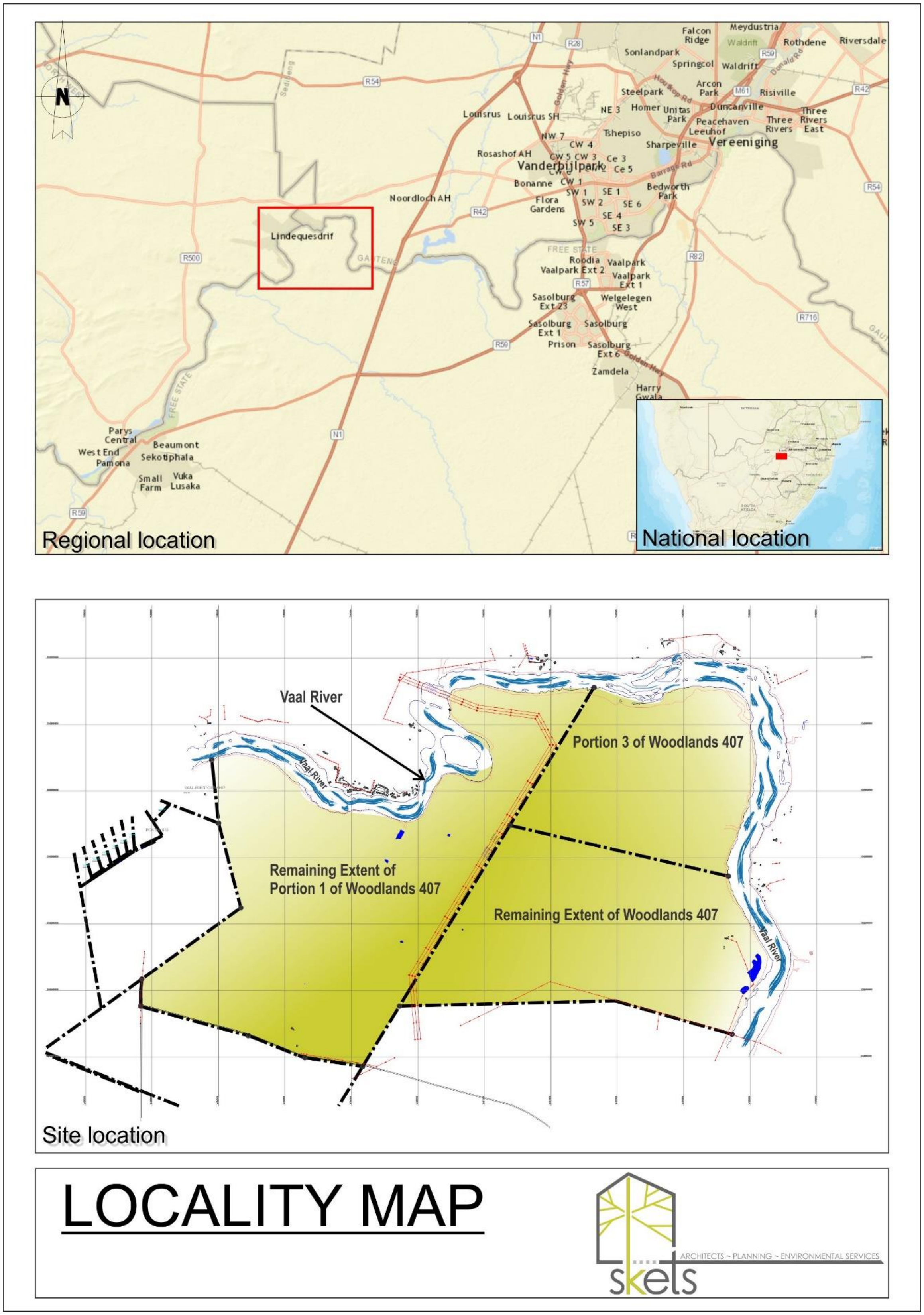


Figure 1: Locality map

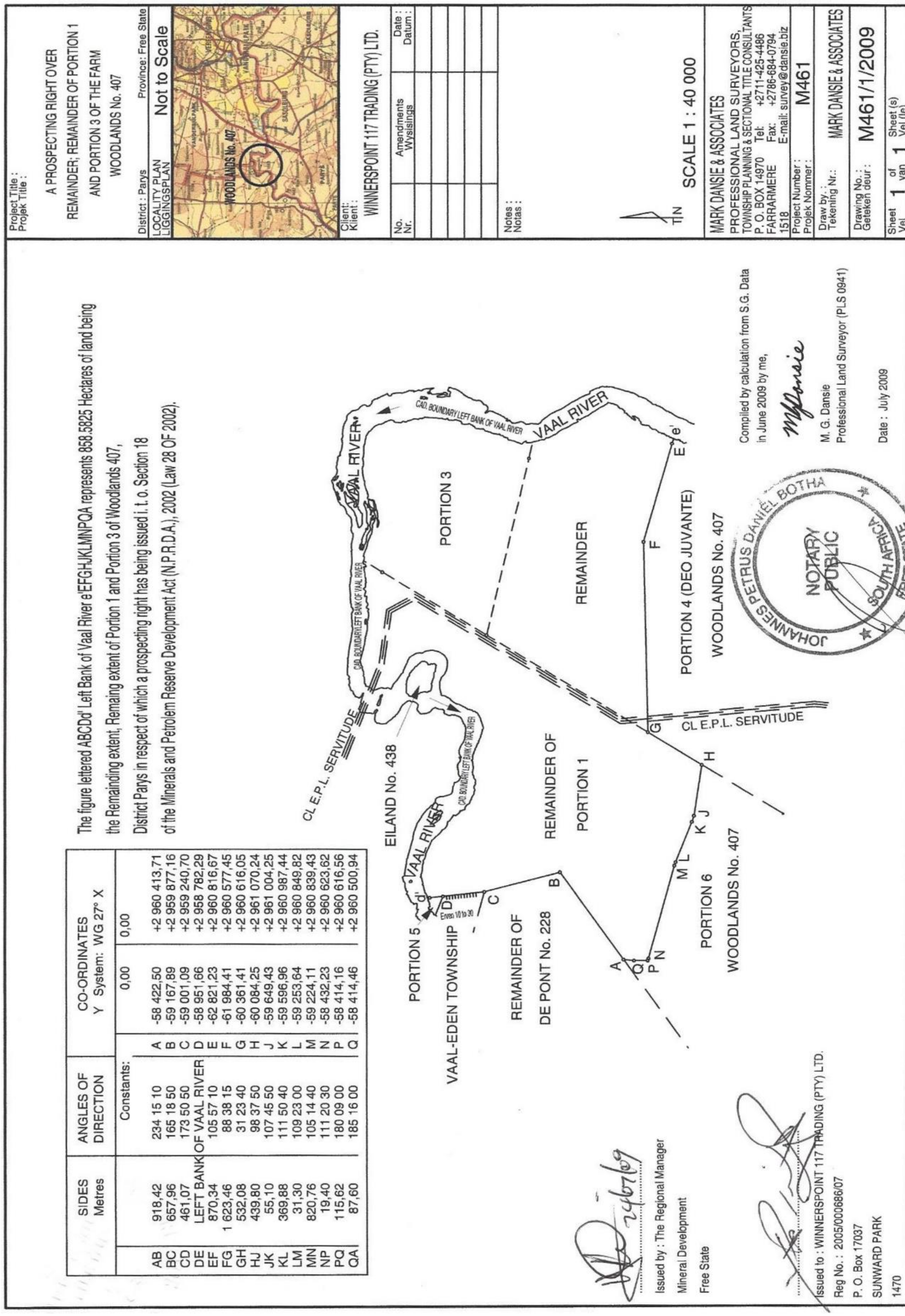


Figure 2: Regulation 2 (2) survey of property

4 BASELINE BIOPHYSICAL ENVIRONMENT AND PROJECT CONTEXT

4.1 INTRODUCTION

i. Many of the draft specialist studies were reviewed to inform the baseline biophysical environment and project context assessment. For the Scoping phase, the following specialist studies were conducted:

- Soil, Land Capability and Agricultural Potential.
- Ecology (Fauna, Avifauna and Flora).
- Terrestrial Biodiversity.
- Aquatics and Wetland Biodiversity.
- Hydrology including Floodlines and Buffer Zone Calculations.
- Heritage.
- Palaeontology.
- Social.
- Economic.
- Visual.
- Noise and Air Quality.
- Traffic.
- Geohydrology and Waste Classification.

ii. A list of potentially negative impacts that were identified during the Scoping phase assessment, and which shall be addressed in the rehabilitation and closure report are listed below:

- Safety risks due to open pit mining and excavations.
- Impact on the existing land uses.
- Sense of place.
- Loss of soil resources and related land capabilities.
- Loss in biodiversity.
- Alterations to surface water quality and flow paths.
- Air pollution
- Noise hazard.
- Negative landscape and visual impacts.
- Loss or disturbance of heritage/cultural or palaeontological resources.
- Spillage of hazardous chemicals.
- Soil contamination.
- Soil compaction.
- Impact on human health.

4.2 GEOLOGY

i. The application area is located on the north-eastern limb of the Vredefort Dome. The predominant geology consists of shale, slate and quartzite of the Pretoria Group, Hekpoort lava, many diabase sills, sporadic occurrence of dolomite and chert, Verterdorp lava, Ecca shale and sandstone.

ii. The geological formations presented in Figure 3 & Figure 4 are described from the oldest to youngest in the following section.

- Klipriviersberg Group (Rk): The Klipriviersberg Group, Ventersdorp Supergroup, consists of basaltic lavas, agglomerates and tuffs. This unit unconformably overlies the Witwatersrand Supergroup, and is locally estimated to be between 3 300 and 3 600 m in thickness. The typical lavas of this unit are mostly basaltic in composition and it is amygdaloidal in places.
- Black Reef Formation (Vbr): The Black Reef Formation has been displaced by faulting on the Klipriviersberg Group and Malmani Subgroup contact.
- Malmani Subgroup (Vmd): This sub-group overlies the Black Reef Formation conformably and consists of dolomite, chert and chert-breccia. This unit is between 1 200 and 1 500 m thick in the vicinity of Woodlands 407. The dolomite of this formation is usually covered by soft sediment, but the more resistant chert and chert-breccia are usually visible as prominent ridges. This unit covers the largest part of the geology on Woodlands.
- Lindeques Drift Complex (Vli): This intrusive igneous complex forms an elongated body of 11 km in length and is emplaced within the Malmani dolomite. It consists of lamprophyre, syenodiorite and albite-syenite dykes.
- Rooihoogte Formation (Vrt): The Rooihoogte Formation unconformably overlies the Malmani Sub-group, and is on average between 10 and 150 m in thickness. Lower down (basal 30 m) in the succession, this formation consists of breccia and conglomerate, and quartzite. The thicker upper remainder of this formation consists of shale and intercalated quartzite.
- The Timeball Hill Formation (Vtq 1): This formation overlies the Rooihoogte Formation conformably and is made up of the Timeball Hill quartzite. This usually forms prominent ridges. The Vtq2 succession contains an elevated amount of iron when compared to Vtq1.
- The Timeball Hill Formation (Vts 3): This formation overlies the Timeball Hill quartzite and consists of shale horizons.
- The Hekpoort Formation (Vh): The main lithologies are finely crystalline andesitic tuffs and lava flows with amygdoloidal zones.
- Quaternary Sands (Q): Most of the formations in the area are overlain by unconsolidated quaternary sediments of waterborne and windblown sands. The Vaal River is a very old and mature drainage system, borne out by the course it takes across the rim of the Vredefort Dome. There is evidence on Woodlands 407 of a paleo-channel cutting across Portion 4 and the southern parts of the remaining extent, as well as the southern part of the remaining extent of portion 1. Further north in an east-west orientation is additional evidence of separate quaternary sediment deposited on Portion 3 and the remaining extent of Portion 1.
- Diamondiferous Gravels (Qs): The mapped diamondiferous gravels are indicated as Qs on Figure 3.

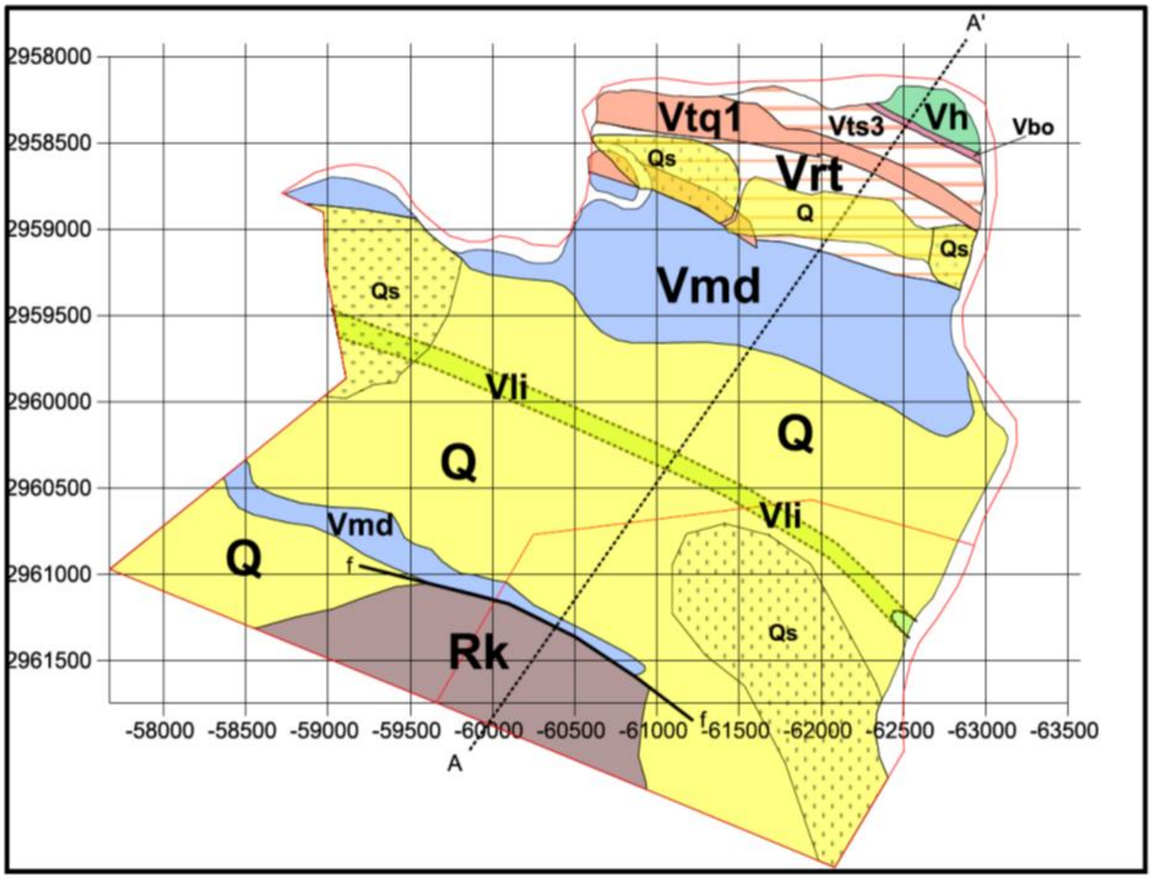


Figure 3: Sub-surface geology of the application area

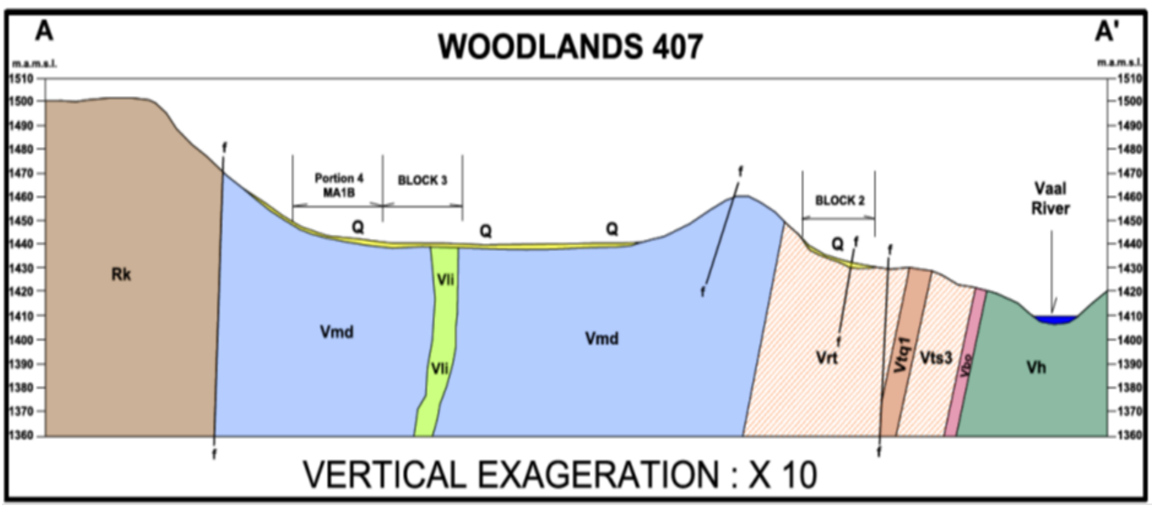


Figure 4: Geological cross section

4.2.1 SAND AND AGGREGATE POTENTIAL

i. Quaternary age sands and aggregates are the mine’s main focus. These sands are unconsolidated and unconformably overlie sediments of the Transvaal Supergroup. The secondary commodity of interest is the unconsolidated, Quaternary gravels, which potentially contain alluvial diamonds.

4.2.2 ALLUVIAL DIAMOND POTENTIAL

i. During the period 1922-1926, some 25,000ct are recorded as having been recovered from five farms located on the northbank (Marshall, 1987). On Kaalplaats and Zeekoeifontein, intermittent diamond production continued up until 1968 and 1973 respectively.

4.3 CLIMATOLOGY

i. The Average Annual Rainfall for the project area is 862mm (Airshed, 2019). Figure 5 (*ibid*) illustrates the monthly rainfall based on modelled MM5 data. Rain typically occurs as thunderstorms during the summer season with the wettest months from October to March.

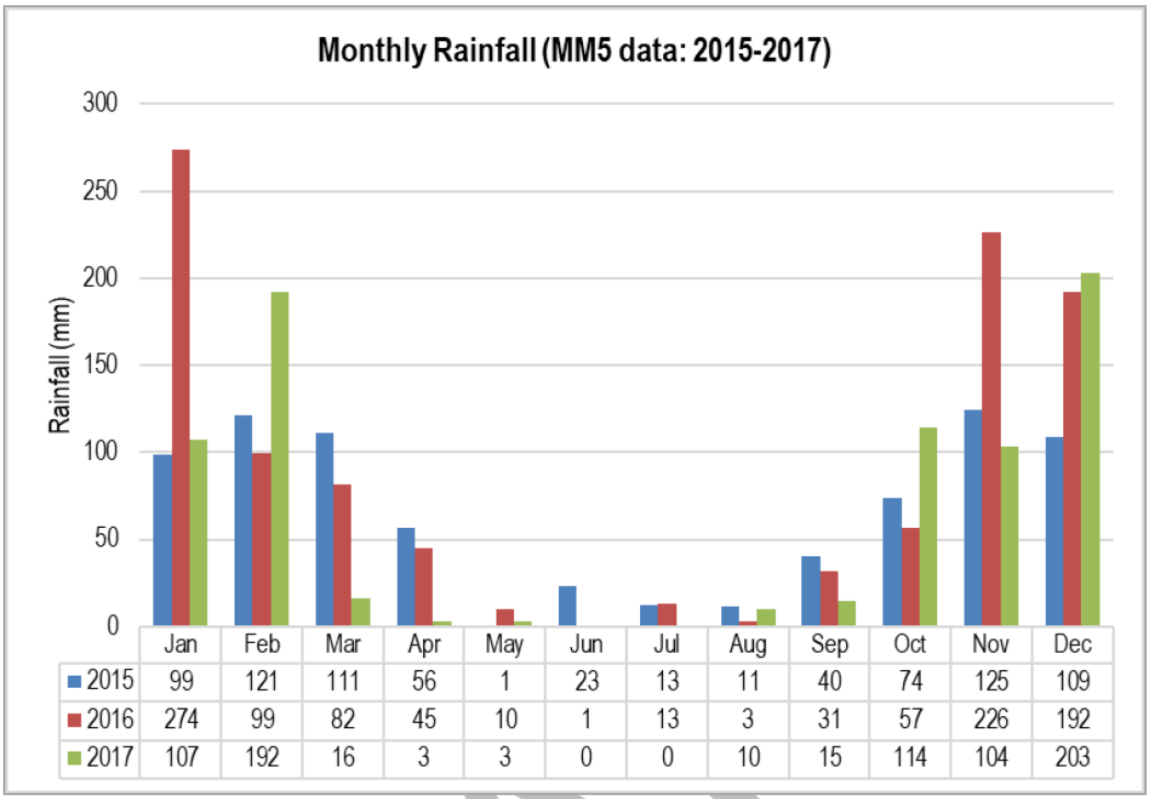


Figure 5: Total monthly rainfall based on modelled MM5 data

ii. Evaporation rates are typically calculated with a Symon's Pan evaporation measurement, but results are generally higher than that of a natural open water body. A conversion factor is used to apply the data to open water evaporation as illustrated in Table 1 (Hydrospatial, 2019)

Table 1: Symon's Pan and open water evaporation rates

Month	Symon's Pan Evaporation (mm)	Open Water Evaporation Factor	Open Water Evaporation (mm)
January	179	0.84	150

Month	Symon's Pan Evaporation (mm)	Open Water Evaporation Factor	Open Water Evaporation (mm)
February	147	0.88	129
March	136	0.88	119
April	102	0.88	90
May	78	0.87	68
June	59	0.85	50
July	65	0.83	54
August	93	0.81	75
September	129	0.81	105
October	161	0.81	131
November	169	0.82	138
December	180	0.83	149
Total	**1498**	**N/A**	**1259**

iii. The period mean, maximum and minimum temperatures for the site is 17°C, 33°C and 0°C respectively. November – February is the months with the highest average temperatures and June-August with the lowest average temperatures. This is illustrated in Figure 6 (Airshed, 2019).

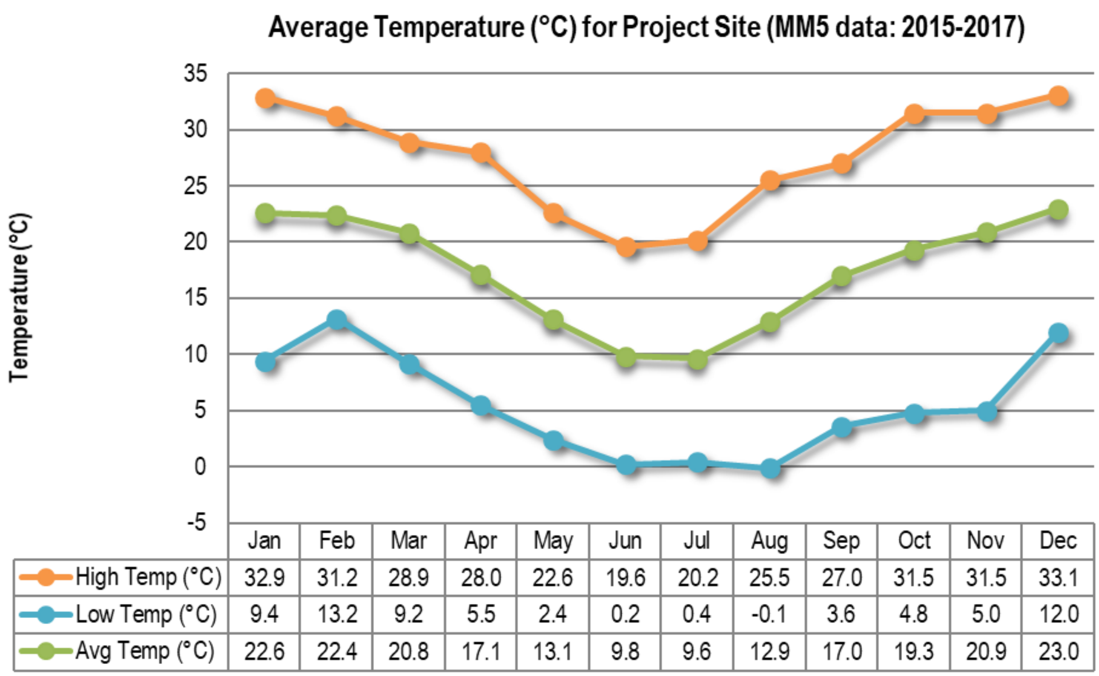


Figure 6: Monthly temperature profile based on modelled MM5 data

iv. "Wind roses comprise 16 spokes which represent the direction from which wind blew during the period. The colours of the spokes reflect the different categories of the wind speed..." (Airshed, 2019). For the project site the wind field is dominated by winds from the northern sector with average speeds of 3.2m/s and 3.3m/s during day- and night times respectively, as illustrated in Figure 7 (*ibid*)

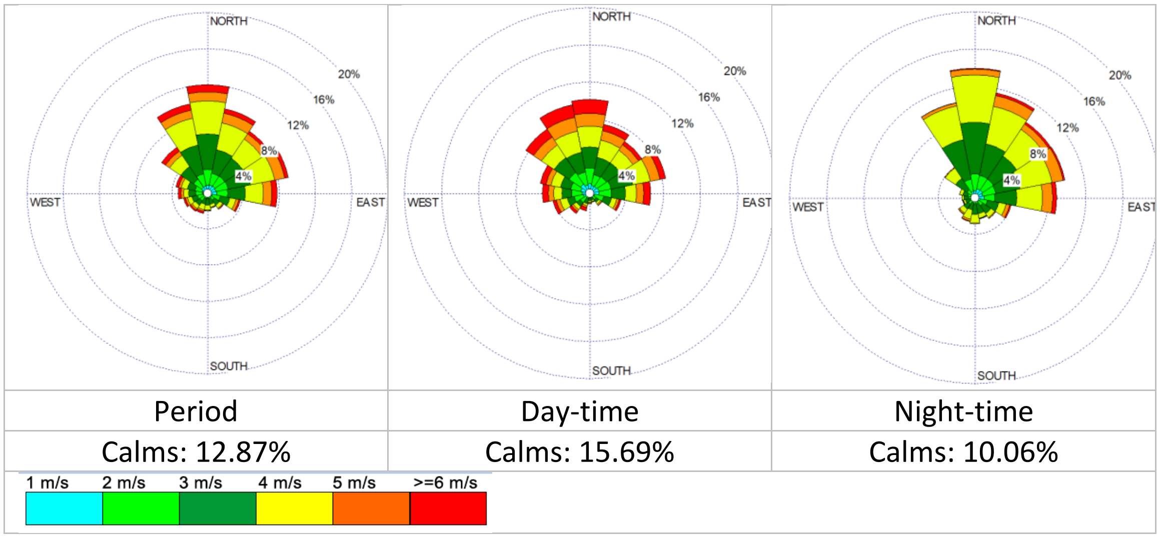


Figure 7:Period, day-time and night-time wind roses based on modelled MM5 data

4.4 TOPOGRAPHY, SURFACE HYDROLOGY AND SOILS

i. The regional topography is characterised by an undulating landscape with a generally downward slope towards the Vaal River along the northern boundary of the farm. Two low lying ridges traverse the properties, but generally the terrain is evenly sloped. The Vaal River forms the Northern and Eastern boundary of the Application Area.

ii. The project is located in the Upper Vaal Water Management Area within quaternary catchment C23B. Several non-perennial drainage lines drain the project area into the Vaal River, which flows in a westerly direction towards the town of Parys. The highest elevation point on the project site is 1470 meters above mean sea level (mamsl) sloping down to the Vaal River at an elevation of 1406mamsl. Topography and surface hydrology of the Application Area are illustrated in Figure 8 (Hydrospatial, 2019).

iii. Figure 9 (*ibid*) illustrates the soils analysis for the project site whilst Table 2 (*ibid*) provides descriptions of each soil's hydrological properties.

iv. Sand mining will occur primarily on the areas categorised as Clovelly soils, while aggregate mining is mainly focused on the Oakleaf and Glenrosa soils. Diamondiferous gravels have the potential to occur in any part of the property but is expected to be under the sandy areas in a gravelly sub layer.

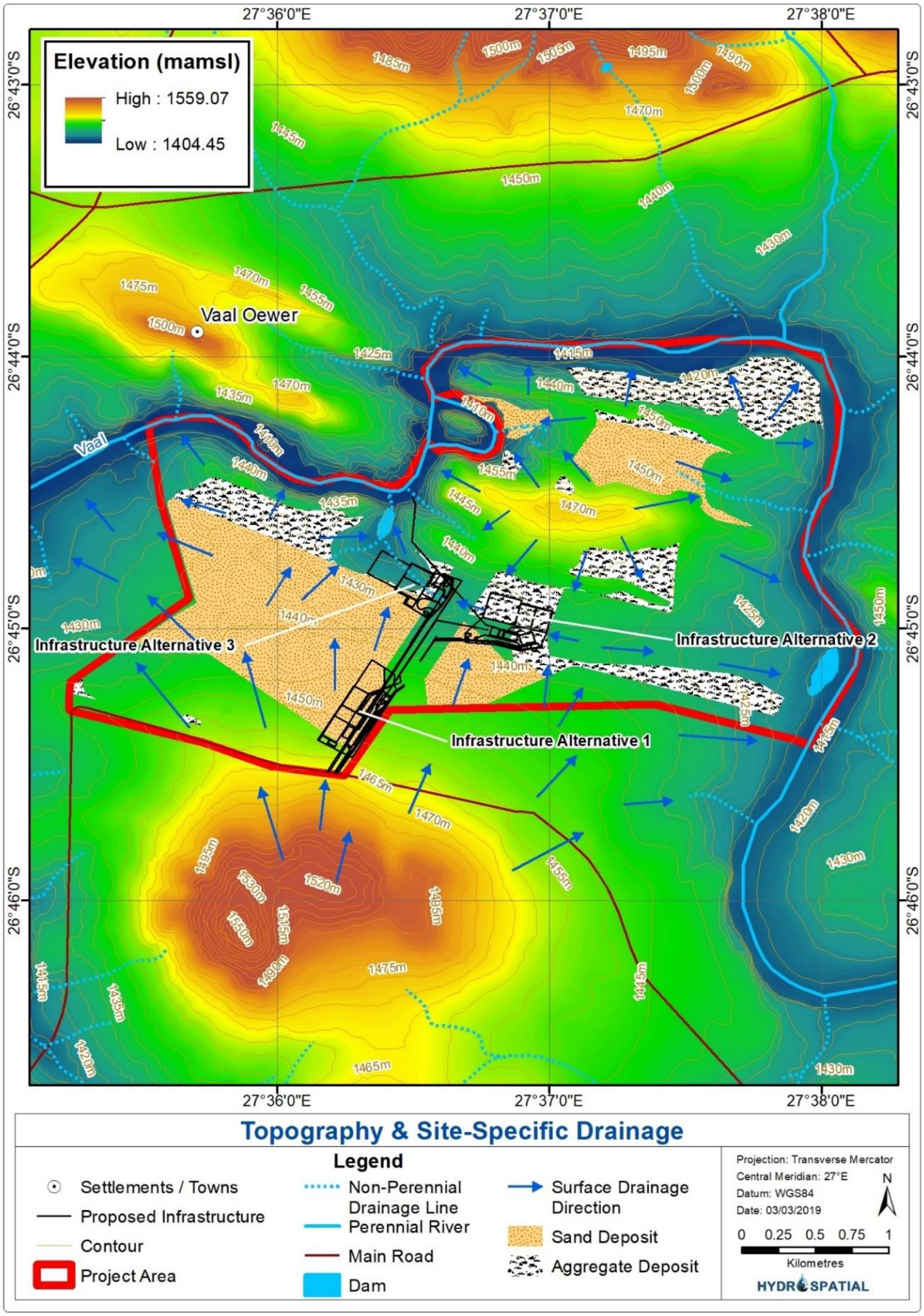


Figure 8: Topography and site-specific drainage

Table 2: Hydrological properties of the soils

Soil Form	Soil Hydrological Group	Hydrological Properties
Mispah	C	Moderately high stormflow potential. Low infiltration rates (final infiltration +- 6 mm/h). Restricted permeability (1.3 to 3.8 mm/h). Poor drainage (frequently shallow soils).
Oakleaf	B	Moderately low stormflow potential. Moderate infiltration rates (final infiltration +- 13 mm/h). Moderate permeability (3.8 to 7.6 mm/h). Moderate drainage.
Westleigh	C	Moderately high stormflow potential. Low infiltration rates (final infiltration +- 6 mm/h). Restricted permeability (1.3 to 3.8 mm/h). Poor drainage (frequently shallow soils).
Avlon	B	Moderately low stormflow potential. Moderate infiltration rates (final infiltration +- 13 mm/h). Moderate permeability (3.8 to 7.6 mm/h). Moderate drainage.
Clovelly	A/B	Low to moderately low stormflow potential.
Fernwood	A	Low stormflow potential. High infiltration rates (final infiltration +- 25 mm/h). Rapid permeability (> 7.6 mm/h). Rapid drainage.
Glenrosa	B/C	Moderately low to moderately high stormflow potential.
Hutton	A	Low stormflow potential. High infiltration rates (final infiltration +- 25 mm/h). Rapid permeability (> 7.6 mm/h). Rapid drainage.
Longlands	C	Moderately high stormflow potential. Low infiltration rates (final infiltration +- 6 mm/h). Restricted permeability (1.3 to 3.8 mm/h). Poor drainage (frequently shallow soils).

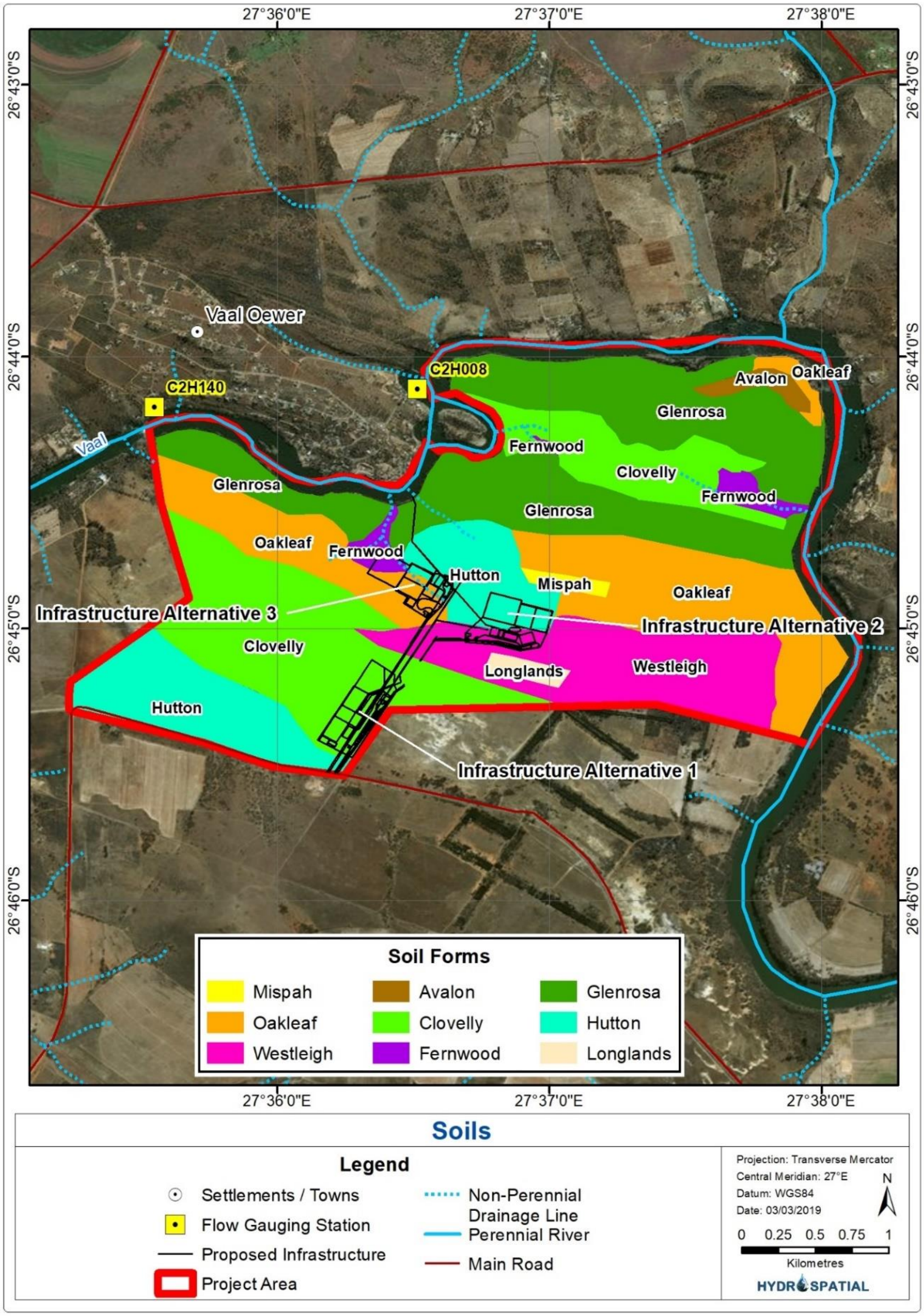


Figure 9: Soils analysis

4.5 GEO-HYDROLOGY AND GROUND WATER MONITORING

i. A hydrocensus was done during the scoping phase and data from 20 sites were collected on and around the Application Area. Borehole extractions are mainly for domestic use or irrigation in some instances. Ground water levels vary between 2.5m to 7m across the Application Area, with a maximum depth of 20.5m bgl along the southern boundary of the application area. There is a 91% correlation between the topographical elevation and the water table.

ii. "The general groundwater flow direction is in a northerly direction towards the Vaal River. There is a strong possibility of good surface water-groundwater interaction based on the shallow groundwater levels in the proposed mining area and the proximity to the Vaal River. The shallow groundwater table in the proposed mining area also indicates the possibility of groundwater inflow into the sand and aggregate excavations (Noa Agencies, 2018)."

iii. Good quality groundwater can be expected in the Pure Source Mine area due to the sandy aquifers, dolomite, rainfall, and active groundwater flow. Stagnant groundwater zones are not expected in the area.

4.6 TERRESTRIAL AND AQUATIC ECOLOGY

i. The project area is located within the Grassland Biome. The regional vegetation category falls under the Soweto Highveld Grassland vegetation type. Scattered small wetlands, narrow stream alluvia, pans and occasional ridges or rocky outcrops interrupt the continuous grassland cover (Mucina & Rutherford, 2006).

ii. "The Soweto Highveld Grassland vegetation type is found in Mpumalanga, Gauteng and to a little extent also in neighbouring Free State and North-West Provinces. This vegetation type typically comprises of an undulating landscape on the Highveld plateau supporting short to medium-high, dense, tufted grassland…" (The Biodiversity Company, 2019).

iii. Based on the South African Bird Atlas Project, Version 2 (SABAP2) database, 317 bird species are expected to occur in the vicinity of the project area…" "Of the expected bird species, twenty-four (24) species are listed as species of conservation concern (SCC) either on a regional scale or international scale (Table 4). The SCC include the following:

- Four (4) species that are listed as Endangered (EN) on a regional basis;
- Six (6) species that are listed as Vulnerable (VU) on a regional basis; and
- Twelve (12) species that are listed as Near Threatened (NT) on a regional basis." (*ibid*)

iv. The probability of these species occurring in the study area is rated moderate with some rated high due to suitable habitats. These suitable habitats are mostly associated with the wetlands and the Vaal River system, although some species prefer grasslands.

v. "The IUCN Red List Spatial Data (IUCN, 2017) lists 78 mammal species that could be expected to occur within the vicinity of the project area. Of these species, 10 are medium to large conservation dependant species, such as *Ceratotherium simum* (Southern White Rhinoceros) and *Equus quagga* (Plains Zebra) that, in South Africa, are generally restricted to protected areas such as game reserves. These species are not expected to occur in the project area and are removed from the expected SCC list. Of the remaining 67 small to medium sized mammal species, eleven (11) are listed as being of conservation concern on a regional or global basis. The list of potential species includes:

- Two (2) that is listed as EN on a regional basis;
- Five (5) that are listed as VU on a regional basis; and
- Six (6) that are listed as NT on a regional scale." (*ibid*)

vi. The probability of these species occurring in the study area is rated high to medium for selected species. The habitats are mostly associated with the wetlands and Vaal River system, but also includes the rocky ridges and outcrops.

vii. "Based on the IUCN Red List Spatial Data (IUCN, 2017) and the ReptileMap database provided by the Animal Demography Unit (ADU, 2017) 20 reptile species are expected to occur in the project area . No reptile species of conservation concern are expected to be present in the project area." (*ibid*)

viii. "Based on the IUCN Red List Spatial Data (IUCN, 2017) and the AmphibianMap database provided by the Animal Demography Unit (ADU, 2017) twenty (20) amphibian species are expected to occur in the project area. One (1) amphibian SCC could be present in the project area according to the above-mentioned sources. The Giant Bull Frog (*Pyxicephalus adspersus*) is a species of conservation concern that will possibly occur in the project area. The Giant Bull Frog is listed as near threatened on a regional scale. It is a species of drier savannahs. It is fossorial for most of the year, remaining buried in cocoons. They emerge at the start of the rains, and breed in shallow, temporary waters in pools, pans and ditches (IUCN, 2017). There appears to be minimal suitable habitat for this species in the project area and therefore the likelihood of occurrence is regarded as low." (*ibid*)

ix. The main habitats in the project area are summarised as:

- Rocky Grassland and Ridges;
- Secondary Grassland;
- Mixed Woodland;
- Transformed Areas;
- Wetland Habitats;
- Riparian zone along the Vaal River. (Figure 10 (*ibid*))

x. Sand mining is primarily concentrated on the area classified as secondary grassland which has a low habitat sensitivity. The aggregate mining will occur on secondary grassland and areas that has been transformed due to previous mining or agriculture. The northern aggregate and parts of the central aggregate resource overlap areas of mixed woodland which has a low-moderate habitat sensitivity.

xi. All wetlands and wetland buffers were excluded from the mining area to protect sensitive habitats.

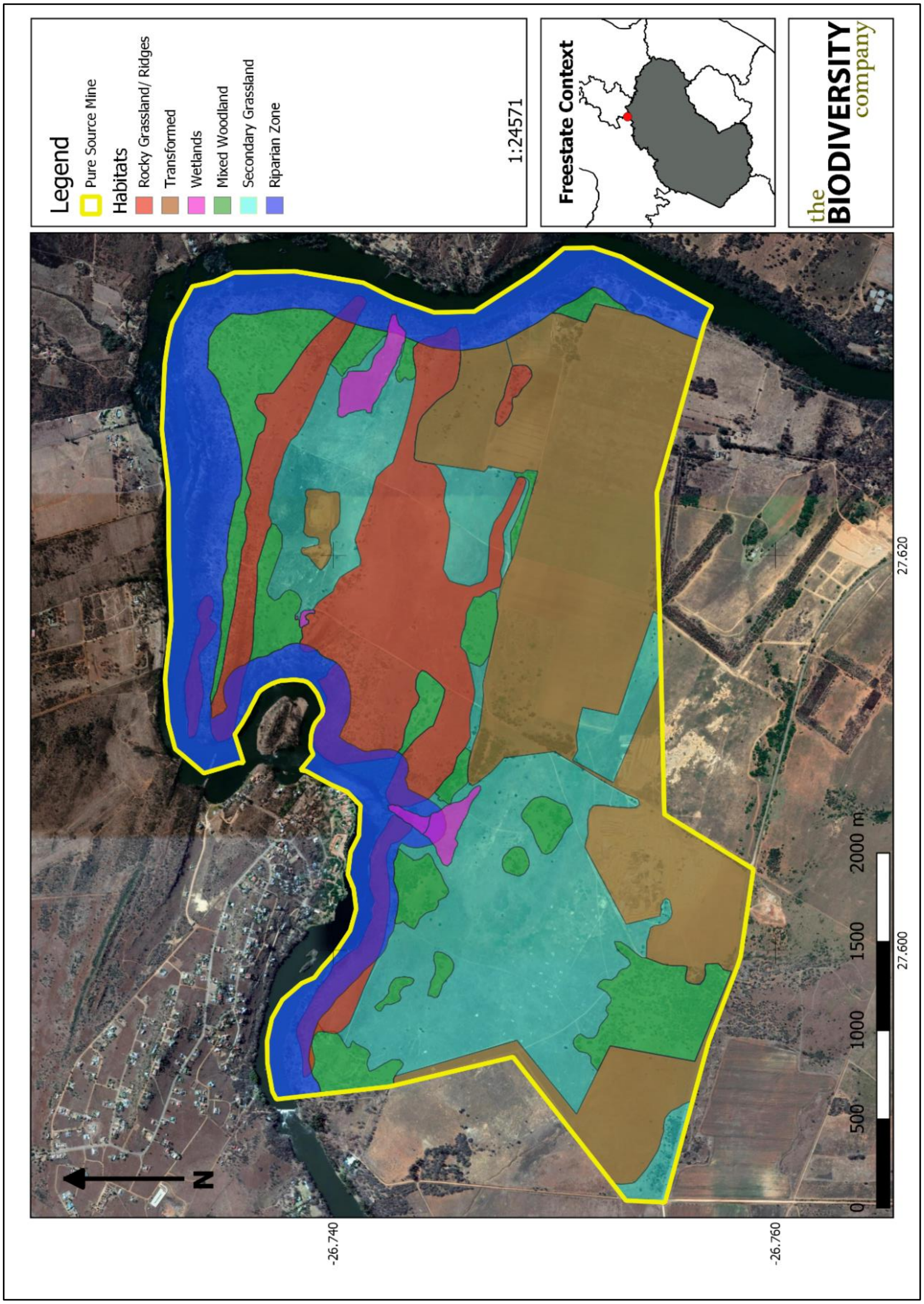


Figure 10: Habitat map

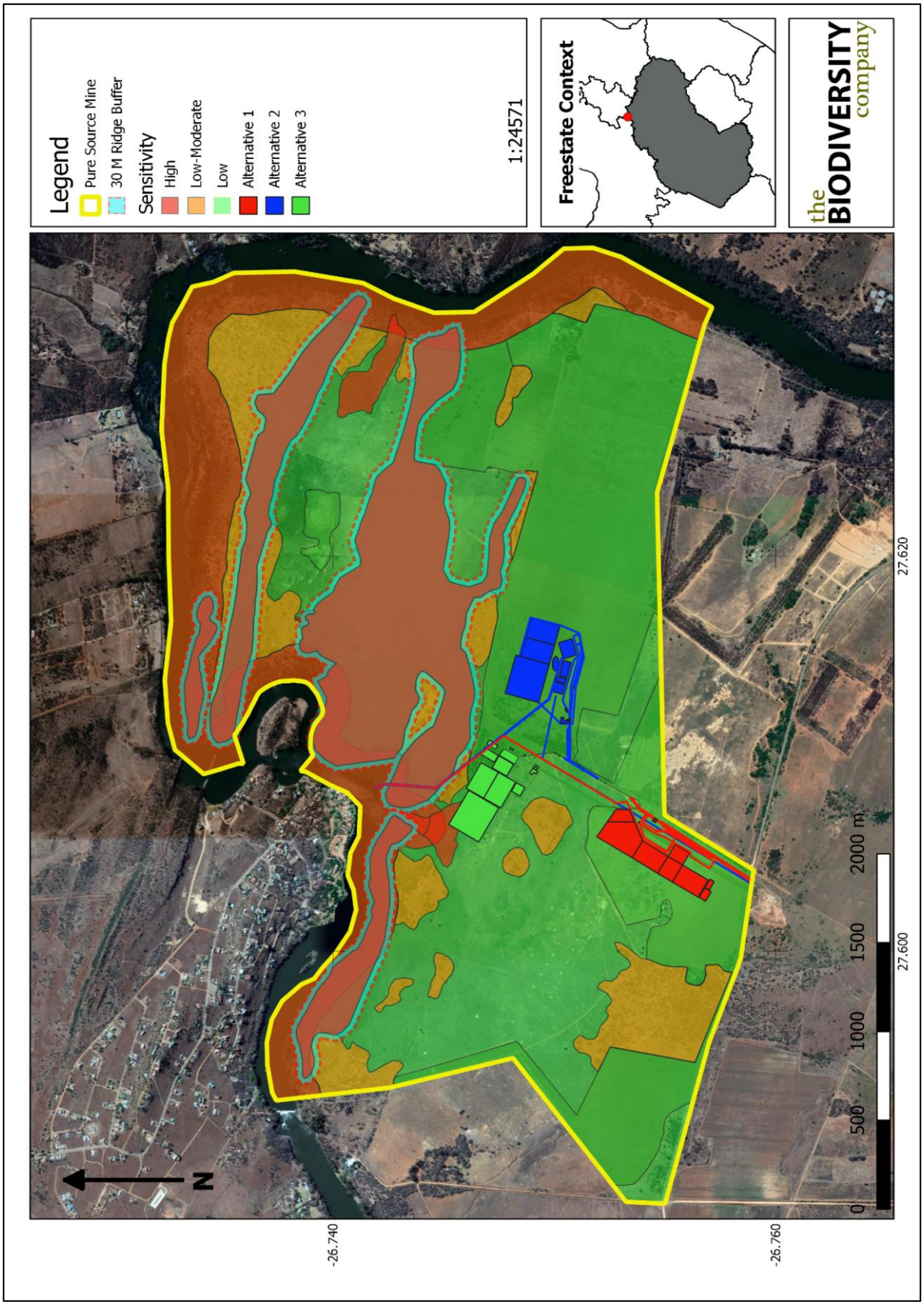


Figure 11: Habitat sensitivity map

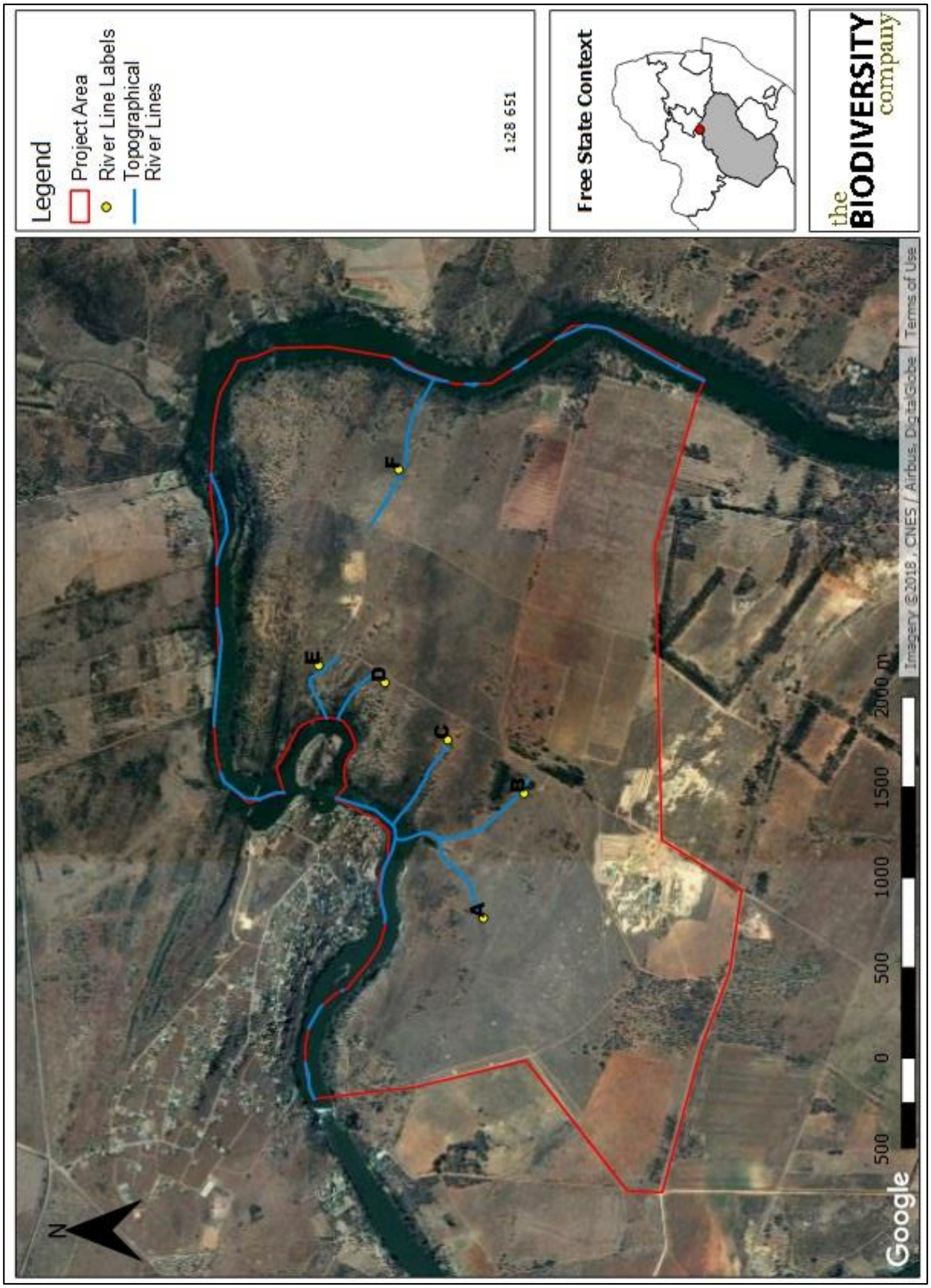


Figure 12: Topographic River lines

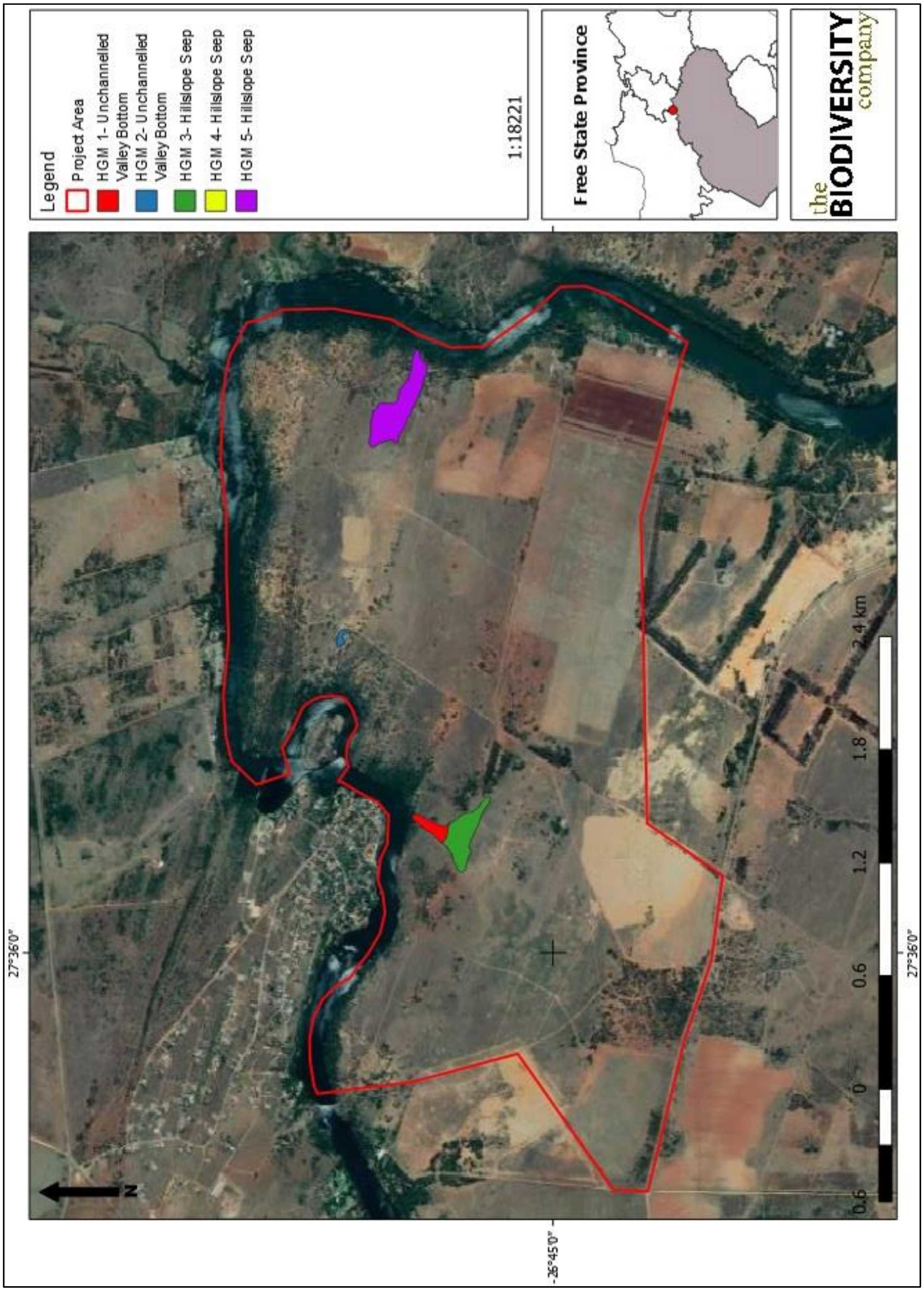


Figure 13: Delineated HGM units

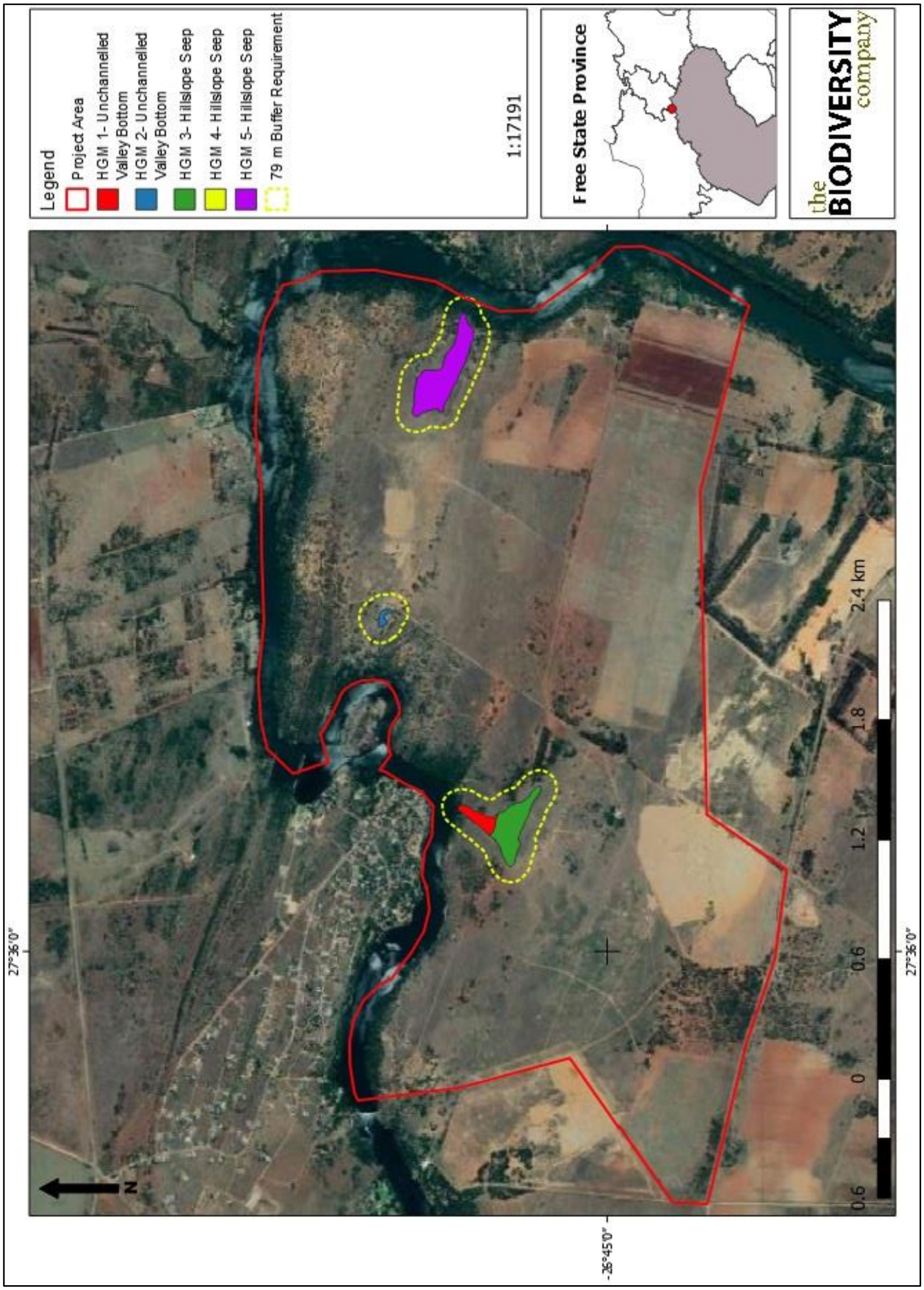


Figure 14: Extent of the recommended buffer requirements

4.7 HERITAGE

i. A Heritage Impact Assessment (HIA) and Palaeontological Impact Assessment (PIA) study was conducted by NGT ESHS on 26 March 2019. During the survey, six stone wall sites, five building structure, one single grave and 51 graves in an informal cemetery were identified. (Figure 15, De Bruyn, 2019)

ii. The stone walls have heritage value of moderate significance and should therefore be avoided and treated as No-Go areas. None of the building structures have heritage value and is considered to have a low significance. Both the grave sites are considered to have high significance and should be treated as No-Go areas (*ibid*).

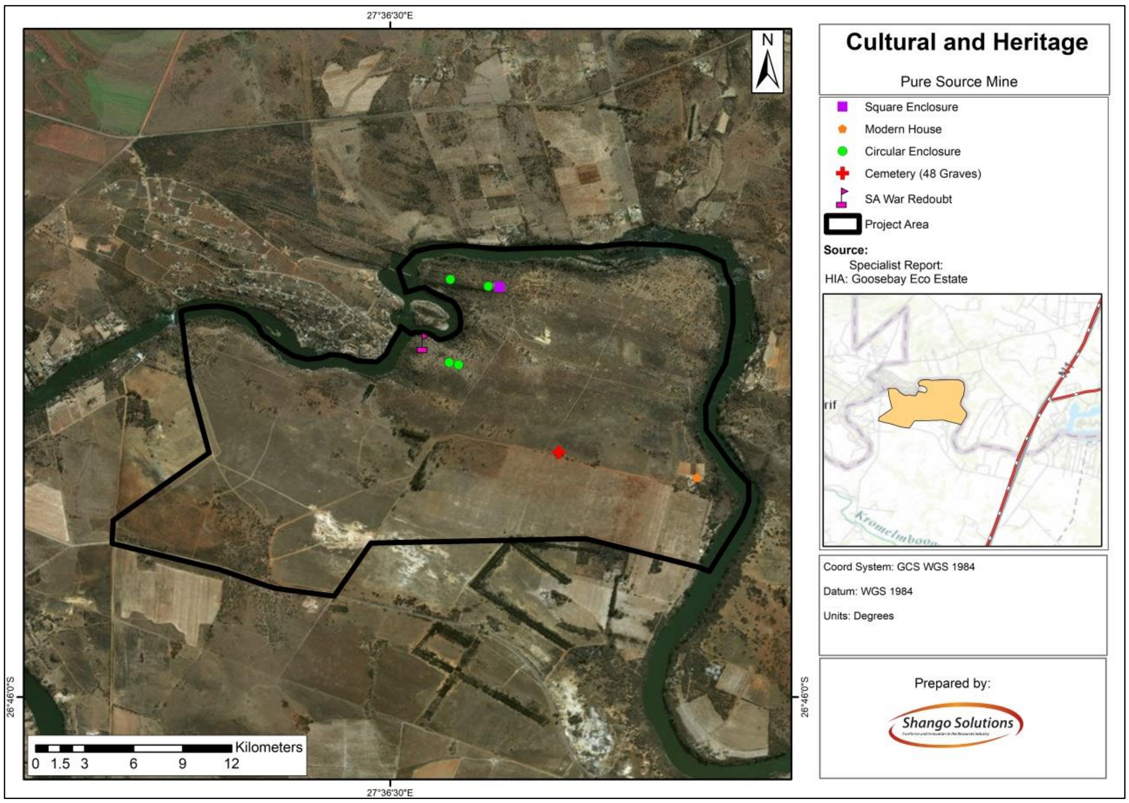


Figure 15: Heritage sites identified during survey

iii. In terms of SAHRA Paleontological Sensitivity Layer, the project area is located in a moderate to very high sensitivity area:

- 60% falls within a moderate sensitivity area (green);
- 25% falls within a high sensitivity area (orange); and
- 15% falls within a high sensitivity zone (red). (Figure 16, *ibid*)

iv. "According to the PIA report, the farm Woodlands lies in the ancient volcanic rocks, some dolomite and Quaternary sands. Based on the geology of the area and the palaeontological record, it can be assumed that the formation and layout of the basal gneisses, granites, sandstones, shales and sands are typical for the country and do not contain any fossil plants, but the dolomites and limestones might contain stromatolites, trace fossils. The sands of the Quaternary period and ancient volcanic rocks would not preserve fossils. Stromatolites have been recorded from the Malmani Group in other parts of the country so there is a possibility that they occur in this area too." (*ibid*)

Figure 16: SAHRA Palaeo-sensitivity layer for application area.

v. Only the cemetery site (Wood-CEM 01) is located within the area allocated for gravel quarrying.

4.8 EXISTING INFRASTRUCTURE

i. The property is privately owned and is predominantly operated as a game farm. Its surface area is approximately 858ha. Its current surface usage is grazing, to support game on the property as well as agriculture for producing crops such as maize and sunflower. Recently, cattle were also introduced as a pilot project to optimise the agricultural potential on the property.

ii. Staff housing are located near the entrance gate. Storerooms and sheds are located near the river on the eastern boundary of Remaining Extent of Woodlands 407. Overnight accommodation in the form of chalets and camping facilities, are present in the south eastern corner of Remaining Extent of Woodlands 407 and are actively operated as a fishing resort. Several dirt roads are utilized during game drives and for general upkeep of the farm. A high-voltage power line dissects the farm on the eastern border of Remaining extent of Portion 1 of Woodlands 407.

iii. The existing allocation of land uses are shown in Figure 17 which illustrates that the largest part of the property is reserved for game.

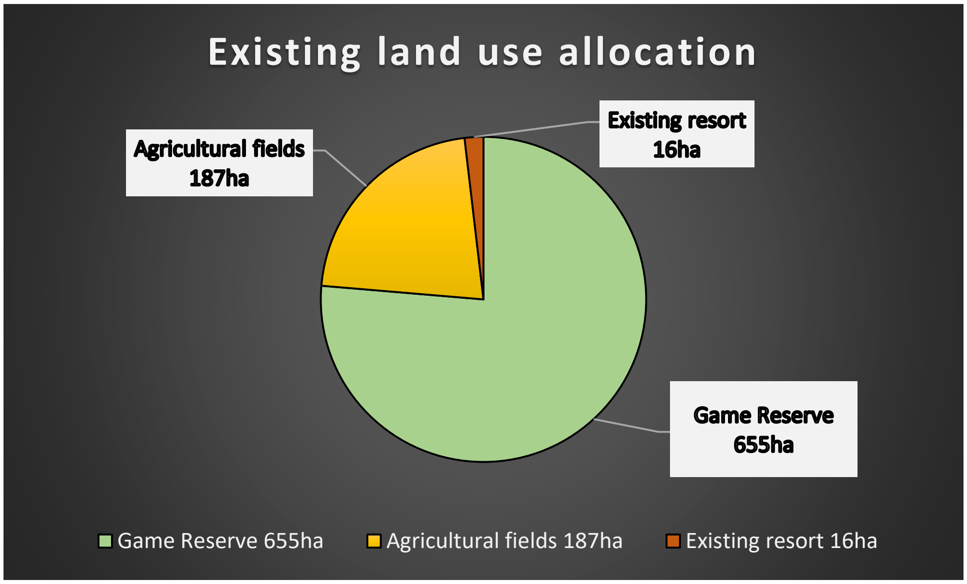


Figure 17: Existing land use allocation pie chart

iv. Signs of historic mining are noticeable on the farm. Diamond prospecting did occur along the Vaal River banks in the vicinity of the application area, presumably during the period 1922-1926 (Marshall, 2018)

v. A prospecting right (FS 30/5/1/1/2/608 PR) and three mining permits (FS/30/5/1/3/2/302MP, FS/30/5/1/3/2/303MP & FS/30/5/1/3/2/304MP) were granted in 2009. Small-scale sand mining occurred until Jan 2018 at which point the permits expired. The areas were rehabilitated and although some areas have not sufficiently recovered, aftercare and maintenance are underway.

4.9 REGIONAL CONTEXT

i. The application area is located in a rural environment, 20km from the nearest town. It is in the Free State Province, but the Gauteng and North West Provinces' borders come together on the northern side of the Vaal River. The community of Vaal Oewer is located directly across the river from the application area and are considered the largest neighbouring community group. Vaal Eden and Lindequesdrif are agricultural holdings, mostly occupying the riverside west of the application area. The southern and eastern borders are farmland with a low population density (Figure 18).

ii. Two existing sand mines are also operating at the time of the writing of this report, on either side of the application area (Figure 19). Du Pont 228 is operated by Sweet Sensations Vaal Sand (Pty) Ltd and Portion 4 of Woodlands 407 is operated by Tja Naledi Beafase Investments Holdings(Pty) Ltd. Signs of historic quarrying is noticeable to the south of the application area. Historic mining has also occurred in the application area, presumably in the form of borrow pits. Diamond exploration occurred in the 1920s all along the Vaal River as described by Marshall (2018)

iii. The main access road is the tarred S171 passing south of the application area, leading to a gravel road further west. This gravel road, locally referred to as the Vaal Eden road follows the rivers path until it reaches the R59 near the town of Parys.

iv. The Vaal River is considered a national water resource and is the second largest river in South Africa. It provides numerous functions of which water for domestic and agricultural use is considered the most prominent. Secondly, the tourism industry has latched on to the opportunity to utilise the river for various other functions such as water sports and waterside wedding and conference facilities. A small weir is located at the north western corner of Remaining Extent of Portion 1 of the farm Woodlands 407, which dams up the upstream part of the river. This has made the river more accessible for boating. Numerous fishing resorts and camp sites are also present along the river of which the Goosebay Canyon cabins and camping sites are located on the eastern border of the application area.

4.10 FUTURE PROPERTY DEVELOPMENT

i. The property was originally purchased (and is still owned) by Goosebay Farm (Pty) Ltd (previously Winners Point 117 (Pty) Ltd) to develop an eco-and wildlife estate (Figure 21 & Figure 22). Environmental authorisation for this development was granted in 2009 after which some progress was made in the development of the properties. Gravel roads were constructed, and the agricultural fields were prepared and fenced off as per the findings of a soil study (Figure 20). Boreholes were drilled and existing ones were rehabilitated. The numbers and health of the game on the farm are continually monitored and managed as an amenity on the property. This includes supplement feeding, pest control, culling, veld management and game fence maintenance. The town establishment is currently underway.

ii. Extensive research and site surveying have been conducted since the property was obtained by Goosebay Farm (Pty) Ltd. Planning and design of a future resort is currently underway in the area were the existing cabins and caravan park is located. A specialised game camp has been identified in the north eastern corner of Portion 3 of the farm Woodlands 407 and studies are underway to determine its feasibility.

iii. All the specialist studies that are conducted for the mining right EIA are supplementary to the planning of the eco-and wildlife estate. The rehabilitation objectives are also aligned to support the future development of the property.

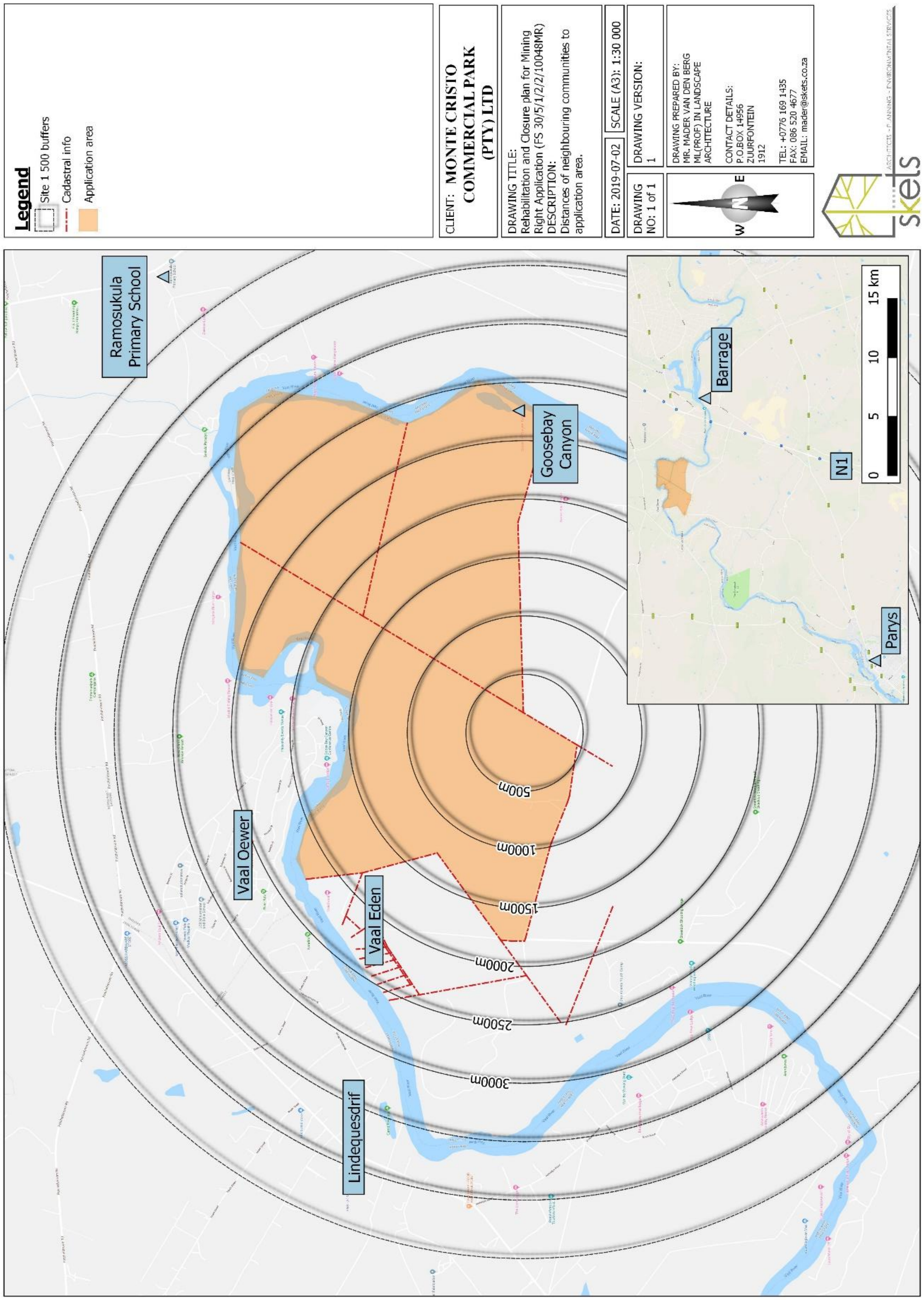


Figure 18: Neighbouring communities to the application area

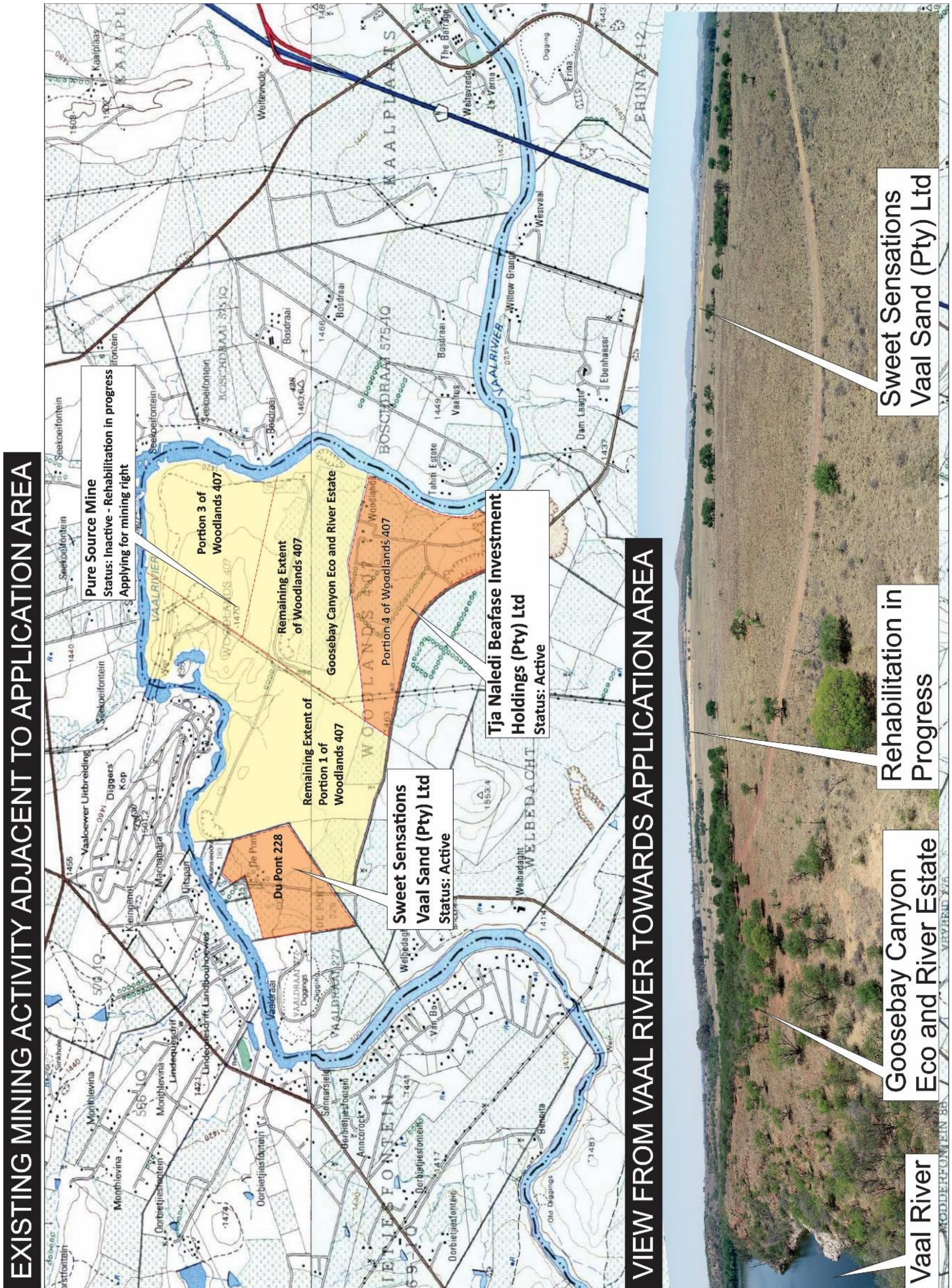


Figure 19: Existing mining activity on adjacent properties

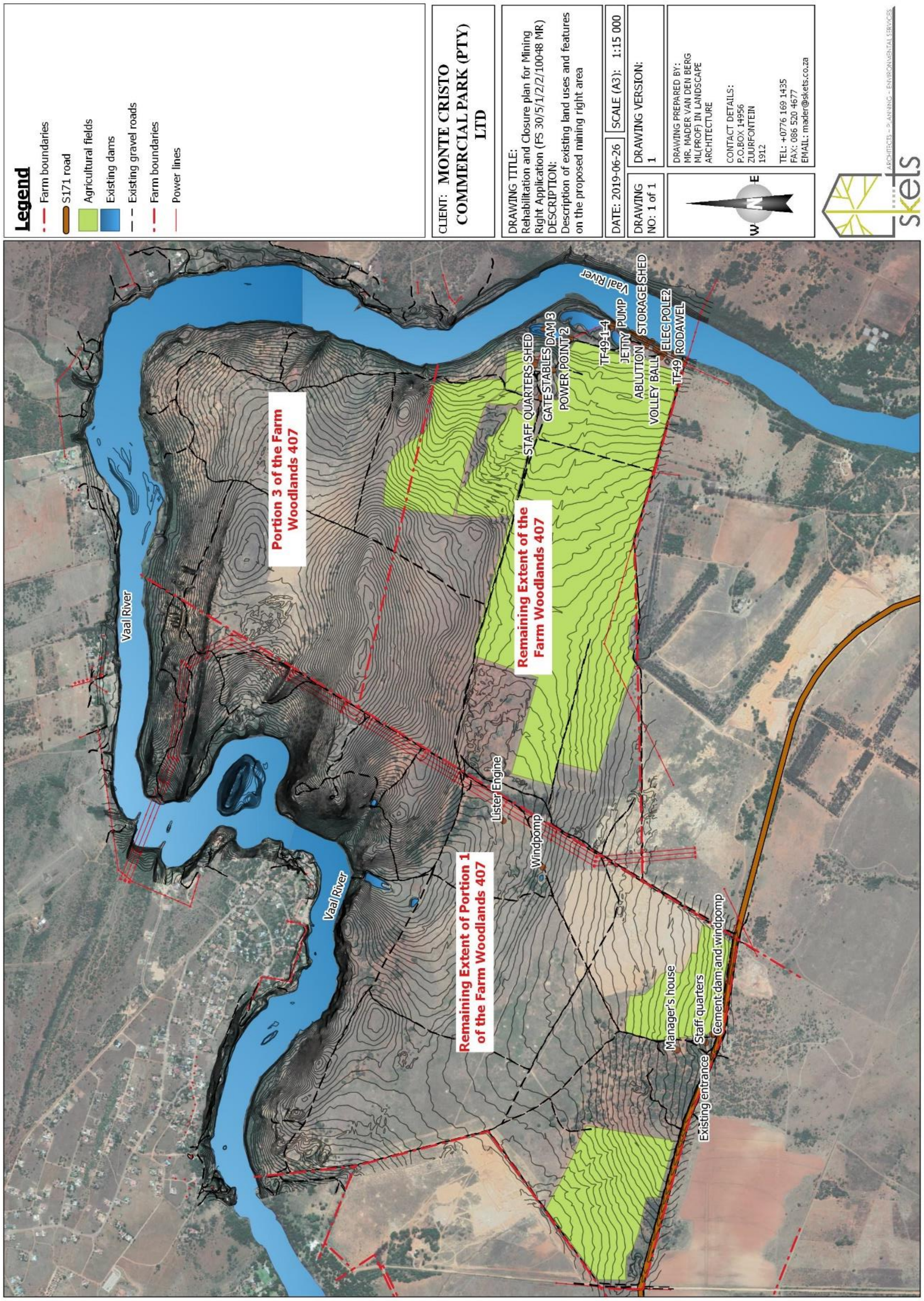


Figure 20: Existing land uses and features

Figure 21: Master plan (2008)

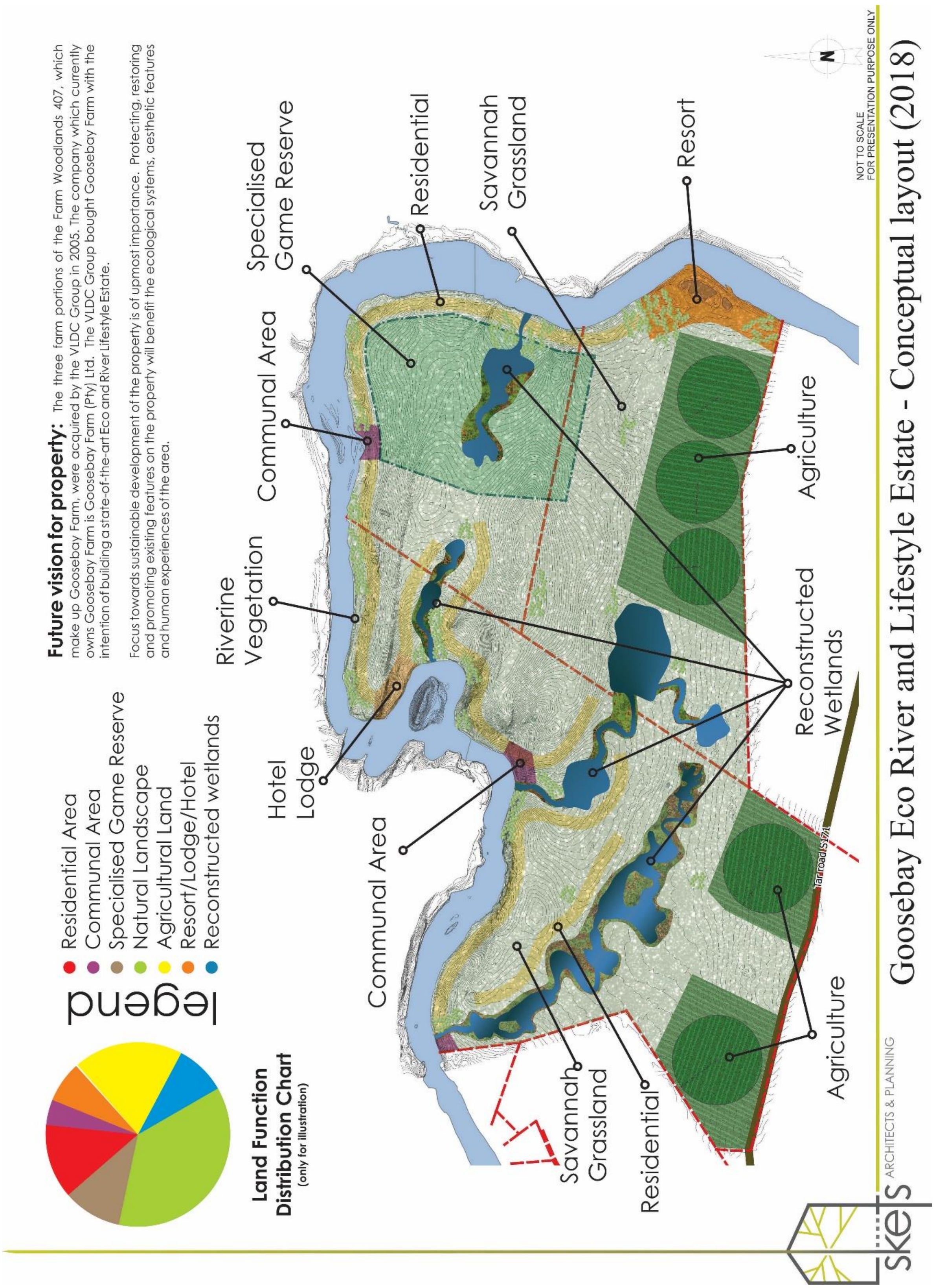


Figure 22: Conceptual Master plan 2018

5 MINING PLAN AND SCHEDULE

5.1 INTRODUCTION

i. The proposed lifetime of the mine is 30 years in which the main products to be mined include:

- Different grades of sand for construction, refractory, recreational and glass industries;
- Aggregates for civil construction industries, in particular G4-G7 aggregates; and
- Alluvial diamonds that may be present in the gravels under the sand deposit, or in other parts of the application area.

ii. An estimate for the sand and aggregate resources is summarised in Table 3. The location and quantity for alluvial diamonds have not been fully established at this stage, but has been substantiated by an expert opinion (Marshall, 2018). According to Marshall's report, alluvial diamonds may occur in the gravels under the sand resource.

iii. Sand mining and aggregate extraction will implement roll-over mining as conceptually illustrated in Figure 24 & Figure 25. This is considered economical and the most responsible use of topsoil as part of concurrent rehabilitation. This also reduces risks with regards to environmental impacts and risks.

5.2 MINING SCHEDULE AND PROCESSING

i. A preliminary mining plan is illustrated in Figure 27 & Figure 28 and shows the progression of the sand and aggregate mining. The average size of a sand pit that will be mined per year is approximately 6.9ha. The aggregate quarry will actively mine an average area of approximately 4.6ha per year. Therefore, an average total of approximately 11.5ha will be actively mined per year[1] (excluding diamond mining).

ii. Year 1 and 2 is considered the construction phase, although truck and shovel mining will commence in the areas illustrated in Figure 27. The sand in year 1 and 2 in the main deposit area, will be removed to prepare the area for the processing plant. The processing plant is required to beneficiate the silica content of the sand. It will consist of a wash plant and a drying plant, with ancillary components such as run-of-mine (ROM) stockpile, offices, workshop etc (Figure 30, Figure 31, Figure 32 & Figure 33).

iii. Aggregate mining requires a mobile crusher at or near the quarry. The aggregates will be sized before loaded onto customer's trucks. A process diagram is illustrated in Figure 34.

[1] Note that these figures are based on the total measured area divided by 30 years and is an approximation of the average.

iv. The in-pit (in-quarry) operations for sand and aggregate are conceptually illustrated in Figure 26. It indicates the possible location of haul roads, a control point which may consist of a temporary office and portable toilet as well as the in-pit stockpiles. The periphery of the pit should be protected with a safety barrier, which my consist of a fence or berm. If needed, a sump to dewater the pit/quarry shall also be installed.

v. Should diamond potential be established via exploration, the proposed extraction strategy is outlined in the following steps and illustrated in Figure 35:

vi. The overburden is removed – the topsoil will be stockpiled as per the current programme for the sand mining and the sand is excavated and diverted to the current sand mining operation.

vii. The basal gravel unit is screened – the oversize is sent back to any open excavation as rehabilitation infill, the -2 mm is forwarded to the sand mining operation and the +2-32 mm fraction are stockpiled as plant feed. Generally, a permanent screening plant is constructed in a central location or a mobile screen is used. As a sampling plant, a rotary pan plant is recommended. This plant is mobile, easy to operate and very accurate for sampling. The process contains no deleterious or toxic chemicals and has limited requirements on both, power and water quality/quantity. All of the plant's waste can be trucked directly back to open excavations as part of the backfill. Some of the fines can be used as a surface dressing, prior to the return of the stockpiled topsoil and the rest can be stored in a small fines residue dam, from which water can be recovered for circulation back to the plant.

viii. Should it be proven that the extraction of diamonds is economically viable, a larger more permanent plant may be erected. The following components may form part of it:

- At the plant site the screened gravel is fed into a scrubber plant to wash the gravels from clay particles;
- The concentrate from the scrubber will then be conveyored to a final recovery circuit comprising of a single-stage FlowSort X-ray recovery unit, followed by hand-sorting in a secure facility.

ix. The location of the rotary pan or processing plant will be at the diamond recovery site. The x-ray sorter's location has not been determined yet and will be a function of where the biggest potential for diamonds is.[2]

[2] Diamond recovery procedure as proposed by Marshall (2018)

Table 3: Resource estimate

Sand Resource Summary			
Pit	Resource Area (m^2)	Average Thickness (m)	Volume (m^3)
Main Pit Sand Resource	1 454 206	13,19	19 186 112
East Pit Sand Resource	226 488	3,54	801 768
North Pit Sand Resource	377 684	5,09	1 922 412
Total Measured	**2 058 378**	**10,64**	**21 910 291**
Aggregate Resource Summary (Fresh)			
Pit	Resource Area (m^2)	Average Thickness (m)	Volume (m^3)
Central Aggregate Resource	625 984	7,50	4 694 880
Southwest Aggregate Resource	13 882	7,50	104 115
Southeast Aggregate Resource	264 745	7,50	1 985 588
Northern Aggregate Resource	464 960	5,98	2 780 461
Subtotal	**1 369 571**	**6,98**	**9 565 043**
Aggregate Resource Summary (Oxidised)			
Pit	Resource Area (m^2)	Average Thickness (m)	Volume (m^3)
Central Aggregate Resource	625 984	0,58	363 071
Southwest Aggregate Resource	13 882	0,58	8 052
Southeast Aggregate Resource	264 745	0,58	153 552
Northern Aggregate Resource	464 960	0,88	409 165
Subtotal	**1 369 571**	**0,68**	**933 839**
Total Measured	**1 369 571**	**7,67**	**10 498 882**

5.3 STOCKPILES

5.3.1 TOPSOIL

i. The conservation of the topsoil layer, or cover soil, is essential for the long-term rehabilitation of disturbed areas. Topsoil is generally considered the top 300-500mm of the pre-mined surface material, unless otherwise determined on site. It serves as a suitable growth medium that sustains the existing plant growth and provides a habitat for macro- and micro-organisms. This layer is distinguished from the deeper horizons by the presence of organic material, air, roots and rhizomes, and provide a condition in which biological soil activity occurs.

ii. Long- and short-term storage of topsoil will be required. The topsoil that will be stripped from the plant area, haul roads or other permanent infrastructure shall be stockpiled for use at the end-of-life of the mine. Short-term stockpiling in the mining area may be required to improve the mining sequence. although a roll-over mining method will limit this.

iii. A suitable placement shall be determined in the case of long- and short-term stockpiling. The initial calculation determined a volume of approximately 80 000-

100 000 m³ long term stockpiling and approximately 40 000 – 60 000 m³ short-term stockpiling.

5.3.2 PRODUCT

i. Product stockpiles will be kept in two main areas, namely; in the individual pit or quarry, and at the processing plant. The fresh material that is being mined will be kept in the pit for the hauling equipment to collect as the processing plant requires it. Different types of resource may also be stockpiled on different piles to separate various grades of resources. This is considered an interim stockpile.

ii. A Run of Mine (RoM) stockpile area of approximately 8000m² is allocated in the plant area, specifically for the sand resource. This may also consist of several stockpiles to separate the various grades of sand. This area can accommodate approximately 48 000m³ if stored at 6m height.

iii. Gravel will be processed and screened in the quarries. The screening equipment already separates various sizes of gravel which will automatically be dumped on a stockpile and collected by haul trucks.

5.3.3 OVERBURDEN/WASTE MATERIAL

i. Overburden is considered the material between the topsoil layer and the resource that has no apparent value and needs to be removed, stockpiled and potentially backfilled after the resource is extracted. No overburden is expected in the mining of sand and aggregate, as the resource is directly under the topsoil layer.

ii. Overburden may be present during the mining of alluvial diamonds. As the diamonds are expected in the gravel layer below the sand deposit, the overburden is in affect the sand resource and may be mined as such. It may be that the quality of the sand above the diamondiferous layer is unsatisfactory and may be classified as overburden which will then be stockpiled and used as backfilling. The volume and therefore the stockpiling location and method can only be confirmed after the potential for diamonds are certain and the appropriate mining method is considered.

5.4 LONG TERM PROPERTY VISION AND INTEGRATION OF MINING ACTIVITY AND INFRASTRUCTURE

i. The mine’s closure strategy is greatly dictated by the long-term development vision for the three farm portions namely, the establishment of an eco-and wildlife estate. Mining is considered an interim land use and should be done in a sensitive and responsible manner in order to allow the development of the properties as conceptually illustrated in Figure 23. The mine’s closure vision is orientated towards the establishment of regenerative habitats that provides a suitable vegetation cover in support of the game on the farm and to the benefit of the natural environment.

ii. The conversion of mining infrastructure into the estate's planning is also considered. For example, the entrance road may be incorporated in the estate's layout as a contractor's entrance. This would be further addressed in Section 6.

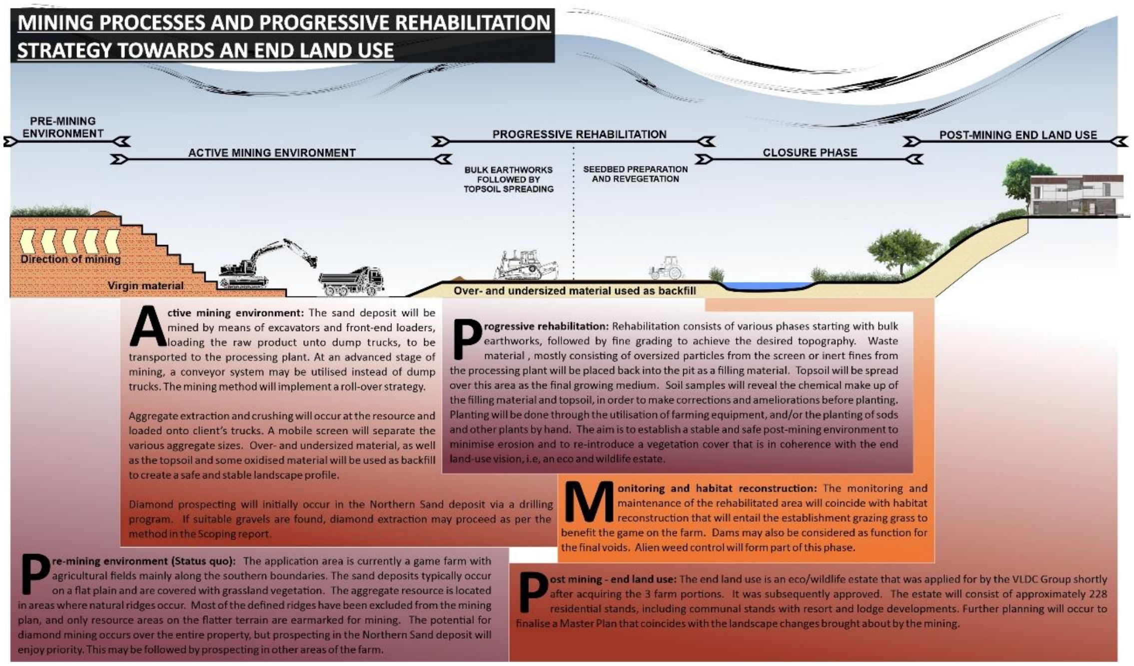


Figure 23: Mining processes and progressive rehabilitation strategy

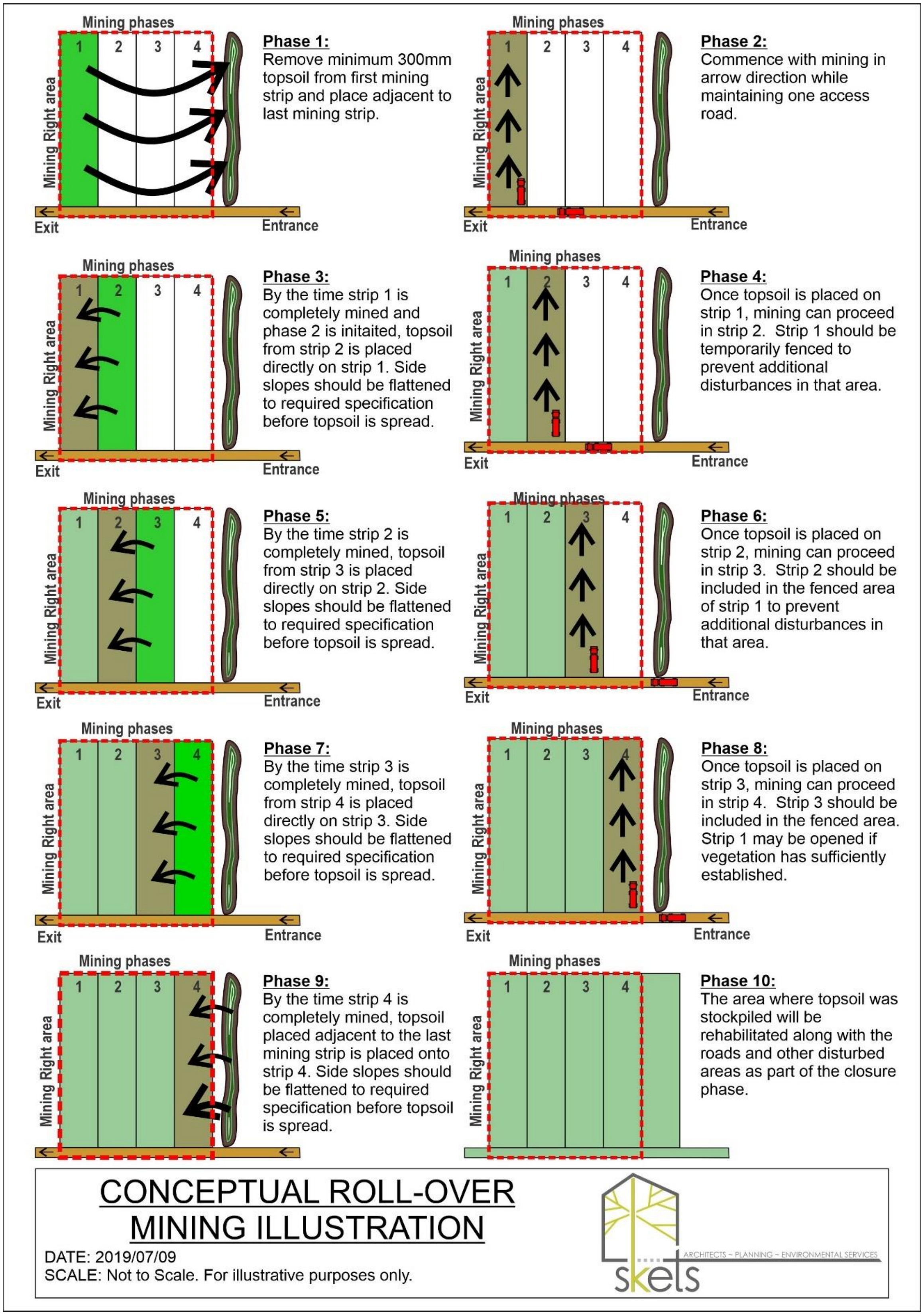


Figure 24: Conceptual roll-over mining procedure (1)

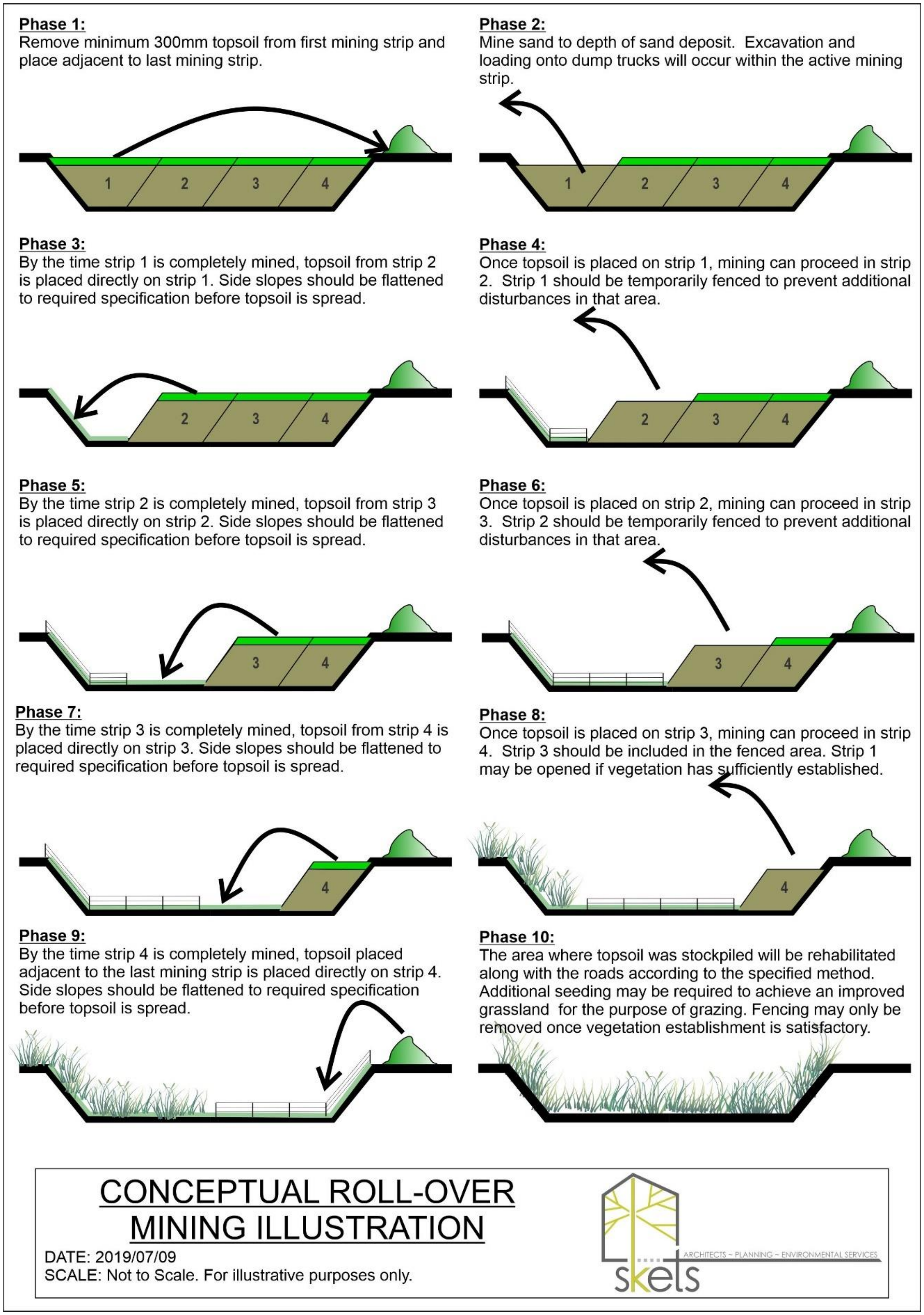


Figure 25: Conceptual roll over mining procedure (2)

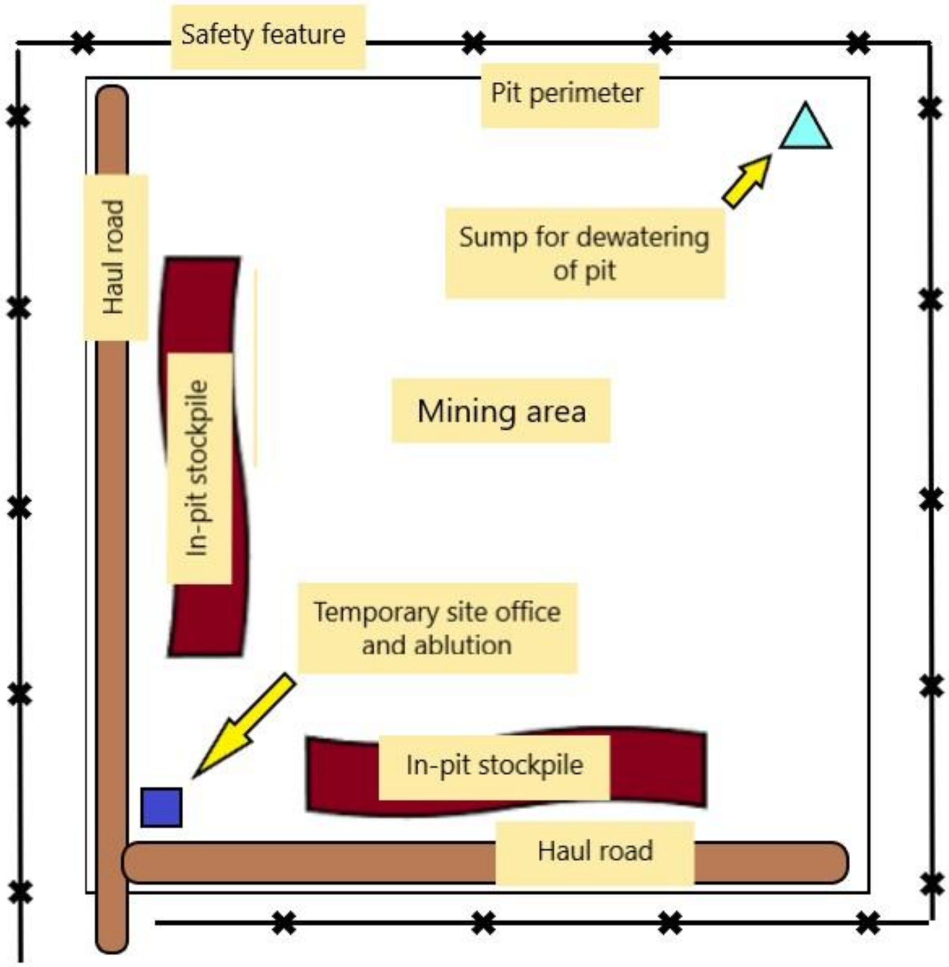


Figure 26: Conceptual in-pit operations

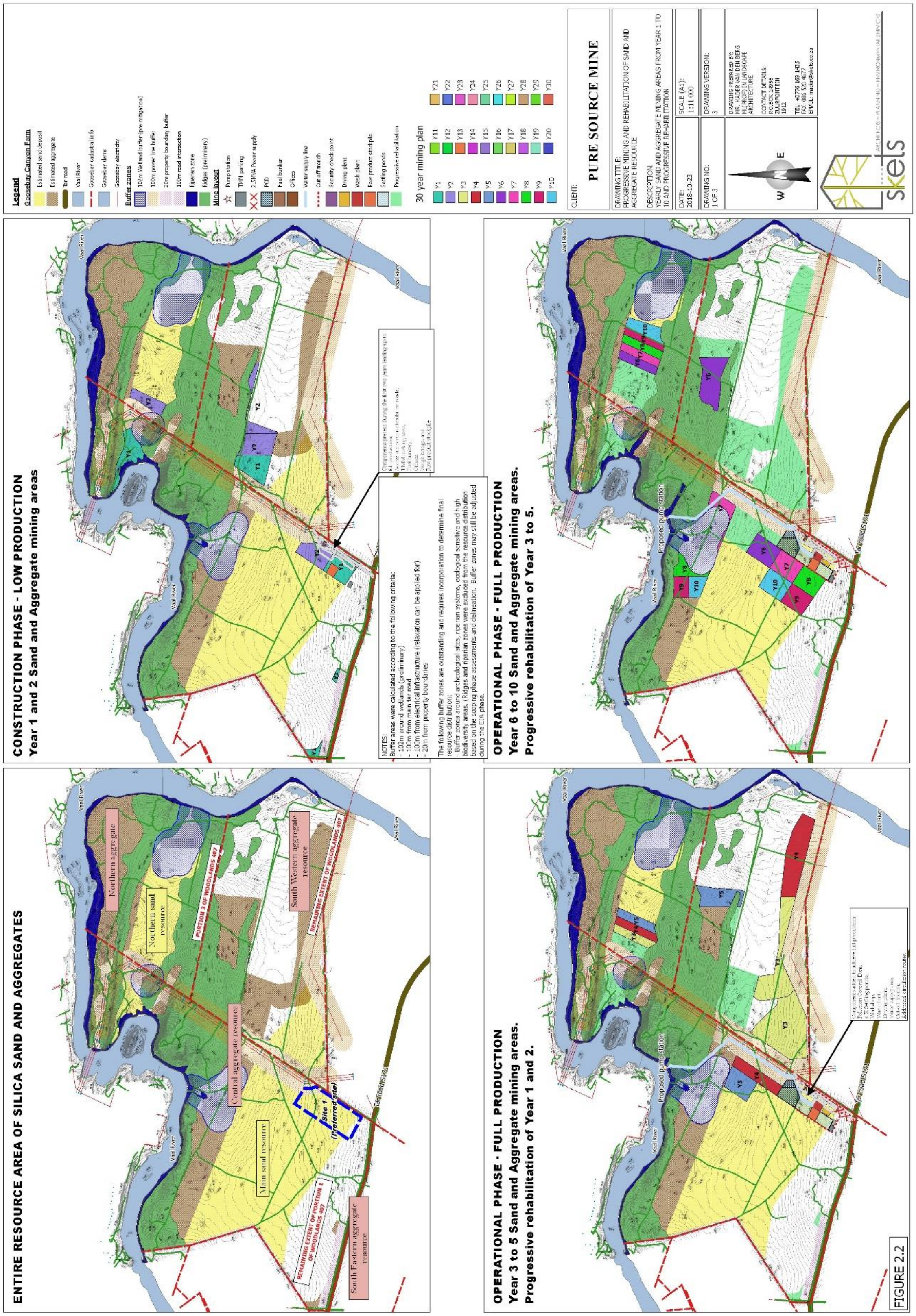


Figure 27: Mining Schedule (1)

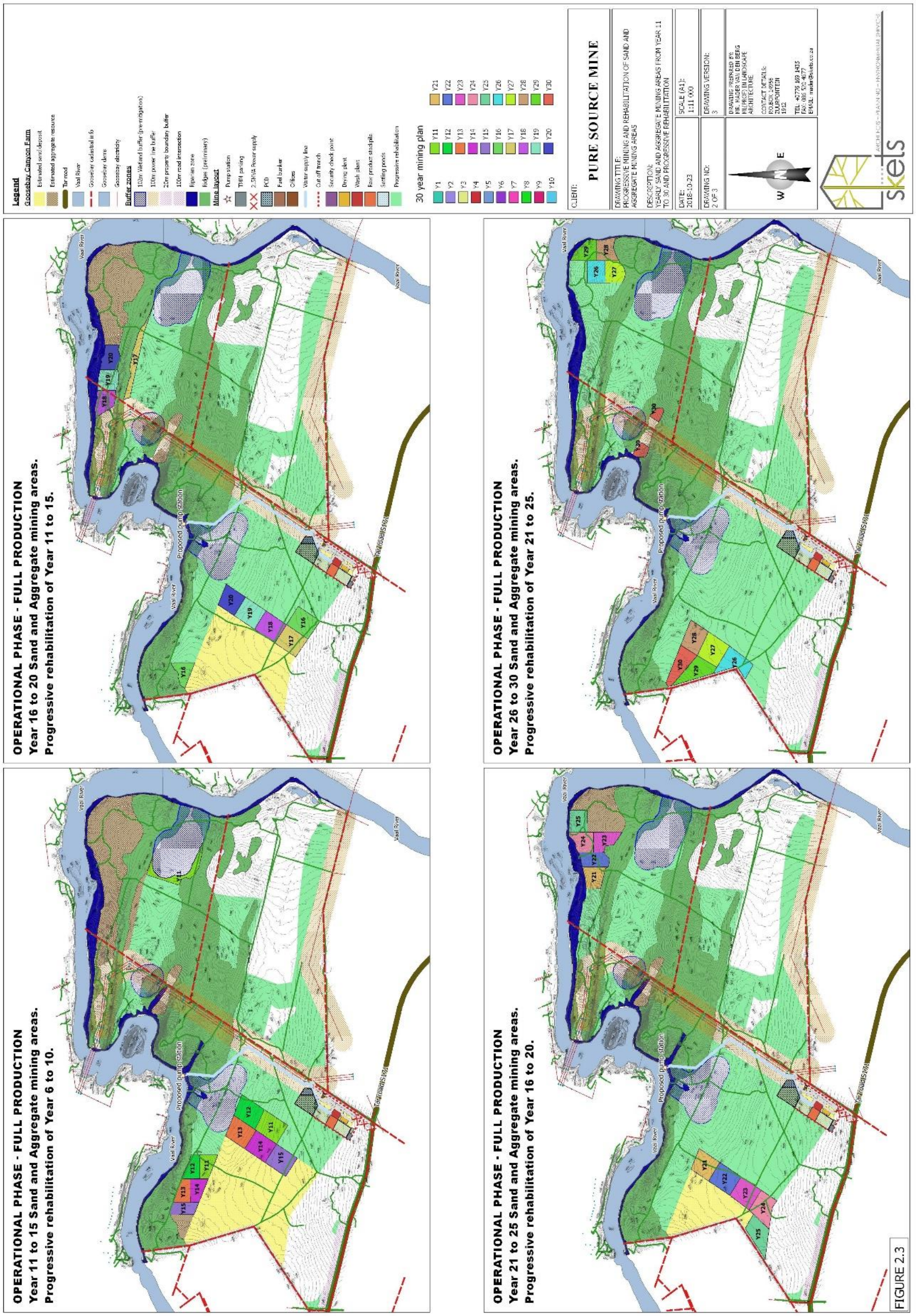


Figure 28: Mining Schedule (2)

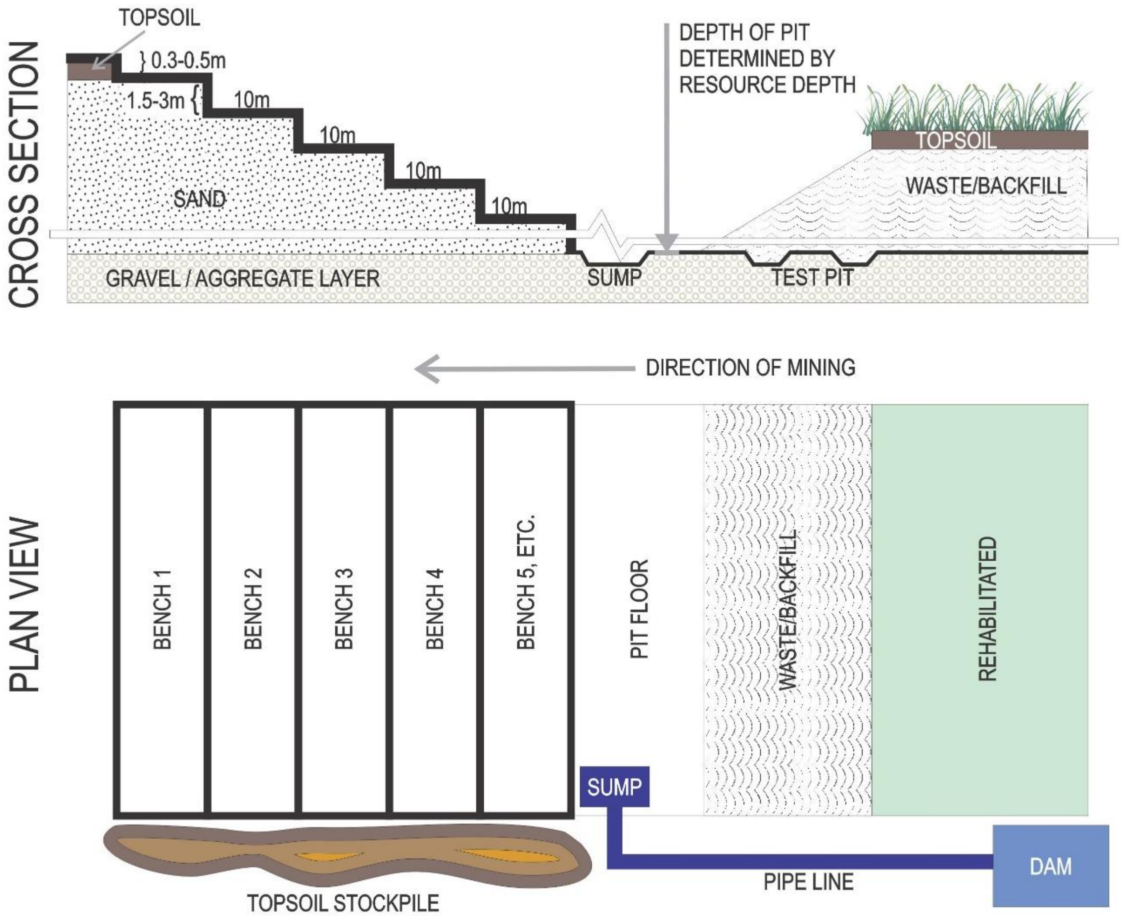


Figure 29: Diagram of yearly pit mining

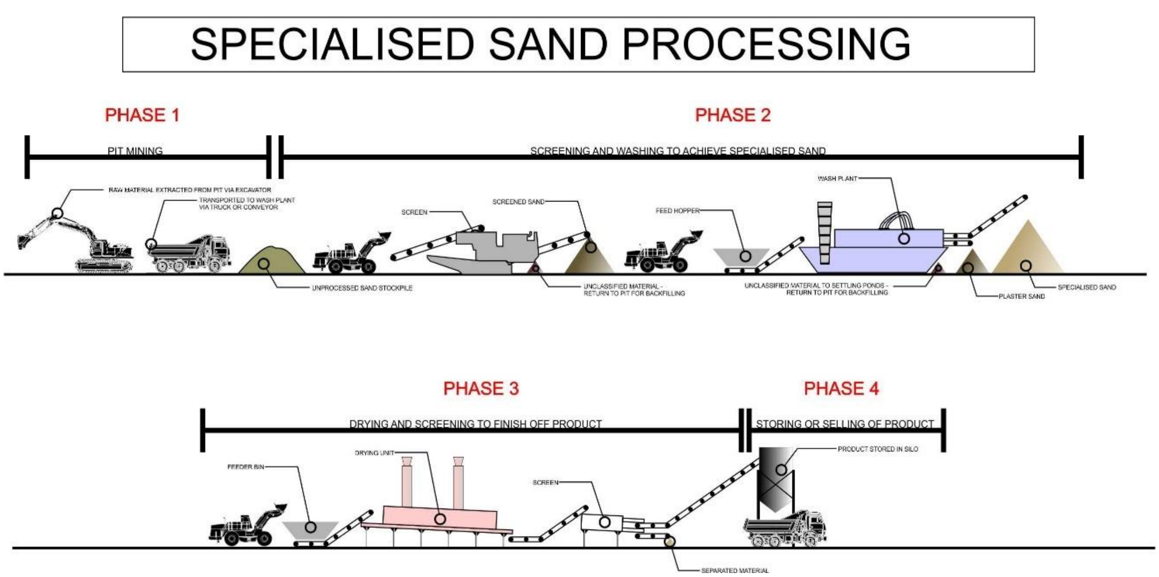


Figure 30: Specialised sand processing procedure

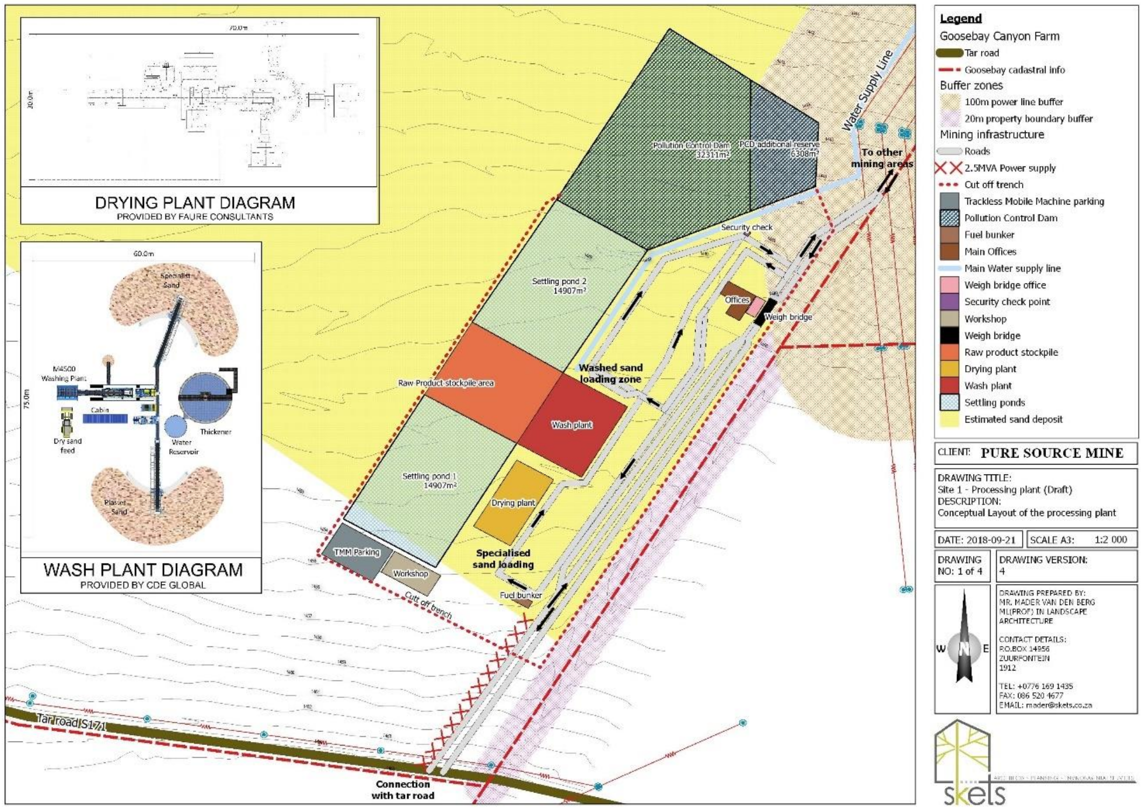


Figure 31: Conceptual layout plan of the processing plant on site 1

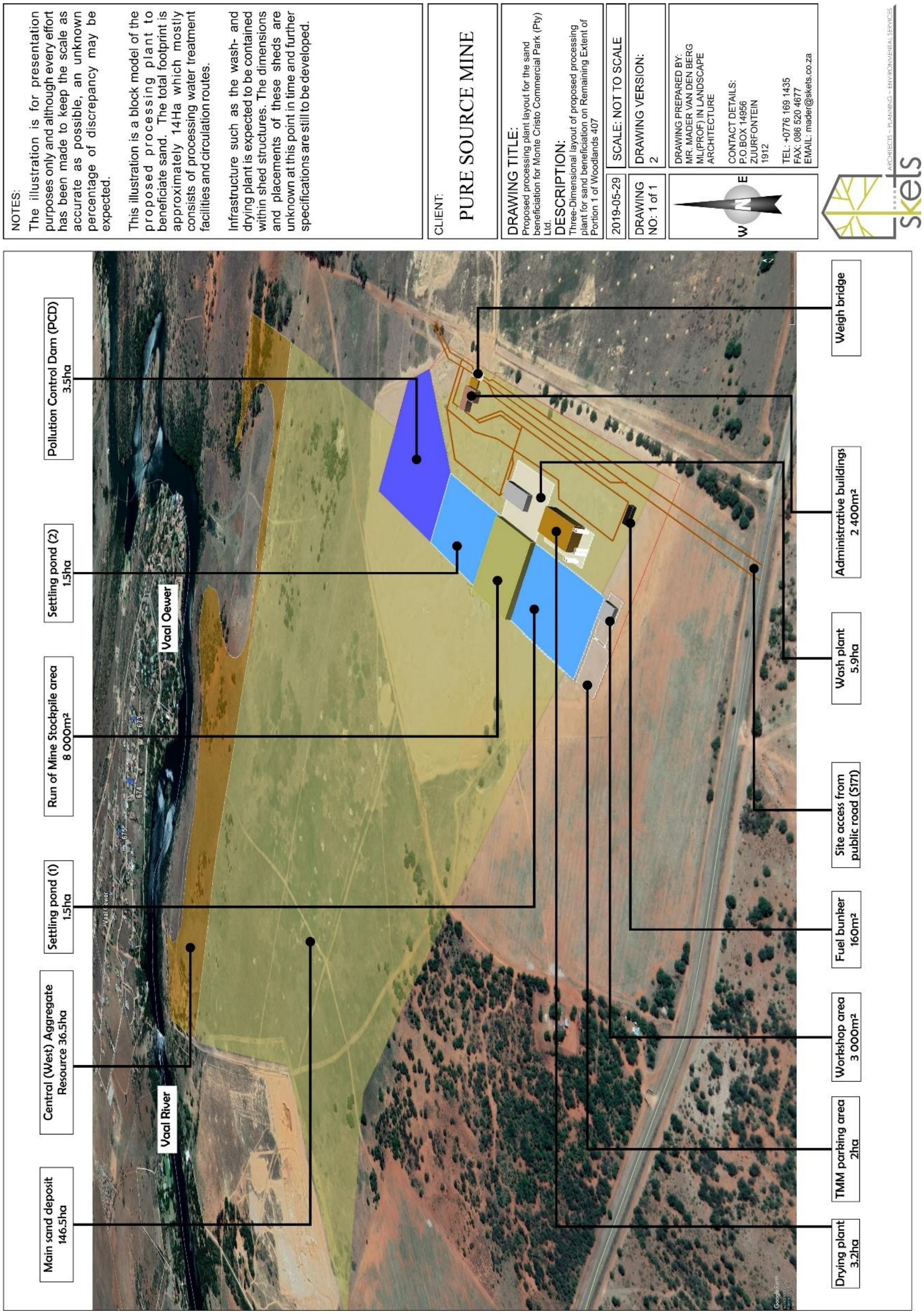


Figure 32: Conceptual illustration of the processing plant on site 1

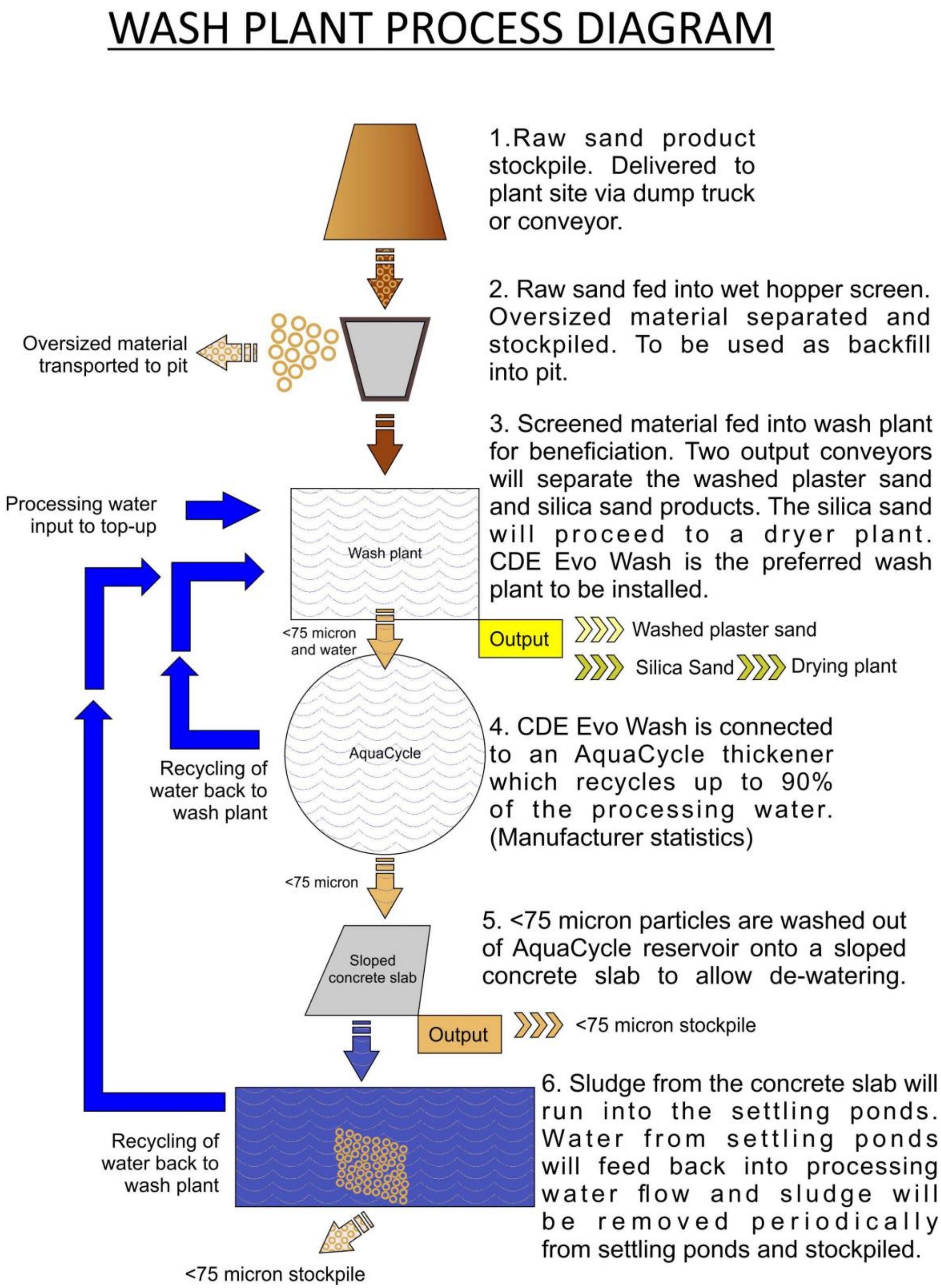


Figure 33: Wash plant process diagram

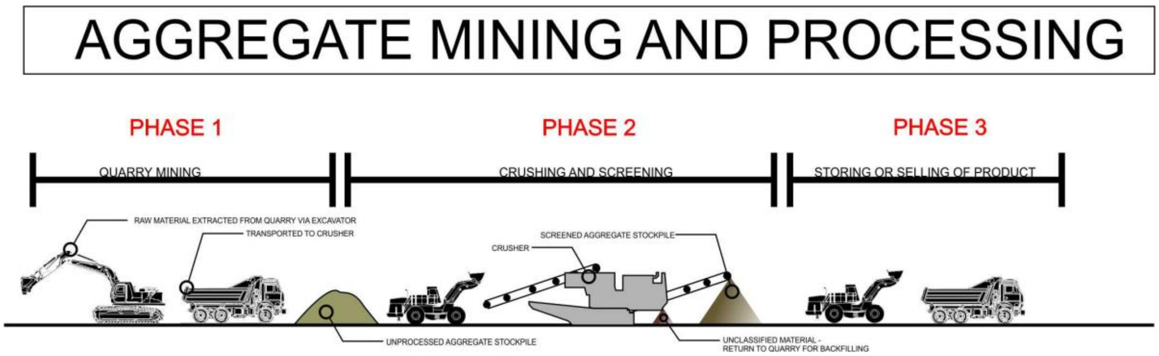


Figure 34: Aggregate mining and processing procedure

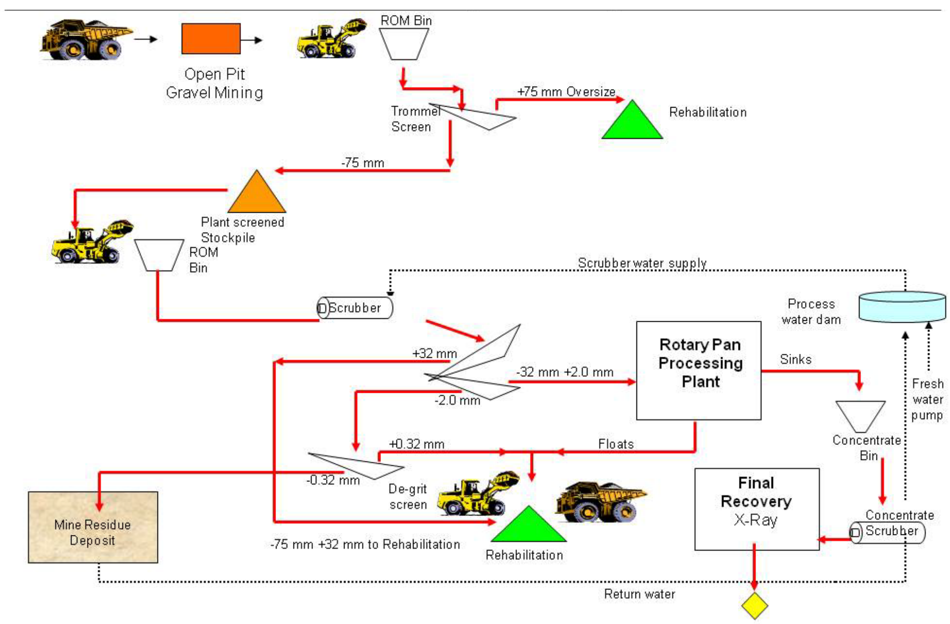
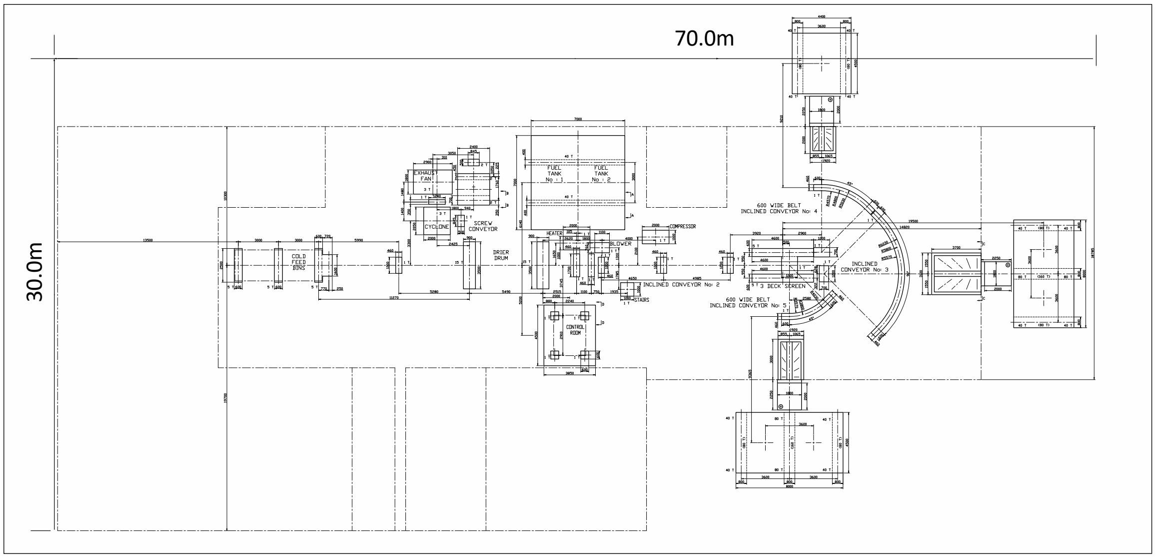


Figure 35: Diamond mining and processing procedure



DRYING PLANT DIAGRAM
PROVIDED BY FAURE CONSULTANTS

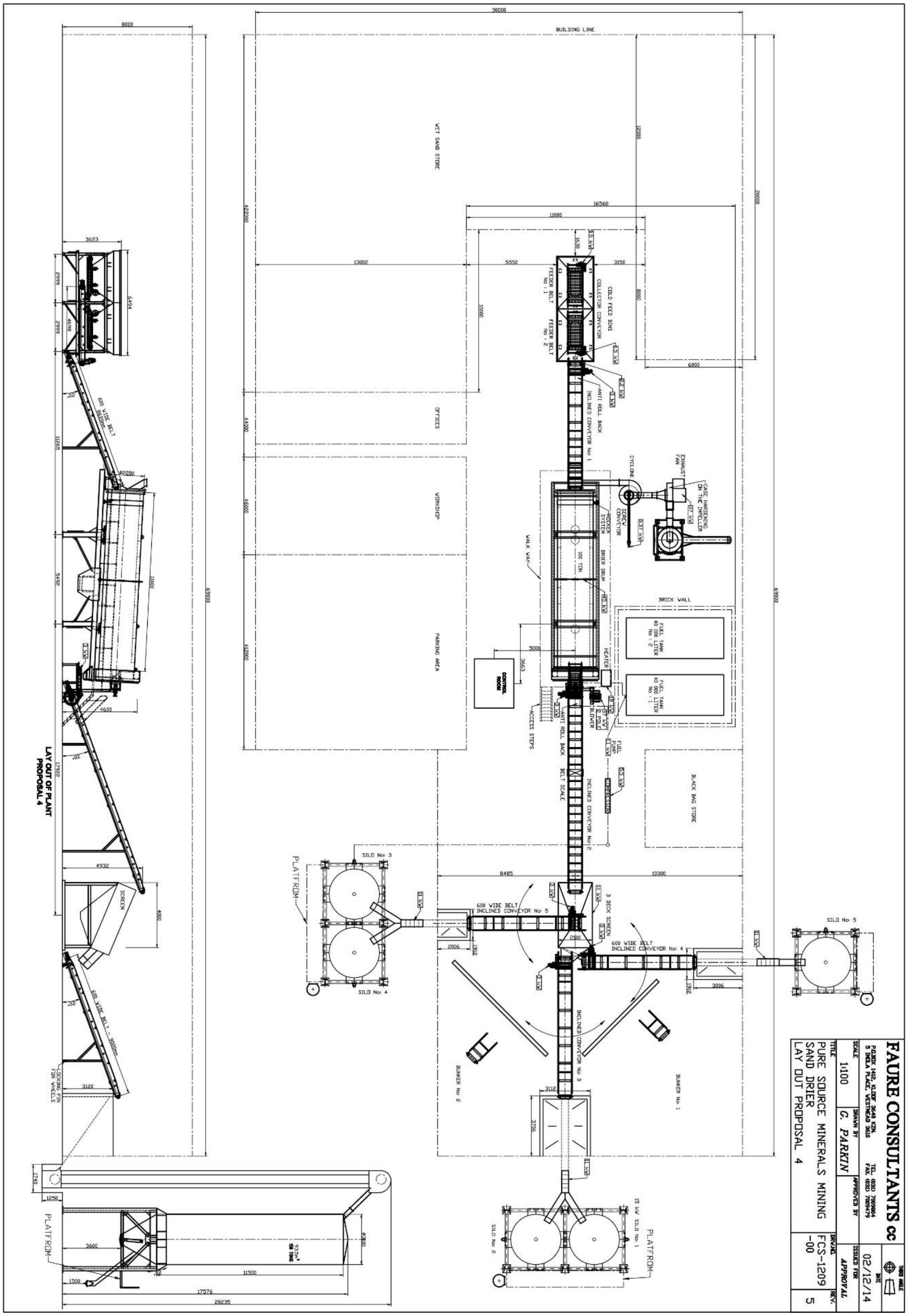


Figure 36: Typical layout of a rotary drying plant

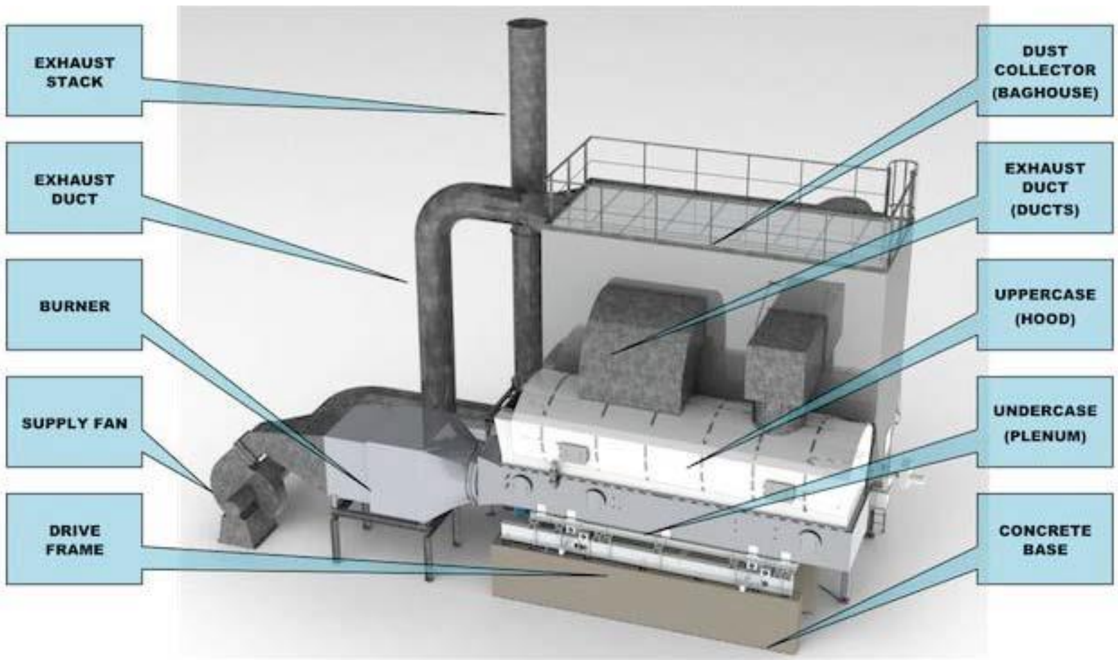


Figure 37: Schematic of a typical fluid bed sand drying unit

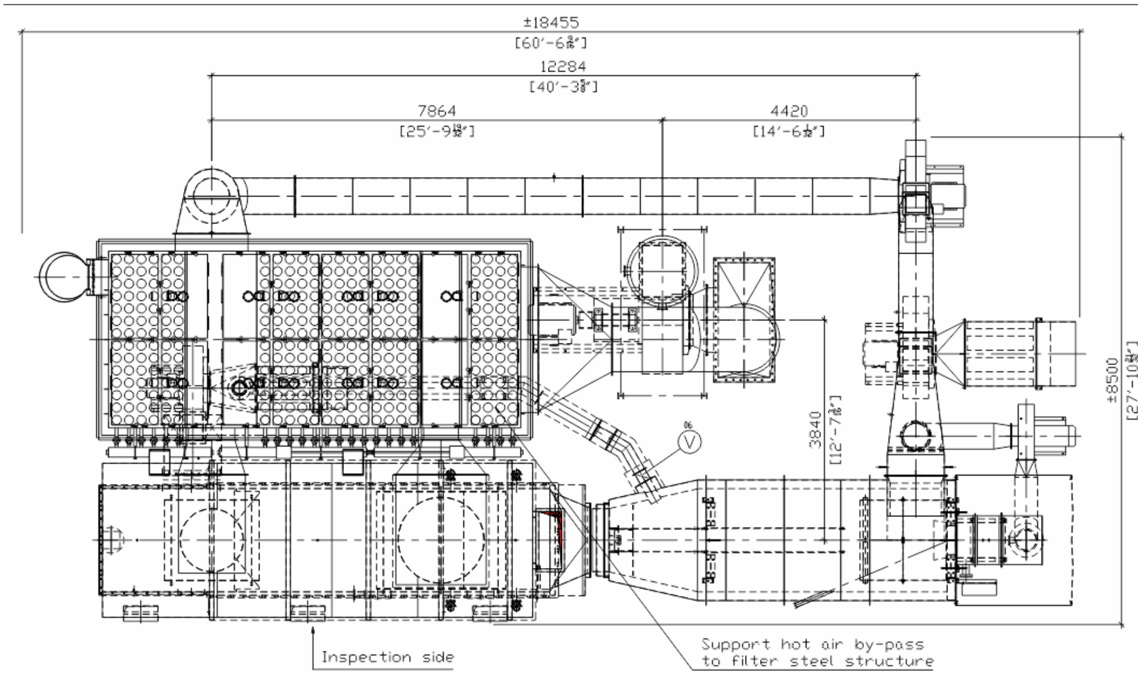


Figure 38: Plan view of a typical fluid bed sand drying unit

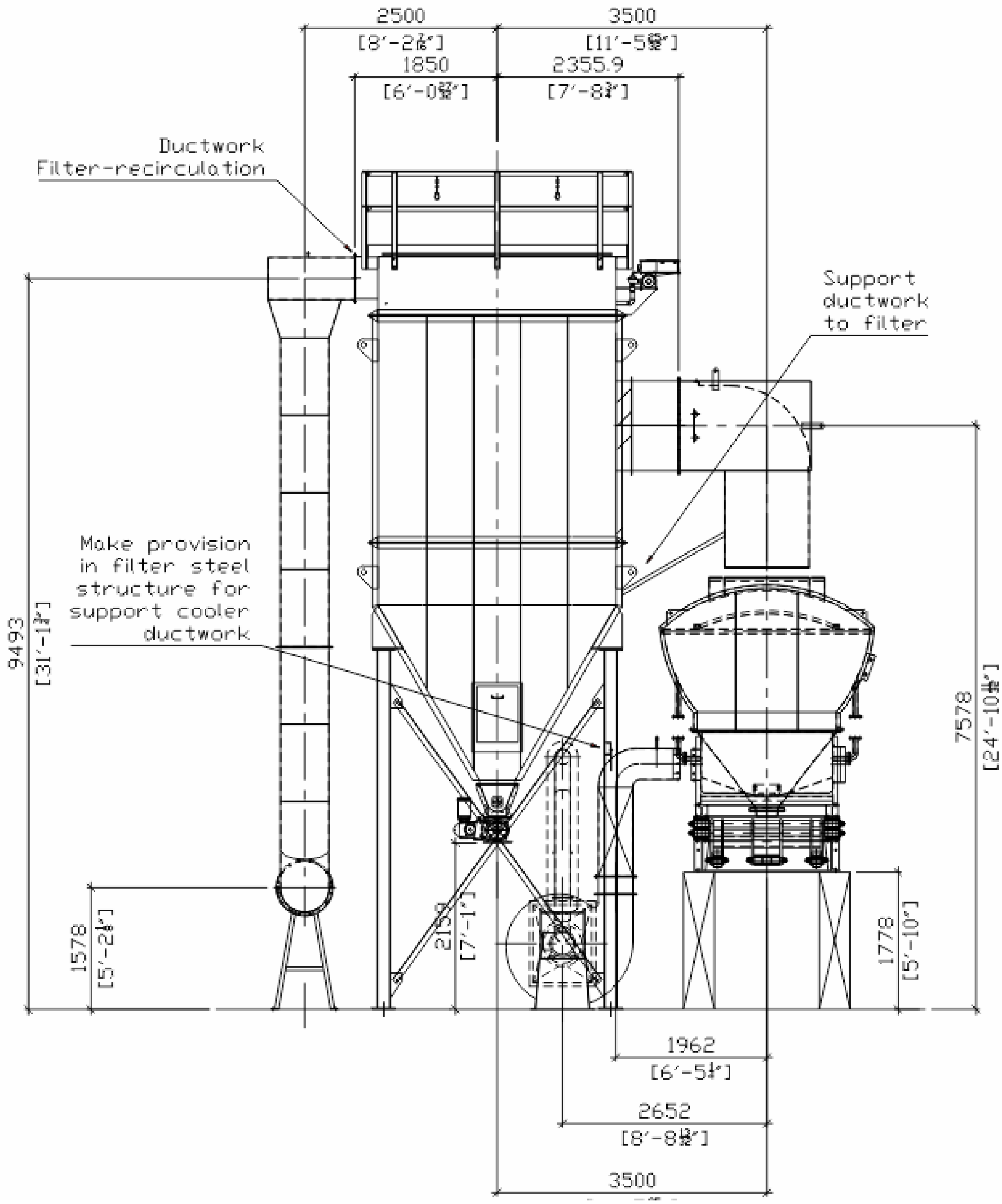


Figure 39: Typical elevation (1) of a fluid bed drying unit

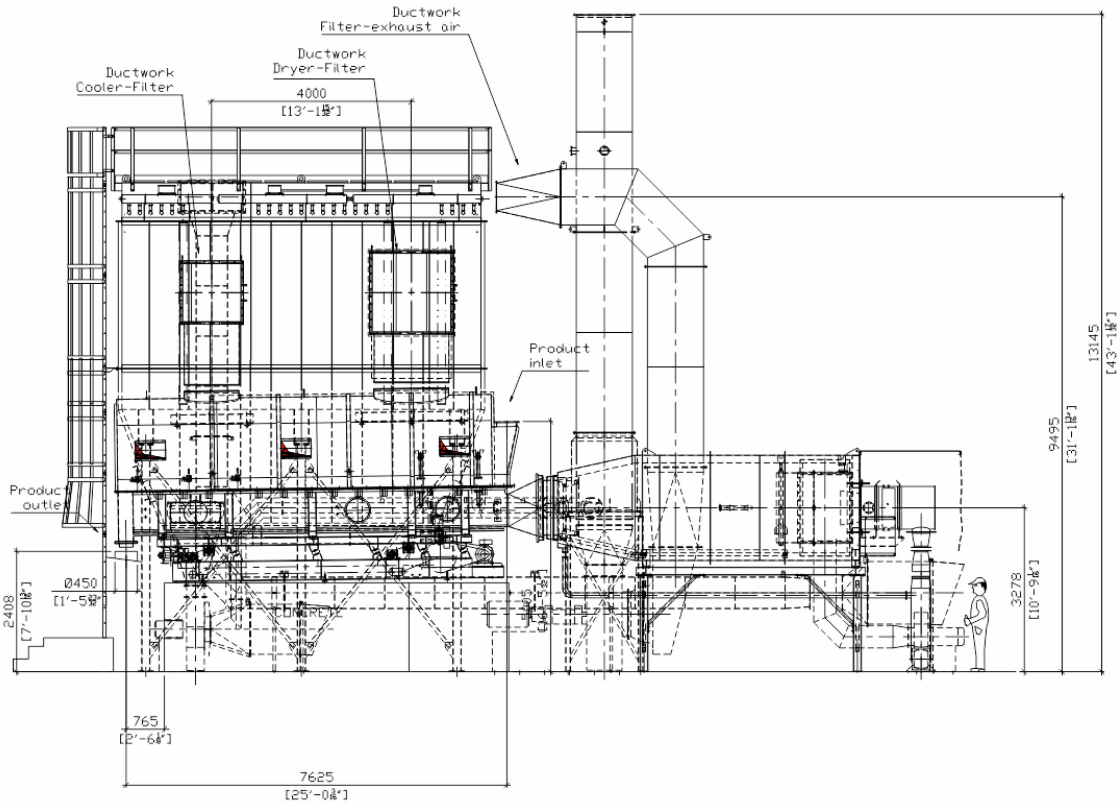
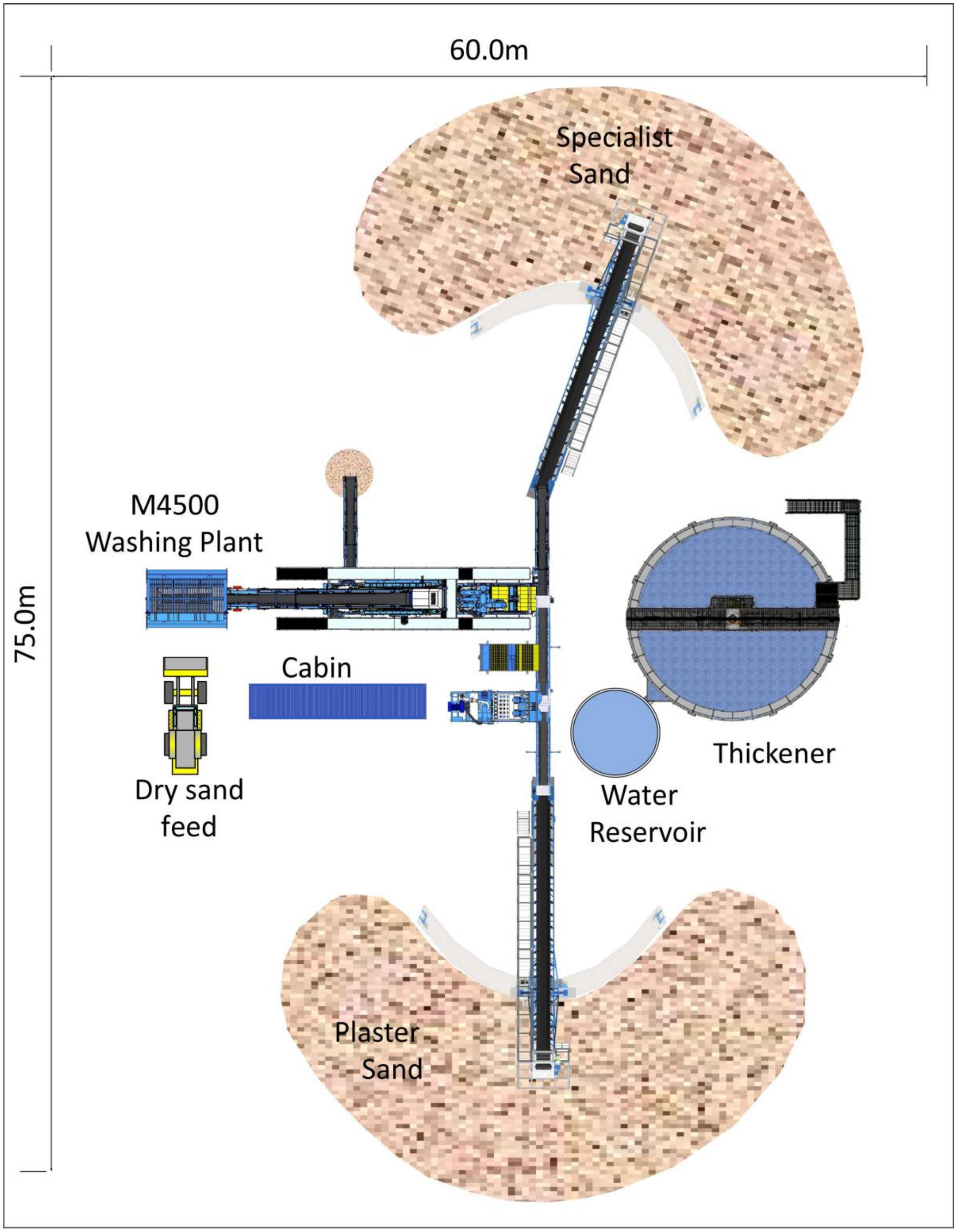


Figure 40: Typical elevation (2) of a fluid bed drying unit



WASH PLANT DIAGRAM

PROVIDED BY CDE GLOBAL

6 REHABILITATION AND CLOSURE DESIGN OBJECTIVES, TARGETS AND ACTIONS

6.1 INTRODUCTION

i. As part of the process of setting closure objectives and targets, one has to acknowledge that open cast mining is a transformative action that could potentially alter the surface conditions forever, or at least for an extended period. Objectives for mine closure should be appropriate, achievable and fit within a regulatory framework. As a minimum, four general rehabilitation goals should be achieved namely:

- The post mining landscape should be safe for humans and animals;
- The post mining landscape should be stable and offer substantial resistance to stresses and disturbances, for example erosion;
- Residual impacts, as a result of the mine, should not cause harm or pollute the environment in and around the mining footprint; and
- The post mining landscape should be able to sustain an agreed post-closure land use or restore pre-determined land capabilities.

ii. These overarching rehabilitation objectives provide a framework for rehabilitation targets. It does not automatically imply that complete restoration of the original pre-mining environment will occur, but it provides a reasonable basis for site-specific rehabilitation objectives and relinquishment criteria. These should also translate to an evaluation program for measuring the level of successes or failures, to be implemented as part of the monitoring phase. The ability to specify closure objectives is dependent on the accuracy and quality of both the environmental data collected at the time and the available engineering information. Assumptions and limitations are discussed in Section 3.

iii. The specific objectives and targets to be achieved are directly related to the attainment of the post-mining land-use objective. Specific rehabilitation objectives for each domain (project components or issues) will be developed in the following sections.

6.2 REHABILITATION HIERARCHY

i. In assessing the level of the proposed rehabilitation objectives, one can evaluate each objective according to the rehabilitation hierarchy (adopted from the Queensland Government: Department of Environment and Science (2014)).

ii. The rehabilitation hierarchy describes different levels of rehabilitation from a *do-nothing* approach, to an *avoid-any-disturbance* approach. The avoidance scenario had been explored extensively during the mine design phase, and it resulted in partially protecting certain sensitive areas, however certain activities within these sensitive areas are simply unavoidable if feasible mining were to take place.

Therefore, the next level of rehabilitation should be explored which involves the attempt to restore the ecosystem/s and reinstate certain functions and ecosystem services.

iii. It is acknowledged that the proposed mining activity will transform many of the biophysical characteristics of the landscape at a local scale. The most noteworthy will be the topography which will alter the surface hydrology, soils and vegetation for example. Backfilling and profiling will be implemented, but voids will remain due to the removal of material. Such mining activities will result in a permanent rearrangement of some biophysical elements.

iv. If restoration is clearly not an achievable objective, the following strategies should be explored which entail development of an alternative land-use or land cover with increased land capability or merely the re-vegetation of the disturbed area in order to achieve some form of surface coverage and stability.

v. Fully restoring the entire disturbed area's biophysical elements as a closure strategy is not considered practically achievable, mainly due to the permanently altered topography over most of the mining site. Partial reinstatement of an altered biophysical scenario can be accomplished through careful mine planning/design, with closure in mind. The success of this closure strategy can only be accurately assessed during a detailed monitoring period.

vi. The last two options in the rehabilitation hierarchy should be avoided at all cost as this does not comply with environmental legislation and exaggerated risks may accumulate to catastrophic scenarios.

vii. The conceptual closure strategy recognises a holistic approach to management and monitoring of all the phases of the mine. Closure is considered the longest phase and should therefore receive a fair level of acknowledgment. This conceptual closure strategy does not exclude future changes in its approach to echo advancements in knowledge, skill or technology.

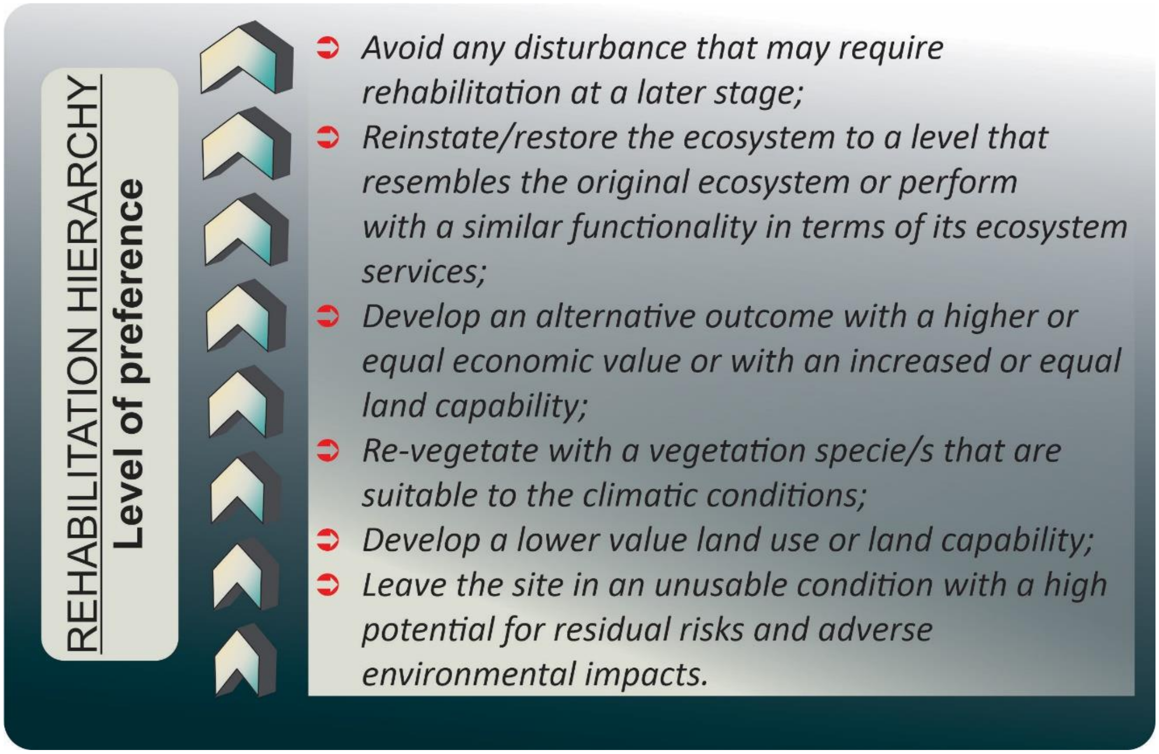


Figure 41: Rehabilitation hierarchy

6.3 LEGISLATIVE FRAMEWORK

- Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996) and common law;
- National Environmental Management Act (Act 107 of 1998), as amended;
- Mineral and Petroleum Resources Development Act (Act 28 of 2002): Mineral and Petroleum Resources Development Regulations (2004);
- International Finance Corporation (IFC) Environmental, Health and Safety (EHS) guidelines;
- Mineral and Petroleum Resources Development Act (Act 28 of 2002);
- Amendment Bill of 2007;
- National Water Act (Act 36 of 1998);
- National Environmental Management: Waste Act 2008 (Act No. 59 of 2008), as amended;
- National Environmental Management: Biodiversity (NEMBA) Act 10 of 2004;
- Mine Health and Safety Act (Act 29 of 1996);
- National Environmental Management: Air Quality Act (Act 39 of 2004);
- National Heritage Resources Act (Act 25 of 1999); and

- Conservation Agricultural Resources Act (Act 43 of 1983).

6.4 SAND, AGGREGATES AND ALLUVIAL DIAMOND MINING

i. For the purpose of rehabilitating the pits and quarries, a distinction is made between structural- and functional rehabilitation. The term *structural rehabilitation* refers to the shaping of the pit or quarry to recreate a final landform that is tailored to its post-closure function. This may include the filling of deep pits, sloping the side angles to stable gradients and fine grading to achieve the final landform. *Functional rehabilitation* includes seed-bed preparation, soil amelioration, re-vegetation via seeding or hand planting, bio-engineering for erosion control and alien invasive control.

ii. The four most basic closure objectives were identified in Section 6.1, but more site specific objectives are required. These are further explored in the following sections under the topics of structural and functional rehabilitation targets.

6.4.1 LANDFORM DESIGN

6.4.1.1 Topsoil management

i. The topsoil or A horizon is considered the top 300-500mm layer of the pre-mining soils. This layer normally consists of higher contents of organic matter, a seed bank and rhizomes of the native plant species (Figure 42 Source: New Hope Group (2014)).

ii. In this particular context, the A horizon in the sand deposit areas is considered a homogenous sandy/clay material of the Clovelly soil form and can be easily stripped with a dozer and pushed onto a stockpile or transported. Minimal stockpiling of the A horizon is expected if roll-over mining is implemented correctly. There is however a need for stockpiling of the first phase mining as illustrated in Figure 24 & Figure 25 to be placed at the last phase. Other areas that should be stripped and stockpiled are the processing plant footprint as well as new roads.

iii. The A horizon of the aggregate areas are typically of the Oakleaf or Glenrosa soil forms. Stripping with a dozer is the optimal way of clearing an area before mining occurs. According to roll-over mining principles, topsoil will be spread directly unto the previous year’s mining area as part of concurrent rehabilitation. As discussed above, some stockpiling is expected to occur from the first phase to be applied to a later phase.

iv. Topsoil stockpiles shall be kept to a maximum height of 2m and a maximum flat surface area, consistent with the available storage area. A greater number of low mounds are preferred, as oppose to a larger and higher dump. Long-term stockpiling, i.e. exceeding 1 year, shall be revegetated to minimise soil loss and retain quality. Caution should be taken not to unnecessarily compact the topsoil stockpile by driving over it with heavy machinery. Final shaping should rather be done with tlb or excavator instead of a dozer.

v. Topsoil stockpiles should adhere to an s-profile slope configuration (Figure 43) in order to minimise erosion and support a resilient vegetation cover.

vi. Topsoil stockpiles shall be marked with a signpost for easy identification and to avoid accidental disturbance or contamination with other materials.

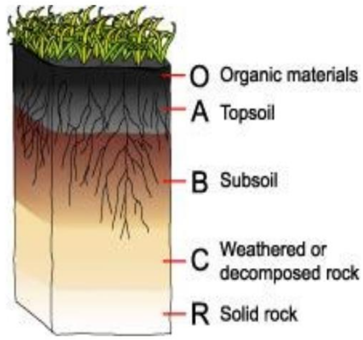


Figure 42: Soil profiles

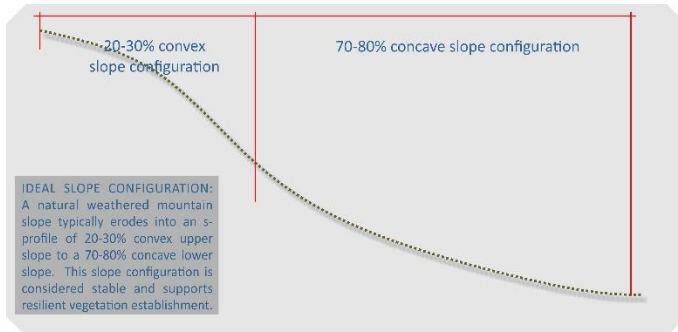


Figure 43: S-profile slope configuration

vii. The approximate volume of long-term and short-term stockpiling is addressed in Section 5.3.1. It is recommended that a detailed topsoil management plan should be developed when information such as locations and volumes have been established.

6.4.1.2 Pit and quarry landform design

i. The depth of the pits and quarries will vary as the resource depth varies across the resource areas. It has been estimated that the sand is an average of 10-12m deep, and aggregates approximately 6m deep. The depth of the diamondiferous gravel under the sand, is undetermined at this stage.

ii. It is expected that the perimeter of the pits and quarries will be left as benches at the end of the resource. This should be rehabilitated to an S-profile by first placing the over- and undersized material that was screened out from the sand and aggregates, and then capping it with the topsoil that is stripped from the next phase (Figure 44).

iii. The processing of the diamondiferous gravels will yield large volumes of over- and undersized material that can all be placed back into the pit, before being capped with the topsoil from the next phase.

iv. Maximum gradients for the sand pits are recommended to be 18°- 20° (1:3) or less, as the topsoil has a high erodibility due to its sandy content. Vegetation establishment will be inhibited if erosion occurs, which is also a sign of instability. Maximum gradients for the aggregate quarries are recommended to be 27°- 25° (1:2) or less.

v. A maximum 5m slope length is allowed for gradients steeper than 25°. In the event where the slope length exceeds 5m, a 1-2m bench shall be constructed. No slopes greater than 27° shall remain in the mining area unless alternative, permanent slope stabilisation methods are implemented.

vi. An S-shaped slope profile is highly recommended for benched slopes. It consists of a 20-30% convex shape at the top, leading into a 70-80% concave profile in the bottom.

This profile has been derived from stable natural landforms and are also considered visually appealing.

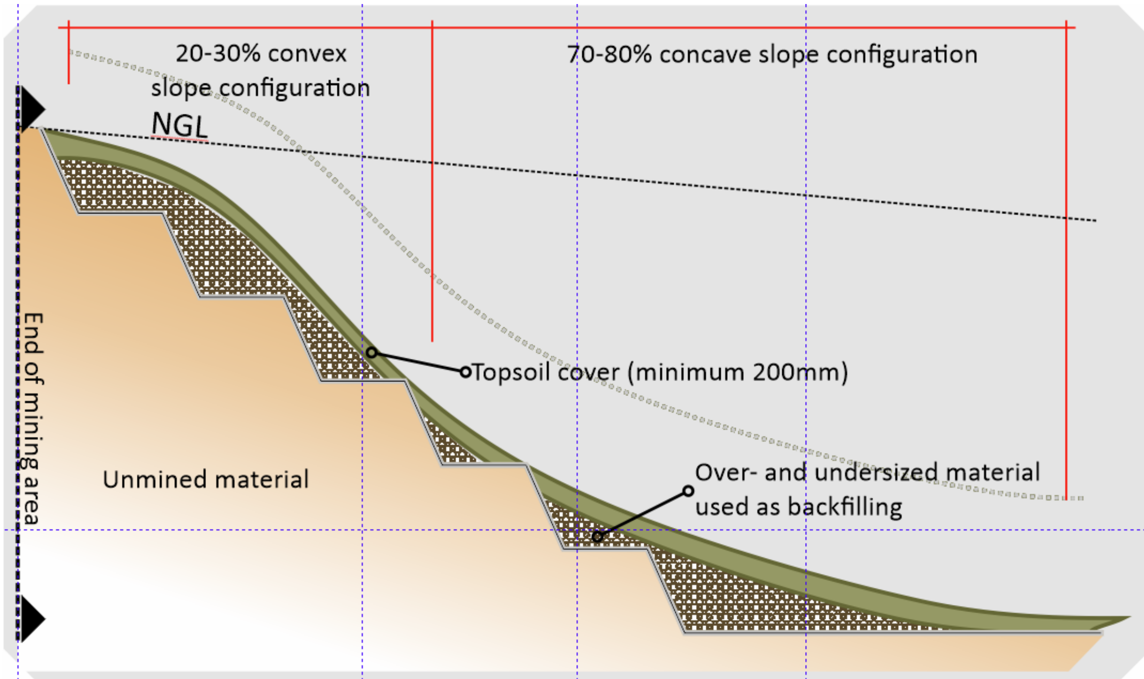


Figure 44: Ideal slope profile over benched face

vii. No open pits, trenches or holes shall remain in the mining areas. Backfill with available material and adhere to maximum gradients as described above. The pit and quarry floors shall be evenly sloped with undulations in a manner that does not create depressions where stagnant water can accumulate. As a basic principle, surface water should be free draining unless collection points are identified that forms part of the post-closure landscape.

6.4.2 SURFACE HYDROLOGY

i. As mentioned above, surface water should be free draining, with the exception of intentionally collecting water in dams or temporary storage in retention facilities. Parts of the final void may be converted into a series of retention facilities or storage dams, subjected to an authorised water use licence. Dams should be designed according to safety legislation published in Government Notice R.139 of 24 February 2012 that applies to dams that have a dam wall greater than 5m and have a storage capacity exceeding 50 000m^3.

ii. A water collection point has been identified in the location of the old gravel pit which will be mined in the first two years after which it will be converted into a dam (capacity still to be determined). This is considered an option for collecting surface water run-off from the south and north as part of the integrated surface hydrology management of the application area and for the future eco and wildlife estate (Figure 45).

iii. Other water collection points may also be required but further monitoring and analysis of the ground water and surface water is required. Preliminary planning of the eco and wildlife estate has suggested a conceptual scenario as indicated in Figure 22.

6.4.3 SOIL REHABILITATION

i. The author was involved with the rehabilitation of the mining permit areas and gained first-hand experience in the handling of topsoil for rehabilitation purposes. One of the first aspects that was noted, was that the existing grass cover that is growing on the mining areas, are a valuable source of biomass and seeds and should be cut and collected prior to the stripping of the topsoil. This can be raked together and baled for later use as described below.

ii. It is paramount that the stripping of the topsoil is done precisely to avoid mixing it with the plaster sand below the A horizon. This can be determined with a hand auger by drilling sampling holes at a sufficient grid density over the area that will be stripped. A dozer or grader can be used to strip the topsoil layer and push it unto the adjacent area that was previously mined as part of the roll-over mining method. At this time, it is assumed that the side gradients and pit floor have been correctly contoured by backfilling it with over-and undersized material.

iii. A soil test should be done to confirm the nutrient content as well as pH balance, etc., in order to establish the required amelioration by means of inorganic/organic supplements. From the rehabilitation of the mining permits, it was often noticed that agricultural lime had to be added as well as organic material. This is where the grass cuttings from the pre-mining areas, are extremely valuable. By spreading the grass cuttings over the newly laid topsoil, it benefits in the following ways:

- It covers the exposed topsoil and limits wind erosion and rain splash erosion of the surface particles, especially on the slopes;
- It retains moisture levels by limiting evaporation, thereby supporting vegetation growth;
- It adds organic matter to the top layer that will decompose over time, releasing nutrients and stimulating micro-organism activity in the soil layer; and
- It provides a protective mulch that regulates temperature fluctuations in the surface which also protects the seeds and enhances germination.

iv. If the grass cuttings are not enough to cover the entire area, it can be laid in windrows, perpendicular to the prevailing wind direction to act as windbreaks. This will minimise wind erosion and provide a stable soil environment for vegetation establishment.

v. Additional soil amelioration is recommended through the addition of organic material. As part of the alien and invasive species control program for the application area, many alien and invasive tree species have been identified that should be cut down according to the National Environmental Management: Biodiversity (NEMBA)

Act 10 of 2004. This is seen as a valuable source of biomass that can be turned into compost or organic mulch. Such a practice requires the trees to be chipped and the material to be stockpiled for a minimum of 2 years to decompose to a degree where it can be used in rehabilitation. Further research is required in this regard to quantify the available biomass and to devise a methodology that is sufficient in manufacturing weed free compost.

vi. Timing of soil rehabilitation is very important, considering that dry and windy conditions are usually encountered from July to September when wind erosion potential is at its peak. Stripping and placement of topsoil should preferably not occur during this period. Ideally, this practice is considered most effective from October until March.

6.4.4 VEGETATION ESTABLISHMENT

i. The re-establishment of vegetation is to support the game and other fauna on the farm in terms of habitat creation and grazing potential. As a minimum objective, a vegetation coverage and diversity, similar to the natural vegetation cover of the pre-mining environment, should be achieved. An improved grazing quality is however recommended, but can only be achieved if soil conditions are improved, i.e. nutrient cycles, water absorption capacity, etc, and with the introduction of high quality grazing grass species.

ii. Planting of a commercially available seed mixture is recommended to improve the grazing potential. This should be planted by cultivating the top 150mm of the surface to prepare a seedbed if the growth medium is not loose enough. The seeds should be planted with a fine-seed planter, followed by the recommended fertilizer informed by a soil test. Covering the planted area with grass cuttings are recommended as described in Section 6.4.3.

iii. It was noted during the rehabilitation of the mining permits that some game congregated in the newly planted areas to graze the new growth. This caused severe damage to the young seedlings and prolonged vegetation establishment. It is recommended that the areas under rehabilitation are enclosed with a temporary fence to keep out the larger game from the area until sufficient vegetation establishment is achieved. It should remain closed for at least two growing seasons or when the vegetation coverage is 60% or more.

iv. It is recommended to establish a higher concentration of creeping grass, such as *Cynodon dactylon*[3], on the side slopes. Creeping grass is normally less favourable for grazing and will limit animal traffic on the side slopes, thereby minimising erosion due to trampling. A creeping grass' spreading growth habit is considered a good soil binding property.

v. Installing temporary irrigation will be beneficial to improve and accelerate vegetation establishment, especially during periods of dry and hot weather conditions. This is not

[3] Couch grass

considered necessary if all the principles of soil rehabilitation, roll -over mining and the timing of vegetation establishment is done correctly, but wetting the surface will also be seen as a form of dust control.

vi. Timing is crucial when attempting vegetation establishment. The growing season for indigenous grasses is between September and March. Outside of this window, only *Avena sativa*[4], an annual exotic grass species, can be established with supplemental irrigation. This is considered an erosion control strategy to establish a vegetation cover during winter in order to combat wind erosion during the dry and windy months of July to September.

vii. Annual or perennial weeds as well as alien invaders should be removed, preferably by hand. If large numbers are germinating and mechanical control methods are ineffective, a suitable herbicide may be applied.

[4] Wheat grass

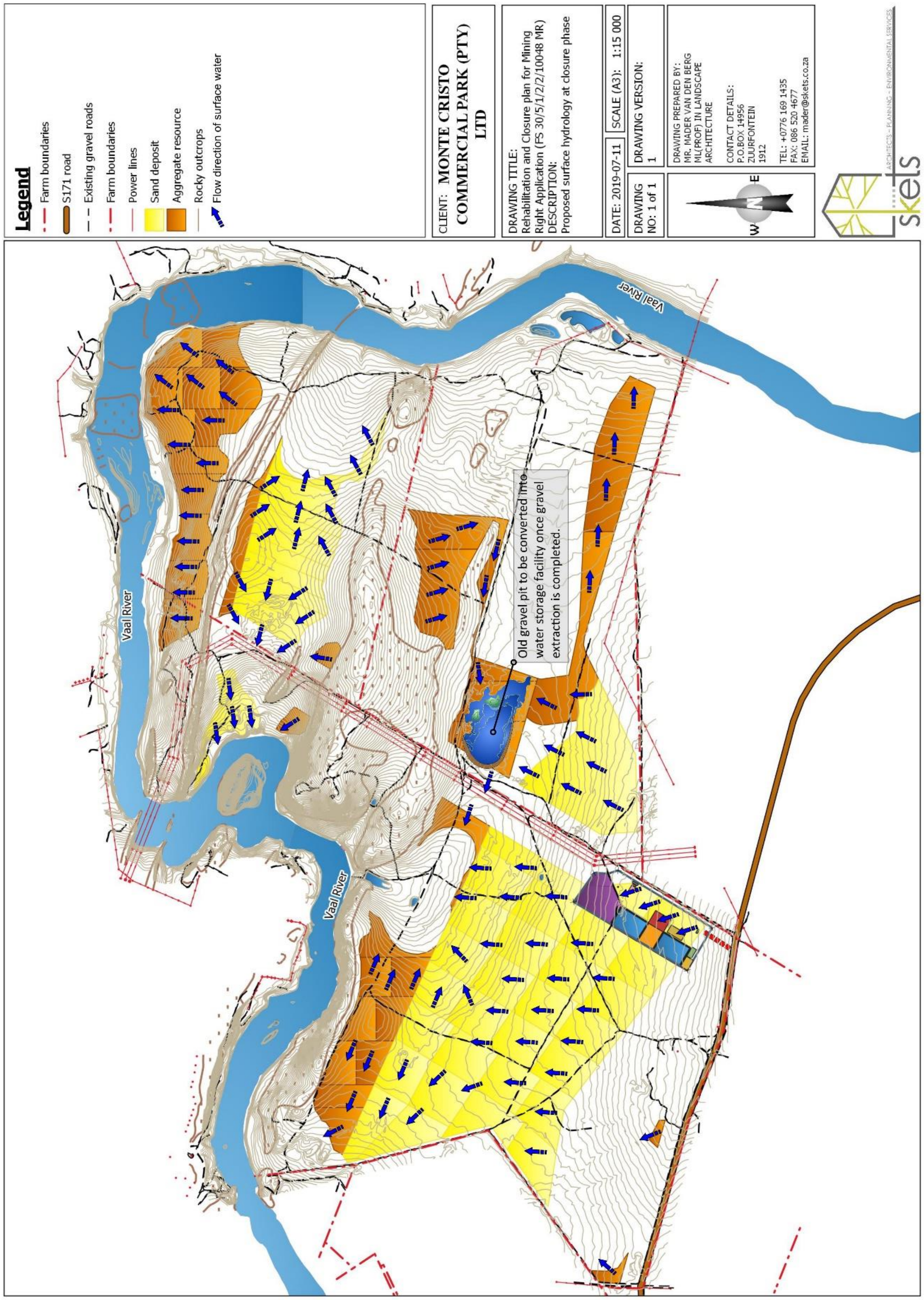


Figure 45: Proposed surface hydrology at closure phase

6.5 BUILDINGS AND SURFACE INFRASTRUCTURE

i. The buildings and surface infrastructure that will be constructed for the mine and processing of sand, include the following items:

- 1 x Drying plant shed with either a rotary drying plant or fluid bed drying plant installed;
- 1 x Wash plant shed with an Evowash M4500 dual sand and aqua cycle installed;
- 1 x Workshop shed;
- 6 x Silos (Size to be determined);
- 1 x Fuel bunker;
- 1 x Administrative offices and weighbridge control room, including change rooms and ablution facilities;
- 1 x Weigh bridge;
- 1 x Fenced TMM parking area;
- 1 x Security check point; and
- Cut-off trenches and diversion channels.

Table 4: Sand processing plant – Dimensional data

	Length	Width	Height	Allowed Footprint
Mobile Screen	18,89m	18.72m	6.7m	N/A
EvoWash M4500 dual sand (capacity 150T/H)	6.8m	2.3m	8m	85x70m 5 950m²
Aqua Cycle A1500	16.7m	16.7m	±6m incl. catwalk	
Rotary drying plant	49m (from feeder bins to silo)	18.7m	6m (excl. silos) 250t silo = 25,5m 200t silo = 21.4m 150t silo = 17.2m	80x40m 3 200m²
Fluid bed drying plant	18.5m	8.5m	13.14m (excl. silos) 250t silo = 25,5m 200t silo = 21.4m 150t silo = 17.2m	80x40m 3 200m²
Workshop area	100m	30m	±10m	100x30m 3 000m²
Fuel bunker area	20m	8m	±4m	160m²
Administrative offices	Not yet determined	Not yet determined	Triple storey	60x40m 2 400m²

And weighbridge office				
Security checkpoint	10m	10m	3m	
Run of Mine stockpile (±48 000m³ capacity)	100m	80m	±6m	100x80m 8 000m²

ii. All sheds will presumably be steel frame structures with corrugated iron or IBR roof and wall cladding. A suitable floor surface, presumably concrete slabs, will be constructed inside of the sheds and as an apron around each shed.

iii. All the sheds have been earmarked for boat houses, storage facilities and a workshop as a post-mining use, incorporated into the eco and wildlife estate. None of the sheds will be dismantled and conversion into these new uses can be easily done with minimal alterations required. The principle of re-use should be applied as part of a sustainable development concept. The re-use of structures will benefit the environment on three levels namely; recycling of material, generating less waste and reducing energy input.

iv. The silos are specific to the storage of the beneficiated silica sand. The structures as well as the concrete footings and foundations will be dismantled and removed off site as scrap metal or sold to a secondary user.

v. The fuel bunker is typically a concrete structure with a suitably sized fuel tank/s installed in it. A fuel storage facility is required for the general maintenance of the farm and the farming practices during and after the mining period. The fuel bunker will not be dismantled and will be integrated into the farming function and the post-closure land use. Due to its location to the future boat houses and storage facilities, it is considered ideally placed.

vi. The administrative buildings, which will include the weighbridge control room, change houses and ablution facilities, is considered to be one building. This building shall be converted into administrative offices for the eco and wildlife estate and will therefore not be dismantled. As its preliminary function is administrative, the conversion and integration into the post-closure land use is considered feasible and economical.

vii. The weighbridge is specific to the mining operations and shall be dismantled and removed off site at closure. The footprint of the weighbridge shall be incorporated into the contractor's entrance and will presumably be levelled and paved (refer to Section 6.6).

viii. The fenced TMM parking area shall remain a fenced parking area for farming equipment as part of the post-closure land use.

ix. The security checkpoint is considered to be a container house for the purpose of regulating traffic and liaison with the weighbridge control room before haul trucks exit the processing plant. The container house will be removed, and its footprint will be rehabilitated or landscaped.

x. Cut off- and diversion channels will be installed as part of the surface water management plan to separate clean and contaminated water. The processing plant area will be isolated from the surrounding areas and all surface water will be diverted to the Pollution Control dam (PCD) for treatment. Clean water will be diverted away from the processing plant and mining areas. These channels are expected to be lined or sufficiently buffered according to guidelines and engineering specifications.

xi. As most of the processing plant infrastructure will remain after closure, it is recommended that the cut off and diversion channels remain in place as part of the integrated surface hydrology management of the eco and wildlife estate.

6.6 ROAD INFRASTRUCTURE OBJECTIVES

i. A new entrance road and gate will be constructed from the S171 at the south western corner of Remaining Extent of Portion 1 of the farm Woodlands 407. It is unknown what the paving material will be, but it will presumably be tarred or paved with a suitable heavy-traffic material. The new entrance will be incorporated in the estate's layout and design as a contractor's entrance. None of the road features will be deconstructed and limited alterations are expected to convert the entrance road and gate into the estate's design and layout.

ii. Internal circulation routes, servicing the processing plant, will presumably also consist of the same material as the entrance road. These roads will remain intact as part of the post-closure land use and will act as access roads to the boat houses, workshops and offices.

iii. The existing gravel roads in the application area will also be utilised to gain excess to and from the sand, aggregate and diamond mining locations. No new roads are required according to the current mine layout and processing scheme. These roads will remain in place after closure to be used as access roads for the eco and wildlife estate and for the general upkeep of the farm. Where additional roads are made, that will not be used in the post-closure use, their surface will be rehabilitated as per the specifications in Section 6.4.

6.7 EQUIPMENT, ELECTRICAL INFRASTRUCTURE OBJECTIVES

i. It is the author's understanding that many of the movable equipment will be hired during the operational phase and is therefore not the Applicant's property. Plant hire will simply return to the owner at the closure of the mine. Movable equipment that does belong to the Applicant, shall be sold, unless it is used in the general operations and maintenance of the farm, for example TLBs and tractors.

ii. The wash plant and drying plant will be dismantled and removed off site, either as scrap metal or sold to a secondary user. The shed structures over the washing- and drying plant will be integrated into the post closure land use as specified above.

iii. A 2.5MVA power supply line will be tapped off from the existing main line that runs parallel to the S171. This will be connected to a substation near the processing plant (location not yet determined). The power supply line and substation will be incorporated into the future estate's electrical supply. The power demand for the estate has not yet been determined and it is uncertain what conversion is required to supply the entire estate.

6.8 STOCKPILES AND WASTE MATERIAL OBJECTIVE

i. The ROM stockpile will be replenished during the operational phase and will be kept a consistent size. The last 3 years of operation will see a decrease in the production to ramp down towards the closure phase. By year 30 the ROM stockpile should be depleted and only the footprint shall be rehabilitated.

ii. If the implementation of roll-over mining is done correctly, no topsoil stockpiles should be present in the mining area at the end of the 30 year period as all topsoil should have been applied to the rehabilitated areas.

iii. Waste material are classified into two categories:

- Over-sized material that are screened out at the pits and quarries.
- Fines that are washed out during the beneficiation process at the plant and are collected in the settling ponds.

iv. The over-sized material will be used as backfilling during concurrent rehabilitation and its handling is regarded part of the operational phase.

v. The fines, collected in the settling dams and PCD, should be removed and treated according to its waste classification and specialist recommendation.

6.9 PROCESS DAMS OBJECTIVES

i. Two settling dams of 1.5ha each, and one PCD, 3.5ha, will be constructed to treat water from the wash plant and manage contaminated surface water, respectively. They will also be used as return-water dams to feed back into the wash plant as part of the water recycling scheme.

ii. No engineering specifications have yet been prepared, but it is expected that the dams will be appropriately designed and constructed according to safety standards and legal requirements. It is assumed that the settling dams and PCD will be lined with a HDPE liner or a similar waterproofing buffer.

iii. The settling dams and PCD are earmarked for reintegration into the eco and wildlife estate as part of the integrated surface hydrology management plan for the estate. These dams will act as stormwater control facilities managing stormwater entering the property from the south. It will also act as a rainwater storage facility channelling rainwater from the roads and roofs of the future boat houses etc.

iv. The post closure use of the settling dams and PCD are subject to an authorised water use licence.

7 MONITORING AND MAINTENANCE PROGRAM

7.1 AFTERCARE AND MAINTENANCE

i. The purpose of aftercare and maintenance is to assess the progression towards closure achievement and to take corrective and precautionary actions in those cases where the development trajectory is not aligned to the ultimate post mining land use and relinquishment criteria. This is an active involvement that commences at the first rehabilitation initiative and continuous until the closure phase, paralleled by a monitoring strategy.

ii. Active monitoring commences during construction which is seen as an Adaptive Management & Monitoring phase (Figure 46: Adapted from Glencore (2017)) in which accumulated knowledge and best practice research influences the following phases of the mine. Regular data sourcing feeds back into the active rehabilitation efforts and mining operations. Proactive monitoring continuous with scheduled data sourcing at a less frequent interval, as environmental risk trajectories decline, and closure objectives are being reached. Reactive monitoring is in response to external forces for example floods, fires etc. It defines and quantifies the residual risks in order to facilitate custodial transfer if required.

iii. The aftercare and maintenance programs should be aligned to the post-closure vision for the three farm portions which is the endeavour of establishing an eco-and wildlife estate. A monitoring and maintenance program should be developed and submitted to the DMR for approval as part of the Final Rehabilitation Plan. The programme is to address the following aspects (Table 5):

- A stable and safe landform whereby erosion is sufficiently managed;
- A vegetation cover that is equal or better than the natural grassland in density and diversity;
- An effective management of storm water runoff;
- Compliance with legislation and safety standards if final voids are converted into dams;
- Commitment from landowner and property developer (VLDC group or companies) that mining infrastructure will be incorporated into the estate plan; and
- Implementation of an alien invasive monitoring program.

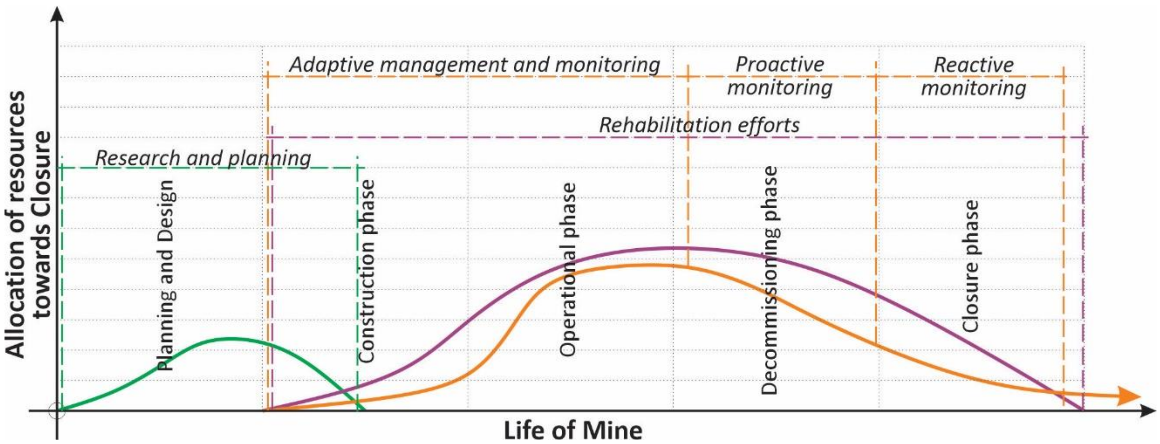


Figure 46: Proposed allocation of resources towards closure

7.2 RELINQUISHMENT CRITERIA

i. Relinquishment is the release of the mining right holder's (private entity) environmental liability when a set of criteria is achieved. This is called the Closure Certificate application in terms of S43 of the MPRDA

ii. The relinquishment criteria are supported by the long-term vision of the properties which is to establish an eco-and wildlife estate and to integrate the mining areas into that development. This should be measured alongside an approved Master plan and town planning scheme by the local municipality.

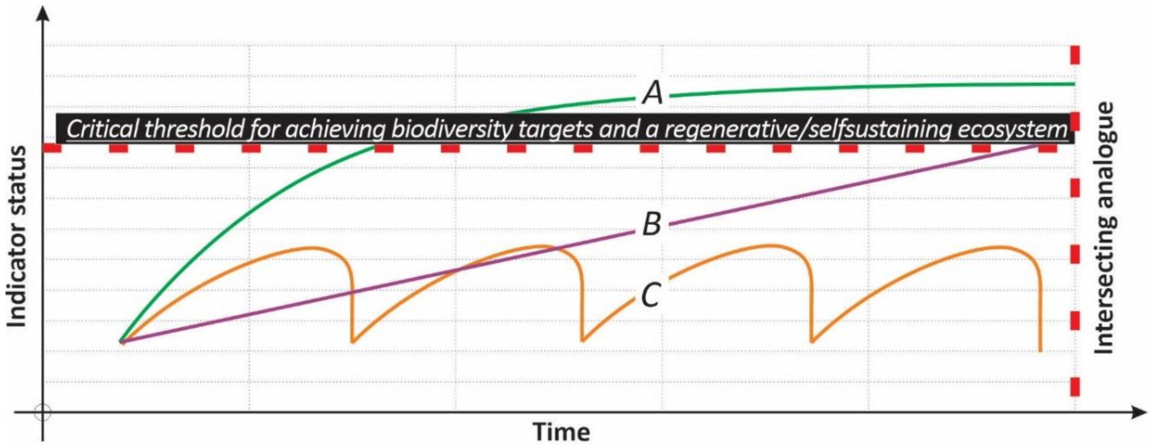
iii. Relinquishment criteria is prescriptive (i.e. require a particular action to be undertaken or documented), or performance based (i.e. require a specific standard or target value for an indicator to be attained) (Butler, 2015) .

iv. Relinquishment criteria should be closely associated with closure- and post-mining land use objectives. They are evidence-based measures that indicate when specific closure targets have been achieved. Relinquishment criteria can be prescriptive, or performance based. Relinquishment occurs at the point where the holder of the right has achieved all agreed to standards and completion criteria for the decommissioning and rehabilitation of the project site. All parties should be satisfied that the site does not pose any danger to public health and safety nor to environmental health. Reports on monitoring results and closure performance should be issued to stakeholders for review. The final relinquishment criteria would in this case be the receipt of a Closure Certificate in terms of Section 43 of the MPRDA (as amended).

v. The most basic relinquishment criteria should achieve:

- Long-term stability of the site in order to ensure safety for humans and animals;
- Non-polluting residual and latent impacts that will not cause harm to the environment;
- A resilient and regenerative landscape that can effectively deal with normal environmental stresses;

- A restructured ecosystem that demonstrates a desired trajectory of development towards a critical threshold as defined by the post mining land use objectives and biodiversity targets (Figure 47: adopted from Corbett, 1999);
- Legal transfer rights to property owner or stakeholders as an outcome of negotiations.



Trajectory development can occur in three ways according to Tongway et al (1997). Curve A is the desired trajectory that is characterised by a steep initial development, followed by a steady incline, before intersecting the status of the reference ecosystem. Curve B represents a linear progression towards the analogue scenario but remains vulnerable and susceptible to failure for a relatively long period until reaching the critical threshold. Curve C is a system that easily collapses under normal environmental stresses and requires frequent remedial intervention and long-term maintenance.

Figure 47: Rehabilitation trajectory scenario

Table 5: Monitoring program

Rehabilitation targets	Method of monitoring	Frequency of monitoring	Monitoring period	Actions to be taken if target is not reached
Stable landform	Visually inspect for erosion gullies, rills, sink holes or depressions along all slopes and quarry floor that exposes underlying soils.	Sep-April: Monthly May-August: Every 2nd month	2 growing seasons or until 60% vegetation cover is achieved	Determine cause of instability. If wind erosion occurs, vegetation cover needs to be improved. If water erosion occurs, storm water runoff diversion berm may be ineffective and requires extension or repairing. Divert water and fill erosion gullies with suitable material. If sink holes or depressions occur, fill with suitable material. In all mentioned scenarios, re-seed area and extend monitoring period.
Vegetation cover	Visually inspect various locations on side slopes, quarry floor and diversion berms for bare patches larger than $2m^2$, or poor vegetation coverage that are less than 60%.	Monthly for 6 months after initial planting. Thereafter, every 2nd month.	2 growing seasons or until 60% of vegetation cover is achieved	Determine cause of poor vegetation growth. Soil amelioration may be required by means of adding organic material and/or suitable fertilizer. Re-seed area and extend monitoring period.
Storm water management	Visually inspect storm water diversion berm and side slopes of quarry as well as surrounding landscape where water is diverted to, for erosion gullies, rills or significant water pooling.	Sep-April: Monthly May-August: Every 2nd month	2 growing seasons or until 60% vegetation cover is achieved	If water erosion occurs due to concentrated water flow, disperse water flow over a larger area by opening the channel and creating an even, sheet flow. Temporary surface stabilisation methods may be required to establish vegetation such as hessian netting or contouring. Re-seed area and extend monitoring period.
Weed eradication	Visual inspection of entire rehabilitated area.	Monthly for 6 months after initial planting. Thereafter, every 2nd month.	2 growing seasons or until 0% weeds are present	If weeds are present in isolated places, mechanical removal can be implemented. If weeds are the dominant plant species, chemical spraying may be required with a broad-leaf herbicide. Soil amelioration and re-seeding may be required.

8 POTENTIAL RESIDUAL AND LATENT RISKS

i. Residual and latent risks are defined as the potential environmental impacts that may occur after relinquishment of the mining right holder's liability. The residual and latent risks will transfer to a third party that is typically the state department (DMR) or another private party. Ideally, no residual or latent risks should remain after a closure certificate is received, but this section explores the potential for such risks to arise once closure is achieved.

ii. Surface erosion is typically considered a residual impact but can be managed sufficiently with a healthy vegetation cover and proper stormwater runoff management.

iii. Soil subsidence may occur in areas where backfilling occurred as this is considered a low risk due to the minimal backfilling that is expected.

iv. Surface water quality may be negatively impacted as a result of erosion but should be sufficiently addressed during rehabilitation.

9 REFERENCES

- Airshed Planning Professionals. 2018. Air Quality Baseline Assessment - Pure Source Mine Project in the Free State, South Africa.
- Butler, Andrew & Anderson, Tim & Sexton, Alex. (2015). "Development of Rehabilitation Objectives and Targets for a Copper Mine in NW Queensland." Retrieved from https://www.researchgate.net/publication/297737066_Development_of_Rehabilitation_Objectives_and_Targets_for_a_Copper_Mine_in_NW_Queensland ;
- Coetzee, F.P. 2008. Cultural Heritage Survey of the Proposed Goosebay Eco Estate situated on Portions 1 and 3 and a Remainder of the Farm Woodlands 407RD, Free State Province, South Africa.
- Corbett MH (1999). Revegetation of mined land in the wet-dry tropics of northern Australia: A review. Supervising Scientist Report 150, Supervising Scientist, Canberra.
- EHP (2014). "Rehabilitation requirements for mining projects", reference number EM1122, Version 2, dated 28 January 2014, Department of Environment and Heritage Protection, Queensland.
- Hydrospatial (Pty) Ltd. 2018. Visual Assessment Scoping Report for the Proposed Woodlands 407 Mining Right Application, South Africa.
- Marshall, T.R. 2018. "Alluvial Diamond Prospecting Programme", South Africa, 10pp.
- McArthur River Mining: Glencore (2017). "Overburden Management Project; Conceptual Mine Closure Plan." Environmental Impact Statement March 2017.
- New Hope Group (2014). "Topsoil Management Plan: New Acland Coal Mine Stage 3 Project". Retrieved from http://eisdocs.dsdip.qld.gov.au/New%20Acland%20Coal%20Mine%20Stage%203/EIS/EIS%2024Dec13/Appendices/Appendix%20J-3%20Topsoil%20Management%20Plan.pdf ;
- Noa Agencies (Pty) Ltd. 2018. Pure Source Mine Groundwater Report, South Africa.
- Queensland Government: Department of Environment and Sciences (2014). "Rehabilitation requirements for mining resource activities." Retrieved from https://environment.des.qld.gov.au/assets/documents/regulation/rs-gl-rehabilitation-requirements-mining.pdf - last modified 1 July 2018
- R.G. Darmody, W.L. Daniels, J.C. Marlin, and D.L. Cremeens (2009). Paper presented at the 2009 National Meeting of the American Society of Mining and Reclamation, Billings, MT Revitalizing the Environment: Proven Solutions and Innovative Approaches May 30 –June 5, 2009. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502. Retrieved from

https://www.asmr.us/Portals/0/Documents/Conference-Proceedings/2009/0237-Darmody.pdf

- SER (2004). "The SER Primer on Ecological Restoration". Version 2: Society for Ecological Restoration. International Science and Policy Working Group. October 2004;
- Shango Solutions. 2018. Pure Source Mine Palaeontological Report, South Africa.
- The Biodiversity Company. 2018. Wetland Assessment for the Proposed Woodlands 407 Mining Operation, South Africa.
- The Biodiversity Company. 2018. Pedology Assessment for the Proposed Woodlands 407 Mining Operation, South Africa.
- The Biodiversity Company. 2018. Riverine Ecology Assessment for the Proposed Woodlands 407 Mining Operation, South Africa.
- The Biodiversity Company. 2018. Biodiversity Assessment for the Proposed Woodlands 407 Mining Operation. South Africa.
- T.R. Marshall (2018), "Woodlands Project: Alluvial Diamond Prospecting Programme", Exploration Unlimited, Gauteng, Specialist Report, July 2018;
- Tongway D, Kearns A, Hindley N & Barnett G 1997. "Indicators of ecosystem rehabilitation success and selection of demonstration sites – ACMER Ecosystem Indicators Project", Final Report, CSIRO Mine Site Rehabilitation Research Program, Adelaide.