Appendix D
Specialist Studies

Appendix D1

Biodiversity: Terrestrial Ecology and Wetlands

THE AQUATIC BIODIVERSITY COMPLIANCE STATEMENT FOR THE PROPOSED FWGR LIBANON RECLAMATION PROJECT

Gauteng Province, South Africa

07/08/2024

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Report Name	**THE AQUATIC BIODIVERSITY COMPLIANCE STATEMENT FOR THE PROPOSED FWGR LIBANON RECLAMATION PROJECT**
Specialist Theme	Aquatic Biodiversity Theme
Project Reference	FWGR – Libanon Reclamation Project
Report Version	07/08/2024
Environmental Assessment Practitioner	KONGIWE
Fieldwork & Report Writer	Divan van Rooyen (SACNASP 151272)
Reviewer	Rowan Buhrmann (SACNASP Pr Sci Nat 136853)
Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.

Table of Contents

1 Introduction 6
1.1 Background 6
1.2 Project Description 9
1.3 Legislative Framework 10
2 Methodology 11
2.1 Identification and Mapping 11
2.2 Ecological Classification and Description 12
2.3 Functional Assessment 12
2.4 Present Ecological Status 12
2.5 Importance and Sensitivity 13
2.6 Recommended Ecological Category and Recommended Management Objective 13
2.7 Buffer Requirements 14
2.8 Risk Assessment 14
2.9 Limitations 14
3 Receiving Environment 14
3.1 South African Inventory of Inland Aquatic Ecosystems 14
3.2 National Freshwater Ecosystem Priority Areas 15
3.3 Survey Results 16
3.3.1 Functional Assessment 21
3.3.2 Buffer Requirements 21
3.4 Ecological Sensitivity 22
4 Impact Assessment 22
4.1 Current Impacts to Freshwater Biodiversity 22
4.2 Risk Assessment 23
4.3 Mitigation Measures: 25
4.3.1 Development Specific Mitigation 25
4.3.2 Erosion and sedimentation of watercourses 25
4.3.3 General Mitigation Measures 26
5 Conclusions 28
5.1 Ecological Sensitivity 28
5.2 Risk Statement 28
5.3 Specialist Statement 28

6 References 29
7 Appendix Items 30
7.1 Appendix A – Specialist Declaration of Independence 30
7.2 Appendix B – Specialist CVs 32

List of Tables

Table 1-1 Aquatic Biodiversity Compliance Statement information requirements as per the relevant protocol, including the location of the information within this report 10

Table 2-1 Classes for determining the likely extent to which a benefit is being supplied 12

Table 2-2 The Present Ecological Status categories (Macfarlane, et al., 2008) 13

Table 2-3 Description of Importance and Sensitivity categories 13

Table 2-4 Recommended Ecological Category (REC) and Recommended management objectives (RMO) scores 14

Table 2-5 Significance ratings (DWS, 2016) 14

Table 3-1 Description of the delineated areas. 18

Table 3-2 Ecological characteristics of the freshwater features within the Libanon PAOI 21

Table 3-3 Post-mitigation buffer requirement 22

Table 3-4 Summary of the Screening Tool Sensitivity versus the Specialist assigned Site Ecological Importance (SEI) for the Field Survey Area of the Project Area 22

Table 4-1 Mitigated DWS Risk Assessment Matrix for wetlands in relation to the proposed development 24

List of Figures

Figure 1-1 The Project Area of Influence in proximity to the nearby towns 7

Figure 1-2 Map of Project Components for FWGR Libanon Reclamation Project 8

Figure 1-3 The aquatic biodiversity theme sensitivity for the FWGR Libanon Reclamation Project 9

Figure 2-1 Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis et al. 2013) 11

Figure 2-2 The watercourse classifications (DWAF, 2005) 12

Figure 3-1 South African Inventory of Inland Aquatic Ecosystems for the FWGR Libanon Reclamation Project 15

Figure 3-2 NFEPA Wetlands in the FWGR Libanon Reclamation Project 16

Figure 3-3 GPS tracks 17

Figure 3-4 Photographical examples of the different water resources found within the 500 m regulated area, A & B) Hydrophytes found in disturbed areas, C) Artificial Canal, D & E) Artificial Channel, F) Biodam and G) Artificial Seepage from mining canal. 19

Figure 3-5 Google Earth Historic Imagery from 11/03/2003 highlighting the reservoirs that has been labelled as Seep wetlands from the NFEPA spatial dataset 19

Figure 3-6 The delineated systems of the FWGR Libanon Reclamation Project 20

Figure 3-7 The watercourse classifications (DWAF, 2005) 21

Figure 4-1 The mitigation hierarchy as described by the DEA (2013) 23

1 Introduction

1.1 Background

The Biodiversity Company was appointed to complete an Aquatic Biodiversity compliance statement for the proposed FWGR Libanon Reclamation Project, located approximately 2 km west of the town of Westonaria, in the Rand West City Local Municipality, Gauteng, South Africa. The proposed FWGR Libanon Reclamation Project was given a 500 m buffer and is referred to as the Project Area of Influence (PAOI; Figure 1-1). In addition, a map highlighting the project components are shown in Figure 1-2.

This assessment has been completed in accordance with the requirements of the published General Notice (GN) 4167 by the Department of Water and Sanitation (DWS) (previously GN 509 of 2016 and GN 3139 of 2023). The said notice was published in the Government Gazette (no. 49833) under Section 39 of the National Water Act (Act no. 36 of 1998) in December 2023, for a Water Use Licence (WUL) in terms of Section 21(c) & (i) water uses. The GN 4167 process provides an allowance to apply for a WUL for Section 21(c) & (i) under a General Authorisation (GA), as opposed to a full Water Use Licence Application (WULA). A water use (or potential) qualifies for a GA under GN 4167 when the proposed water use/activity is subjected to analysis using the DWS Risk Assessment Matrix (RAM), provided the identified risks are all considered a low risk, and the applicant is listed under Appendix D1 or Appendix D2 of the same notice. This assessment will implement the RAM and provide a specialist opinion on the appropriate water use authorisation.

This assessment was conducted in accordance with the amendments to the Environmental Impact Assessment Regulations. 2014 (GNR 326, 7 April 2017) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). The approach has taken cognisance of the recently published Government Notices (GN) 320 (20 March 2020): “Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation” (Reporting Criteria). The National Web based Environmental Screening Tool has characterised the aquatic theme sensitivity as “Low” for the Project Footprint (Figure 1-3). Figure 1-3 is a map created to show the screening tool of the FWGR Libanon Reclamation Project. Section 3.4 confirms the site sensitivity.

The purpose of conducting the specialist study is to provide relevant input into the overall Environmental Authorisation application process, with a focus on the proposed project activities and their associated impacts. This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Registered Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making as to the ecological viability of the proposed project.

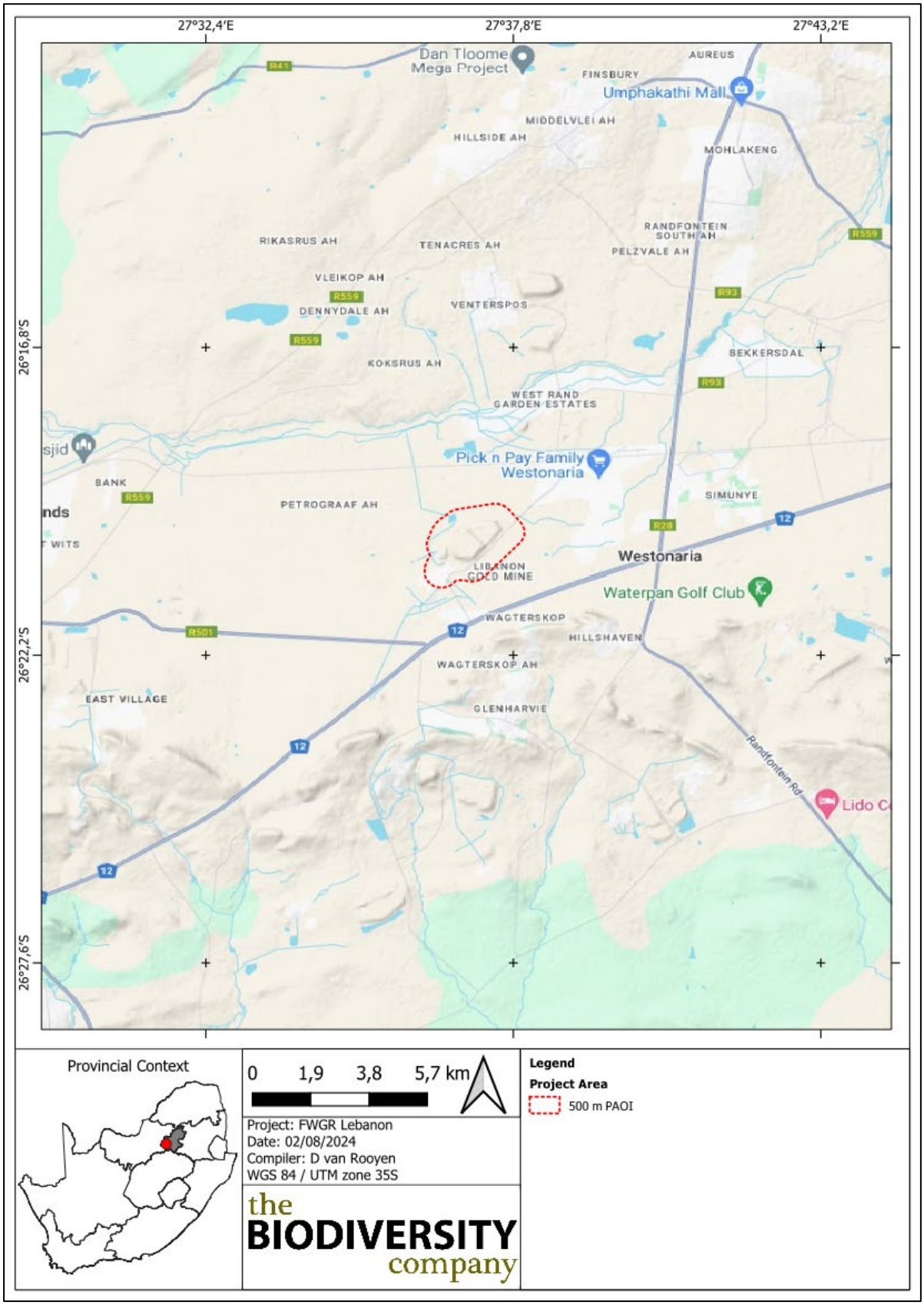


Figure 1-1 The Project Area of Influence in proximity to the nearby towns

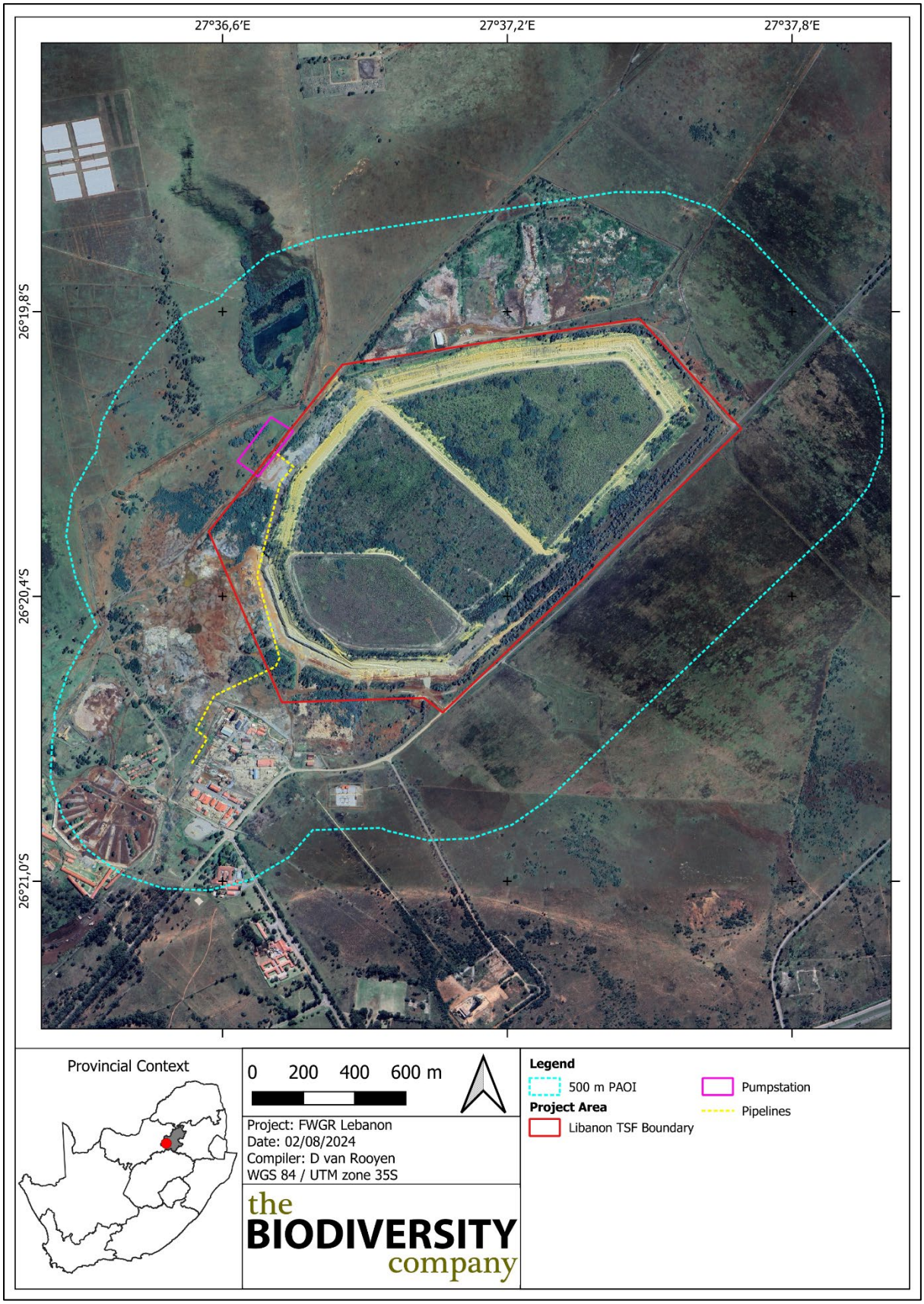
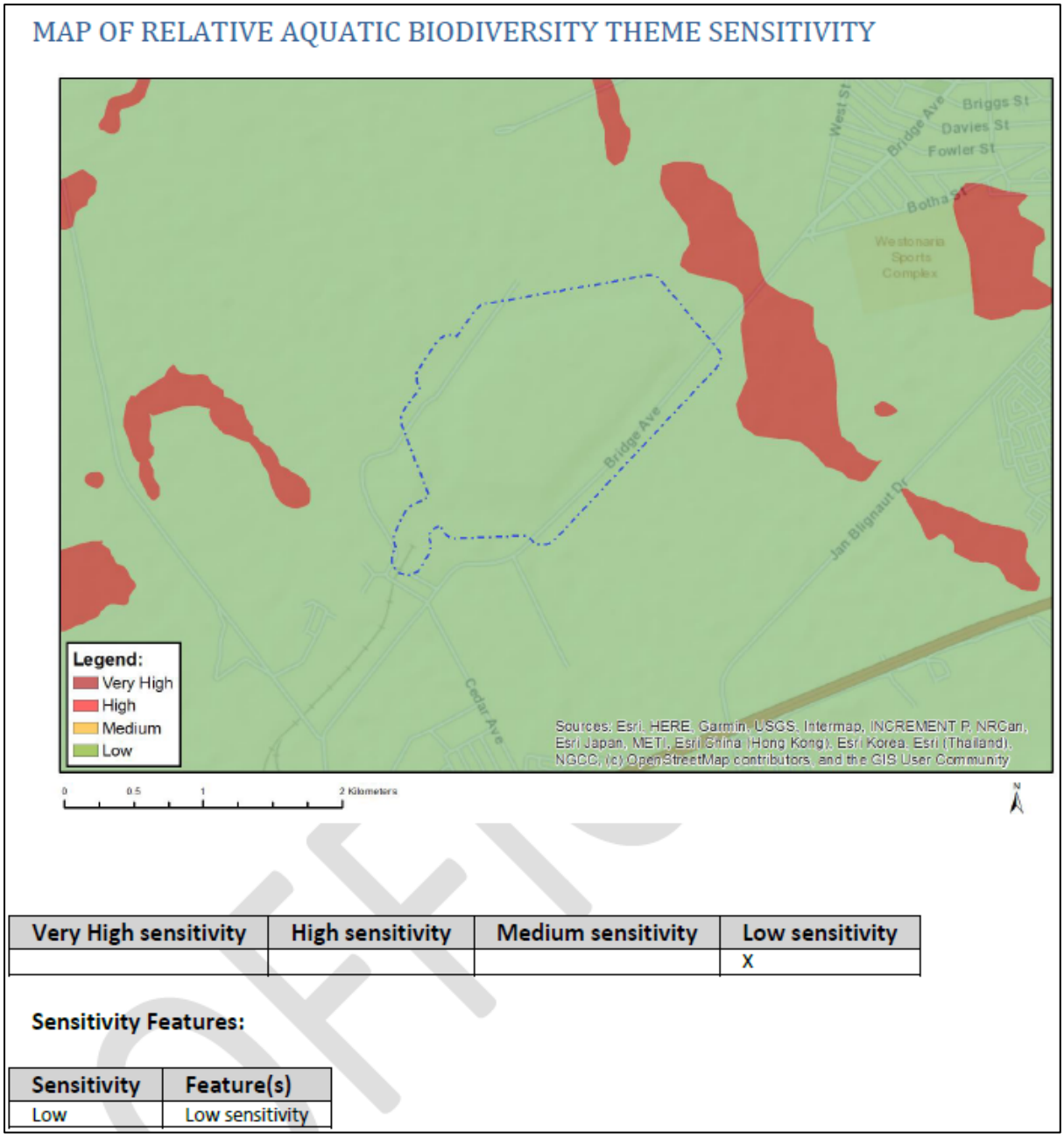


Figure 1-2 Map of Project Components for FWGR Libanon Reclamation Project



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low sensitivity

Figure 1-3 The aquatic biodiversity theme sensitivity for the FWGR Libanon Reclamation Project

1.2 Project Description

Far West Gold Recoveries (Proprietary) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSF are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF) (Kongiwe, 2024).

FWGR plans to reclaim and reprocess gold residues from the Libanon TSF, with slurry processed at the Driefontein No. 2 Plant and or other gold plants located in the Kloof area. The necessary infrastructure includes pump stations, process water from Kloof Shaft 10#, pollution control paddocks, access roads, laydown areas, and powerlines. The TSF is located about 2 km west of Westonaria in the Rand West City Local Municipality. Existing pipelines and roads will be used, with new 4m wide

gravel roads constructed where necessary. The reclamation will require 3kVA of electricity from Eskom and potable water from Rand Water Board or the Municipality. The project is expected to last approximately 12 years, pumping an estimated 600,000 tons/month of slurry to the Plant for beneficiation (Kongiwe, 2024).

The reclamation method will employ top-down hydraulic reclamation, using high-pressure water cannons to create a slurry from the tailings, which will then be processed for gold extraction to the plant. Once reclamation is complete, the area will be assessed for contamination, with necessary remediation followed by land levelling and returning the land to its original topography. This project aims to remove a pollution source, aiding in the rehabilitation of the mining legacy in the area (Kongiwe, 2024).

1.3 Legislative Framework

In line with the protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial biodiversity, as per Government Notice 320 published in terms of NEMA, dated 20 March 2020: “Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation” – the following has been assumed:

An applicant intending to undertake an activity identified in the scope of this protocol on a site identified on the screening tool as being of:

“Low Sensitivity” for aquatic biodiversity, must submit an Aquatic Biodiversity Compliance Statement.

Where the information gathered from the site sensitivity verification differs from the screening tool designation of “very high” aquatic biodiversity sensitivity, and it is found to be of a “low” sensitivity, an Aquatic Biodiversity Compliance Statement must be submitted.

An Aquatic Biodiversity Compliance Statement must contain the information as presented in Table 1-1 below.

Table 1-1 Aquatic Biodiversity Compliance Statement information requirements as per the relevant protocol, including the location of the information within this report

Information to be Included (as per GN 320, 20 March 2020)	Report Section
contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae	7
a signed statement of independence by the specialist	7.1
a statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment	2 / 3.3
a baseline profile description of biodiversity and ecosystems of the site	3.3
the methodology used to verify the sensitivities of the aquatic biodiversity features on the site including the equipment and modelling used where relevant;	2
where required, proposed impact management outcomes or any monitoring requirements for inclusion in the EMPr	N/A
a description of the assumptions made as well as any uncertainties or gaps in knowledge or data	2.9
any conditions to which this statement is subjected	N/A

A signed copy of the compliance statement must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.

2 Methodology

A site visit was conducted on 5th of August 2024, which is considered a suitable (dry) season to undertake a freshwater assessment.

2.1 Identification and Mapping

The wetland areas were delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 2-1. The outer edges of the wetland areas were identified by considering the following four specific indicators:

The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur;

The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.

The soil forms (types of soil) found in the landscape were identified using the South African soil classification system namely; Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group, 1991);

The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation; and

The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

Vegetation is used as the primary wetland indicator. However, in practice the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role.

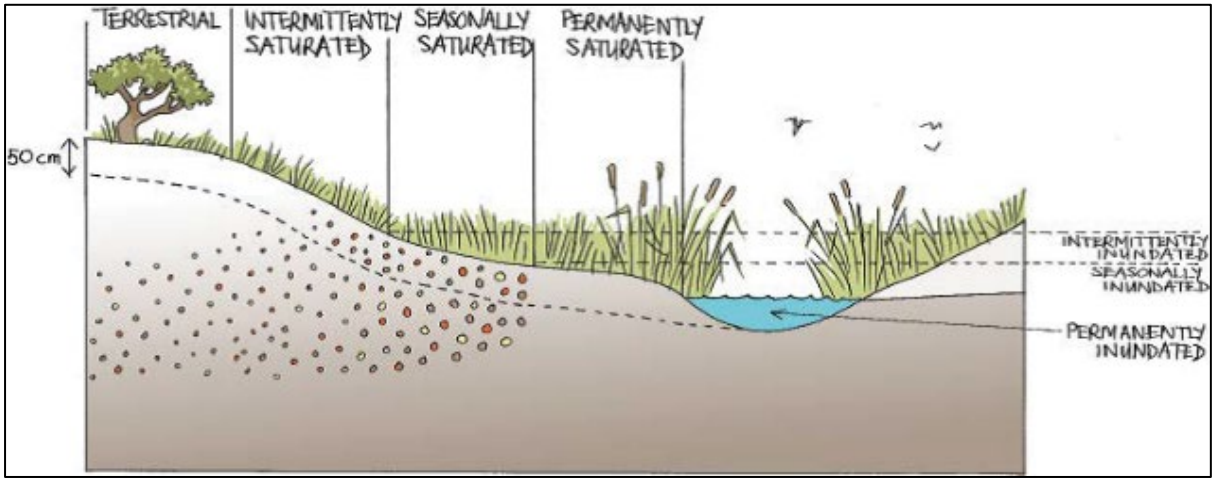


Figure 2-1 Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis et al. 2013)

The DWAF (2005) manual separates the classification of watercourses into three (3) separate types of channels or sections defined by their position relative to the zone of saturation in the riparian area. The classification system separates channels into:

those that do not have baseflow ('A' Sections);

those that sometimes have baseflow ('B' Sections) or non-perennial; or

those that always have baseflow ('C' Sections) or perennial.

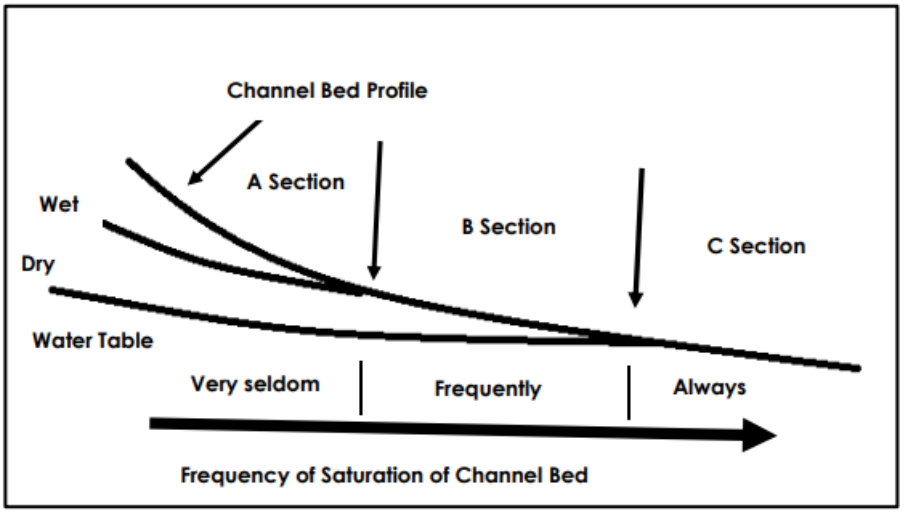


Figure 2-2 The watercourse classifications (DWAF, 2005)

2.2 Ecological Classification and Description

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) will be considered for this study. This system comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels, and then also includes structural features at the lower levels of classification (Ollis *et al*., 2013).

2.3 Functional Assessment

Wetland Functionality refers to the ability of wetlands to provide healthy conditions for the wide variety of organisms found in wetlands as well as humans. Eco Services serves as the main factor contributing to wetland functionality.

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze *et al*. 2008). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided (Table 2-1).

Table 2-1 Classes for determining the likely extent to which a benefit is being supplied

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low
1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

2.4 Present Ecological Status

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The Present State categories are provided in Table 2-2.

Table 2-2 The Present Ecological Status categories (Macfarlane, et al., 2008)

Impact Category	Description	Impact Score Range	PES
None	Unmodified, natural	0 to 0.9	A
Small	Largely Natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1.0 to 1.9	B
Moderate	Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	2.0 to 3.9	C
Large	Largely Modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4.0 to 5.9	D
Serious	Seriously Modified. The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognizable.	6.0 to 7.9	E
Critical	Critical Modification. The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.0 to 10	F

2.5 Importance and Sensitivity

The importance and sensitivity of water resources is determined to establish resources that provide higher than average ecosystem services, biodiversity support functions or are particularly sensitive to impacts. The mean of the determinants is used to assign the Importance and Sensitivity (IS) category as listed in Table 2-3.

Table 2-3 Description of Importance and Sensitivity categories

IS Category	Range of Mean	Recommended Ecological Management Class
Very High	3.1 to 4.0	**A**
High	2.1 to 3.0	**B**
Moderate	1.1 to 2.0	**C**
Low Marginal	< 1.0	**D**

2.6 Recommended Ecological Category and Recommended Management Objective

The Recommended Ecological Category (REC) and Recommended Management Objective (RMO) was determined based on the results obtained from the PES and ecological IS of the assessed wetlands, with the objective of recommending how a water resource should be managed. This is achieved by either maintaining or improving the ecological integrity of the wetland in order to ensure continued ecological functionality (DWA, 1999).

Table 2-4 Recommended Ecological Category (REC) and Recommended management objectives (RMO) scores

			Ecological Importance and Sensitivity			
			Very High	*High*	*Moderate*	*Low*
PES	*A*	Pristine	A Maintain	A Maintain	A Maintain	A Maintain
	B	Natural	A Improve	A/B Improve	B Maintain	B Maintain
	C	Good	A Improve	B/C Improve	C Maintain	C Maintain
	D	Fair	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	Poor	D Improve	E/F Improve	E/F Maintain	E/F Maintain

2.7 Buffer Requirements

The "Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries" (Macfarlane *et al*., 2014) was used to determine the appropriate buffer zone for the proposed activity.

2.8 Risk Assessment

The Department of Water and Sanitation (DWS) risk matrix assesses impacts in terms of consequence and likelihood. The significance (product of the likelihood and consequence) of the impact is then rated according to Table 2-5.

Table 2-5 Significance ratings (DWS, 2016)

Rating	Class	Management Description
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s)impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

2.9 Limitations

The following limitations should be noted for the assessment:

The assessment area was based on the spatial file provided by the client and any alterations to the development area may affect the results;

No functional assessment was undertaken due to all watercourses being artificial;

The GPS used for delineations is accurate to within five meters. Therefore, the delineation plotted digitally may be offset by at least five meters to either side; and

The seasonality of the site survey is not considered to be a limiting factor for this project.

3 Receiving Environment

3.1 South African Inventory of Inland Aquatic Ecosystems

The South African Inventory of Inland Aquatic Ecosystems (SAIIAE) wetland dataset is a recent outcome of the National Biodiversity Assessment (NBA, 2018) and, was a collaborative project by the South African National Biodiversity Institute (SANBI) and the Council for Scientific and Industrial

Research (CSIR). The SAIIAE dataset provides further insight into wetland occurrences and extents building on the information from the NFEPA, as well as other datasets. One wetland system was identified within the 500 m regulated area of the FWGR Libanon Phase 2 Expansion project (see Figure 3-1). This wetland was identified as a Unchannelled valley-bottom (UVB) wetland. Furthermore, the project components (TSF, pipeline or pumpstation) does not traverse any of the identified SAIIAE systems.

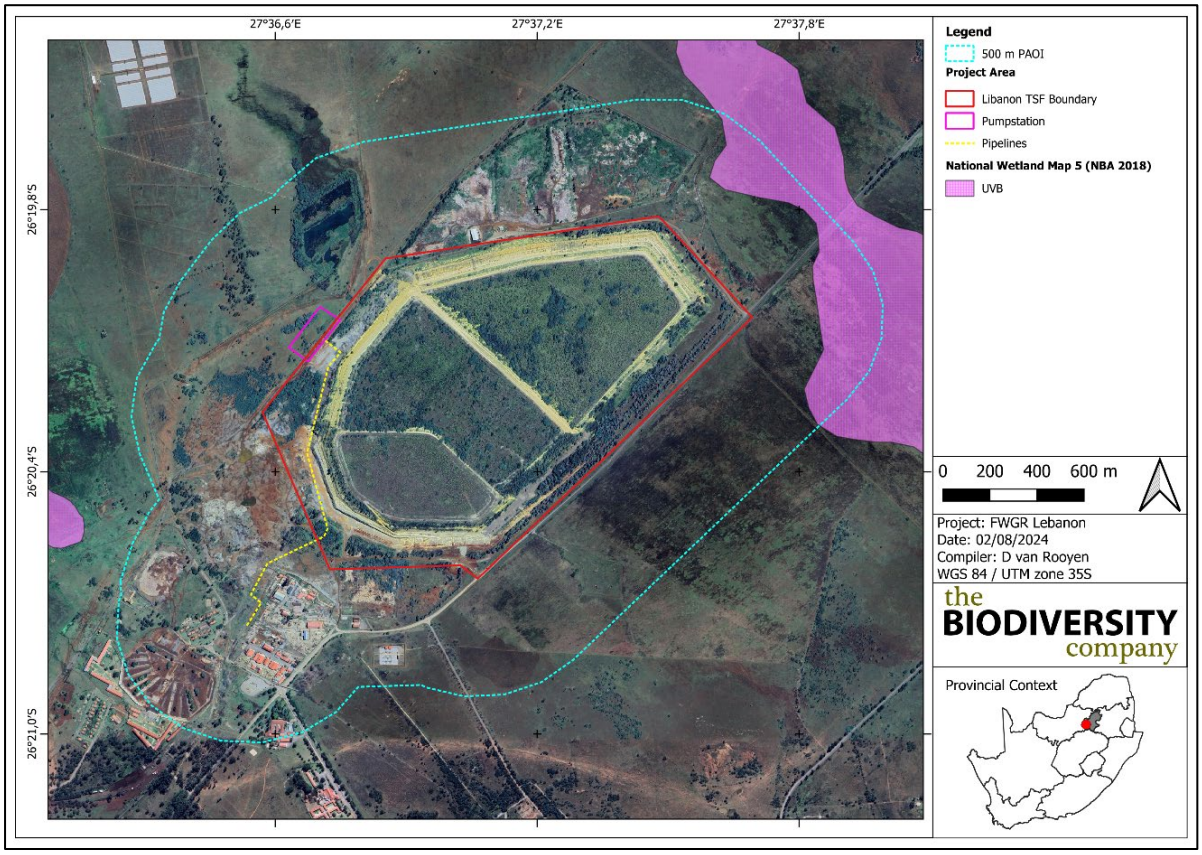


Figure 3-1 South African Inventory of Inland Aquatic Ecosystems for the FWGR Libanon Reclamation Project

3.2 National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas (NFEPA) database forms part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act (Act 36 of 1998) (NWA). This directly applies to the NWA, which feeds into Catchment Management Strategies, water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel *et al*., 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the biodiversity goals of the National Environment Management Biodiversity Act (NEM:BA) (Act 10 of 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel *et al*., 2011). Multiple NFEPA wetland systems (UVB and seep wetlands) are located within the 500 m regulated area of the FWGR Libanon Reclamation Project (see Figure 3-2). In addition, the boundary of the Libanon TSF traverse two small seep wetlands. Furthermore, these wetlands are all classified as artificial, unclassified wetlands. All artificial wetlands were classified with a condition within the "Z3 – Less than 25% natural land cover remaining" category, as per the dataset.

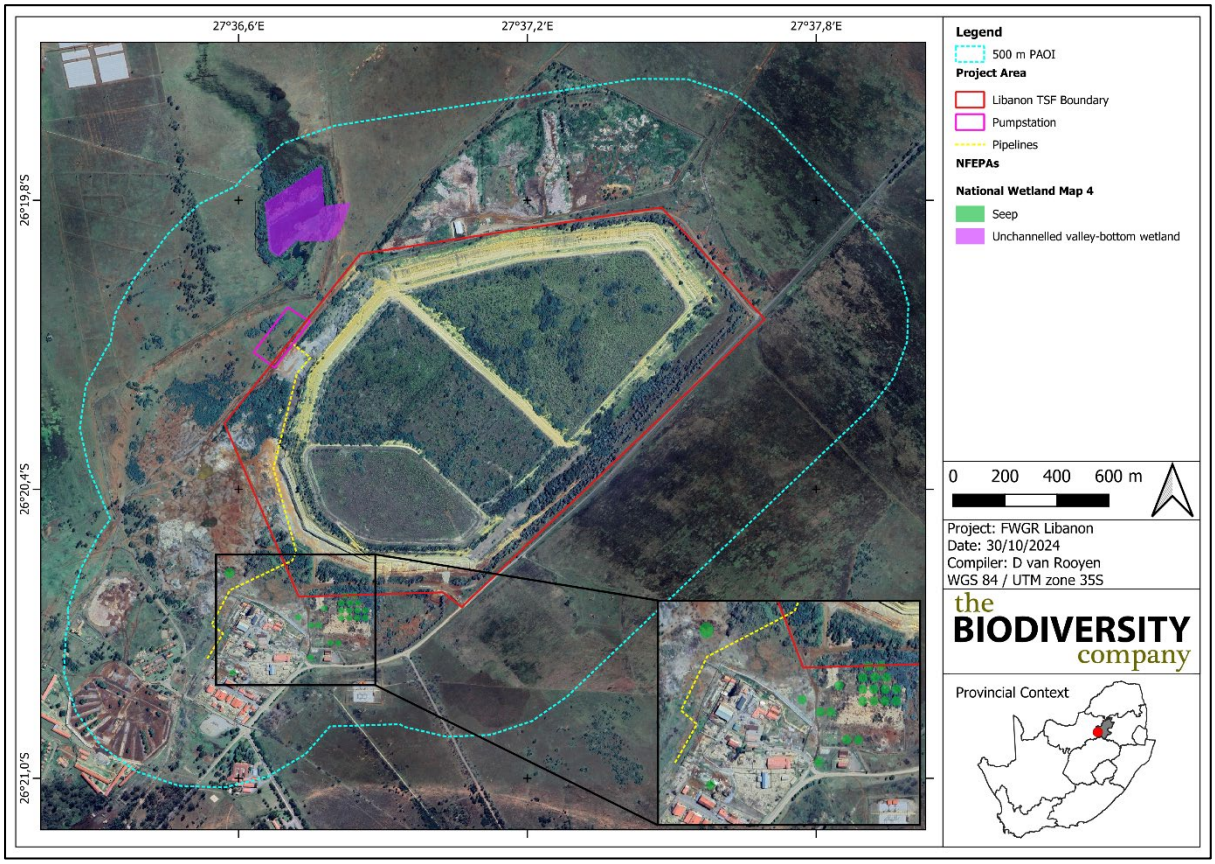


Figure 3-2 NFEPA Wetlands in the FWGR Libanon Reclamation Project

3.3 Survey Results

The water resources were delineated in accordance with the DWAF (2005) guidelines. A site visit was conducted on the 5th of August 2024, this would constitute a dry season survey. The development area was traversed on foot, with numerous checks being undertaken to identify any soil wetness indicators, and to determine the local soil forms.

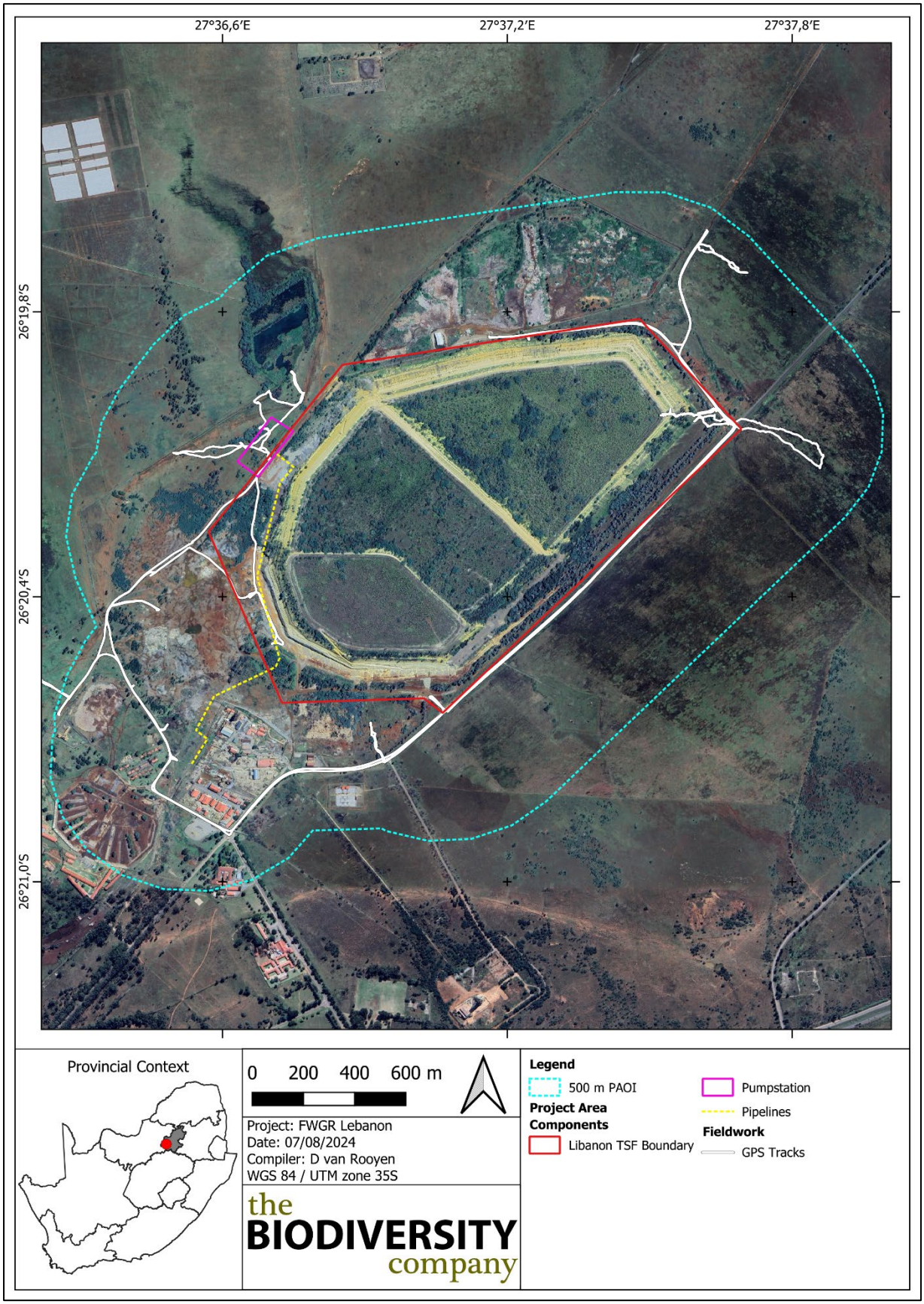


Figure 3-3 GPS tracks

During the site visit numerous artificial wet areas, which were created by mining infrastructure, were identified within the project area of influence. These include artificial seepage from biodam, canal and aboveground pipeline, disturbed areas with hydrophyte vegetation, artificial channels, an artificial canal, and a biodam (Figure 3-4 & Figure 3-6; Table 3-1). Furthermore, no natural wetlands or rivers were identified within the 500 m PAOI and does not coincide with what the desktop datasets (SAIIAE and NFEPA) have identified. However, the Department of Water and Sanitation (DWS) has requested that the SAIIAE and NFEPA wetlands be included as part of the assessment. As a result, they have been labelled as HGM 1 (Unchannelled valley-bottom - UVB) and HGM 2 (Seep) in Figure 3-6. Both HGM units have been classified as artificial systems within the SAIIAE and NFEPA datasets. It is the opinion of the specialist that the systems requested to be included in the assessment are not present.

Importantly, the project components (TSF, pipeline and pumpstation) do not traverse any natural watercourses, ensuring minimal disruption to the natural hydrological environment. The DWS has requested that functional assessments be done for the UVB and the seep wetlands. The delineated seepage areas are artificial systems, which are typically downslope of dams and formed due to dam seepage and overflow. These artificial areas are indicative of water movement through and beneath these artificial containment systems. These seepage areas would cease to exist and become relic wetlands with the removal of these dams. Despite their limited functioning, no further assessment has been undertaken for them.

The seep systems within the project area requested by the DWS to be included, as identified by the NFEPA wetland spatial datasets (Figure 3-2), were historically reservoirs, as evidenced by Google Earth Historic Imagery from 11/03/2003 (Figure 3-5). This imagery shows that these areas were once reservoirs, which have since been decommissioned. Current imagery reveals that these reservoirs have been transformed into seep systems, indicating that they are all artificial in nature.

Table 3-1 Description of the delineated areas.

Delineated Areas	Descriptions
Biodam	A biodam is a type of dam that integrates biological elements or ecosystems into its structure and operation. The concept aims to achieve various environmental benefits, including habitat creation, water quality improvement, and enhanced aesthetic and recreational values. Biodams often incorporate features like green roofs, vegetated spillways, or planted embankments, and are designed to work in harmony with the surrounding ecosystem. The aim is to mitigate the environmental impact of traditional dam structures by promoting ecological balance and biodiversity.
Artificial Canal	An artificial canal constructed from active mining areas to an attenuation pond serves as a conduit for transporting excess water, often laden with sediments and potential pollutants, from the mining site to the pond.
Artificial channels	These channels are essential components of stormwater management systems, designed to mitigate flooding and manage runoff in urban, suburban, and rural areas.
Artificial Seepage from biodam, mining canal and pipeline	Artificial seepage refers to the intentional or accidental movement of water through soil or rock, induced by human activities. This can occur in various contexts, such as: Irrigation, Dam and Reservoir Management, Land Reclamation and Drainages, Artificial Recharge of Aquifers and Mining Activities.
Disturbed Area	A disturbed area, previously mined, now supports hydrophytes but lacks wetland status, indicating partial ecological recovery without full wetland characteristics.
HGM 1 - UVB	Unchannelled valley bottom wetlands are typically found on valley floors where the landscape does not allow high energy flows.
HGM 2 - Seep	A typical hillslope seep is located within slopes. Isolated hillslope seeps are characterised by colluvial movement of material. These systems are fed by very diffuse sub-surface flows which seep out at very slow rates, ultimately ensuring that no direct surface water connects this wetland with other water courses within the valleys.

Figure 3-4 ***Photographical examples of the different water resources found within the 500 m regulated area, A & B) Hydrophytes found in disturbed areas, C) Artificial Canal, D & E) Artificial Channel, F) Biodam and G) Artificial Seepage from mining canal.***

Figure 3-5 ***Google Earth Historic Imagery from 11/03/2003 highlighting the reservoirs that has been labelled as Seep wetlands from the NFEPA spatial dataset***

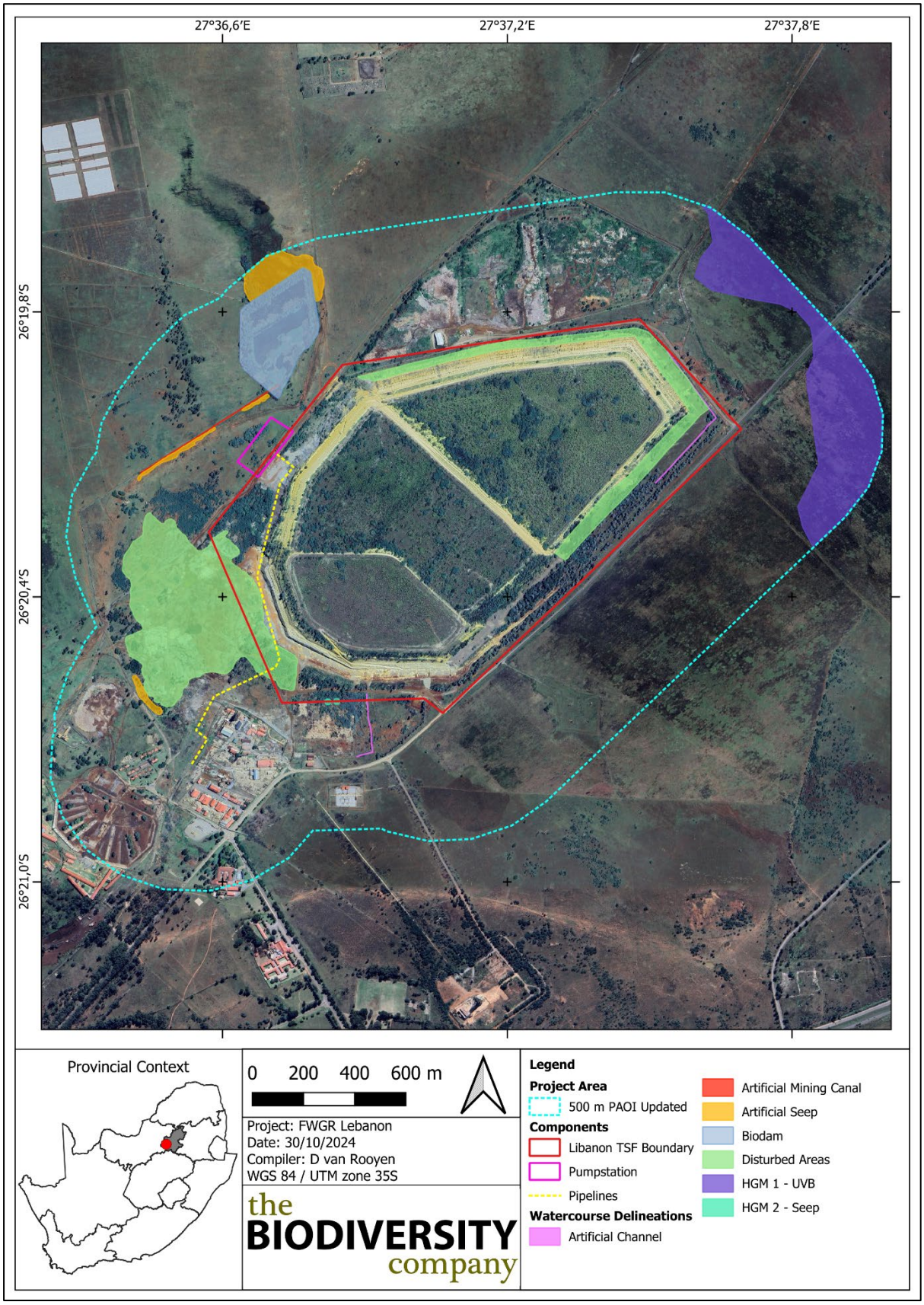


Figure 3-6 The delineated systems of the FWGR Libanon Reclamation Project

The DWAF (2005) manual separates the classification of watercourses into three (3) separate types of channels or sections defined by their position relative to the zone of saturation in the riparian area. The classification system separates channels into:

- those that do not have baseflow ('A' Sections);
- those that sometimes have baseflow ('B' Sections) or non-perennial; or
- those that always have baseflow ('C' Sections) or perennial.

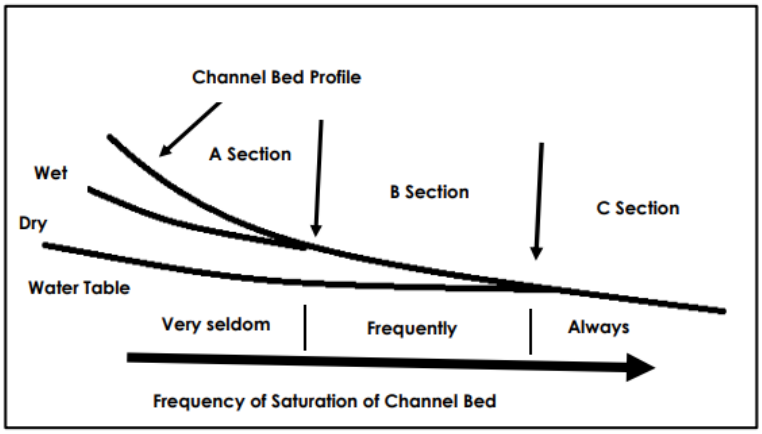


Figure 3-7 The watercourse classifications (DWAF, 2005)

3.3.1 Functional Assessment

Following the functional assessment using the WET-EcoServices (Kotze *et al*. 2008) method, PES, Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Category and Recommended Management Category, the following can be summarised (Table 3-2):

The UVB and seep wetlands within the project area provide Low Ecosystem Services;

The integrity of both systems has been Critically Modified (Class F), indicating extensive loss of natural habitat and ecosystem function;

The Ecological Importance and Sensitivity of these wetlands were determined to be Low/Marginal (Class D); and

The recommended ecological category for both systems is to maintain a seriously/critically modified state (Class E/F).

Table 3-2 Ecological characteristics of the freshwater features within the Libanon PAOI

Aspect	Present Ecological State	Ecological Importance and Sensitivity (EIS)	REC – RMO
HGM 1 – UVB	F – Critically Modified	Low/Marginal	E/F: Maintain
HGM 2 – Seep	F – Critically Modified	Low/Marginal	E/F: Maintain

3.3.2 Buffer Requirements

The "*Buffer zone guidelines for wetlands, rivers and estuaries*" (Macfarlane *et al.,* 2014) was used to determine the appropriate wetland buffer zone for the proposed project.

Buffer zones have been used in land-use planning to protect natural resources and limit the impact of one land-use on another. A buffer zone has been prescribed for this project to serve as a "barrier" between the proposed development and the wetland systems. This buffer area would only be applicable

to wetland areas that will not be lost or where infrastructure is required to traverse a system due to the project.

The wetland buffer zone tool was used to calculate the appropriate buffer required for the proposed project. The model shows that the largest risk posed by the project during the construction phase is that of “increased sediment inputs and turbidity”. During the operational phase, the flow patterns being altered (increase flood peaks); increased sediment inputs; and altered water quality are high risks. These risks are based on what could threaten the wetlands and what buffer would be required at a desktop level. A post-mitigation buffer of 15 m is recommended for the wetlands (Table 3-3).

Table 3-3 Post-mitigation buffer requirement

	Required Buffer after mitigation measures have been applied
Valley Bottom	**15 m**
Seep	**15 m**

3.4 Ecological Sensitivity

The National Web based Environmental Screening Tool has characterised the aquatic theme sensitivity of the development footprint as “Low” sensitivity while the larger regulated area (500 m) traverse “Very High” sensitivity (due to SAIIAE wetland).

Table 3-4 provides a comparison between the Environmental Screening Tool and the specialist determined Site Ecological Importance (SEI) of the project. The specialist-assigned sensitivity ratings are based largely on the SEI process.

Table 3-4 Summary of the Screening Tool Sensitivity versus the Specialist assigned Site Ecological Importance (SEI) for the Field Survey Area of the Project Area

Screening Tool Theme	Screening Tool	System	Specialist	Tool Validated or Disputed by Specialist - Reasoning
Aquatic Biodiversity Theme	Very High	Agricultural land	Low	Disputed – The entire area flagged as a wetland is active grazing pastures with no signs of wetlands indicators. The proposed activities are not anticipated to significantly modify the hydrological characteristics of the entire area; therefore a “Low” sensitivity has been assigned for these areas in relation to freshwater biodiversity.
	Low	Artificial watercourses	Low	Validated - Due to being artificially created, this area is regards as degraded due to removal of vegetation and excavations. Furthermore, the artificial watercourses provide no ecological function. Therefore, these watercourses were assigned a “Low” sensitivity
	Low	Remaining area	Low	Validated – No natural surface water features were identified within the rest of the project area of influence.

4 Impact Assessment

4.1 Current Impacts to Freshwater Biodiversity

The assessed wetlands exhibit impacts at local scale. These impacts result from present and historical land use relating to agricultural practices, developing in or in near proximity to wetlands and mining activities which have transformed the wetland habitats and has altered their natural hydrological regime and vegetation composition. The list below refers to the present-day local impacts observed within the assessed wetland areas:

Wetland disturbance from grazing activities and other agricultural practises (crop fields);

Altered hydrological inputs resulting from changes to the surrounding landscape;

Altered geomorphology from historical agricultural practices;

Loss of wetland vegetation from continual disturbances, historical land use and the establishment of alien invasive flora species in some approaches of the wetlands; and

Wetland degradation from mining activities.

4.2 Risk Assessment

This assessment has been completed in accordance with the requirements of the published General Notice (GN) 4167 by the Department of Water and Sanitation (DWS) (previously GN 509 of 2016 and GN 3139 of 2023). The said notice was published in the Government Gazette (no. 49833) under Section 39 of the National Water Act (Act no. 36 of 1998) in December 2023, for a Water Use Licence (WUL) in terms of Section 21(c) & (i) water uses. The GN 4167 process provides an allowance to apply for a WUL for Section 21(c) & (i) under a General Authorisation (GA), as opposed to a full Water Use Licence Application (WULA). A water use (or potential) qualifies for a GA under GN 4167 when the proposed water use/activity is subjected to analysis using the DWS Risk Assessment Matrix (RAM), provided the identified risks are all considered a low risk, and the applicant is listed under Appendix D1 or Appendix D2 of the same notice. This assessment will implement the RAM and provide a specialist opinion on the appropriate water use authorisation.

The assessment considered the anticipated direct and indirect risks to the wetland systems as a result of the proposed development (Table 4-1). The mitigation hierarchy as discussed by the Department of Environmental Affairs (2013) will be considered for this component of the assessment (Figure 4-1). In accordance with the mitigation hierarchy, the preferred mitigatory measure is to avoid impacts by considering alternate options in project location, sitting, scale, layout, technology and implementing project/activity phasing to avoid impacts.

Under the assumption that the proposed activities will be designed such that the wetland will be avoided, the pre- and post- mitigation risks were therefore determined to be “Low” in relation to the proposed development. It should be noted that even if avoided, some direct as well as indirect impacts are potential, therefore the focus will be on minimising impacts to the watercourses and wetlands.

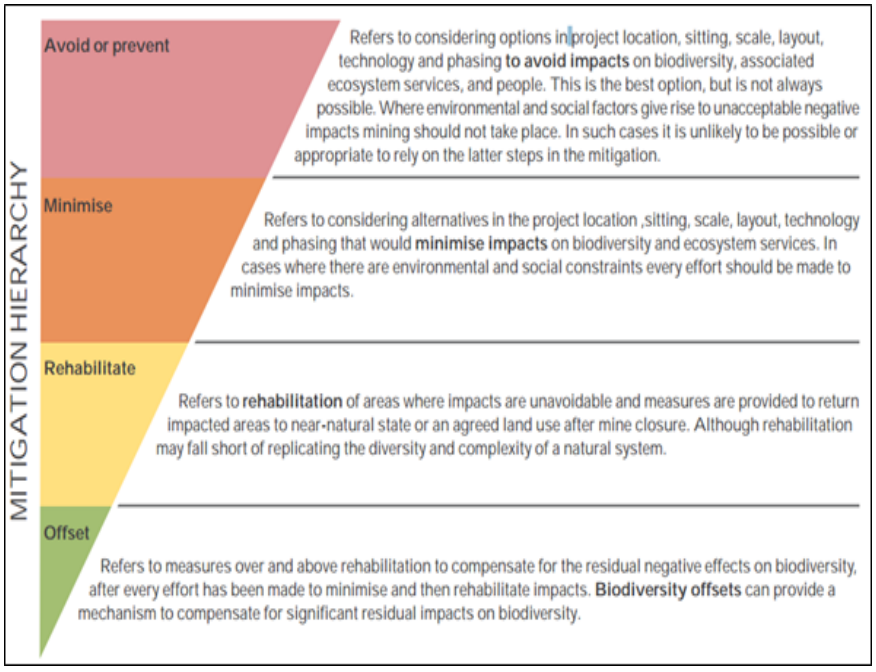


Figure 4-1 The mitigation hierarchy as described by the DEA (2013)

Table 4-1 Mitigated DWS Risk Assessment Matrix for wetlands in relation to the proposed development

Phase	Activity	Impact	Significance (max = 100)	Risk Rating	Confidence level
CONSTRUCTION	Site clearing and preparation.	Disturbance and degradation of wetland vegetation	**12,6**	**L**	High
		Increased bare surfaces, runoff and potential for erosion	**8,4**	**L**	High
		Introduction and spread of alien and invasive vegetation	**16,2**	**L**	High
	Excavation, levelling and installation of the structures.	Increased sediment loads to downstream reaches	**8,4**	**L**	High
		Contamination of wetlands with hydrocarbons due to leaks and spillages from machinery, equipment & vehicles as well as Contamination and eutrophication of wetland systems with human sewerage and litter.	**18**	**L**	High
	Routine operation and maintenance of the structures	Degradation of wetland vegetation.	**15,6**	**L**	High
		Proliferation of alien and invasive species	**16,2**	**L**	High
OPERATIONAL	Routine operation and maintenance of the structures	Degradation of wetland vegetation.	**13,2**	**L**	High
		Proliferation of alien and invasive species	**10,8**	**L**	High
DECOMMISSIONING	Removal of the structures	Degradation of wetland vegetation and proliferation of alien and invasive species	**10,8**	**L**	High
		Increased bare surfaces, runoff and potential for erosion	**12,6**	**L**	High

4.3 Mitigation Measures:

In light of the expected impacts from proposed activities the following mitigation measures have been proposed to lower the intensity of the impacts on the ecological integrity of the wetlands.

The focus of mitigation measures should be to reduce the significance of potential environmental impacts associated with the proposed development and thereby to:

Prevent the unnecessary destruction and fragmentation of the vegetation community of the wetland areas; and

Limit the construction area to the defined project areas and only impact those areas where it is unavoidable to do so otherwise.

4.3.1 Development Specific Mitigation

The following pipeline development specific mitigation measures are provided:

- Adherence to the buffer areas. These should be visibly demarcated to avoid encroachment into these areas;
- Silt traps and sediment trapping berms must be in place around drainage lines around the construction site to prevent the movement of contaminated or sediment laden runoff from entering the wetlands;
- Erosion prevention and sediment control measures (wetland and drainage line) are imperative and need to be implemented throughout the entire project footprint area of the proposed development, access roads and temporary laydown / storage sites. Temporary erosion control methods may include silt fences, interceptor ditches, seeding and sodding, riprap of exposed embankments, erosion mats, and mulching; and
- All removed soil and material must not be stockpiled within the watercourse and buffers. Stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds.

4.3.2 Erosion and sedimentation of watercourses

The alteration of surface topography and hydrology for the project infrastructure will inevitably be accompanied by an increase in erosion and sedimentation as rainwater erodes and washes exposed soils (active working and exposed areas) into the watercourses. This is a key consideration for the project due to the current levels of exposed soils within watercourses.

Mitigation:

Loose soils are particularly prone to loss due to wind or water. It is therefore preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces;

Practice good soil management across the construction footprint;

Avoid the creation of concentrated flow paths wherever possible;

Signs of erosion must be addressed immediately to prevent further erosion of the area to prevent head cut erosion from forming;

Temporary and permanent erosion control methods may include silt fences, flotation silt curtains, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed embankments, erosion mats, and mulching;

Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil;

Relandscape to gentler gradients and re-vegetate all cleared areas, which includes the areas adjacent to the proposed infrastructure, as soon as possible to limit erosion potential. Sandbags and geotextiles should be used to assist until vegetation has established in these reworked areas;

Stem any head cut/ erosion gulley as it occurs by bulldozing, filling, re-contouring to gentler gradients and re-vegetating; and

The rehabilitation of watercourse banks must take place following construction. Key areas where erosion has occurred should be rehabilitated through bank reprofiling to gentler gradients and the revegetation of the wetland periphery areas.

4.3.3 General Mitigation Measures

The following general mitigation measures are provided in addition to the aforementioned mitigation:

It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces;

The wetland areas outside of the specific project site area must be avoided where possible;

The project should be relocated to outside of the wetland buffer zones, which would significantly reduce potential impacts to the said systems;

The construction vehicles and machinery must make use of existing access routes as much as possible, before adjacent areas are considered for access;

Laydown yards, camps and storage areas must be beyond the wetland areas. Where possible, the construction of the road and crossings must take place from the existing paths;

Prevent uncontrolled access of vehicles through the watercourses that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas;

All chemicals and toxicants to be used for the construction must be stored outside the watercourse areas and their respective buffers and in a bunded area;

All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site in a designated area;

All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good “housekeeping”;

Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel within the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);

Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems;

The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;

All removed soil and material must not be stockpiled within the system. Stockpiling should take place outside of the watercourse buffers. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds;

Mixing of concrete must under no circumstances take place within the drainage or wetland systems. Scrape the area where mixing and storage of sand and concrete occurred to clean once finished;

No dumping of construction material on-site may take place;

All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported; and

Consideration should be given to implementing an alien invasive plant management plan post construction to control any current invaded areas and prevent the growth of alien invasive species on cleared areas.

5 Conclusions

The development area was traversed on foot, with numerous checks being undertaken to identify any soil wetness indicators, and to determine the local soil forms.

During the site visit, several artificial watercourses, established as a result of mining infrastructure, were identified within the PAOI. These include artificial seep wetlands, channels, a mining canal, and a biodam. Notably, no natural wetlands or rivers were found within the 500 m PAOI, which contradicts the desktop datasets from SAIIAE and NFEPA. Despite this discrepancy, DWS has requested the inclusion of the SAIIAE and NFEPA wetlands in the assessment. Consequently, these have been designated as HGM units: HGM 1 (UVB) and HGM 2 (Seep), both classified as artificial systems within the datasets.

The delineated seepage areas, typically located downslope of dams, are artificial, formed due to dam seepage and overflow. These areas exemplify water movement through and beneath these containment systems and would cease to exist, reverting to relic wetlands, upon dam removal. Although their functionality is limited, no further assessment has been conducted.

Historical Google Earth imagery from 11/03/2003 confirms that these seep systems were originally reservoirs, which have since been decommissioned and transformed into artificial seep systems. Importantly, the project's components, including the TSF, pipeline, and pump station, do not intersect any natural watercourses, thereby minimizing disruption to the natural hydrological environment. The DWS has requested functional assessments for the UVB and seep wetlands. The functional assessments were be summarised as:

Aspect	Present Ecological State	Ecological Importance and Sensitivity (EIS)	REC – RMO
HGM 1 – UVB	F – Critically Modified	Low/Marginal	E/F: Maintain
HGM 2 – Seep	F – Critically Modified	Low/Marginal	E/F: Maintain

5.1 Ecological Sensitivity

Screening Tool Theme	Screening Tool	System	Specialist	Tool Validated or Disputed by Specialist - Reasoning
Aquatic Biodiversity Theme	Very High	Agricultural land	Low	Disputed – The entire area flagged as a wetland is active grazing pastures with no signs of wetlands indicators. The proposed activities are not anticipated to significantly modify the hydrological characteristics of the entire area; therefore a “Low” sensitivity has been assigned for these areas in relation to freshwater biodiversity.
	Low	Artificial watercourses	Low	Validated - Due to being artificially created, this area is regards as degraded due to removal of vegetation and excavations. Furthermore, the artificial watercourses provide no ecological function. Therefore, these watercourses were assigned a “Low” sensitivity
	Low	Remaining area	Low	Validated – No natural surface water features were identified within the rest of the project area of influence.

5.2 Risk Statement

The risk assessment was completed in accordance with the requirements of GN 4167 by the DWS in terms of Section 21(c) & (i) water uses. The overall residual risks were determined to be low.

5.3 Specialist Statement

Due to the proposed project area being comprised of only artificial watercourses, the proposed project area will have an insignificant impact on the aquatic biodiversity of the area. The proposed development will not alter the integrity of the two HGM units (Class F), and maintenance of this category is recommended for the project. Therefore, the proposed development can be favourably considered for authorisation.

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7 Appendix Items

7.1 Appendix A – Specialist Declaration of Independence

I, Divan van Rooyen, declare that:

I act as the independent specialist in this application;

I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;

I declare that there are no circumstances that may compromise my objectivity in performing such work;

I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;

I will comply with the Act, regulations and all other applicable legislation;

I have no, and will not engage in, conflicting interests in the undertaking of the activity;

I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;

All the particulars furnished by me in this form are true and correct; and

I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Divan van Rooyen

Freshwater Ecologist

The Biodiversity Company

August 2024

I, Rowan Buhrmann, declare that:

I act as the independent specialist in this application;

I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;

I declare that there are no circumstances that may compromise my objectivity in performing such work;

I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;

I will comply with the Act, regulations and all other applicable legislation;

I have no, and will not engage in, conflicting interests in the undertaking of the activity;

I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;

All the particulars furnished by me in this form are true and correct; and

I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Rowan Buhrmann

Ecologist

The Biodiversity Company

August 2024

7.2 Appendix B – Specialist CVs

Divan van Rooyen

Ph.D. Environmental Science

Can Sci Nat (151272)

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Email: divan@thebiodiversitycompany.com
Identity Number: 9312205072085
Date of birth: 20 December 1993

Profile Summary

Working experience throughout Southern Africa

Specialist experience with mining, WWTW's and construction.

Specialist expertise include wetlands resources, aquatic ecology and ecotoxicology.

Areas of Interest

Mining, Seismic Surveys, Renewable Energy, Bulk Services Infrastructure Development & WWTW's.

Key Experience

- Environmental Impact Assessments (EIA)
- Environmental Management Programmes (EMP)
- Wetland delineations and ecological assessments
- Rehabilitation Plans and Monitoring
- Aquatic biomonitoring

Country Experience

South Africa

Nationality

South African

Languages

English – Proficient

Afrikaans – Proficient

Qualifications

- PhD (North-West University of Potchefstroom) – Environmental Science with Aquatic Ecosystem Health
- MSc (North-West University of Potchefstroom) – Environmental Science (Ecological Remediation and Sustainable Management)
- BSc Honours (North-West University of Potchefstroom) – Environmental Science with Ecological Remediation and Sustainable Management
- BSc Environmental sciences
- Can Sci Nat (151272)

Rowan Buhrmann

MSc Biology (Plant Ecophysiology)

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Email: rowan@thebiodiversitycompany.com

Identity Number: 9111085091086

Date of birth: 08 November 1991

Profile Summary

Working experience throughout KwaZulu-Natal (South Africa).

Experience in Environmental Consulting as an EAP (EIAs and WULA).

Environmental Control Officer (ECO).

Specialist expertise in Climate Change (elevated temperatures) and Botany.

Areas of Interest

Aquatic Ecology and Water Resource Management.

Renewable Energy.

Sustainability and Conservation.

Landscape rehabilitation.

Geographic Information Systems.

Experimental Design.

Key Experience

- Environmental Impact Assessments and Water Use Licence Applications
- Vegetation Assessments
- Wetland delineations and ecological assessments
- Rehabilitation Plans and Monitoring

Countries worked in

South Africa

Nationality

South African

Languages

English – Proficient

Qualifications

- MSc (University of KwaZulu-Natal) – Plant EcoPhysiology.
- BSc Honours (University of KwaZulu-Natal) – Biology
- BSc (University of KwaZulu-Natal) – Biology
- Certificate of Competence: Wetland WET-Health (V2)
- Pr Sci Nat (136853)

TERRESTRIAL BIODIVERSITY COMPLIANCE STATEMENT FOR THE PROPOSED FGWR PHASE 2 EXPANSION: LIBANON

West Rand District Municipality, Gauteng Province, South Africa

08/01/2025

Prepared by:

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Report Name	**TERRESTRIAL BIODIVERSITY COMPLIANCE STATEMENT FOR THE PROPOSED FGWR PHASE 2 EXPANSION: LIBANON**
Specialist Theme	Terrestrial Biodiversity Compliance Statement
Project Reference	FWGR Phase 2 Expansion: Libanon
Report Version	Draft 1 / 08/01/2025
Environmental Assessment Practitioner	KONGIWE
Fieldwork + Report Writer	Julia Elliott (SACNASP Pending)
Reviewer	Sarah Newman (Cand. Sci. Nat. 158474)
Reviewer	Martinus Erasmus (SACNASP 118630)
Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, Amended. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.

Table of Contents

1. Introduction 5
1.1 Background 5
1.2 Project Description 7
1.3 Scope of Work 7
1.4 Assumptions and Limitations 8
1.5 Legislative Framework 8
2. Fieldwork 10
2.1 Biodiversity Field Assessment 10
3. 3. Results & Discussion 11
3.1 3.1 Ecologically Important Landscape Features 11
3.2 Biodiversity Field Survey 12
3.3 Habitat Assessment 16
3.4 Site Ecological Importance 18
3.5 Desktop Ecological Sensitivity 19
3.5.1 Screening Tool Comparison 23
4. Impact Management and Mitigation Plan 24
5. Conclusion 30
5.1 5.1 Impact Statement 30
5.2 5.2 Specialist Opinion 30
6. References 31
7. Appendix Items 33
7.1 Appendix A: Methods 33
7.1.1 Desktop Dataset Assessment 33
7.2 Appendix C – Specialist Declaration of Independence 40
7.3 Appendix D – Specialist CVs 42

List of Tables

Table 1-1 Terrestrial Biodiversity Compliance Statement information requirements as per the relevant protocol, including the location of the information within this report 9

Table 3-1 Summary of relevance of the proposed project to ecologically important landscape features 11

Table 3-2 Sensitivity summary of the survey points and habitat types delineated within the PAOI.. 12

Table 3-3 Table providing descriptions of the habitat types delineated for the PAOI 17

Table 3-4 Summary of habitat types delineated within the PAOI 18

Table 3-5 Summary of the screening tool vs specialist assigned sensitivities 23

Table 4-1 Project specific mitigation measures including requirements for timeframes, roles and responsibilities 25

Table 7-1 Summary of Conservation Importance (CI) criteria 36

Table 7-2 Summary of Functional Integrity (FI) criteria 37

Table 7-3 Matrix used to derive Biodiversity Importance (BI) from Functional Integrity (FI) and Conservation Importance (CI) 37

Table 7-4 Summary of Receptor Resilience (RR) criteria 38

Table 7-5 Matrix used to derive Site Ecological Importance from Receptor Resilience (RR) and Biodiversity Importance (BI) 38

Table 7-6 Guideline for interpreting Site Ecological Importance in the context of proposed activities 39

List of Figures

Figure 1-1 Map illustrating the regional context of the PAOI 6
Figure 1-2 Map illustrating the Project Area of Influence (PAOI) 6
Figure 2-1 Map illustrating the field tracks of the field survey 10
Figure 3-1 Habitats identified within the PAOI 16
Figure 3-2 Terrestrial Biodiversity Theme Sensitivity 20
Figure 3-3 Plant Species Theme Sensitivity 21
Figure 3-4 Animal Species Theme Sensitivity 22
Figure 3-5 Map illustrating the site ecological importance for the PAOI 23

1. Introduction

1.1 Background

The Biodiversity Company (TBC) was appointed to undertake a terrestrial biodiversity baseline assessment for the proposed Libanon Tailings Storage Facility (TSF) Reclamation Project near Westonaria, Gauteng Province. The existing TSF and proposed pipelines were all assigned a 100m buffer, collectively referred to as the Project Area of Influence (PAOI) from here on. A map presenting the regional context of the PAOI can be seen in Figure 1-1 and a map presenting the PAOI can be seen in Figure 1-2.

To determine the baseline ecological state of the area and to present a detailed description of the receiving environment, both a desktop assessment, as well as a field survey on the 5th of August 2024, were conducted. Furthermore, the desktop assessment and field survey both involved the detection, identification and description of any locally relevant sensitive receptors and habitats. The way these sensitive features may be affected by the proposed development was also investigated.

This assessment was conducted in accordance with the amendments to the Environmental Impact Assessment Regulations, 2014 (No. 326, 7 April 2017) of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998). The approach has taken cognisance of the Government Notice 320 in terms of NEMA dated 20 March 2020 as well as the Government Notice 1150 in terms of NEMA dated 30 October 2020: “Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation”. The National Web based Environmental Screening Tool has characterised the terrestrial biodiversity theme for the area as ‘Very High’ sensitivity (National Environmental Screening Tool, 2024).

The purpose of conducting the specialist study is to provide relevant input into the Environmental Authorisation application process, with a focus on the proposed activities and their impacts associated with the project. This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Registered Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making as to the ecological viability of the proposed project.

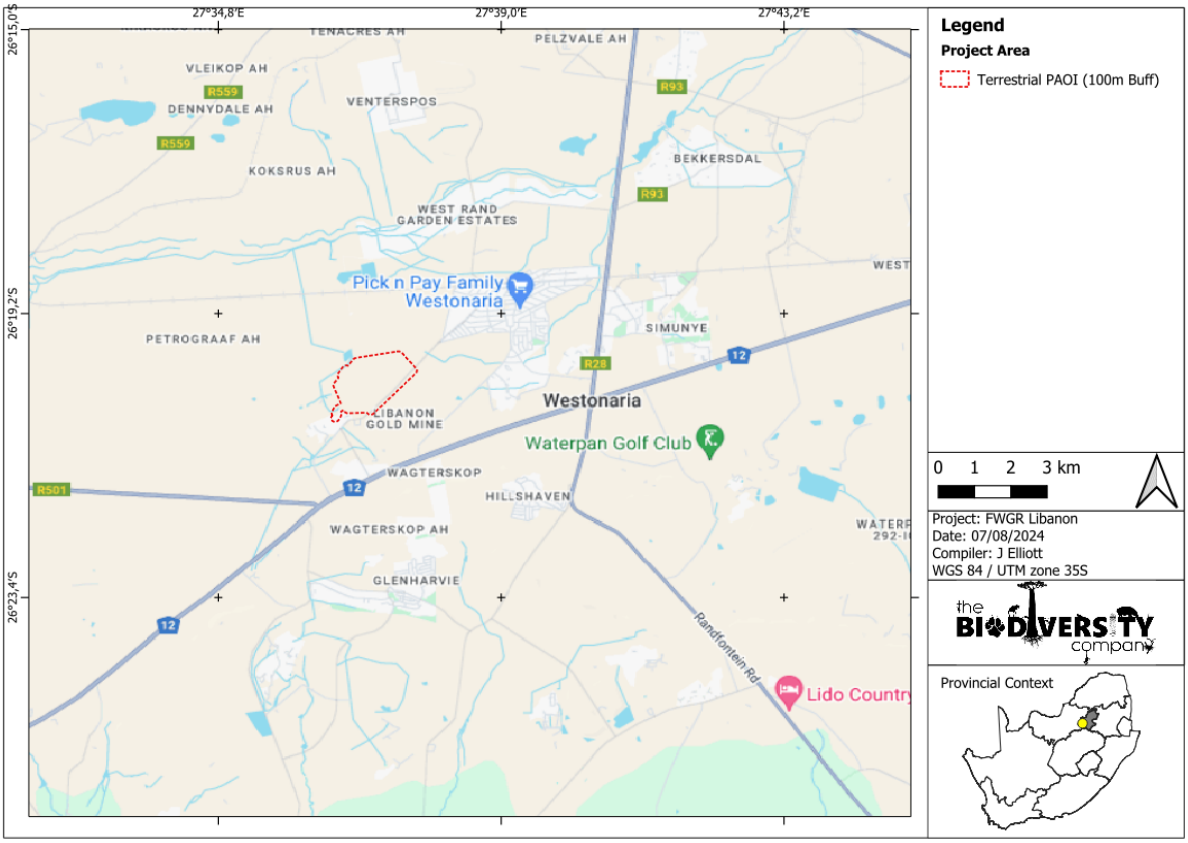


Figure 1-1 Map illustrating the regional context of the PAOI

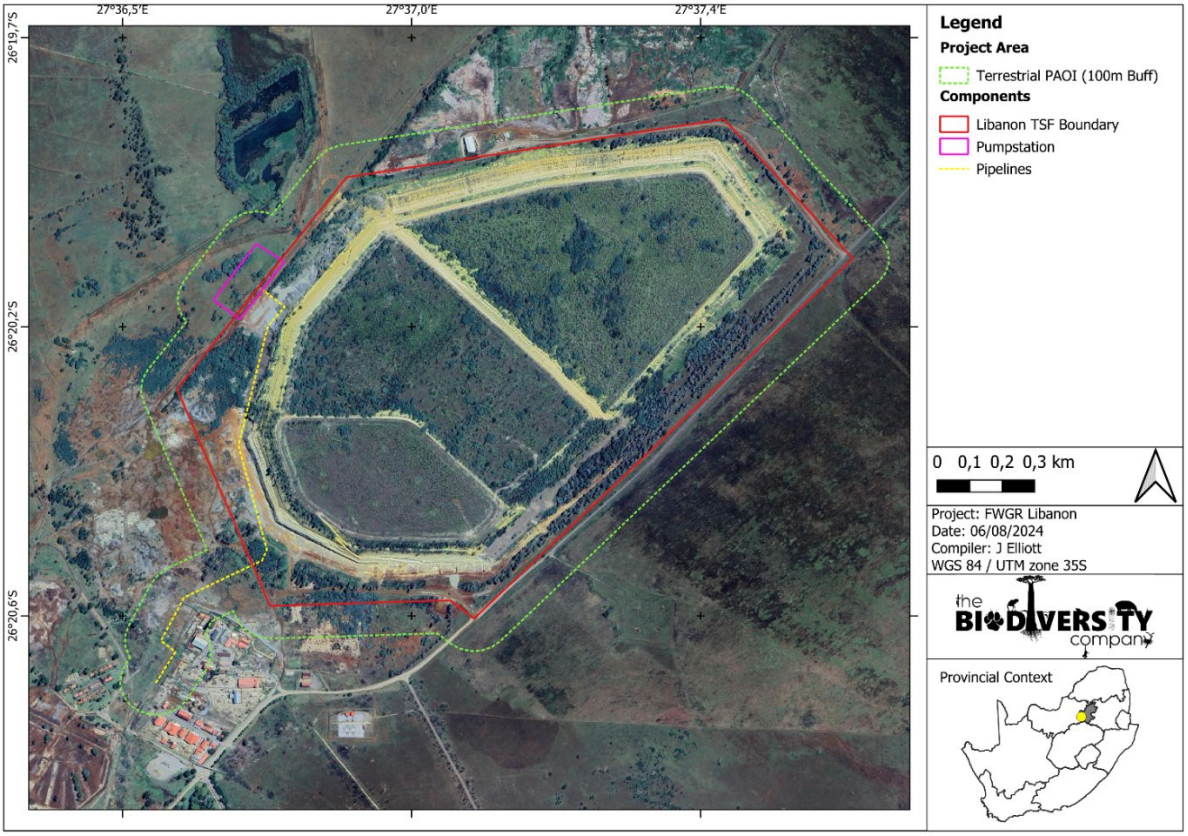


Figure 1-2 Map illustrating the Project Area of Influence (PAOI)

1.2 Project Description

In 2017, Sibanye Gold Limited, a subsidiary of Sibanye-Stillwater Limited, received approval (Licence No. 10/C22B/ACFGI/4976) to execute the West Rand Tailings Retreatment Project (WRTRP). This project involves reclaiming historic tailings storage facilities (TSFs) in Gauteng's West Rand, treating tailings, and disposing of residue on the Regional TSF (RTSF). The project spans several Mining Right Areas owned by Sibanye, including Driefontein, Kloof, Cooke, and Ezulwini. In 2018, a commercial agreement between DRDGOLD Limited and Sibanye formed Far West Gold Recoveries (FWGR), which acquired specific assets of the WRTRP, focusing on the surface plant and tailings dam assets of Driefontein and Kloof, with potential future acquisitions from Cooke operations (Kongiwe, 2024).

FWGR plans to reclaim and reprocess gold residues from the Libanon TSF, with slurry processed at the Driefontein No. 2 Plant. The necessary infrastructure includes pump stations, process water from Kloof Shaft 10#, pollution control paddocks, access roads, laydown areas, and powerlines. The TSF is located about 2 km west of Westonaria in the Rand West City Local Municipality. Existing pipelines and roads will be used, with new 4 m wide gravel roads constructed where necessary. The reclamation will require 3 kVA of electricity from Eskom and potable water from Rand Water Board or the Municipality. The project is expected to last approximately 12 years, pumping an estimated 600,000 tons/month of slurry to the Driefontein 2 Plant for beneficiation (Kongiwe, 2024).

The reclamation method will employ top-down hydraulic reclamation, using high-pressure water cannons to create a slurry from the tailings, which will then be processed for gold extraction at the Driefontein No. 2 Plant. Once reclamation is complete, the area will be assessed for contamination, with necessary remediation followed by land levelling and returning the land to its original topography. This project aims to remove a pollution source, aiding in the rehabilitation of the mining legacy in the area (Kongiwe, 2024).

1.3 Scope of Work

The aim of the biodiversity assessment was to provide information to guide the risk of the proposed activity to the current state of the associated ecosystems within the development area. This was achieved through the following:

- Desktop assessment to identify the ecologically important features within the landscape comprising of terrestrial features;
- Desktop assessment to identify possible Species of Conservation Concern (SCC) that occur within the landscape;
- Field survey to record flora and fauna species, especially Species of Conservation Concern (SCC);
- Determination of the Site Ecological Importance (SEI), also commonly referred to as sensitivity; and
- The prescription of mitigation measures for identified risks.

1.4 Assumptions and Limitations

The following assumptions and limitations are applicable for this assessment:

- It is assumed that all information received from the client and landowner is accurate;
- All datasets accessed and utilised for this assessment are considered to be representative of the most recent and suitable data for the intended purposes;
- The assessment area (PAOI) was based on the footprint areas as provided by the client, and any alterations to the area and/or missing GIS information pertaining to the assessment area would have affected the area surveyed and hence the results of this assessment;
- The area was surveyed during a single site visit, therefore, this assessment does not consider temporal trends (note that the data collected is considered sufficient to derive a meaningful baseline);
- The single site visit was conducted during the dry season (winter), and this means that certain flora and fauna would not have been present or observable due to seasonal constraints;
- Whilst every effort was made to cover as much of the PAOI as possible, representative sampling was completed, and by its nature it is possible that some plant and animal species that are present within the PAOI were not recorded during the field investigations;
- This report must be considered in conjunction with the accompanying freshwater report (TBC, 2024); and
- The GPS used in the assessment has an accuracy of 5 m and consequently any spatial features may be offset by up to 5 m.

1.5 Legislative Framework

In line with the protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial biodiversity, as per Government Notice 320 published in terms of NEMA, dated 20 March 2020: “Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation” – section 3, subsection 1:

- An applicant intending to undertake an activity identified in the scope of the protocol, on a site identified on the screening tool as being of 'Very High’ sensitivity for terrestrial biodiversity, must submit a Terrestrial Biodiversity Specialist Assessment; however
- Where the information gathered from the site sensitivity verification differs from the designation of ‘Very High’ terrestrial biodiversity sensitivity on the screening tool and it is found to be of a ‘Low’ sensitivity, then a Terrestrial Biodiversity Compliance Statement must be submitted.

The information obtained from a site sensitivity verification, which involved both a desktop assessment as well as a field survey, confirmed that the proposed PAOI is of a ‘Low’ sensitivity. Therefore, this report constitutes a Terrestrial Biodiversity Compliance Statement.

As per sections 2 and 3 of the protocol discussed above, a Terrestrial Biodiversity Compliance Statement must contain the information as presented in Table 1-1 below.

Table 1-1 Terrestrial Biodiversity Compliance Statement information requirements as per the relevant protocol, including the location of the information within this report

Information to be Included (as per GN 320, 20 March 2020)	Report Section
Methodology used to undertake the site assessment and survey, and prepare the compliance statement, including relevant equipment and modelling used	7.1
Description of the assumptions and any uncertainties or gaps in knowledge or data	1.4
A baseline profile description of biodiversity and ecosystems of the site	2.1
Site sensitivity verification: Desktop Analysis using satellite imagery and available information	3.1
A statement on the duration, date and season of the site inspection	2
Site sensitivity verification: Onsite inspection, include a description of current land use and vegetation found on-site	3.2
Site sensitivity verification: Photographs/evidence of environmental sensitivity	3.2/3.3/3.4
Screening tool confirmation/dispute: The assessment must verify the "low" sensitivity of the site, in terms of plant, animal, and terrestrial biodiversity themes	3.5.1
Proposed impact management outcomes or monitoring requirements for inclusion in the EMPr	4
Indicate whether or not the proposed development will have any impact on the terrestrial environment, animals and/or plants	5
A signed statement of independence by the specialist	7.2
Specialist details, including a CV	7.3

A signed copy of the compliance statement must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.

2. Fieldwork

2.1 Biodiversity Field Assessment

A single season field survey was undertaken on the 5th of August 2024, which constitutes a dry season survey, to determine the presence of any local SCC and to achieve the delineation of local habitat types and their associated sensitivities. Effort was made to cover all the different habitat types within the PAOI, within the limits of time, access and security. This site visit is considered sufficient for the project (Figure 2-1).

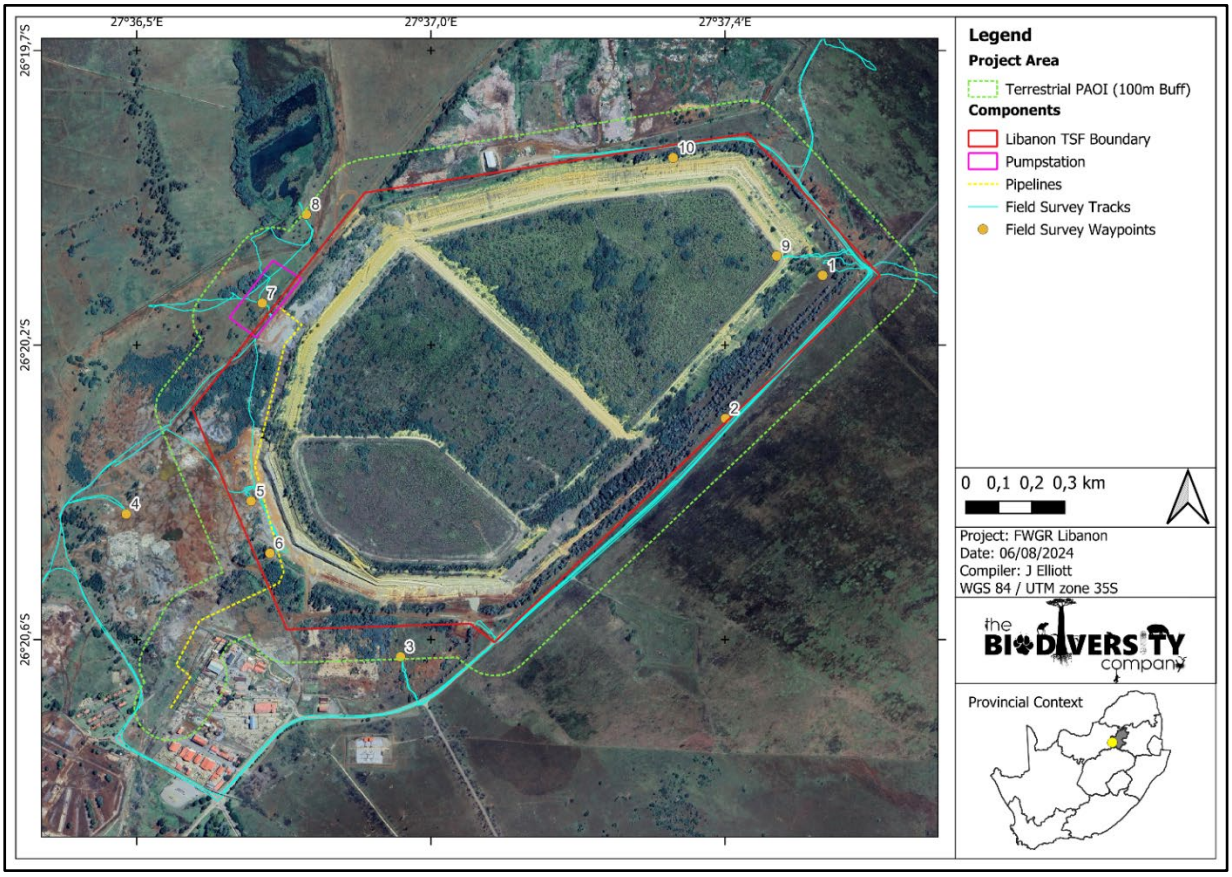


Figure 2-1 Map illustrating the field tracks of the field survey

3. 3. Results & Discussion

3.1 3.1 Ecologically Important Landscape Features

Table 3-1 below has been produced as a result of the spatial data collected and analysed as provided by relevant sources. It presents a summative breakdown of the ecological boundaries considered and the associated relevance that each has to the region or PAOI.

Table 3-1 Summary of relevance of the proposed project to ecologically important landscape features

Desktop Information Considered	Relevance	Reasoning
Ecosystem Threat Status	Relevant	Overlaps with a 'Least Concern' Ecosystem (RLE, 2021)
Ecosystem Protection Level	Relevant	Overlaps with a 'Poorly Protected' Ecosystem (NBA, 2018)
Provincial Conservation Plan	Relevant	Overlaps marginally with an Ecological Support Area (ESA) and a CBA: Important Area (CBA 2)
SAPAD & SACAD	Irrelevant	Does not overlap with any relevant areas
Gauteng Ridges	Relevant	Overlaps with a Class 4 Gauteng Ridge
National Protected Areas Expansion Strategy	Relevant	Overlaps with an NPAES Focus Area (NPAES, 2018)
Key Biodiversity Area (KBA)	Relevant	Does not overlap with any relevant KBAs
South African Inventory of Inland Aquatic Ecosystems (SAIIAE)	Relevant	PAOI 500 m regulated area overlaps with a 'Critically Endangered' wetland
National Freshwater Priority Area (NFEPA)	Relevant	PAOI 500 m regulated area overlap with a 'Non-priority' FEPA wetland
Strategic Water Source Area (SWSA)	Relevant	Overlaps with Far West Karst Region Groundwater SWSA

3.2 Biodiversity Field Survey

The following sections discuss the results from the field survey that was conducted for the proposed project, which was undertaken on the 5th of August 2024. Each sample point is described in Table 3-2.

Table 3-2 Sensitivity summary of the survey points and habitat types delineated within the PAOI

Survey Point	Description	SEI	Photographs
Site GPS Reference: Marker 7 Date: 05/08/2024 GPS Coordinates: 26°20'50.49"S 27°36'41.09"E	**Degraded Grassland around a Quarry** Made up of grassland habitat that is currently not in a functional state. Quarry was highly disturbed with a dominating presence of the alien plant species - *Acacia dealbata.* Evidence of littering as well as livestock grazing. No fauna or flora SCC observed, and none expected for the habitat unit. Common mammal species observed such as yellow mongoose and ground squirrel.	Low	
Site GPS Reference: Marker 1 Date: 05/08/2024 GPS Coordinates: 26°20'20.77"S 27°37'35.96"E	**Secondary Grassland** Made up of secondary grassland habitat which remains in a disturbed sate evident by the presence of invasive plant species (*Eucalyptus spp.*) as well as encroacher species (*Asparagus africanus*). Native grass species covered a large portion of the area and not a lot of land was left bare. Evidence of anthropogenic disturbance present such as litter throughout the habitat. No fauna or flora SCC observed, and none expected for the habitat unit.	Low	

Survey Point	Description	SEI	Photographs
Site GPS Reference: Marker 8 Date: 05/08/2024 GPS Coordinates: 26°19'56.82"S 27°36'45.40"E	**Artificial Water Resource** Made up of wetland habitat dominated by hydrophytes. No fauna or flora SCC observed, and none expected for the habitat unit. More information regarding this habitat unit can be found in the accompanying freshwater assessment (TBC, 2024).	Low	
Site GPS Reference: Marker 3 Date: 17/04/2024 GPS Coordinates: 26°20'40.07"S 27°36'54.63"E	**Degraded Grassland** Made up of grassland habitat that is currently not in a functional state. Evidence of anthropogenic disturbance present via the observation of residue tailings materials, invasion of alien plant species (*Eucalyptus spp.*) and the presence of actively used rods throughout the grassland. Presence of native grassland species, however, very low habitat connectivity with large areas of bare ground present. No fauna or flora SCC observed, and none expected for the habitat unit.	Low	
Site GPS Reference: Marker 10 Date: 05/08/2024 GPS Coordinates: 26°20'20.77"S 27°37'35.96"E	**Artificial Water Resource** Characterised by an artificial wetland surrounded by modified grassland habitat. Large areas of bare ground present. No fauna or flora SCC observed, and none expected for the habitat unit. More information regarding this habitat unit can be found in the accompanying freshwater assessment (TBC, 2024).	Low	

Survey Point	Description	SEI	Photographs
Site GPS Reference: Marker 5 Date: 05/08/2024 GPS Coordinates: 26°20'24.84"S 27°36'39.99"E	**Degraded Grassland** Made up of grassland habitat that is currently not in a functional state. Evidence of disturbance via the presence of alien species (*Acacia dealbata*) as well as a network of used roads. Presence of residue tailings material and large areas of bare and cleared ground. Evidence of common mammal species such as visuals of ground squirrels and yellow mongoose. No fauna or flora SCC observed, and none expected for the habitat unit.	Low	
Site GPS Reference: Marker 9 Date: 05/08/2024 GPS Coordinates: 26°20'00.87"S 27°37'31.46"E	**Secondary Grassland** Made up of secondary grassland habitat which remains in a disturbed sate – evident via the presence of alien plant species such as *Bidens Pilosa* and *Datura stramonium.* Native grassland species present (mainly *Themeda triandra)* however, the habitat is fragmented via artificial wetlands, roads and thickets of invasive plants. Habitat functionality is low however, some fauna SCC may occur here or utilize this habitat as a movement corridor due to the lack of active anthropogenic disturbance. No fauna or flora SCC observed.	Low	

Survey Point	Description	SEI	Photographs
Site GPS Reference: Marker 6 Date: 05/08/2024 GPS Coordinates: 26°20'29.16"S 27°36'41.84"E	**Alien Stands:** Made up of alien vegetation and small patches of grassland. High levels of Anthropogenic disturbances. Low chance of the occurrence of any fauna or flora SCC.	Very Low	
Site GPS Reference: Marker 6 Date: 05/08/2024 GPS Coordinates: 26°20'24.84"S 27°36'39.99"E	**Degraded Grassland:** Made up of grassland habitat that is currently not in a functional state. Area contains high levels of anthropogenic disturbance as truck frequently drive in and around the habitat. Large areas of bare ground present and where grassland is present, it is heavily invaded by *Acacia dealbata.* Evidence of common mammal species via the visual of ground squirrels. No fauna or flora SCC observed, and none expected for the habitat unit.	Low	

3.3 Habitat Assessment

Four (4) main habitat types were identified across the PAOI and include:

- Degraded Grassland;
- Secondary Grassland;
- Artificial Water Resources; and
- Alien Stands.

The habitat units for the PAOI can be seen delineated in Figure 3-1 and descriptions of the habitat units can be found in Table 3-3.

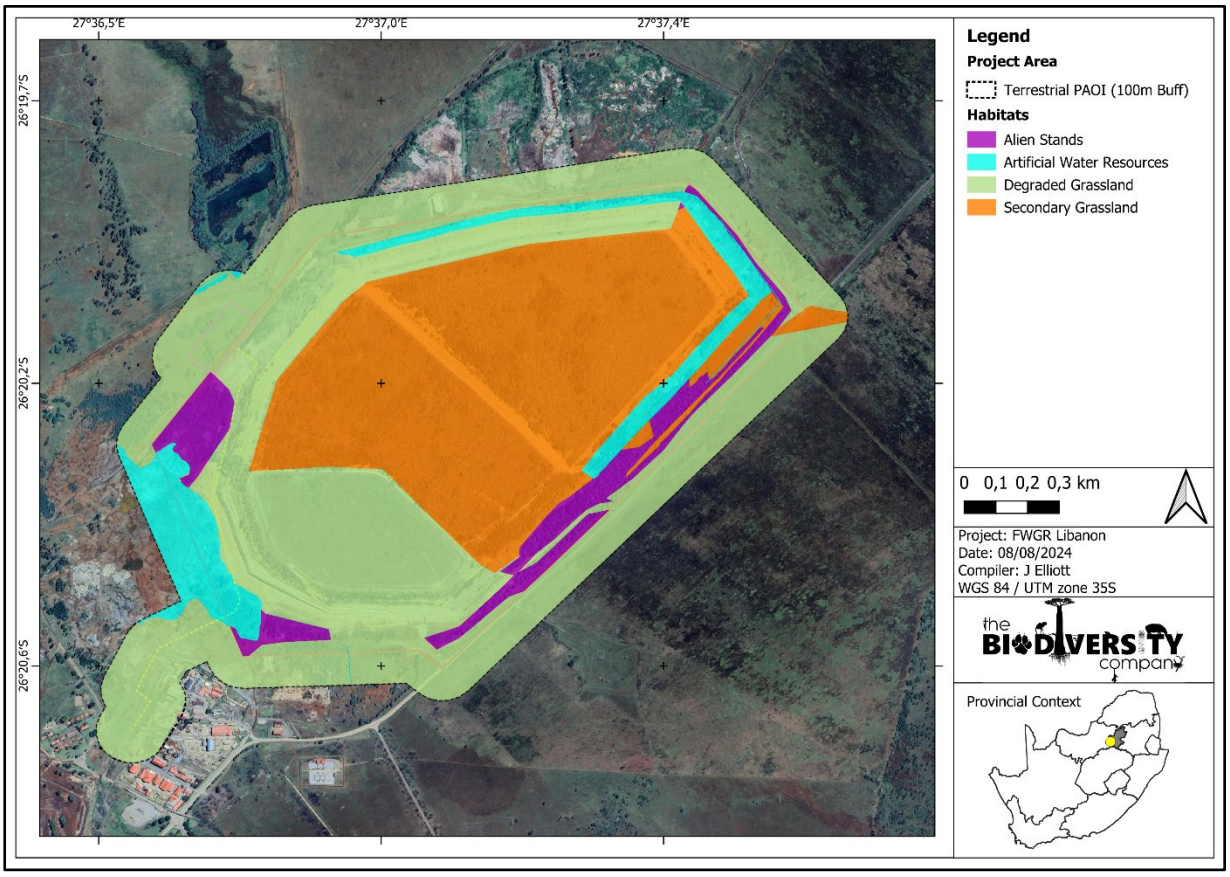


Figure 3-1 Habitats identified within the PAOI

Table 3-3 Table providing descriptions of the habitat types delineated for the PAOI

Habitat	Description and Condition
Secondary Grassland	This habitat unit is characterised by secondary growth grassland habitat that has naturalized from historical clearing as the PAOI has not been cleared in more than 10 years. Due to the high levels of disturbance, this habitat never regained full ecological function and is associated with high numbers of alien and invasive plants, such as, *Datura stramonium, Verbena bonariensis, V. brasiliensis, Bidens Pilosa, Acacia mearnsii* and *Eucalyptus camaldulensis*. Anthropogenic disturbances were present via the evidence of litter amongst the grassland as well as building materials such as concrete blocks and barbed wire. Some sections of this habitat unit are in better condition than others, particularly those bordering on the artificial water resource habitat, with good potential for rehabilitation back to an ecologically stable state. The areas of the site that overlap with the ESA and CBA are not representative of such. Future active rehabilitation would be required to create a potential functional habitat. Dominant indigenous species include, *Themeda triandra, Eragrostis rigidor, Cymbopogon caesius, Hyparrhenia hirta* and *Cynodon dactylon.* Additional common grassland species associated with disturbance and secondary growth are expected. No fauna or flora SCC were observed, and none are expected to be resident in the PAOI. Some fauna SCC may make use of the PAOI for foraging and as a movement corridor.
Degraded Grassland	This habitat unit is characterised by the presence of native grassland species in areas with high anthropogenic disturbances such as livestock grazing, dumping and a well-used road network. This grassland has been cleared within the last 10 years and has not fully recovered. The habitat has a low ecological functionality due to high disturbance levels and the presence of numerous alien plant species such as *Datura stramonium, Verbena bonariensis, V. brasiliensis, Bidens Pilosa, Erigeron bonariensis, Acacia mearnsii* and *Acacia dealbata* as well as areas of bare ground associated with tailings material. Anthropogenic activity has substantially modified this area's primary ecological functions and species composition. Dominant indigenous species include, *Cymbopogon pospischilii, Hyparrhenia hirta, Themeda triandra*, *Cynodon dactylon, Asparagus africanus* and *Gomphocarpus fruticosus.* Additional common grassland species associated with disturbance and secondary growth are expected, as well as some provincially protected species, particularly geophytes. No fauna or flora SCC were observed, and none are expected to be resident in the PAOI. Some fauna SCC may make use of the PAOI for foraging and as a movement corridor however, due to current anthropogenic activity this is unlikely.
Alien Stands	The alien stands habitats, characterized by the presence of fully grown *Eucalyptus camaldulensis, Acacia dealbata,* and *Melia azedarach species*, have established themselves within degraded and modified grasslands, as well as open patches. These non-native species dominate the landscape, significantly altering the ecological balance. The habitat often occurs near roads and heavily anthropogenically modified areas, where human activities have facilitated the spread of these invasive trees. The ecological characteristics of this habitat are marked by low rehabilitation potential and low ecological functionality. The dominance of alien species, coupled with extensive habitat degradation, makes ecological restoration challenging. The alien stands represent a heavily altered habitat with low ecological value, resulting in a challenging environment for native species and low potential for natural rehabilitation. No fauna or flora SCC were observed, and none are expected to be resident in the PAOI. Some fauna SCC may make use of the PAOI for foraging and as a movement corridor.

Habitat	Description and Condition
Artificial Water Resources	This is a non-terrestrial habitat made up of artificial wetlands and dams within the PAOI. This habitat unit is associated with hydrophytes, such as *Phragmites australis*, as well as high numbers of alien plant species, such as, *Arundo donax* and *Verbena brasiliensis.* No fauna or flora SCC were observed, and none are expected to be resident in the PAOI. Some fauna SCC may make use of the PAOI for foraging and as a movement corridor. Additional information regarding this habitat unit may be found in the accompanying freshwater assessment (TBC, 2024).

3.4 Site Ecological Importance

Based on the criteria provided in Appendix B of this report, all habitats within the PAOI were assigned a sensitivity category, i.e., a SEI category. The PAOI was categorised as possessing habitats with areas ranging from 'Very Low' to 'Low' SEI (Table 3-3 and Figure 3-5). This indicates that the findings of this assessment are contrary to the Screening Tool with respect to the Combined Terrestrial Biodiversity Theme sensitivity.

Table 3-4 Summary of habitat types delineated within the PAOI

Habitat Type	Conservation Importance	Functional Integrity	Biodiversity Importance	Receptor Resilience	Site Ecological Importance Guidelines
Secondary Grassland	**Low**	**Low**	**Low**	**Medium**	**Low**
	No confirmed or highly likely populations of SCC	Almost no habitat connectivity but migrations still possible across some modified or degraded natural habitat		Will recover slowly (~ more than 10 years) to restore > 75% of the original species composition and functionality of the receptor functionality	Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities.
Degraded Grassland	**Low**	**Low**	**Low**	**Medium**	**Low**
	< 50% of receptor contains natural habitat with limited potential to support SCC.	Almost no habitat connectivity but migrations still possible across some modified or degraded natural habitat		Will recover slowly (~ more than 10 years) to restore > 75% of the original species composition and functionality of the receptor functionality	Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities.
Alien Stands	**Low**	**Very Low**	**Very Low**	**High**	**Very Low**
	No confirmed or highly likely populations of SCC	Very small (< 1 ha) area. No habitat connectivity except for flying species or flora with wind-dispersed seeds.		Will recover relatively quickly (~ 5–10 years) to restore > 75% of the original species composition and functionality of the receptor functionality	Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities.
	Low	Low	**Low**	**Medium**	**Low**

Artificial Water Resource	No confirmed or highly likely populations of SCC	Several minor and major current negative ecological impacts.	Will recover slowly (~ more than 10 years) to restore > 75% of the original species composition and functionality of the receptor functionality	Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities.

3.5 3.4Desktop Ecological Sensitivity

The following is deduced from the National Web-based Environmental Screening Tool Regulation 16(1)(v) of the Environmental Impact Assessment Regulations 2014, as amended):

- Terrestrial Biodiversity Theme sensitivity is Very High for the proposed development area, due to it overlapping with Terrestrial CBA 1, CBA 2, ESA 1, ESA 2, NPAES (Figure 3-2);
- Plant Species Theme sensitivity is Medium for the proposed development area due to the possible presence of three medium sensitivity plant species (Figure 3-3); and
- Animal Species Theme sensitivity is Medium for the proposed development area due to the possible presence of a number of medium sensitivity species (Figure 3-4).

MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY

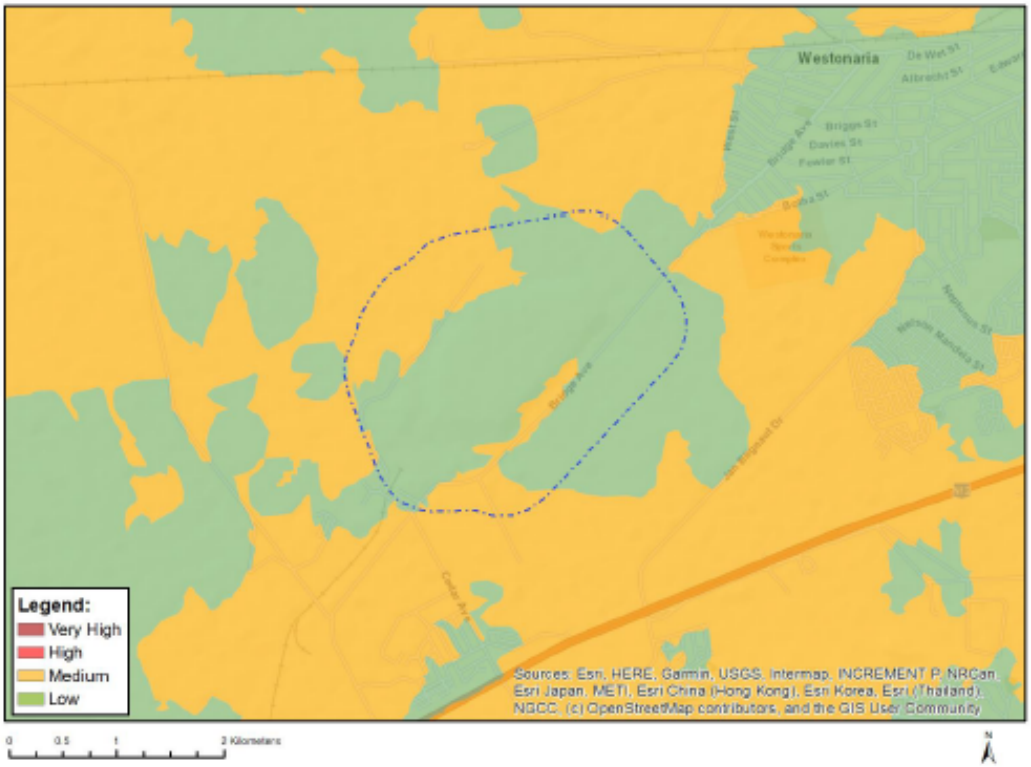
Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity
Very High	CBA 1
Very High	CBA 2
Very High	ESA 1
Very High	ESA 2
Very High	National Protected Area Expansion Strategy (NPAES)

Figure 3-2 Terrestrial Biodiversity Theme Sensitivity

MAP OF RELATIVE PLANT SPECIES THEME SENSITIVITY



Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

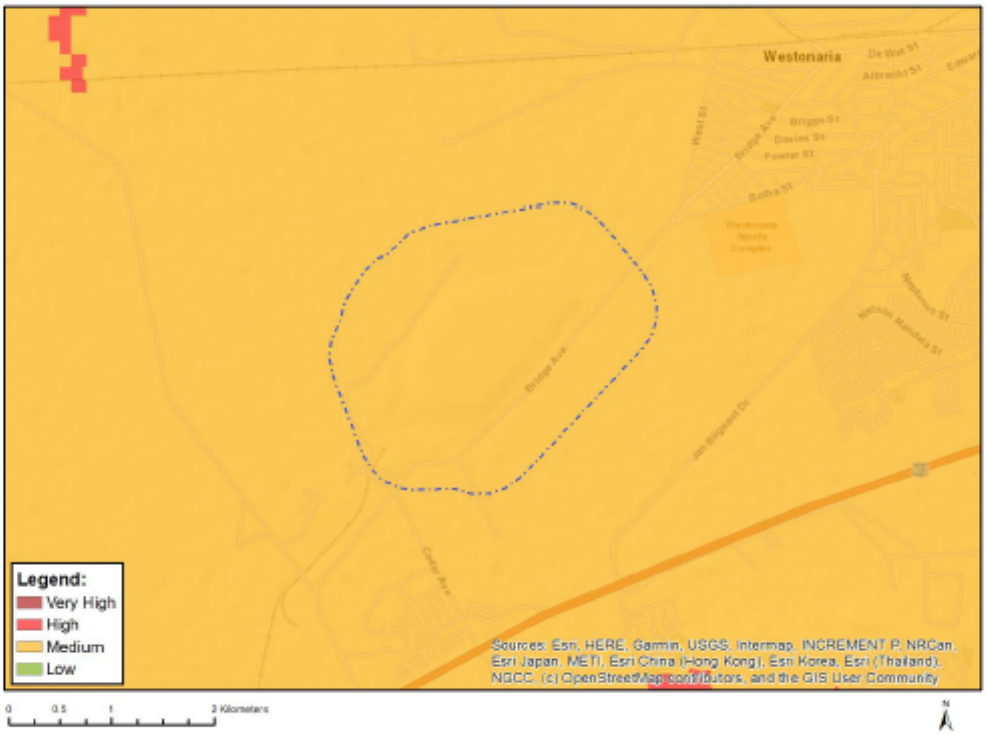
Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		x	

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity
Medium	Khadia beswickii
Medium	Sensitive species 1147
Medium	Sensitive species 1248

Figure 3-3 Plant Species Theme Sensitivity

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		x	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Aves-Tyto capensis
Medium	Aves-Hydroprogne caspia
Medium	Aves-Eupodotis senegalensis
Medium	Insecta-Lepidochrysops praeterita
Medium	Mammalia-Crocidura maquassiensis
Medium	Mammalia-Hydrictis maculicollis
Medium	Invertebrate-Clonia uvarovi

Figure 3-4 Animal Species Theme Sensitivity

3.5.1 Screening Tool Comparison

The allocated sensitivities for each of the relevant themes are either disputed or validated for the overall PAOI in Table 3-5 below. A summative explanation for each result is provided as relevant. The specialist-assigned sensitivity ratings are based largely on the SEI process followed in the previous section, and consideration is given to any observed or likely presence of SCC species. A map illustrating the overall SEI allocations for the PAOI can be seen in Figure 3-5.

Table 3-5 Summary of the screening tool vs specialist assigned sensitivities

Screening Tool Theme	Screening Tool	Specialist	Tool Validated or Disputed by Specialist - Reasoning
Animal Theme	**Medium**	**Low**	Disputed – Habitat exists in a largely degraded or modified state with high levels of anthropogenic disturbance, particularly those associated with the TSF on site, as well as historical land clearing. No SCC observed and unlikely to be resident, although some may use the habitats on site for foraging and as a movement corridor.
Plant Theme	**Medium**	**Low**	Disputed – Habitat exists in a largely degraded or modified state with high levels of anthropogenic disturbance, particularly those associated with the TSF on site. High numbers of alien and invasive plants. No SCC observed and unlikely to occur.
Terrestrial Theme	**Very High**	**Low**	Disputed – Habitat exists in a largely degraded or modified state with high levels of anthropogenic disturbance, particularly those associated with the TSF on site, and has therefore lost much of its ecosystem functionality. Habitat will not recover without human intervention and will continue to degrade over time without rehabilitation. Rehabilitation efforts thus far have been inadequate to return the ecosystem to a functional state. The habitat is no longer representative of an ESA or CBA.

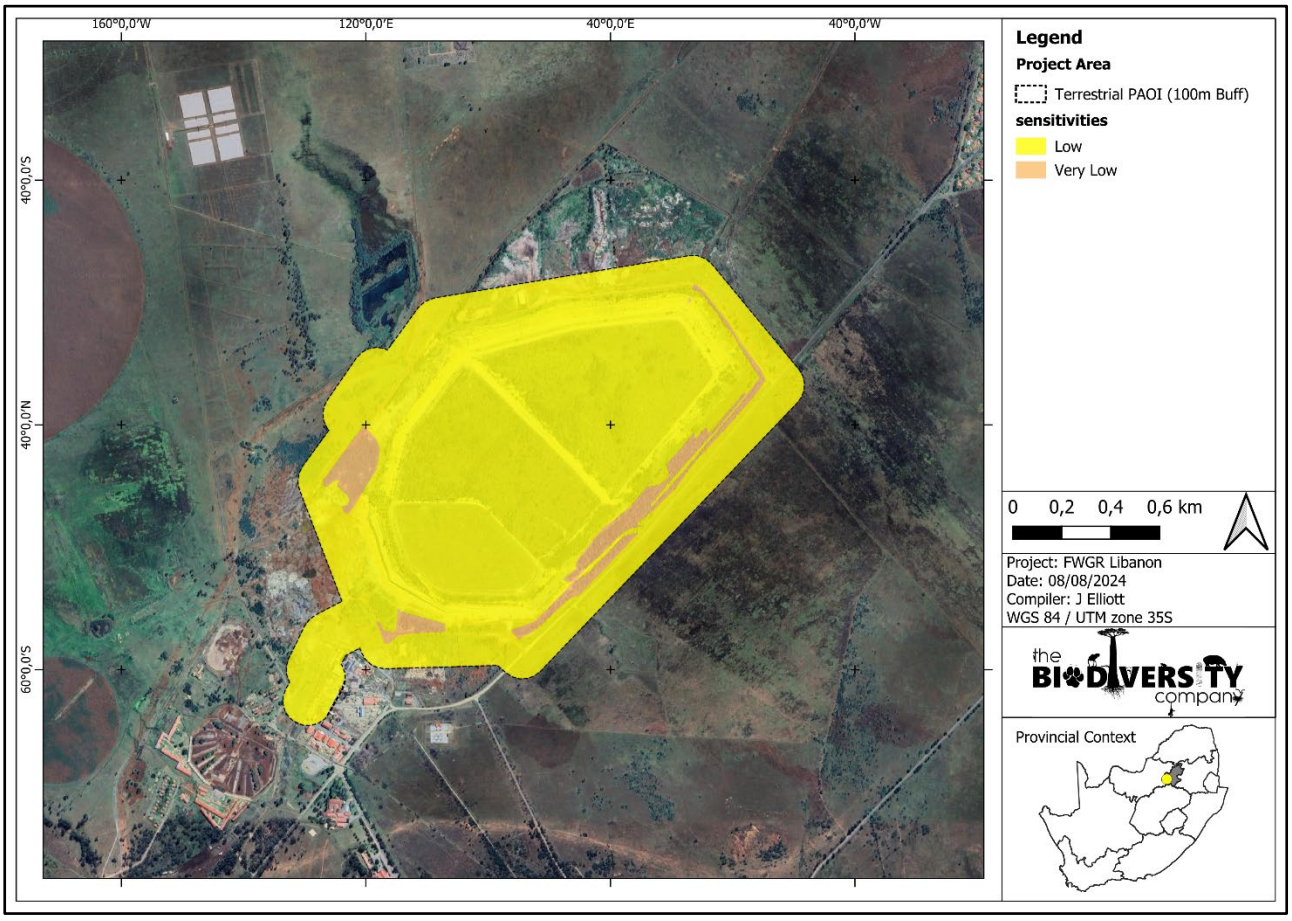


Figure 3-5 Map illustrating the site ecological importance for the PAOI

4. Impact Management and Mitigation Plan

The aim of the management outcomes is to present mitigation actions in such a way that they can be incorporated into the Environmental Management Programme (EMPr), and possible biodiversity management programme, for the project, which should in turn allow for a more successful implementation and auditing of the mitigations and monitoring guidelines. Table 4-1 presents the recommended mitigation measures and the respective time frames, targets, and performance indicators relative to the terrestrial assessment.

The focus of mitigation measures is to reduce the significance of the likely impacts associated with the development, and thereby:

- Prevent the further loss and fragmentation of indigenous vegetation communities within the ecosystem in the vicinity of the PAOI;
- Reduce the negative fragmentation effects of the development and enable the safe movement of fauna species;
- Prevent the direct and indirect loss and disturbance of flora and fauna species and communities, including the negative effects associated with the introduction and proliferation of alien and invasive species; and
- Adequately follow the guidelines for interpreting the Site Ecological Importance ratings assigned to the PAOI.

Table 4-1 Project specific mitigation measures including requirements for timeframes, roles and responsibilities

Management outcome: Vegetation and Habitats				
Impact Management Actions	**Implementation**		**Monitoring**	
	Phase	Responsible Party	Aspect	Frequency
Laydown and construction preparation activities (such as cement mixing, temporary toilets, etc.) must be limited to already modified areas and should take up the smallest footprint possible.	Construction Phase	Project manager, Environmental Officer	Development footprint	Ongoing
Develop post-mining environments, in conjunction with regional development plans; and the recreation of habitats, where possible; or structure altered landscapes to be compatible with regional habitats.	Life of operation	Project manager, Environmental Officer	Development footprint	Ongoing
Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should not be fragmented or disturbed further if possible.	Construction Phase	Project manager, Environmental Officer	Development footprint	Ongoing
All vehicles and personnel must make use of existing roads and walking paths as far as possible, especially construction/operational vehicles.	Construction Phase	Project manager, Environmental Officer	Development footprint	Ongoing
The clearing of vegetation must be minimised where possible. All activities must be restricted to within the authorised areas.	Life of operation	Project manager, Environmental Officer	Areas of indigenous vegetation	Ongoing
All laydown, chemical toilets etc. should be restricted to Very Low SEI areas. Any materials may not be stored for extended periods of time and must be removed from the project area once the construction/closure phase has been concluded.	Construction and Operational Phase	Environmental Officer, Design Engineer, and Contractor	Laydown areas and material storage & placement.	Ongoing
Areas that are denuded during construction need to be re-vegetated with indigenous vegetation, to prevent erosion during flood and wind events and to promote the regeneration of functional habitat. This will also reduce the likelihood of encroachment by alien invasive plant species. All grazing mammals must be kept out of the areas that have recently been re-planted.	Operational phase	Environmental Officer & Contractor	Assess the state of rehabilitation and encroachment of alien vegetation	Quarterly for up to two years after the closure
All footprints to be rehabilitated after construction is complete. Rehabilitation of the disturbed areas existing in the project area must be made a priority. Topsoil must also be utilised, and any disturbed area must be re-vegetated with plant and grass species which are endemic to this vegetation type.	Life of Operation	Environmental Officer & Contractor	Rehabilitation	Quarterly monitoring
A hydrocarbon spill management plan must be put in place to ensure that should there be any chemical spill out or over that it does not run into the surrounding areas. A TSF operational plan must be put in place to avoid tailings spillage. The Contractor shall be in possession of an emergency spill kit that must always be complete and available on site. • Drip trays or any form of oil absorbent material must be placed underneath vehicles/machinery and equipment when not in use. • No servicing of equipment on site unless necessary.	Life of operation	Environmental Officer & Contractor	Spill events, Vehicles dripping.	Ongoing

• All contaminated soil / yard stone shall be treated in situ or removed and be placed in containers. • Appropriately contain any generator diesel storage tanks, machinery spills (e.g., accidental spills of hydrocarbons oils, diesel etc.) in such a way as to prevent them from leaking and entering the environment. • Construction activities and vehicles could cause spillages of lubricants, fuels and waste material negatively affecting the functioning of the ecosystem. • All vehicles and equipment must be maintained, and all re-fueling and servicing of equipment is to take place in demarcated areas outside of the PAOI.				
It must be made an offence for any staff member to remove any indigenous plant species from the PAOI or bring any alien species in. This is to prevent the spread of exotic or alien species or the illegal collection of plants.	Life of operation	Project manager, Environmental Officer	Any instances	Ongoing
All construction waste must be removed from site at the closure of the construction phase.	Construction phase	Environmental Officer & Contractor	Construction waste	During Phase
Precautions must be taken against the erosion damage that would be caused by unplanned pipe leaks. A leak warning and detection system must be installed. Dense indigenous pioneer grass seeds should also be planted across all bare earth areas to prevent erosion.	Life of operation	Project manager, Environmental Officer	Damaged pipes and unplanned leaks	Weekly

Management outcome: Fauna

Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Clearing and disturbance activities must be conducted in a progressive linear manner, always outwards and away from the centre of the PAOI and over several days, so as to provide an easy escape route for all small mammals and herpetofauna.	Construction Phase	Environmental Officer & Contractor	Progressive land clearing operations and the movement of fauna	Ongoing
The areas to be disturbed must be specifically and responsibly demarcated to prevent the movement of staff or any individual into the surrounding environments, signs must be put up to enforce this.	Construction/Operational Phase	Project manager, Environmental Officer	Infringement into these areas	Ongoing
The duration of the activities should be minimised to as short a term as possible, to reduce the period of disturbance on fauna.	Construction	Project manager, Environmental Officer & Design Engineer	Construction/Closure Phase	Ongoing
Noise must be kept to an absolute minimum during the evenings and at night to minimise all possible disturbances to reptile species and nocturnal mammals.	Construction/Operational Phase	Environmental Officer	Noise levels	Ongoing
No trapping, killing, or poisoning of any wildlife is to be allowed and **s**igns must be put up to enforce this. Monitoring must take place in this regard.	Life of operation	Environmental Officer	Evidence of trapping etc	Ongoing
Outside lighting should be designed and limited to minimise impacts on fauna. All outside lighting should be directed away from any	Construction/Operational Phase	Project manager, Environmental	Light pollution and period of light	Ongoing

sensitive areas. Fluorescent and mercury vapor lighting should be avoided, and sodium vapor (green/red) lights should be used wherever possible.		Officer & Design Engineer		
All construction and maintenance motor vehicle operators should undergo an environmental induction that includes instruction on the need to comply with speed limits, to respect all forms of wildlife. Speed limits must be enforced to ensure that road killings and erosion is limited.	Life of operation	Health and Safety Officer	Compliance to the training	Ongoing
Schedule activities and operations during least sensitive periods, to avoid migration, nesting, and breeding seasons. In this case, activities should take place during the day.	Life of operation	Project manager, Environmental Officer & Design Engineer	Activities should take place during the day	Ongoing
Any holes/deep excavations must be dug in a progressive manner and shouldn't be left open overnight. Should any holes remain open overnight they must be properly covered temporarily to ensure that no small fauna species fall in. Holes must be subsequently inspected for fauna prior to backfilling.	Planning and Construction	Environmental Officer & Contractor, Engineer	Presence of trapped animals and open holes	Ongoing
If fencing is required: wildlife-permeable fencing with holes large enough for mongoose and other smaller mammals should be installed, the holes must not be placed in the fence where it is next to a major road as this will increase road killings in the area.	Planning and construction	Environmental Officer & Contractor, Engineer	Fauna movement corridor	Ongoing

Management outcome: Alien Species

Impact Management Actions	**Implementation**		**Monitoring**	
	Phase	Responsible Party	Aspect	Responsible Party
An Alien Invasive Plant (AIP) Management Plan must be compiled and implemented. This should regularly be updated to reflect the annual changed in AIP composition.	Life of operation	Project manager, Environmental Officer & Contractor	Manage and assess presence and encroachment of alien vegetation	Twice a year
The footprint area of the construction should be kept to a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas. Footprints of the roads must be kept to prescribed widths.	Construction/Operational Phase	Project manager, Environmental Officer & Contractor	Footprint Area	Life of operation
A pest control plan must be put in place and implemented; it is imperative that poisons not be used to control pests.	Life of operation	Environmental Officer & Health and Safety Officer	Evidence or presence of pests	Life of operation

Management outcome: Dust

Impact Management Actions	**Implementation**		**Monitoring**	
	Phase	Responsible Party	Aspect	Responsible Party
Dust-reducing mitigation measures must be put in place and must be strictly adhered to. This includes the wetting of exposed soft soil surfaces. No non-environmentally friendly suppressants may be used as this could result in the pollution of water sources.	Construction phase	Contractor	Dustfall	Dust monitoring program.

Management outcome: Waste Management

Impact Management Actions	**Implementation**		**Monitoring**	
	Phase	Responsible Party	Aspect	Frequency

Waste management must be a priority and all waste must be collected and stored effectively and responsibly according to a site-specific waste management plan. Dangerous waste such as metal wires and glass must only be stored in fully sealed and secure containers, before being moved off site as soon as possible.	Life of operation	Environmental Officer & Contractor	Waste Removal	Weekly
Litter, spills, fuels, chemical and human waste in and around the PAOI must be minimised and controlled according to the waste management plan.	Construction/Closure Phase	Environmental Officer & Health and Safety Officer	Presence of Waste	Daily
Toilets at the recommended Health and Safety standards must be provided. These should be emptied regularly and once no longer required, they must be pumped dry to prevent leakage into the surrounding environment and removed from site.	Life of operation	Environmental Officer & Health and Safety Officer	Number of toilets per staff member. Waste levels	Daily
The Contractor should supply sealable and properly marked domestic waste collection bins and all solid waste collected shall be disposed of at a licensed disposal facility within every 10 days at least.	Life of operation	Environmental Officer & Health and Safety Officer	Availability of bins and the collection of the waste	Ongoing
Refuse bins will be responsibly emptied and secured. Temporary storage of domestic waste shall be in covered and secured waste skips. Maximum domestic waste storage period will be 10 days.	Life of operation	Environmental Officer, Contractor & Health and Safety Officer	Management of bins and collection of waste	Ongoing, every 10 days

Management outcome: Environmental Awareness Training				
Impact Management Actions	**Implementation**		**Monitoring**	
	Phase	Responsible Party	Aspect	Frequency
All personnel and contractors are to undergo Environmental Awareness Training. A signed register of attendance must be kept for proof. Discussions are required on sensitive environmental receptors within the PAOI to inform contractors and site staff of the presence of protected species, their identification, conservation status and importance, biology, habitat requirements and management requirements in line with the Environmental Authorisation and within the EMPr.	Pre-construction phase	Health and Safety Officer, Environmental Officer	Compliance to the training	Ongoing

Management outcome: Erosion				
Impact Management Actions	**Implementation**		**Monitoring**	
	Phase	Responsible Party	Aspect	Frequency
Speed limits must be put in place to reduce erosion. Soil surfaces must be wetted as necessary to reduce the dust generated by the project activities. Speed bumps and signs must be erected to enforce slow speeds.	Life of operation	Project manager, Environmental Officer	Water Runoff from road surfaces	Ongoing
Only existing access routes and walking paths may be made use of.	Life of operation	Project manager, Environmental Officer	Routes used within the area	Ongoing
Areas that are denuded during construction need to be re-vegetated with indigenous vegetation to prevent erosion during flood events etc.	Life of operation	Project manager, Environmental Officer	Re-establishment of indigenous vegetation	Progressively

A stormwater management plan must be compiled and implemented if necessary.	Life of operation	Project manager, Environmental Officer	Management plan	Before construction phase: Ongoing

Management outcome: Pipeline Leak or Spill

Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Leak detection or any similar monitoring tool must be incorporated to try identifying leaks. Dense indigenous pioneer grass seeds should also be planted across all bare earth areas to prevent erosion.	Life of operation	Environmental Officer, Health and Safety Officer	Detection of leaks	Weekly

5. Conclusion

The PAOI exists in a predominantly degraded or modified state owing to previous and current anthropogenic disturbances as well as a low rate of habitat rehabilitation procedures. The PAOI has been subjected to various anthropogenic impacts such as, human and vehicle ingress, invasions and infestations by alien and invasive plants, overgrazing by livestock, and the edge effects associated with the nearby mining activities. This habitat is unlikely to recover without human intervention and will continue to degrade further without active rehabilitation.

Due to the seasonal restraints at the time of this assessment, a site walkdown is recommended prior to any construction activities taking place to identify any potential protected plant species which may occur on site. These must be marked and relocated to a similar habitat nearby which will not be affected by construction activities.

The desktop assessment classifies the PAOI as a Class 4 ridge however, it is not a ridge but rather the raised TSF. Desktop assessments also showed that the PAOI overlapped with the Critical Biodiversity Area 1 (CBA) as well as an Ecological Support Area (ESA) however, a very small portion falls within the PAOI and the habitat is no longer representative of an ESA or CBA. Completion of the terrestrial biodiversity assessment led to the dispute of the 'Very High' classification for the terrestrial biodiversity theme sensitivity as allocated by the National Environmental Screening Tool. The PAOI is instead assigned an overall terrestrial sensitivity of 'Low'.

The Animal Species Theme sensitivity is 'Medium' for the PAOI as allocated by the National Environmental Screening Tool, which was disputed and found to be 'Low' due to lack of suitable habitat and high levels or persecution. Plant Species Theme sensitivity is 'Medium' for the project area as allocated by the National Environmental Screening Tool, which was disputed due to a lack of suitable habitat.

5.1 Impact Statement

The location, state and size of the ecosystem suggests that it is unlikely that any functional habitat or SCCs will be lost as a result of the impacts arising from the proposed activities. However, these assumptions pertain to the terrestrial habitat within the PAOI only and the recommendations and mitigations presented in the accompanying freshwater assessment must be strictly adhered to.

5.2 Specialist Opinion

It is the opinion of the specialist that the proposed development is favourable only if all mitigation measures provided in this and other specialist reports are implemented, as well as the following:

- A site walkdown during the correct flowering season (between October and March) should be conducted for all provincially protected plant species present on site;
- An alien invasion plant (AIP) management plan must be compiled and implemented; and
- A rehabilitation plan must be compiled and implemented for all areas of the PAOI impacted by the project activities.

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7. Appendix Items

7.1 Appendix A: Methods

7.1.1 Desktop Dataset Assessment

7.1.1.1 Ecologically Important Landscape Features

Existing ecologically relevant data layers were incorporated into a GIS to establish how the proposed development might interact with any ecologically important entities. Emphasis was placed around the following spatial datasets:

- National Biodiversity Assessment 2018 (Skowno *et al,* 2019) - The purpose of the National Biodiversity Assessment (NBA) is to assess the state of South Africa's biodiversity based on best available science, with a view to understanding trends over time and informing policy and decision-making across a range of sectors. The NBA deals with all three components of biodiversity: genes, species and ecosystems; and assesses biodiversity and ecosystems across terrestrial, freshwater, estuarine and marine environments. The two headline indicators assessed in the NBA are:

- Ecosystem Protection Level – indicator of the extent to which ecosystems are adequately protected or under-protected. Ecosystem types are categorised as Well Protected (WP), Moderately Protected (MP), Poorly Protected (PP), or Not Protected (NP), based on the proportion of the biodiversity target for each ecosystem type that is included within one or more protected areas. Not Protected, Poorly Protected or Moderately Protected ecosystem types are collectively referred to as under-protected ecosystems.

- Red List of Ecosystems (RLE) 2021 – The list was first published in 2011 and has since been substantially revised by authors Dr Andrew Skowno and Mrs Maphale Monyeki (SANBI, 2022). This list is based on assessments that followed the International Union for Conservation of Nature (IUCN) Red List of Ecosystems Framework (version 1.1) and covers all 456 terrestrial ecosystem types described in South Africa by Mucina and Rutherford (2006). A total of 120 of the 456 terrestrial ecosystem types assessed are categorised as threatened and together make up approximately 10% of the remaining natural habitat in the country. Of these 120 ecosystem types, 55 are Critically Endangered (CR), 51 Endangered (EN) and 14 are Vulnerable (VU). The remainder are categorised as Least Concern (LC) (SANBI, 2022; Skowno & Monyeki, 2021).

- Protected areas:

- South Africa Protected Areas Database (SAPAD) and South Africa Conservation Areas Database (SACAD) (DFFE, 2023a) – The South African Protected Areas Database (SAPAD) and South Africa Conservation Areas Database (SACAD) contains spatial data for the conservation of South Africa. It includes spatial and attribute information for both formally protected areas and areas that have less formal protection. The database is updated on a continuous basis and forms the basis for the Register of Protected Areas which is a legislative requirement under the National Environmental Management: Protected Areas Act, Act 57 of 2003.

- National Protected Areas Expansion Strategy (NPAES) (DFFE, 2022b) – The National Protected Area Expansion Strategy (NPAES) provides spatial information on areas that are suitable for terrestrial ecosystem protection. These focus areas are large, intact and unfragmented and are therefore, of high importance for biodiversity, climate resilience and freshwater protection.

- Conservation/Biodiversity Sector Plans:

  The Gauteng Conservation Plan (Version 3.3) (GDARD, 2014b) classified areas within the province on the basis of its contribution to reach the conservation targets within the province. These areas are classified as Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) to ensure sustainability in the long term. The CBAs are classified as either 'Irreplaceable' (must be conserved), or 'Important'.

  Critical Biodiversity Areas (CBAs) are terrestrial and aquatic areas of the landscape that need to be maintained in a natural or near-natural state to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. Thus, if these areas are not maintained in a natural or near natural state then biodiversity targets cannot be met.

- Gauteng Ridges

  The quartzite ridges of Gauteng are one of the most important natural assets in this northern province of South Africa. This is because these ridges, and the areas immediately surrounding them, provide unique habitat for a wide variety of fauna and flora, some of which are Red-Listed, rare or endemic species, or in the case of certain plant species, are found nowhere else in South Africa or around the world.

  In order to give practical effect to this policy, the Gauteng Department of Agriculture and Rural Development (GDARD) has classified all ridges in Gauteng into one of four classes, based on the existing extent and percentage of area converted by urban development or disturbed by other human activities. According to GDARD (2019), the ridges within Gauteng may be classified as follows:

- Class 1 Ridges: 5% or less of the ridge area has been transformed by human activity (Approx. 58% of ridges fall within this category);

- Class 2 Ridges: Between 6 and 34% of the ridge area has been transformed by human activity (Approx. 23% of ridges fall within this category);

- Class 3 Ridges: Between 35 and 64% of the ridge area has been transformed by human activity (Approx. 8% of ridges fall within this category); and

- Class 4 Ridges: Over 65% of the ridge area has been transformed by human activity (Approx. 11% of ridges fall within this category).

  The 2019 Ridges Guideline has defined general guidelines that must be followed with regard to the amount of development that should be permitted on different ridges according to their class. GDARD (2019) stipulates that no development is to be permitted on any class 1 ridge, and varying levels of development may be permissible with regards to the higher ridge classes – depending on the impact level of the proposed activity and the corresponding spatial scale. Buffers and permitted developments are as follows (GDARD, 2019):

- Class 1 Ridges: Only low impact activities with an ecological footprint of 5% or less in the 200 m buffer zone of the ridge will be supported and no development will be permitted in the ridge itself;

- Class 2 Ridges: Development activities and uses that have a high environmental impact on a Class 2 ridge will not be permitted. Low impact development activities, such as tourism facilities,

which comprise of an ecological footprint of 5% or less of the property may be supported (the ecological footprint includes all areas directly impacted on by a development activity, including all paved surfaces, landscaping, property access and service provision). Low impact development activities on a ridge will not be supported where it is feasible to undertake the development on a portion of the property abutting the ridge;

- Class 3 Ridges: The guidelines for Class 2 ridges will be applied to areas of the ridge that have not been significantly impacted on by human activity. The guidelines for Class 3 ridges will be applied to areas of the ridge that have been significantly impacted on by human activity; and

- Class 4 Ridges: Further development activities will not be supported in areas of the ridge where the remaining contiguous extent of natural habitat is 4 ha or more.

- Key Biodiversity Areas (KBA, NCG, 2024) – A new set of Key Biodiversity Areas (KBA) specific to South Africa has been identified using the Global Standard for the Identification of Key Biodiversity Areas version 1.2 (IUCN 2016), applied to South African species and ecosystems. KBAs are critical sites that play a vital role in maintaining global biodiversity by serving as essential habitats for species. The identification of KBAs enables governments and civil society to pinpoint key locations crucial for species and their habitats worldwide. This understanding facilitates collaborative efforts to manage and conserve these areas, thereby safeguarding global biological diversity and supporting international biodiversity objectives. Unlike the Important Bird Areas (IBAs), which primarily focus on birds, the KBA framework encompasses a broader spectrum of biodiversity, including mammals, amphibians, plants, and other taxa. BirdLife South Africa (BLSA), in consultation with the KBA National Coordination Group, has opted to retire IBAs and integrate KBAs into its conservation strategy. This strategic shift acknowledges the necessity of investing resources effectively to protect avian and other macroecological elements at the site level within a comprehensive framework of biodiversity conservation; and

- Freshwater Ecology:

- Strategic Water Source Areas (SWSAs) (Le Maitre *et al,* 2018) – SWSAs are defined as areas of land that supply a quantity of mean annual surface water runoff in relation to their size and therefore, contribute considerably to the overall water supply of the country. These are key ecological infrastructure assets and the effective protection of surface water SWSAs areas is vital for national security because a lack of water security will compromise national security and human wellbeing.

- South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Van Deventer *et al*, 2018) – A South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was established during the National Biodiversity Assessment of 2018. It is a collection of data layers that represent the extent of river and inland wetland ecosystem types as well as pressures on these systems.

- National Freshwater Ecosystem Priority Area (NFEPA) (Nel *et al.,* 2011) – The NFEPA database provides strategic spatial priorities for conserving the country's freshwater ecosystems and associated biodiversity as well as supporting sustainable use of water resources.

Appendix B: Terrestrial Site Ecological Importance

The different habitat types within the PAOI were delineated and identified based on observations made during the field survey, and information from available satellite imagery. These habitat types were assigned Ecological Importance (EI) categories based on their ecological integrity, conservation value, the presence of SCC and their ecosystem processes.

Site Ecological Importance (SEI) is a function of the Biodiversity Importance (BI) of the receptor (e.g., SCC, the vegetation/fauna community or habitat type present in the Project Area) and Receptor Resilience (RR) (its resilience to impacts).

BI is a function of Conservation Importance (CI) and the Functional Integrity (FI) of the receptor. The criteria for the CI and FI ratings are provided in Table 7-1 and Table 7-2 respectively.

Table 7-1 Summary of Conservation Importance (CI) criteria

Conservation Importance	Fulfilling Criteria
Very High	Confirmed or highly likely occurrence of Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Extremely Rare or CR species that have a global extent of occurrence (EOO) of < 10 km^2. Any area of natural habitat of a CR ecosystem type or large area (> 0.1% of the total ecosystem type extent) of natural habitat of an EN ecosystem type. Globally significant populations of congregatory species (> 10% of global population).
High	Confirmed or highly likely occurrence of CR, EN, VU species that have a global EOO of > 10 km^2. IUCN threatened species (CR, EN, VU) must be listed under any criterion other than A. If listed as threatened only under Criterion A, include if there are less than 10 locations or < 10 000 mature individuals remaining. Small area (> 0.01% but < 0.1% of the total ecosystem type extent) of natural habitat of EN ecosystem type or large area (> 0.1%) of natural habitat of VU ecosystem type. Presence of Rare species. Globally significant populations of congregatory species (> 1% but < 10% of global population).
Medium	Confirmed or highly likely occurrence of populations of Near Threatened (NT) species, threatened species (CR, EN, VU) listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals. Any area of natural habitat of threatened ecosystem type with status of VU. Presence of range-restricted species. > 50% of receptor contains natural habitat with potential to support SCC.
Low	No confirmed or highly likely populations of SCC. No confirmed or highly likely populations of range-restricted species. < 50% of receptor contains natural habitat with limited potential to support SCC.
Very Low	No confirmed and highly unlikely populations of SCC. No confirmed and highly unlikely populations of range-restricted species. No natural habitat remaining.

Table 7-2 Summary of Functional Integrity (FI) criteria

Functional Integrity	Fulfilling Criteria
Very High	Very large (> 100 ha) intact area for any conservation status of ecosystem type or > 5 ha for CR ecosystem types. High habitat connectivity serving as functional ecological corridors, limited road network between intact habitat patches. No or minimal current negative ecological impacts, with no signs of major past disturbance.
High	Large (> 20 ha but < 100 ha) intact area for any conservation status of ecosystem type or > 10 ha for EN ecosystem types. Good habitat connectivity, with potentially functional ecological corridors and a regularly used road network between intact habitat patches. Only minor current negative ecological impacts, with no signs of major past disturbance and good rehabilitation potential.
Medium	Medium (> 5 ha but < 20 ha) semi-intact area for any conservation status of ecosystem type or > 20 ha for VU ecosystem types. Only narrow corridors of good habitat connectivity or larger areas of poor habitat connectivity and a busy used road network between intact habitat patches. Mostly minor current negative ecological impacts, with some major impacts and a few signs of minor past disturbance. Moderate rehabilitation potential.
Low	Small (> 1 ha but < 5 ha) area. Almost no habitat connectivity but migrations still possible across some modified or degraded natural habitat and a very busy used road network surrounds the area. Low rehabilitation potential. Several minor and major current negative ecological impacts.
Very Low	Very small (< 1 ha) area. No habitat connectivity except for flying species or flora with wind-dispersed seeds. Several major current negative ecological impacts.

BI can be derived from a simple matrix of CI and FI as provided in Table 7-3.

Table 7-3 Matrix used to derive Biodiversity Importance (BI) from Functional Integrity (FI) and Conservation Importance (CI)

Biodiversity Importance		Conservation Importance				
		Very High	**High**	**Medium**	**Low**	**Very Low**
Functional Integrity	**Very High**	Very High	Very High	High	Medium	Low
	High	Very High	High	Medium	Medium	Low
	Medium	High	Medium	Medium	Low	Very Low
	Low	Medium	Medium	Low	Low	Very Low
	Very Low	Medium	Low	Very Low	Very Low	Very Low

The fulfilling criteria to evaluate RR are based on the estimated recovery time required to restore an appreciable portion of functionality to the receptor, as summarised in Table 7-4.

Table 7-4 Summary of Receptor Resilience (RR) criteria

Resilience	Fulfilling Criteria
Very High	Habitat that can recover rapidly (~ less than 5 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a very high likelihood of: (i) remaining at a site even when a disturbance or impact is occurring, or (ii) returning to a site once the disturbance or impact has been removed.
High	Habitat that can recover relatively quickly (~ 5–10 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a high likelihood of: (i) remaining at a site even when a disturbance or impact is occurring, or (ii) returning to a site once the disturbance or impact has been removed.
Medium	Will recover slowly (~ more than 10 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a moderate likelihood of: (i) remaining at a site even when a disturbance or impact is occurring, or (ii) returning to a site once the disturbance or impact has been removed.
Low	Habitat that is unlikely to be able to recover fully after a relatively long period: > 15 years required to restore ~ less than 50% of the original species composition and functionality of the receptor functionality, or species that have a low likelihood of: (i) remaining at a site even when a disturbance or impact is occurring, or (ii) returning to a site once the disturbance or impact has been removed.
Very Low	Habitat that is unable to recover from major impacts, or species that are unlikely to: (i) remain at a site even when a disturbance or impact is occurring, or (ii) return to a site once the disturbance or impact has been removed.

After the determination of BI and RR, the SEI can be ascertained using the matrix as provided in Table 7-5.

Table 7-5 Matrix used to derive Site Ecological Importance from Receptor Resilience (RR) and Biodiversity Importance (BI)

Site Ecological Importance		Biodiversity Importance				
		Very High	**High**	**Medium**	**Low**	**Very Low**
Receptor Resilience	**Very Low**	Very High	Very High	High	Medium	Low
	Low	Very High	Very High	High	Medium	Very Low
	Medium	Very High	High	Medium	Low	Very Low
	High	High	Medium	Low	Very Low	Very Low
	Very High	Medium	Low	Very Low	Very Low	Very Low

Interpretation of the SEI in the context of the proposed project is provided in Table 7-6.

Table 7-6 Guideline for interpreting Site Ecological Importance in the context of proposed activities

Site Ecological Importance	Interpretation in relation to proposed development activities
Very High	Avoidance mitigation – no destructive development activities should be considered. Offset mitigation not acceptable/not possible (i.e., last remaining populations of species, last remaining good condition patches of ecosystems/unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains.
High	Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted, limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities.
Medium	Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities.
Low	Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities.
Very Low	Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required.

The SEI evaluated for each taxon can be combined into a single multi-taxon evaluation of SEI for the assessment area. Either a combination of the maximum SEI for each receptor should be applied, or the SEI may be evaluated only once per receptor but for all necessary taxa simultaneously. For the latter, justification of the SEI for each receptor is based on the criteria that conforms to the highest CI and FI, and the lowest RR across all taxa.

7.2 Appendix C – Specialist Declaration of Independence

I, Julia Elliott, declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Julia Elliott

Terrestrial Ecologist

The Biodiversity Company

August 2024

I, Sarah Newman, declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Sarah Newman

Terrestrial Ecologist

The Biodiversity Company

August 2024

7.3 Appendix D – Specialist CVs

Julia Elliott

BSc Honours – Biodiversity and Ecology (Cand Nat Sci pending)

Cell: +27 64 854 5834
Email: julia@thebiodiversitycompany.com
Identity Number: 9906010091089
Date of birth: 1 June 1999

Profile Summary

Work experience throughout South Africa.

Experience with wildlife management and ecological monitoring in Hluhluwe-iMfolozi Game Park and surrounding game reserves.

Areas of Interest

Sustainability and Conservation.

Green Finance.

Renewable Energy & Mining.

Landscape rehabilitation.

Research publication with a conservation influence.

Botany and Zoology.

Key Experience

- Vegetation Assessments
- Fire management plans
- Pesticide management plans
- Water management plans
- Monitoring programmes
- Field work and research

Country Experience

South Africa

Costa Rica

Nationality

South African

Languages

English – Proficient

Afrikaans – Conversational

Qualifications

- BSc Honours Biodiversity and Ecology
- BSc Biodiversity and Ecology
- SACNASP (Application Pending)

Sarah Newman

M.Sc Entomology

Cell: +27 73 391 6933
Email: sarah@thebiodiversitycompany.com
Identity Number: 9312170034086
Date of birth: 17 December 1993

Profile Summary

Work experience in South Africa, Lesotho and Costa Rica.

Extensive experience working in the Sani Pass region of southern Africa investigating the patterns and drivers of ant diversity across an elevation gradient.

Experience with sea turtle monitoring and conservation in Costa Rica.

Areas of Interest

Entomology, Zoology, Biodiversity, Conservation and Community Ecology.

Key Experience

- Terrestrial Ecological Assessments
- Rehabilitation plans and monitoring
- Field work and research
- Taxonomic classification of insects

Country Experience

South Africa

Lesotho

Mauritius

Costa Rica

Nationality

South African

Languages

English – Proficient

Afrikaans – Conversational

Spanish – Conversational

Qualifications

- MSc Entomology (*Distinction*), University of Pretoria
- BSc (Hons) Zoology, University of Pretoria
- BSc Zoology, University of Pretoria
- Cand Sci Nat (158474)

CURRICULUM VITAE: Sarah Newman

Appendix D2
Surface Water and Stormwater Master Plan

Hydrological Study for the Proposed Reclamation of the Libanon Tailings Storage Facility

Project Number:

KON033

Prepared for:

Kongiwe Environmental (Pty) Ltd

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December 2024

DOCUMENT CONTROL

Project Name	Hydrological Study for the Proposed Reclamation of the Libanon Tailings Storage Facility
Report Type	Hydrological Study
Client	Kongiwe Environmental (Pty) Ltd
Project Number	KON033
Report Number	01
Report Status	Draft
Submission Date	6 December 2024
Author	Andy Pirie (Senior Hydrologist, M.Sc., *Pr.Sci.Nat.114988*)
Author Signature	

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **IX**

1 INTRODUCTION AND BACKGROUND **1**

1.1 Project Location 1

1.2 Project Description 1
1.2.1 Required Authorisations 1
1.2.2 Mining Method 3
1.2.3 Proposed Infrastructure 4
1.2.4 Water Sources and Power Supply 5
1.2.5 Life of the Project 7
1.2.6 Access 7
1.2.7 Rehabilitation 7

1.3 Legal Requirements and Guidelines 7

1.4 Site Investigation 8

1.5 Details of the Specialist 8

2 SCOPE OF WORK **8**

3 BASELINE HYDROLOGY **8**

3.1 Climate 8
3.1.1 Rainfall 8
3.1.2 Evaporation 10

3.2 Hydrological Setting 10
3.2.1 Regional Catchments 10
3.2.2 Topography 11
3.2.3 Drainage and Wetlands 11
3.2.4 Land Cover/Use 12
3.2.5 Soils 12
3.2.6 Geology and Groundwater 12
3.2.7 Surface Water Use 13

3.3 Surface Water Runoff 17

3.4 Surface Water Quality 17
3.4.1 Sources of Water Quality Data 17
3.4.2 Sampling Locations 17
3.4.3 Sampling Method 17
3.4.4 Guideline Limits 19
3.4.5 Results and Discussion 19

4 STORMWATER MANAGEMENT PLAN **23**

4.1 Identified Stormwater Issues 23

4.1.1 Libanon East 23
4.1.2 Libanon West 23
4.1.3 Libanon TSF 23
4.1.4 Libanon Paddocks 23
4.2 Proposed Stormwater Measures 25
4.2.1 Libanon East and West 25
4.2.1.1 Earth Berm along Southern side of Bridges Avenue 25
4.2.2 Libanon TSF and Paddocks 27
5 WATER BALANCE 29
5.1 Objectives 29
5.2 Process Flow and Water Balance Components 29
5.3 Hydraulic Reclamation Water Requirements 30
5.4 Assumptions and Limitations 30
5.5 Input Parameters 31
5.6 Water Balance Results 32
5.7 Slurry Sump and Lined Catchment Paddock Sizing 32
6 SURFACE WATER IMPACT ASSESSMENT 34
6.1 Project Activities Assessed 34
6.1.1 Construction Phase 34
6.1.2 Operational Phase 34
6.1.3 Closure and Rehabilitation Phase 34
6.2 Methodology 34
6.2.1 Part A: Defining Consequence in Terms of Magnitude, Duration and Spatial Scale 34
6.2.2 Part B: Determining the Consequence Rating 35
6.2.3 Part C: Determining Significance Rating 36
6.3 Impact Assessment and Mitigation 36
6.3.1 Construction Phase 36
6.3.2 Operational Phase 37
6.3.3 Closure and Rehabilitation Phase 39
6.3.4 Post Closure Phase 41
6.4 Cumulative Impacts 41
6.5 Impact Summary Table 42
7 MONITORING PLANS 45
7.1 Surface Water Quality 45
7.2 Stormwater Infrastructure 45
8 CONCLUSIONS AND RECOMMENDATIONS 46

9 REFERENCES 47

APPENDIX A: WATER QUALITY LABORATORY CERTIFICATE 48

APPENDIX B: CURRICULUM VITAE 49

LIST OF TABLES

Table 3-1: Storm rainfall depths for the project 9

Table 3-2: Evaporation for the area 10

Table 3-3: Description of the surface water quality sampling locations 17

Table 3-4: Site visit surface water quality results 21

Table 3-5: Sibanye monitoring water quality results (Hydrospatial, 2021) 22

Table 5-1: Estimated water requirements and planned water supply 30

Table 5-2: Parameters and assumptions/sources used in the water balance calculations 31

Table 6-1: Consequence rating definitions 34

Table 6-2: Consequence rating 35

Table 6-3: Significance rating 36

Table 6-4: Summary of activities and impacts for the construction phase 36

Table 6-5: Significance rating for the construction phase 37

Table 6-6: Summary of activities and impacts for the operational phase 38

Table 6-7: Significance rating of operational impact 1 38

Table 6-8: Significance rating of operational impact 2 39

Table 6-9: Summary of activities and impacts for the closure and rehabilitation phase 40

Table 6-10: Significance rating of closure impact 1 40

Table 6-11: Cumulative impact rating for surface water quality 41

Table 6-12: Summary of the potential surface water impacts and proposed mitigation measures 43

LIST OF FIGURES

Figure 1-1: Location of the project 2
Figure 1-2: Mobile tracked hydraulic monitor on a tailings facility 4
Figure 1-3: Typical bench widths and heights for gold reclamation from tailings facilities 4
Figure 1-4: Proposed infrastructure 6
Figure 3-1: Mean monthly rainfall for the area 9
Figure 3-2: Kloof Mine Biodam located immediately north of the proposed pump station 12
Figure 3-3: Topography and drainage 14
Figure 3-4: Land Cover 15
Figure 3-5: Geology 16
Figure 3-6: Surface water quality sampling locations 18
Figure 4-1 - Contributing Stormwater Catchment Areas 24
Figure 4-2 - Earth Berm Detail 25
Figure 4-3 – Proposed stormwater solution 26
Figure 5-1: Average monthly water balance for the Libanon TSF 33

DECLARATION OF INDEPENDENCE

I, Andy Pirie declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have the expertise in conducting the specialist study relevant to this application, including knowledge of the various Acts, regulations and any guidelines that have relevance to the proposed project;
- I will comply with the Acts, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of Section 24F of the Act.

Andy Pirie
Senior Hydrologist
Pr.Sci.Nat (reg no. 114988)

ACRONYMS AND ABBREVIATIONS

BPG	Best Practice Guideline
CV	Curriculum Vitae
DEM	Digital Elevation Model
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
FWGR	Far West Gold Recoveries
GN R704	Government Notice No. 704
IWULA	Water Use Licence Application
IWWMP	Integrated Water and Waste Management Plan
km	Kilometres
kV	Kilovolt
kVA	Kilovolt-ampere
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
mamsl	metres above mean sea level
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
m	Metres
m^2	Square metres
m^3	Cubic metres
mm	Millimetres
mbgl	Metres below ground level
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
No.	Number
NWA	National Water Act, 1998 (Act No. 36 of 1998)
Pr.Sci.Nat.	Professional Natural Scientist
RQO	Resource Quality Objective
RTSF	Regional Tailings Storage Facility
TDS	Total Dissolved Solids
SWMP	Stormwater Management Plan
SANS	South African National Standards
SACNASP	South African Council for Natural Scientific Professions
SCS	Soil Conservation Service
TSF	Tailings Storage Facility
TWQR	Target Water Quality Range
WMA	Water Management Area
WRC	Water Research Commission

WR2012	Water Resources of South Africa, 2012 Study
WRTRP	West Rand Tailings Retreatment Project
WUL	Water Use Licence
WWTW	Wastewater Treatment Works

EXECUTIVE SUMMARY

Introduction and Background

Hydrospatial (Pty) Ltd was appointed by Kongiwe Environmental (Pty) Ltd (hereafter "Kongiwe") to conduct a surface water hydrological study for the proposed reclamation of the Libanon Tailings Storage Facilities (TSF) and associated pipeline (hereafter referred to as the "project"). This report provides the surface water hydrological study for the Environmental Impact Assessment (EIA) and Integrated Water Use Licence Application (IWULA) processes, that are being prepared by Kongiwe.

The project is located in the Rand West City Local Municipality, which falls within the Gauteng Province of South Africa. The towns of Westonaria and Randfontein are situated 3 kilometres (km) and 19 km to the north-east of the project, respectively.

It is Far West Gold Recoveries (FWGR) intention to reclaim and reprocess the gold residues of the Libanon TSF, with the slurry being processed at the existing Driefontein No. 2 Plant, and alternatively in the future at other existing gold plants. Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised.

The proposed mining method which will be used to remove the Libanon TSF is referred to as top-down hydraulic mining. This technique uses high-pressure water monitors (or mobile tracked hydraulic monitors) to deliver a high-pressure water jet to excavate tailings material from the dump. The water from the monitors mixes with the tailings and forms a slurry. The slurry then flows under gravity along trenches to a collection sump which is positioned at the lowest elevation of the bench being mined on the TSF. At the collection sump, finger screens remove debris that may impact the pumping station. The position of the collection sump may change as the reclamation progresses. From the collection sump, the slurry reports to a reclamation pump station located at the topographically lowest available position below the TSF. To control the volume of slurry reporting to the reclamation station, a flapper valve is used to hold and release the slurry from the collection sump. The slurry will then be pumped via pipelines to the Driefontein No. 2 Plant, where the slurry will be prepared and treated for gold extraction and beneficiation. Residue from the gold extraction process will be pumped via approved pipelines to the Regional TSF (RTSF).

The following infrastructure is proposed:

- Reclamation infrastructure consisting of a pump station which include:
  - Slurry sump;
  - Penstock;
  - Vibrating Screen;
  - Water tank;
  - Motor control centre; and
  - Pump.
- A short connecting 600 millimetres (mm) pipeline for process water from Kloof Shaft 10#;

- A short connecting 550 mm pipeline that will connect to the slurry pipeline that goes to Driefontein No. 2 Plant;
- Stormwater management infrastructure that will include:
  - Water infrastructure and stormwater systems;
  - Existing catchment paddocks on the TSF footprint; and
  - Pollution control paddock.
- An 11 kilovolt (kV) overhead powerline capable of transmitting 3 kilovolt-ampere. (kVA) of electricity as well as electricity reticulation;
- Administration buildings, including change houses and ablution facilities;
- Access roads, routed from existing entry points; and
- Construction contractors' yards (temporary facilities).

Power will be supplied by Eskom and potable water will be purchased from Rand Water Board or the Municipality, with a contingency for portable JoJo tanks or a connection to existing water pipeline infrastructure.

Water required for reclamation activities will be sourced from dewatering that currently takes places at the nearby Kloof Shaft 10#, and will be conveyed through an existing process water pipeline to the project site for reuse in a closed-circuit system. FWGR are authorised to use 9 487 500 m^3/annum of water from the Kloof Shaft 10#. Water will also be sourced from the RTSF.

The anticipated life span of the project is approximately 12 years. It is expected that there would be a 1 year construction and ramp-up period, which would include the placement of infrastructure and site preparation, a 6 year operational phase where active hydraulic reclamation and mechanical removal would take place, a 2 year ramp-down period, and 3 years to rehabilitate the reclaimed site.

Once reclamation of the TSF is complete, the area will be assessed for contamination (particularly in terms of radiation). Contaminated soils will be removed, and the land will be levelled to its original functioning topography levels. Following rehabilitation, it is anticipated that the land will be returned to the landowner to use at their discretion. The project will reclaim the historic TSF and remove a pollution source from the area, aiding in the rehabilitation of the mining legacy left behind in the area.

Scope of Work

The scope of work included the following:

- Description of the baseline (current) surface water hydrology in terms of water quality and quantity. The purpose of the baseline is to ensure that a thorough understanding of the pre-mining surface water conditions is provided;
- Development of a water balance according to the DWS Best Practice Guideline G2: Water and Salt Balances. The water balance will provide the water volumes for the proposed project;

- An assessment of the potential surface water impacts and recommended mitigation measures; and
- Development of monitoring plans that can be used to monitor potential impacts resulting from the proposed project.

Baseline Hydrology

Rainfall data for the area was obtained from the DWS weather station C2E007 located at the Zuurbekom pump station, 19 km east of the project. This station is the closest available weather station to the project with a recent rainfall record and a similar altitude. Rainfall data was extracted for the period between October 2002 – September 2020, which was the most recent and complete record available. The area has a Mean Annual Precipitation (MAP) of 685 mm. Rainfall is highest over the summer months of October to April, with January generally being the wettest month. The remaining winter months receive much less rain, with July being the driest month. Symons Pan (S-Pan) evaporation data was sourced from C2E007 and was converted into open water evaporation. The open water Mean Annual Evaporation (MAE) is 1 267 mm, with evaporation being highest over the warmer months of September to March, and lowest over the cooler months of April to August.

The project is located in quaternary catchment C23D which forms part of the Vaal Water Management Area (WMA). Drainage of the site is in a north-westerly direction towards the Wonderfonteinspruit. The 1:50 000 topographical data for the area shows that a non-perennial drainage line occurs to the north-east of the TSF, however, during the site visit, this area was found to be dry, and no defined channel could be located. According to TBC (2024), all wetlands within a 500 m radius of the project are artificially created. The Wonderfonteinspruit to the north of the TSF, which is the main river in the area, is dry all year around, due to the flow being diverted into a 1 m diameter pipeline near the upstream Donaldson Dam. In addition to this, due to dewatering of the underlying dolomite, large sinkholes have formed along the Wonderfonteinspruit and its tributaries, which consume any runoff generated.

The project is located on Malmani Dolomite which has been dewatered for several decades by the mines in the area. The land cover/use of the area is dominated by mining, agricultural, grassland and residential areas. The TSF and associated infrastructure are located within Land Type Ab7, which according to the Land Type database (Land Type Survey Staff, 1972 - 2006), is almost entirely dominated by Hutton soil forms, which are well drained permeable soils with soil depths of between 600 – 800 mm. Surface water in the region is primarily used for livestock watering and irrigation.

Water quality samples were obtained from the Wonderfonteinspruit and the Kloof Mine Biodam near to the Libanon TSF, and were compared to the Resource Quality Objectives (RQOs) for the Wonderfonteinspruit, as well as the DWS guideline limits for irrigation, livestock watering and aquatic ecosystems. The samples were analysed at Aquatico Laboratories in Centurion. In addition to the above, water quality data was also obtained from the report: Surface Water Study for the Sibanye-Stillwater Kloof Operations Environmental Management Programme and Water Use Licence Update (Hydrospatial, 2021). The following provides a summary of the water quality:

- pH exceeded the DWS irrigation limit at the Wonderfonteinspruit and Biodam. The high pH values that have been recorded are most likely due to agricultural, livestock and mining activities in the area;
- Electrical Conductivity (EC) and Total Dissolved Solids (TDS), which provide an indication of the dissolved salts in water, exceeded the irrigation limit along the Wonderfonteinspruit. Sodium, which contributes to elevated EC and TDS levels, followed a similar trend. The exceedances are likely due to agricultural and mining activities;
- Orthophosphate and nitrate were elevated along the Wonderfonteinspruit. These exceedances are most likely due to sewage runoff from the upstream settlements and Wastewater Treatment Works (WWTW);
- Aluminium exceeded the stringent DWS limit for aquatic ecosystems along the Wonderfonteinspruit, but was regularly within the RQO limit at all sampling points;
- Copper exceeded the RQO limit along the Wonderfonteinspruit;
- Zinc exceeded the DWS aquatic ecosystem limit at the Biodam, but was within the Kloof WUL limit at this sampling point. Zinc also exceeded the DWS aquatic ecosystem limit along the Wonderfonteinspruit on a number of occasions;
- Manganese exceeded the DWS aquatic ecosystem limit along the Wonderfonteinspruit; and
- Uranium was within limits at all of the points sampled during the site visit, however, uranium regularly exceeded the RQO limit along the Wonderfonteinspruit from the information obtained from Hydrospatial (2021).

Stormwater Management Plan

Waiting for the engineers to provide the stormwater management plan.

Water Balance

A monthly water balance was setup in Microsoft Excel spreadsheet format, to estimate the volumes of water for the project. The water balance was setup to simulate the average yearly, average dry and average wet season volumes. The following provides a summary of the main outcomes of the water balance:

- The reclamation water requirement is 6 337 495 m^3/annum. This water will be sourced from the Kloof Shaft 10# (5 055 615 m^3/annum), whilst the RTSF can supply up to 25 386 115 m^3/annum;
- Runoff from reclamation activities reporting to the collection sump is expected to be in the order of 5 070 000 m^3/annum (422 500 m^3/month);
- On average, 5 089 296 m^3/annum (424 108 m^3/month) is estimated to report to the reclamation pump station, which will be pumped to the Driefontein No. 2 Plant; and
- The potable water requirement was calculated to be 372 m^3/annum (31 m^3/month).

Surface Water Impact Assessment

The surface water impact assessment showed that the main identified impacts are the following:

- Uncontained runoff of dirty water from the operational area at the TSF running off into the downslope watercourses. This can be mitigated by the implementation of a closed SWMP that captures and contains all dirty water runoff from the site;
- Poor maintenance of stormwater infrastructure such as silted paddocks and eroded berms, that can lead to overflows and spills into the downslope watercourses. This can be mitigated by the implementation of the monitoring plan detailed in this report; and
- Exposure of potential contaminated soils during the closure and rehabilitation phase once the TSF has been removed. This can be mitigated by runoff being contained onsite through the implementation of paddocks until the contaminated soils are removed. Once contaminated soils are removed, the area must be backfilled with uncontaminated soils, and levelled to its original functioning topography and re-vegetated.

Monitoring Plans

Monitoring plans for water quality and stormwater management are provided under section 7.

Conclusions and Recommendations

In conclusion, the most important aspect to prevent negative impacts from a surface water perspective, is to ensure that a sound SWMP is implemented prior to the commencement of reclamation activities, in accordance with the conditions stipulated in GN R704. Monitoring and maintenance of stormwater measures is of utmost importance and should be conducted as outlined in this report. The removal of the TSF is expected to have a positive long-term impact on the surrounding watercourses, provided that rehabilitation is successfully implemented.

Based on the findings of this report, the project can commence provided that the mitigation measures and monitoring plans are implemented.

1 INTRODUCTION AND BACKGROUND

Hydrospatial (Pty) Ltd was appointed by Kongiwe Environmental (Pty) Ltd (hereafter "Kongiwe") to conduct a surface water hydrological study for the proposed reclamation of the Libanon Tailings Storage Facilities (TSF) and associated pipeline (hereafter referred to as the "project"). This report provides the surface water hydrological study for the Environmental Impact Assessment (EIA) and Integrated Water Use Licence Application (IWULA) processes, that are being prepared by Kongiwe.

1.1 Project Location

The project is located in the Rand West City Local Municipality, which falls within the Gauteng Province of South Africa. The towns of Westonaria and Randfontein are situated 3 kilometres (km) and 19 km to the north-east of the project, respectively. Figure 1-1 indicates the location of the proposed project.

1.2 Project Description

Far West Gold Recoveries (Pty) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSFs are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF).

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the existing Driefontein No. 2 Plant, and alternatively in the future at other existing gold plants. Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised.

1.2.1 Required Authorisations

The proposed project will require authorisation in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) for Section 21 water uses, the National Environmental Management Act, 1998 (Act No 107 of 1998) (NEMA) and the National Environmental Management: Waste Act, 2008 (Act No 59 of 2008), Category B Activities. An IWULA will be prepared and submitted in accordance with the Water Use Licence Application and Appeals Regulations 2017 published in GNR 267 on 24 March 2017, and will be supported by a Technical Report and Integrated Water and Waste Management Plan (IWWMP).

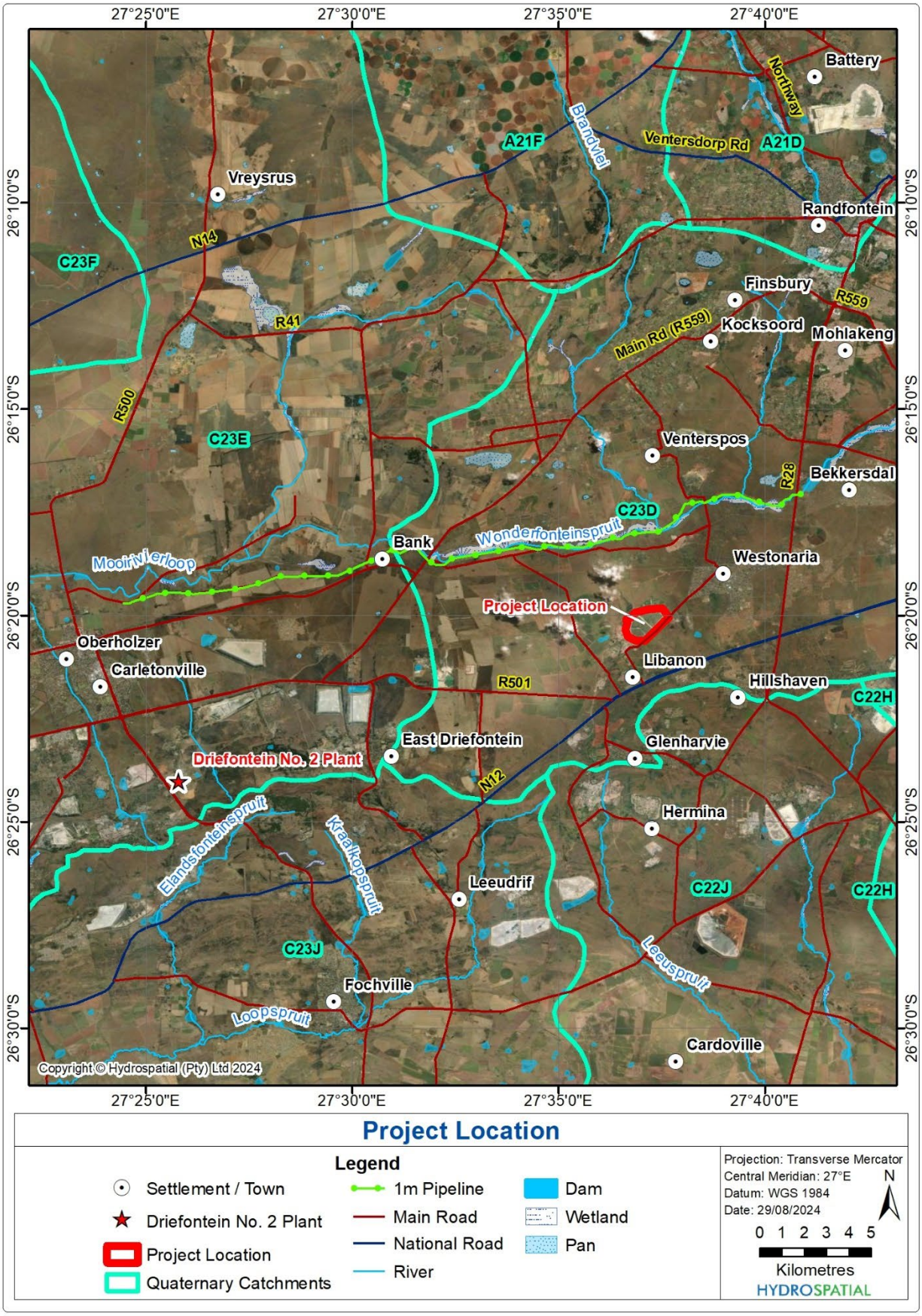

Figure 1-1: Location of the project

1.2.2 Mining Method

The proposed mining method which will be used to remove the Libanon TSF is referred to as top-down hydraulic mining. This technique uses high-pressure water monitors (or mobile tracked hydraulic monitors) to deliver a high-pressure water jet to excavate tailings material from the dump (Figure 1-2). The water from the monitors mixes with the tailings and forms a slurry. The slurry then flows under gravity along trenches to a collection sump which is positioned at the lowest elevation of the bench being mined on the TSF. At the collection sump, finger screens remove debris that may impact the pumping station. The position of the collection sump may change as the reclamation progresses. From the collection sump, the slurry reports to a reclamation pump station located at the topographically lowest available position below the TSF. To control the volume of slurry reporting to the reclamation station, a flapper valve is used to hold and release the slurry from the collection sump. The slurry will then be pumped via pipelines to the Driefontein No. 2 Plant, where the slurry will be prepared and treated for gold extraction and beneficiation. Residue from the gold extraction process will be pumped via approved pipelines to the RTSF.

Reclamation will take place in predetermined benches (or cuts) and will move unidirectionally until the entire TSF has been reclaimed. Generally, 15 m to 30 m cuts are made for reclamation as per Figure 1-3 below.

Figure 1-2: Mobile tracked hydraulic monitor on a tailings facility

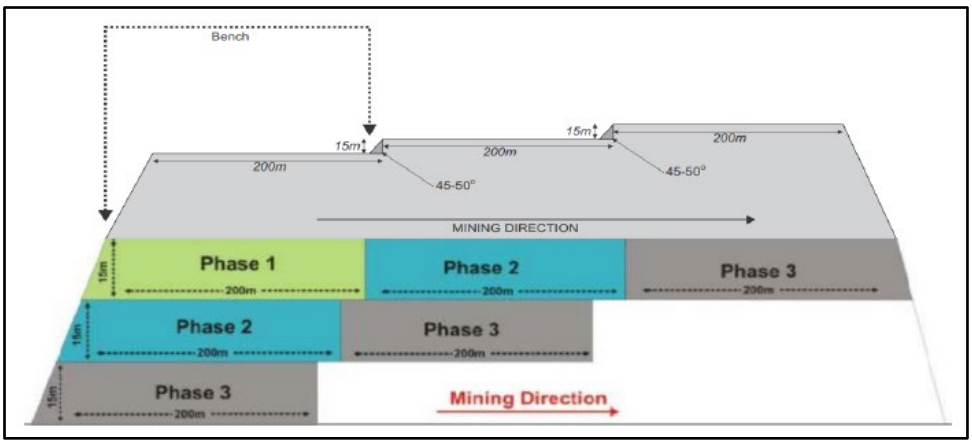

Figure 1-3: Typical bench widths and heights for gold reclamation from tailings facilities

1.2.3 Proposed Infrastructure

The following infrastructure is proposed:

- Reclamation infrastructure consisting of a pump station which include:
  - Slurry sump;
  - Penstock;
  - Vibrating Screen;
  - Water tank;
  - Motor control centre; and
  - Pump.
- A short connecting 600 millimetres (mm) pipeline for process water from Kloof Shaft 10#;
- A short connecting 550 mm pipeline that will connect to the slurry pipeline that goes to Driefontein No. 2 Plant;

- Stormwater management infrastructure that will include:
  - Water infrastructure and stormwater systems;
  - Existing catchment paddocks on the TSF footprint; and
  - Pollution control paddock.
- An 11 kilovolt (kV) overhead powerline capable of transmitting 3 kilovolt-ampere. (kVA) of electricity as well as electricity reticulation;
- Administration buildings, including change houses and ablution facilities;
- Access roads, routed from existing entry points; and
- Construction contractors' yards (temporary facilities).

The proposed infrastructure is indicated on Figure 1-4.

1.2.4 Water Sources and Power Supply

Power will be supplied by Eskom and potable water will be purchased from Rand Water Board or the Municipality, with a contingency for portable JoJo tanks or a connection to existing water pipeline infrastructure.

Water required for reclamation activities will be sourced from dewatering that currently takes places at the nearby Kloof Shaft 10#, and will be conveyed through an existing process water pipeline to the project site for reuse in a closed-circuit system. FWGR are authorised to use 9 487 500 m^3/annum of water from the Kloof Shaft 10#. Water will also be sourced from the RTSF.

Figure 1-4: Proposed infrastructure

1.2.5 Life of the Project

The anticipated life span of the project is approximately 12 years. It is expected that there would be a 1 year construction and ramp-up period, which would include the placement of infrastructure and site preparation, a 6 year operational phase where active hydraulic reclamation and mechanical removal would take place, a 2 year ramp-down period, and 3 years to rehabilitate the reclaimed site.

1.2.6 Access

The main access route is off Bridges Avenue which runs parallel to the south of the TSF. As far as possible, existing access roads will be utilised, and where this is not possible, these will be constructed. Where access roads are to be constructed, they will be 4 m wide gravel roads, with mitre drains to protect the road structure from flood damage. Intersections will be properly designed to provide safe entry and exit in and out of the reclamation area. Approvals from the Provincial Roads authorities will be obtained where necessary.

1.2.7 Rehabilitation

Once reclamation of the TSF is complete, the area will be assessed for contamination (particularly in terms of radiation). Contaminated soils will be removed, and the land will be levelled to its original functioning topography levels.

Following rehabilitation, it is anticipated that the land will be returned to the landowner to use at their discretion. The project will reclaim the historic TSF and remove a pollution source from the area, aiding in the rehabilitation of the mining legacy left behind in the area.

1.3 Legal Requirements and Guidelines

The following key legislative requirements and guidelines are relevant to this study:

- National Water Act, 1998 (Act No. 36 of 1998) (NWA)
- Regulations on the Use of Water for Mining and Related Activities aimed at the Protection of Water Resources (published under Government Notice 704 (GN R704) in Government Gazette 20119, 4 June 1999);
- National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and associated Environmental Impact Assessment (EIA) 2014 regulations;
- Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA); and
- Department of Water and Sanitation (DWS) Best Practice Guideline (BPG) documents, particularly:
  - BPG G1: Storm Water Management;
  - BPG G2: Water and Salt Balances; and
  - BPG A5: Water Management for Surface Mines.

1.4 Site Investigation

A site investigation of the project area was undertaken on 14 August 2024. The purpose of the site investigation was to assess the hydrological characteristics of the area, and to obtain water samples from nearby watercourses.

1.5 Details of the Specialist

The study was undertaken by Andy Pirie who is a senior hydrologist at Hydrospatial (Pty) Ltd. Andy graduated with a Master of Science (M.Sc.) in Water Resource Management (cum laude). He is registered as a Professional Natural Scientist (Pr.Sci.Nat) (registration number: 114988) in Water Resources Science with the South African Council for Natural Scientific Professions (SACNASP). Work experience includes rainfall – runoff modelling, floodline determinations, development of stormwater management plans, water and salt balance modelling, setup of water monitoring networks and programmes, analysis of surface water quality and quantity, and surface water specialist studies for EIAs and IWULAs. Andy has more than 10 years' experience and has worked on projects in South Africa, Cameroon, Senegal, Mali, Democratic Republic of Congo, Botswana, Zambia and Namibia. His curriculum vitae is provided in Appendix B.

2 SCOPE OF WORK

The scope of work included the following:

- Description of the baseline (current) surface water hydrology in terms of water quality and quantity. The purpose of the baseline is to ensure that a thorough understanding of the pre-mining surface water conditions is provided;
- Development of a water balance according to the DWS Best Practice Guideline G2: Water and Salt Balances. The water balance will provide the water volumes for the proposed project;
- An assessment of the potential surface water impacts and recommended mitigation measures; and
- Development of monitoring plans that can be used to monitor potential impacts resulting from the proposed project.

3 BASELINE HYDROLOGY

3.1 Climate

3.1.1 Rainfall

Rainfall data for the area was obtained from the DWS weather station C2E007 located at the Zuurbekom pump station, 19 km east of the project. This station is the closest available weather station to the project with a recent rainfall record and a similar altitude. Rainfall data was extracted for the period between October 2002 – September 2020, which was the most recent and complete record available. The mean monthly rainfall is depicted in Figure 3-1. The area has a Mean Annual Precipitation (MAP) of 685 mm. Rainfall is highest over the summer

months of October to April, with January generally being the wettest month. The remaining winter months receive much less rain, with July being the driest month.

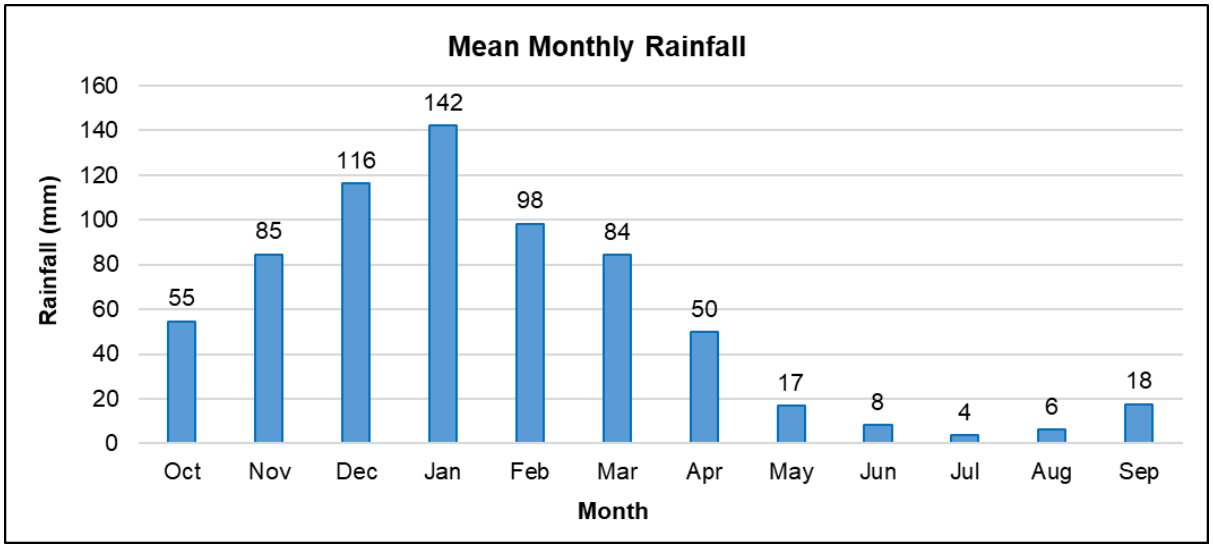

Figure 3-1: Mean monthly rainfall for the area

The storm rainfall depths for the centre position of the Libanon TSF were extracted from the Design Rainfall Estimation in South Africa software programme (Smithers and Schulze, 2002). The programme uses the six closest rainfall stations to a user specified position, to calculate the storm rainfall depths. The extracted storm rainfall depths for various storm durations and recurrence intervals for the project are provided in Table 3-1.

Table 3-1: Storm rainfall depths for the project

Storm Duration	Storm Rainfall Depth (mm)						
	1:2 yr	1:5 yr	1:10 yr	1:20 yr	1:50 yr	1:100 yr	1:200 yr
5 min	9	12	14	16	18	20	22
10 min	13	17	20	23	26	29	32
15 min	16	21	25	28	33	36	40
30 min	20	27	32	36	42	46	51
45 min	23	31	37	42	48	53	58
1 hr	26	35	40	46	53	59	65
1.5 hr	30	40	47	53	62	68	75
2 hr	33	44	52	59	68	75	83
4 hr	39	53	61	70	81	90	98
6 hr	44	58	68	77	90	99	108
8 hr	47	62	73	83	96	106	116
10 hr	49	66	77	88	102	112	123
12 hr	52	69	81	92	106	118	129
16 hr	56	74	86	99	114	126	138
20 hr	59	78	91	104	121	133	146
24 hr	61	82	96	109	126	140	153

Storm Duration	Storm Rainfall Depth (mm)						
	1:2 yr	1:5 yr	1:10 yr	1:20 yr	1:50 yr	1:100 yr	1:200 yr
1 day	53	71	83	94	110	121	132
2 day	65	87	102	116	135	149	163
3 day	74	99	115	131	152	168	184
4 day	80	107	125	142	165	182	200
5 day	86	114	133	152	176	194	213
6 day	90	120	140	160	185	205	224
7 day	94	126	147	167	194	214	234

3.1.2 Evaporation

As with the rainfall, Symons Pan (S-Pan) evaporation data for the area was obtained from the DWS weather station C2E007, which is located at a similar altitude as the project. S-Pan evaporation measurements are not a true reflection of evaporation from natural open water bodies, as the water temperatures in the S-Pan are higher, resulting in higher evaporation rates. To convert S-Pan measurements to open water evaporation, monthly open water evaporation conversion factors were used, which were obtained from the WR2012 study. The adopted monthly evaporation for the project is indicated in Table 3-2. The open water Mean Annual Evaporation (MAE) is 1 267 mm, with evaporation being highest over the warmer months of September to March, and lowest over the cooler months of April to August.

Table 3-2: Evaporation for the area

Month	S-Pan Evaporation (mm)	Evaporation Factor	Open Water Evaporation (mm)
Oct	162	0.81	132
Nov	166	0.82	136
Dec	168	0.83	139
Jan	168	0.84	141
Feb	139	0.88	122
Mar	128	0.88	113
Apr	101	0.88	89
May	84	0.87	73
Jun	67	0.85	57
Jul	75	0.83	62
Aug	106	0.81	85
Sep	144	0.81	117
Total	**1 508**	**N/A**	**1 267**

3.2 Hydrological Setting

3.2.1 Regional Catchments

The DWS has divided South Africa into primary, secondary, tertiary and quaternary catchments. Primary catchments are the largest defined catchments for South Africa, of which

there are 22, and are assigned a letter ranging from A – X (excluding O). Secondary catchments are subdivisions of the primary catchments, and are the second largest catchments in South Africa, assigned the primary catchment letter within which they are located and a number e.g. A5 (secondary catchment 5 located within primary catchment A). Similarly, tertiary catchments are subdivisions of secondary catchments, represented for example by A53 (tertiary catchment 3 located within secondary catchment A5). Lastly, quaternary catchments are the smallest defined catchments and are assigned the tertiary catchment number, along with a quaternary catchment letter e.g. A53D (quaternary catchment D located within tertiary catchment A53).

Further to the above, the DWS has divided South Africa into 9 Water Management Areas (WMAs). The 9 WMAs consist of the Limpopo, Olifants, Inkomati-Usuthu, Pongola-Mtamvuna, Vaal, Orange, Mzimvubu-Tsitsikamma, Breede-Gouritz and Berg-Olifants.

The project is located in quaternary catchment C23D which forms part of the Vaal WMA (Figure 1-1).

3.2.2 Topography

Figure 3-3 indicates the topography of the site. The general topography of the area is flat, with a very gradual dip in a north-westerly direction towards the Wonderfonteinspruit. The ground level elevation varies from 1 600 metres above mean sea level (mamsl) at the southern corner of the TSF, to 1 582 mamsl along the northern boundary. The TSF is approximately 55 m high and has a maximum elevation of 1 646 mamsl. Steep slopes in excess of 30 % occur along the sides of the TSF. A large number of sinkholes occur in the area, specifically along the Wonderfonteinspruit.

3.2.3 Drainage and Wetlands

The general drainage of the area is in a north-westerly direction towards the Wonderfonteinspruit (Figure 3-3). The 1:50 000 topographical data for the area shows that a non-perennial drainage line occurs to the north-east of the TSF, however, during the site visit, this area was found to be dry, and no defined channel could be located. The Kloof Mine Biodam (Figure 3-2) is located immediately north of the proposed pump station, which has created an artificial seep to the north of it (TBC, 2024). Groundwater dewatered from the underground workings at the Kloof Shaft 10#, is discharged into a canal that conveys water to the Biodam. The Biodam filters and settles out suspended solids, before discharging into a pipeline that connects to the 1 m metre pipeline to the north at the Wonderfonteinspruit. The Wonderfonteinspruit is diverted into a 1 m diameter pipeline at the Donaldson Dam, which conveys the flow of the Wonderfonteinspruit for a distance of approximately 30 km across the dewatered Venterspost, Bank and Oberholzer dolomitic compartments, discharging back into the Wonderfonteinspruit near the town of Carletonville. The 1 m pipeline was constructed in 1977, to prevent recharge of the underlying dolomitic compartments, and thereby reducing pumping costs associated with dewatering. As mentioned previously, a vast number of sinkholes occur in the area, specifically along the Wonderfonteinspruit, and therefore, very little surface water runoff occurs, as it is mostly lost to the underlying dolomite. For this reason, as well as due to the 1 m pipeline, the Wonderfonteinspruit to the north of the project is dry.

According to TBC (2024), all wetlands within a 500 m radius of the project are artificially created.

Figure 3-2: Kloof Mine Biodam located immediately north of the proposed pump station

3.2.4 Land Cover/Use

The land cover/use of the area is indicated on Figure 3-4 (DFFE, 2024). The area surrounding the TSF is dominated by agricultural, grassland and residential areas. The Kloof Shaft 10# is located to the south-west of the TSF, whilst the Libanon Landfill Site is located immediately north of the TSF.

3.2.5 Soils

Land Type data for South Africa was used to obtain the generalized soil patterns for the project area. Land Type data exists in the form of published 1:250 000 maps indicating delineated areas of similar terrain types, pedo-systems (uniform terrain and soil pattern) and climate (Land Type Survey Staff, 1972 - 2006). The TSF and associated infrastructure are located within Land Type Ab7 (Figure 3-4), which according to the Land Type database, is almost entirely dominated by Hutton soil forms, which are well drained permeable soils with soil depths of between 600 – 800 mm.

3.2.6 Geology and Groundwater

The geology of the area is shown on Figure 3-5. The project is located on Malmani Dolomite. Several dykes, which are considered to be impermeable barriers, divide the dolomite into a series of compartments. The project is primarily located on the Venterspost compartment, with the western side being partly located on the Bank compartment. These compartments are dewatered to varying degrees and the groundwater levels may be up to several hundred metres below ground level (mbgl). Due to the deep groundwater water levels, the compartment eyes (springs), which are generally located at the topographically lowest point along the Wonderfonteinspruit, no longer flow.

3.2.7 Surface Water Use

Surface water in the region is primarily used for livestock watering and irrigation.

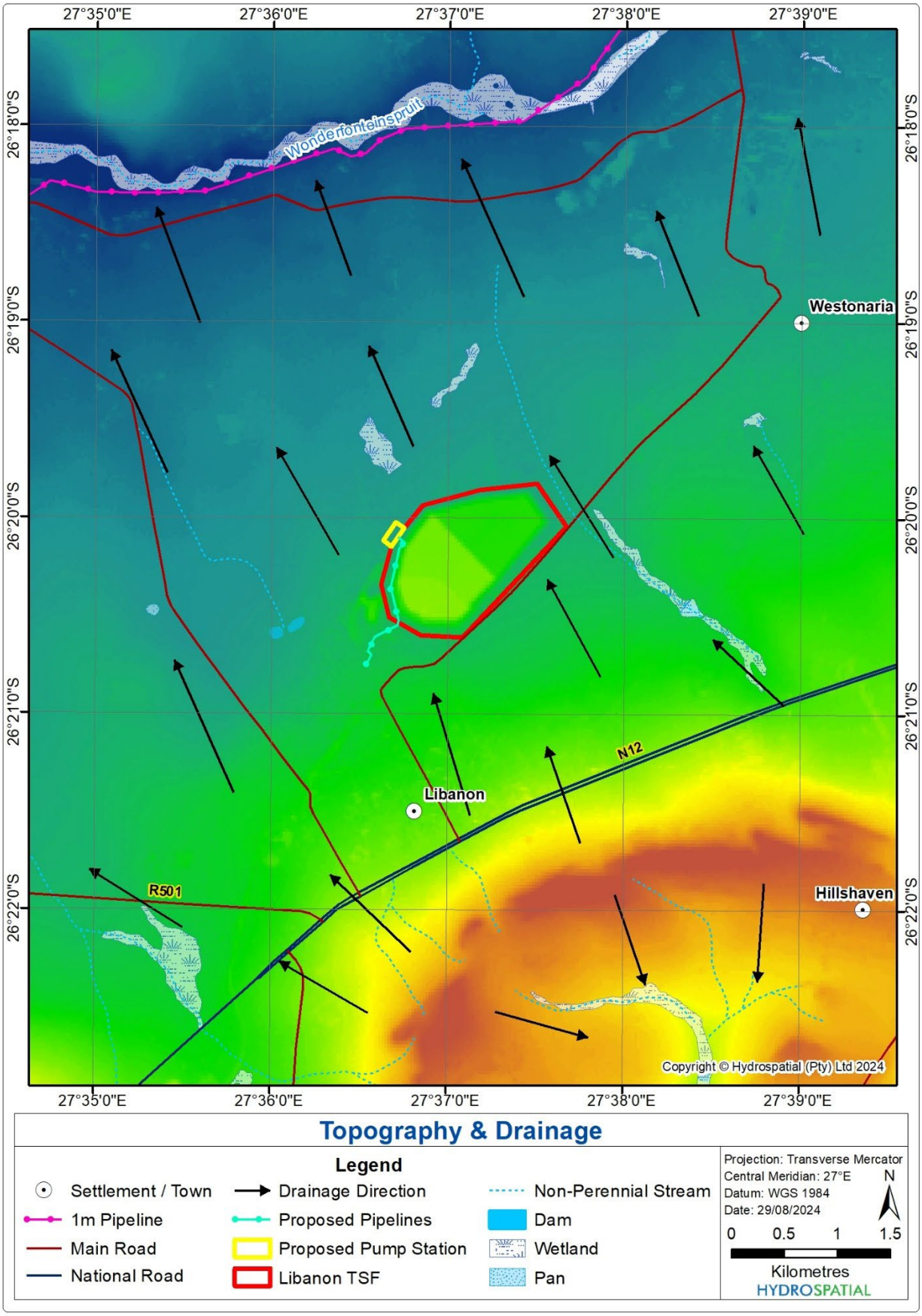

Figure 3-3: Topography and drainage

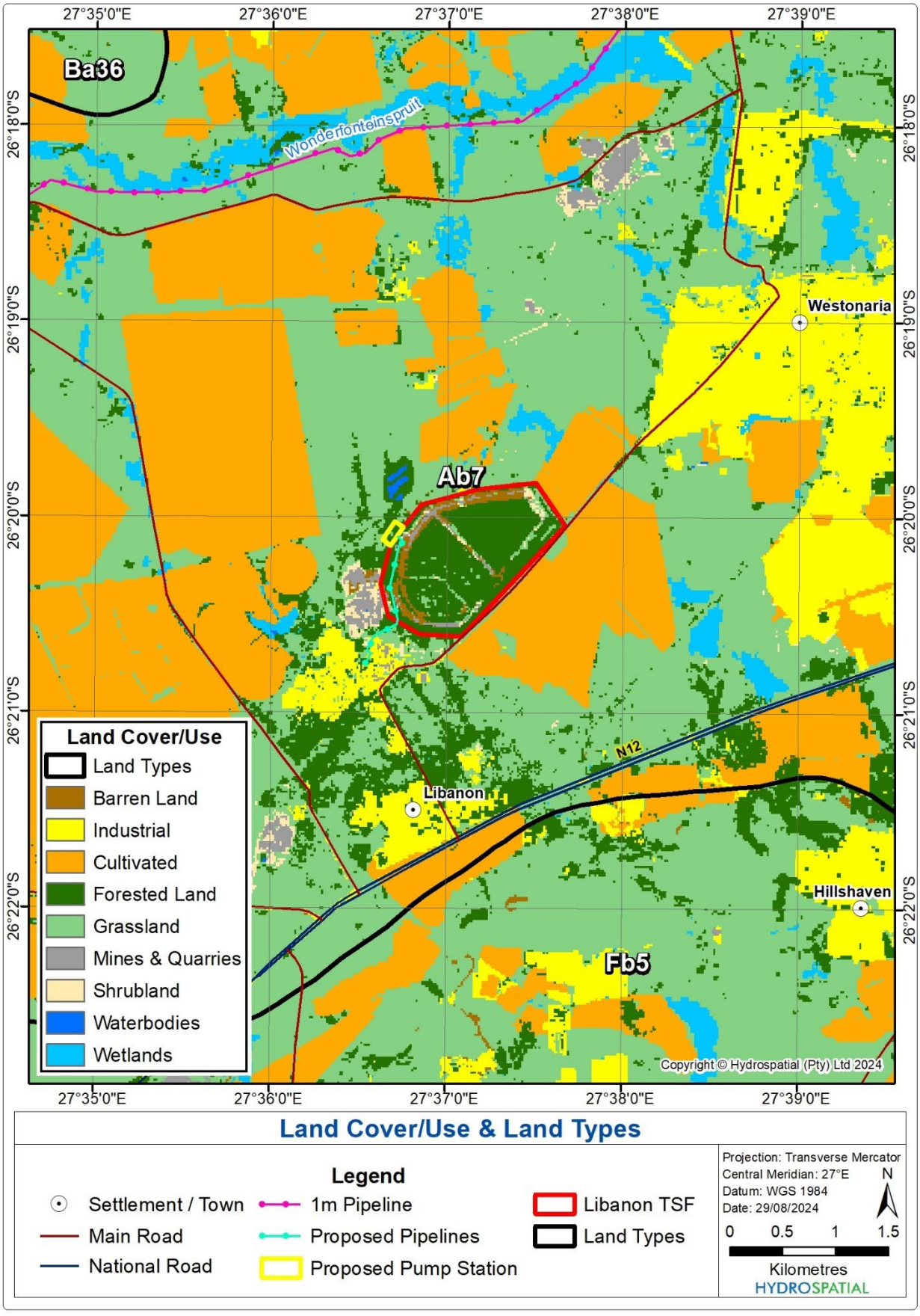

Figure 3-4: Land Cover

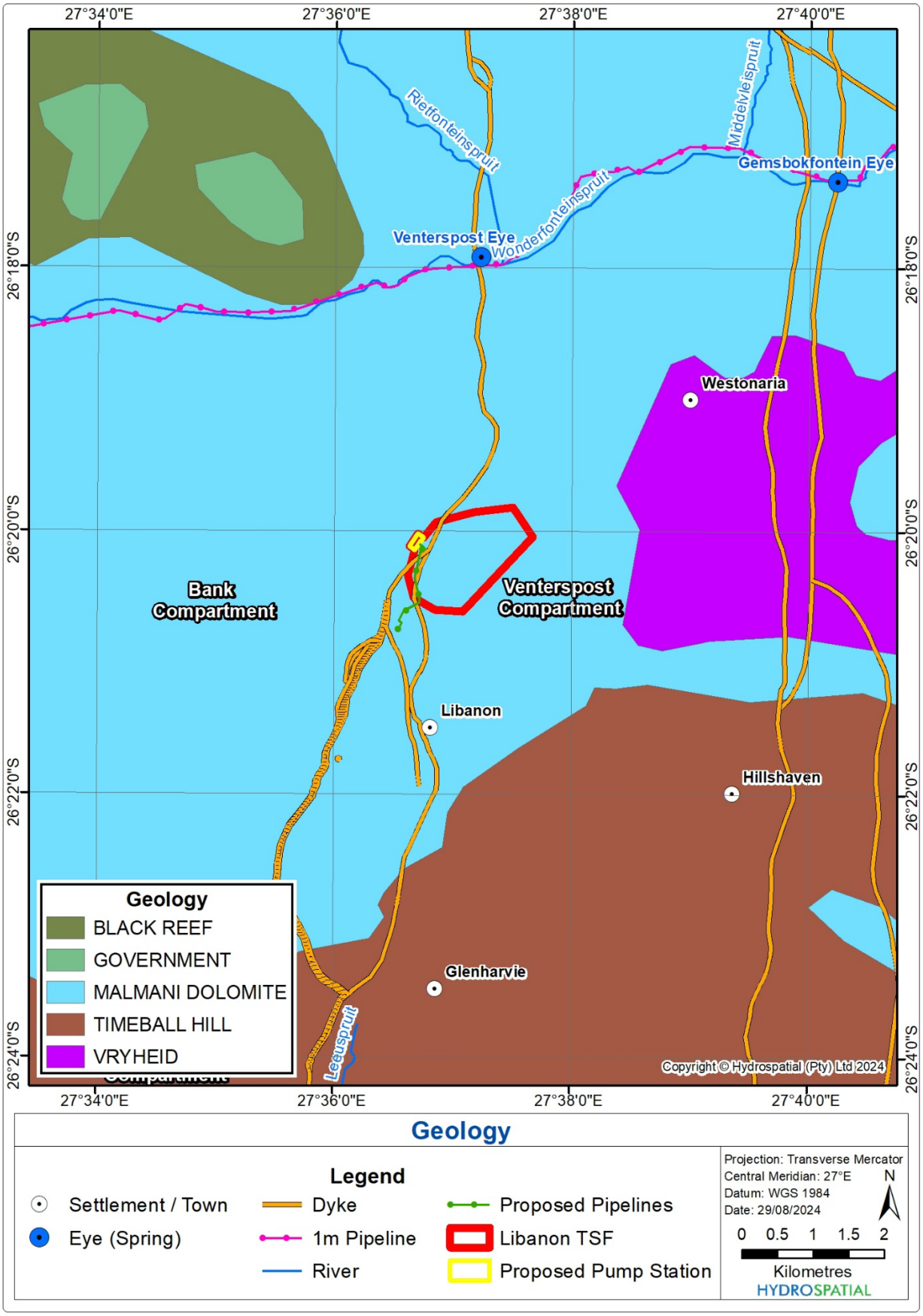

Figure 3-5: Geology

3.3 Surface Water Runoff

Due to the large number of sinkholes that have formed along non-perennial drainage lines and the Wonderfonteinspruit, surface water runoff within quaternary catchment C23D is limited, as it is almost entirely lost to the underlying dolomite via sinkholes. For this reason, as well as the 1 m pipeline that conveys the flow of the Wonderfonteinspruit between the Donaldson Dam and Carletonville, the Wonderfonteinspruit to the north of the project is dry.

3.4 Surface Water Quality

3.4.1 Sources of Water Quality Data

The following sources were used to describe the surface water quality for the project:

- Water quality sampling undertaken on the site visit on 14 August 2024 (laboratory certificate provided in Appendix A); and
- Water quality data obtained from the report: Surface Water Study for the Sibanye-Stillwater Kloof Operations Environmental Management Programme and Water Use Licence Update (Hydrospatial, 2021). Sampling points WS001 and WS006 were sampled monthly (31 times) between 2018/01/11 - 2020/08/18, whilst WS107 was sampled weekly (139 times) between 2018/01/03 - 2020/09/07. These sampling points form part of the Sibanye monitoring network for the area.

3.4.2 Sampling Locations

The sampling locations are indicated on Figure 3-6 and are summarised in Table 3-1.

Table 3-3: Description of the surface water quality sampling locations

Sampling Point	Description	Latitude	Longitude
SW1	Kloof Mine Biodam	26°19'55.27"S	27°36'44.67"E
SW4	1 m pipeline upstream of the project	26°17'19.58"S	27°40'9.18"E
SW5	Wonderfonteinspruit downstream of the project	26°18'14.54"S	27°35'33.34"E
WS001	1 m pipeline upstream of the project	26°17'19.58"S	27°40'9.26"E
WS006	Outlet of the 1 m pipeline near Carletonville	26°19'41.58"S	27°24'25.69"E
WS107	Outlet of the Kloof Mine Biodam	26°19'47.30"S	27°36'40.35"E

3.4.3 Sampling Method

Water samples obtained on the site visit, were taken approximately 20 centimetres (cm) below the water surface using a grab sampling technique. 500 millimetre (ml) plastic bottles provided by the laboratory was used to store the samples. The samples were kept cool and out of direct sunlight, and were delivered to Aquatico Laboratories in Centurion for water quality analysis.

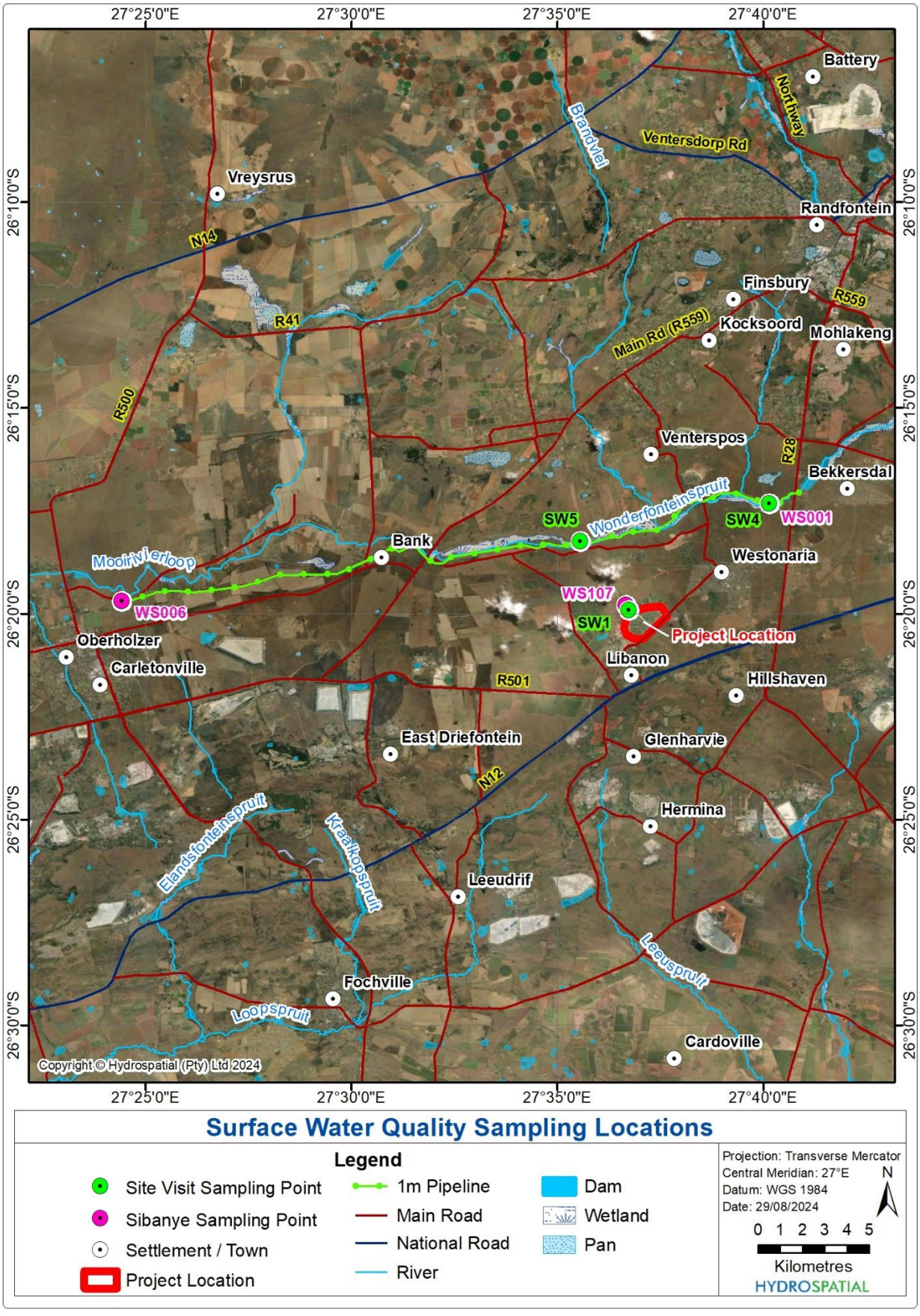

Figure 3-6: Surface water quality sampling locations

3.4.4 Guideline Limits

The water quality was compared to the Resource Quality Objective (RQO) limits for the Wonderfonteinspruit. Additionally, the DWS Target Water Quality Range (TWQR) limits for irrigation, livestock watering and aquatic ecosystems were also used for comparison purposes, as the main surface water uses in the region are irrigation and livestock watering. Furthermore, the Kloof Mine Water Use Licence (WUL) limits were included in Table 3-5, as they are applicable to sampling point WS107 at the Biodam. The water quality limits were obtained from the following documents:

- Department of Water and Sanitation. 2016. Classes and Resource Quality Objectives (RQOs) of Water Resources for Catchments of the Upper Vaal (Government Notice No. 468, 22 April 2016) – coloured in green in Table 3-4 and Table 3-5;
- Kloof Mine WUL – coloured in red in Table 3-5;
- Department of Water Affairs and Forestry, 1996. South African Water Quality Guidelines (second edition). Volume 4: Agricultural Use: Irrigation – coloured in orange in Table 3-4 and Table 3-5;
- Department of Water Affairs and Forestry, 1996. South African Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering – coloured in yellow in Table 3-4 and Table 3-5; and
- Department of Water Affairs and Forestry, 1996. South African Water Quality Guidelines. Volume 7: Aquatic Ecosystems – coloured in blue in Table 3-4 and Table 3-5.

3.4.5 Results and Discussion

The site visit water quality results are summarised in Table 3-4, whilst the Sibanye monitoring results are summarised in Table 3-5. Parameters exceeding limits are coloured in their respective colours in the above-mentioned tables. It should be noted that the water sampled at SW5, originates mostly from the water discharged from the Kloof Mine Biodam, as a valve was observed to be open on the Kloof Mine pipeline from the Biodam to just before it joins the 1 m pipeline. The following provides a summary of the water quality:

- pH exceeded the DWS irrigation limit at SW1, SW4, WS001 and WS006. The high pH values that have been recorded are most likely due to agricultural, livestock and mining activities in the area;
- Electrical Conductivity (EC) and Total Dissolved Solids (TDS), which provide an indication of the dissolved salts in water, exceeded the irrigation limit at SW4, as well as regularly at WS001 and WS006. Sodium, which contributes to elevated EC and TDS levels, followed a similar trend. The exceedances are likely due to agricultural and mining activities;
- Orthophosphate was elevated at SW4 and SW5, as well as regularly at WS001 and WS006. Nitrate was elevated at SW4. These exceedances are most likely due to sewage runoff from the upstream settlements and Wastewater Treatment Works (WWTW);

- Aluminium exceeded the stringent DWS limit for aquatic ecosystems at SW4, but was regularly within the RQO limit at all sampling points;
- Copper exceeded the RQO limit at SW1, SW4 and SW5, as well as occasionally at WS001 and WS006;
- Zinc exceeded the DWS aquatic ecosystem limit at SW1, but was within the Kloof WUL limit at this sampling point. Zinc also exceeded the DWS aquatic ecosystem limit at WS001 and WS006 on a number of occasions;
- Manganese exceeded the DWS aquatic ecosystem limit at WS001 and WS006 on a number of occasions; and
- Uranium was within limits at all of the points sampled during the site visit, however, uranium regularly exceeded the RQO limit at WS001 and WS006.

From the above, it is apparent that the water quality of the area is impacted by mining, sewage and agricultural and urban runoff.

Table 3-4: Site visit surface water quality results

Parameter	Units	DWS TWQR: Irrigation Limit	DWS TWQR: Livestock Watering Limit	DWS TWQR: Aquatic Eco-systems Limit	RQO Limit	SW1	SW4	SW5
pH	**pH**	**6.5-8.4**	**-**	**-**	**-**	8.5	8.81	8.35
Electrical conductivity (EC)	**mS/m**	**90**	**153**	**-**	**111**	86.2	88.4	82.6
Total dissolved solids (TDS)	**mg/l**	**585**	**1000**	**-**	**722****	562	618	552
Total Alkalinity	**mg $CaCO_3$/l**	**-**	**-**	**-**	**-**	249	181	230
Chloride (Cl)	**mg/l**	**100**	**1500**	**-**	**-**	27.6	48.7	28.1
Sulphate (SO_4)	**mg/l**	**-**	**1000**	**-**	**500**	180	175	187
Nitrate (NO_3) as N	**mg/l**	**-**	**100**	**-**	**4**	<0.194	4.07	0.391
Total oxidised nitrogen as N	**mg/l**	**-**	**-**	**-**	**-**	<0.194	4.07	0.391
Ammonium (NH_4) as N	**mg/l**	**-**	**-**	**-**	**-**	0.08	0.299	0.063
Orthophosphate (PO_4) as P	**mg/l**	**-**	**-**	**-**	**0.125**	<0.009	1.18	0.522
Fluoride (F)	**mg/l**	**2**	**2**	**0.75**	**3**	0.387	0.421	0.339
Calcium (Ca)	**mg/l**	**-**	**1000**	**-**	**-**	90	80.4	85.4
Magnesium (Mg)	**mg/l**	**-**	**500**	**-**	**-**	42.3	25.3	45.4
Sodium (Na)	**mg/l**	**70**	**2000**	**-**	**-**	54	85	53
Potassium (K)	**mg/l**	**-**	**-**	**-**	**-**	<0.015	7.14	<0.015
Aluminium (Al)	**mg/l**	**5**	**5**	**0.01**	**0.15**	0.02	<0.002	<0.002
Iron (Fe)	**mg/l**	**5**	**10**	**-**	**-**	<0.004	<0.004	<0.004
Manganese (Mn)	**mg/l**	**10**	**10**	**0.18**	**1.3**	0.083	0.02	<0.001
Chromium (Cr)	**mg/l**	**-**	**-**	**-**	**-**	<0.003	<0.003	<0.003
Copper (Cu)	**mg/l**	**0.2**	**0.5**	**0.0014***	**0.008**	0.017	0.011	0.016
Nickel (Ni)	**mg/l**	**0.2**	**1**	**-**	**-**	0.01	0.009	<0.002
Zinc (Zn)	**mg/l**	**1**	**20**	**0.002**	**0.036**	0.005	<0.002	<0.002
Cobalt (Co)	**mg/l**	**0.05**	**1**	**-**	**-**	0.006	0.006	0.004
Cadmium (Cd)	**mg/l**	**0.01**	**0.01**	**0.0004***	**0.005**	<0.002	<0.002	<0.002
Lead (Pb)	**mg/l**	**0.2**	**0.1**	**0.0012***	**0.013***	<0.004	<0.004	<0.004
Total hardness	**mg $CaCO_3$/l**	**-**	**-**	**-**	**-**	399	305	400
Total suspended solids (TSS)	**mg/l**	**50**	**-**	**-**	**-**	<4.5	7	5
Dissolved Uranium (U)	**mg/l**	**0.1**	**-**	**-**	**0.015**	<0.015	<0.015	<0.015

*Below detection limit

**TDS limit calculated by multiplying EC by the DWS recommended value of 6.5

Table 3-5: Sibanye monitoring water quality results (Hydrospatial, 2021)

Parameter	Units	DWS TWQR: Irrigation Limit	DWS TWQR: Livestock Watering Limit	DWS TWQR: Aquatic Eco-systems Limit	RQO Limit	Kloof Mine WUL Limit	WS107					WS001					WS006				
							Min	25th Percentile	50th Percentile	75th Percentile	Max	Min	25th Percentile	50th Percentile	75th Percentile	Max	Min	25th Percentile	50th Percentile	75th Percentile	Max
pH	pH Units	6.5-8.4	-	-	-	5.5-9.5	7.3	8.0	8.1	8.2	8.4	7.6	8.2	8.4	8.7	9.5	7.3	7.8	8.4	8.7	9.5
EC	mS/m	90	153	-	111	112	54	87	89	95	102	68	92	101	117	143	68	90	96	113	143
TDS	mg/l	585	1000	-	722**	784	330	561	606	643	780	428	620	690	787	1062	440	590	658	748	1086
SS	mg/l	50	-	-	-	25	0	1	1	1	245	1	1	4	8	27	1	1	1	6	18
Ca	mg/l	-	1000	-	-	100	66	74	77	83	90	65	80	91	102	149	59	74	85	99	148
Mg	mg/l	-	500	-	-	70	10	42	44	47	58	18	25	27	30	36	18	25	27	32	40
Na	mg/l	70	2000	-	-	100	45	58	59	61	94	52	76	96	105	123	52	73	84	103	122
K	mg/l	-	-	-	-	-	3	3	3	3	16	8	9	10	11	17	5	9	9	10	13
F	mg/l	2	2	0.75	3	0.8	0.05	0.31	0.39	0.44	1.57	0.05	0.17	0.23	0.26	0.54	0.05	0.17	0.21	0.30	0.51
Cl	mg/l	100	1500	-	-	100	29	32	34	36	48	30	43	49	53	62	21	40	49	52	62
SO_4	mg/l	-	1000	-	500	400	169	201	216	242	287	186	259	289	346	577	98	224	283	332	571
Ca Hard	mg/l	-	-	-	-	-	164	184	192	207	226	161	200	228	255	372	148	184	213	247	370
Mg Hard	mg/l	-	-	-	-	-	41	173	180	193	237	73	103	109	125	146	73	102	109	132	167
Tot Hard	mg/l	-	-	-	-	-	217	359	371	402	442	234	302	336	380	518	235	297	326	379	518
PO_4 as P	mg/l	-	-	-	0.125	1	0.050	0.098	0.098	0.098	0.978	0.098	0.575	0.768	0.908	1.280	0.098	0.529	0.798	0.925	2.906
NH_4 as N	mg/l	-	-	-	-	-	0.008	0.078	0.078	0.078	0.318	0.078	0.078	0.093	0.365	1.312	0.078	0.078	0.116	0.446	11.570
NO_3 as N	mg/l	-	100	-	4	-	0.023	0.140	0.194	0.358	1.584	0.091	0.672	1.453	2.283	3.664	0.051	0.512	1.201	2.200	3.717
COD	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Malk	mg/l	-	-	-	-	-	158	205	212	226	541	89	147	163	183	217	103	148	165	197	234
Palk	mg/l	-	-	-	-	-	0	0	0	0	16	0	0	0	12	115	0	0	0	13	88
U	ug/l	100	-	-	15	70	1	19	26	36	88	5	36	41	52	93	11	31	36	50	95
Al	mg/l	5	5	0.01*	0.15	0.5	0.024	0.028	0.028	0.035	0.310	0.028	0.028	0.036	0.072	0.198	0.028	0.028	0.028	0.067	0.212
Fe	mg/l	5	10	-	-	0.2	0.005	0.065	0.120	0.182	1.160	0.004	0.033	0.043	0.080	0.253	0.009	0.033	0.046	0.087	0.258
Cd	mg/l	0.01	0.01	0.0004*	0.005	0.01	0.003	0.003	0.003	0.003	0.006	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Cu	mg/l	0.2	0.5	0.0014*	0.008	0.1	0.001	0.005	0.005	0.005	0.050	0.005	0.005	0.005	0.005	0.010	0.005	0.005	0.005	0.007	0.050
Cr	mg/l	-	-	-	-	-	0.003	0.007	0.007	0.007	0.070	0.007	0.007	0.007	0.007	0.020	0.007	0.007	0.007	0.007	0.020
Mn	mg/l	10	10	0.18	1.3	0.1	0.002	0.004	0.008	0.017	0.315	0.002	0.029	0.184	0.319	0.526	0.002	0.022	0.101	0.233	0.516
Ni	mg/l	0.2	1	-	-	0.2	0.010	0.015	0.022	0.027	0.087	0.011	0.015	0.015	0.015	0.040	0.015	0.015	0.015	0.017	0.100
Pb	mg/l	0.2	0.1	0.0012*	0.013*	0.1	0.010	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
B	mg/l	0.5	5	-	-	0.5	0.006	0.111	0.119	0.128	0.154	0.006	0.027	0.036	0.040	0.052	0.019	0.030	0.037	0.046	0.089
Zn	mg/l	1	20	0.002	0.036	0.1	0.002	0.002	0.002	0.008	0.082	0.002	0.002	0.002	0.005	0.017	0.002	0.002	0.002	0.006	0.019
T CN	mg/l	-	-	-	-	0.5	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Turbidity	NTU	-	-	-	-	-	0.0	1.0	1.5	2.6	17.3	0.8	1.3	2.1	4.5	8.4	0.4	1.3	2.1	3.3	9.4
Hg	mg/l	-	-	-	-	-	0.000	0.000	0.000	0.001	0.002	-	-	-	-	-	-	-	-	-	-
As	mg/l	-	-	-	-	-	0.002	0.041	0.055	0.060	0.089	-	-	-	-	-	-	-	-	-	-

*Below detection limit

**TDS limit calculated by multiplying EC by the DWS recommended value of 6.5

4 STORMWATER MANAGEMENT PLAN

The Libanon TSF has 3 catchment areas contributing stormwater runoff to it (see Figure 4-1):

- Clean water areas:
- Libanon East – the biggest area commencing on the high lying ridge to the south, flowing northwards and concentrating at the eastern corner of the Libanon TSF; and,
- Libanon West – commencing at the N12 to the south, flowing northwards and concentrating at the western corner of the Libanon TSF;
- Dirty water areas:
- Libanon TSF – the TSF footprint where stormwater will be contained on the TSF by earth berms constructed as part of the reclamation process; and,
- Paddocks constructed at the toe of the TSF, to contain stormwater runoff from the side slopes of the TSF and allowing the ponded “dirty” water to either evaporate or infiltrate

4.1 Identified Stormwater Issues

4.1.1 Libanon East

The runoff concentrates at the north eastern corner of the catchment area (corner of Libanon TSF). Under the 1 in 50 year condition and the average slope of the land of 2% (Google Earth), the flow width will be 3.926 m and the velocity of flow is 13 m/s. This far exceeds the acceptable maximum velocity for earth of 1.2 m/s, so excessive erosion will occur. The high flow velocity will also be harmful to life.

4.1.2 Libanon West

The runoff concentrates at the north western corner of the catchment area (corner of Libanon TSF). Under the 1 in 50 year condition and the average slope of the land of 1% (Google Earth), the flow width will be 2.742 m and the velocity of flow is 7.3 m/s. However, inspections on site indicate that the land is degraded after previous developments in the area, and the flow will scatter across the area, thus reducing the velocity.

4.1.3 Libanon TSF

With the proposed reclamation method, the stormwater runoff is being collected within the berm on top of the Libanon TSF and allowed to infiltrate or evaporate. In effect this is a dam on top of the Libanon TSF on top of underlying dolomites, so SANS 1936 must be complied with.

4.1.4 Libanon Paddocks

The stormwater runoff from the TSF side slopes and the paddocks is collected in the paddocks and allowed to infiltrate or evaporate. In effect this is a dam on top of the underlying dolomites, so SANS 1936 must be complied with..

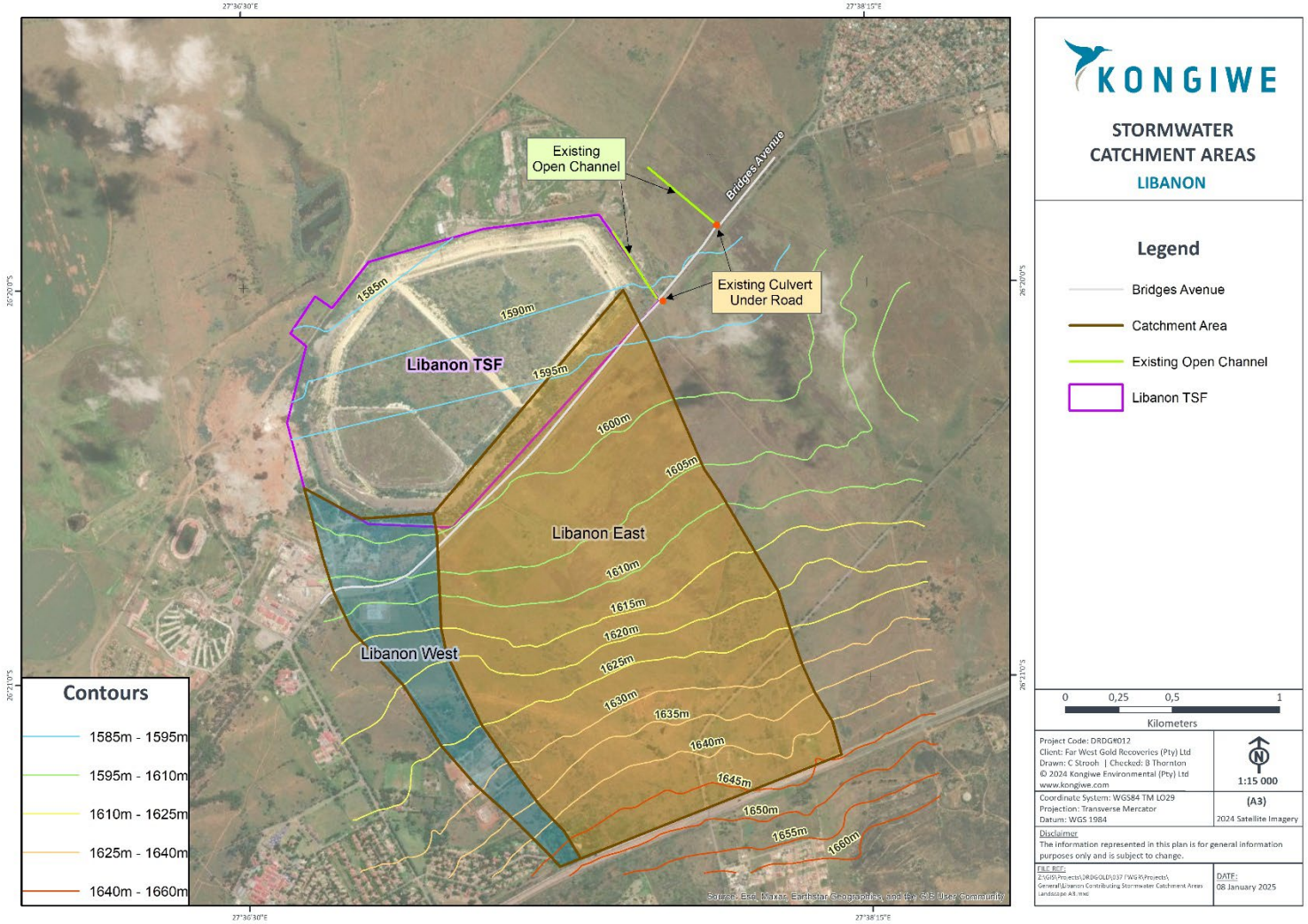

Figure 4-1 - Contributing Stormwater Catchment Areas

4.2 Proposed Stormwater Measures

4.2.1 Libanon East and West

4.2.1.1 Earth Berm along Southern side of Bridges Avenue

The proposed stormwater attenuation measure for the Libanon East and West catchments are shown in Figure 4-3.

It is proposed to construct an earth berm immediately to the south of Bridges Avenue adjacent to the Libanon TSF to the existing culvert under Bridges Avenue, described as follows:

- An earth berm top width 1 m, side slopes 1 vertical to 2 horizontal, 1 m high from point A to point B, a length of 1 845 m;

The berm detail is shown in Figure 4-2 below:

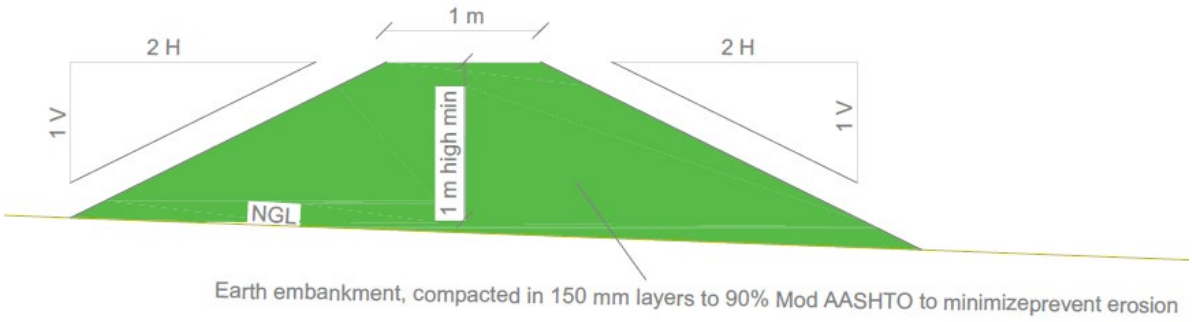

Figure 4-2 - Earth Berm Detail

The above structure will collect all the runoff from the Libanon East catchment, and 60% of the runoff from the Libanon West catchment.

The existing culvert under Bridges Avenue must be cleaned out and reinstated to its original design state. The size of the culvert could not be ascertained, but normally these structures are designed to handle the 1 in 5 year incident. In the event of the 1 in 50 year storm, the balance of the water not going through the culvert will flow across the road surface.

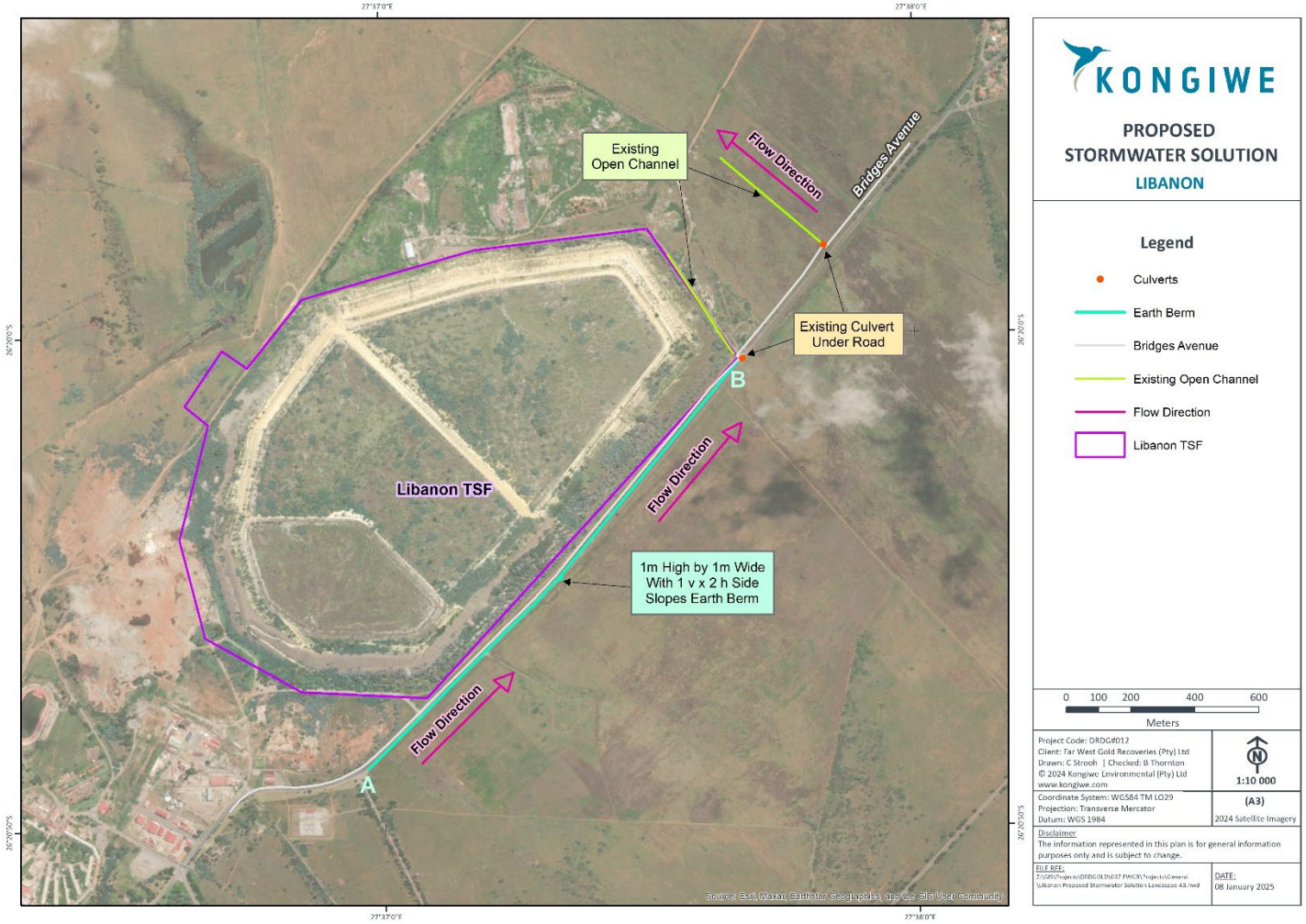

Figure 4-3 – Proposed stormwater solution

4.2.2 Libanon TSF and Paddocks

It is proposed to contain all stormwater falling on the top surface of the TSF within a berm located on the outside edge of the TSF top surface, as well as to contain all stormwater falling on the slopes of the TSF and in the paddocks at the toe of the side slopes of the TSF within these paddocks.

Due to the underlying dolomitic condition, the requirements of SANS 1936 must be adhered to. This will require the following to be carried out:

- Dolomitic stability investigation
  - General
    - Investigations shall conform to the requirements of SANS 1936-2 (4.3.2 and 4.3.3). The investigator/Competent Person (geo-professional) shall, during the investigation, confirm and refine the Inherent Hazard Zone and the associated Dolomite Area Designations and confirm that the mandatory precautions associated with a designation have been observed;
    - The investigator/Competent Person (geo-professional) shall, as a minimum to comply with the above requirements, interact with suitably qualified professionals and the person responsible for the development of the parcel of land or the relevant portions thereof concerning appropriate planning, design of infrastructure, buildings, and structures; and,
    - The investigator/Competent Person (geo-professional) shall develop a risk management plan strategy specific to the development in accordance with the requirements of SANS 1936;
  - Report
    - The investigator/Competent Person (geo-professional) shall prepare a report including the following:
      - a method description of the work undertaken;
      - a drawing indicating the location of the points profiled in the service trenches;
      - records of all profiles, boreholes and tests;
      - records of any geotechnically problematic conditions intercepted, such as paleokarts structures, sinkholes etc.;
      - a description of any additional geotechnical investigations undertaken;

- a description of any precautionary or remedial measures applied to problematic conditions identified during the design-level inspections;
- a site/development layout drawing which confirms the Inherent Hazard Classes and Dolomite Area Designations, in accordance with the requirements of SANS 1936;
- an indication where the dolomite designations have been changed and provide a motivation for such changes;
- a comprehensive list and description of any ongoing monitoring required;
- an identification of monitoring area designations where a risk management plan has been developed; and,
- an indication that amended water precautionary measures shall apply;

▪ Additional Requirements for **Attenuation Dams, Retention Dams, Reservoirs** and Public Swimming Pools:
  - The requirements for dams, reservoirs and public swimming pools shall comply with the requirements of SANS 1936-2, Annex A (A.8). The investigation shall also include the following:
    - a gravity survey over the site at 30 m grid spacing with a minimum of three lines;
    - additional investigations for alternative sites in the event that Inherent Hazard Class 3, 5, 6, 7 and 8 conditions (refer to SANS 1936) are encountered;
    - inspection of the excavation to verify the stability zonation and to check for paleokarst structures;
    - investigation of potential paleosinkhole structures wherever they are exposed; and,
    - where justified, supplementary geotechnical site investigations.

Note 1: The proposed site for dams and reservoirs should be at least 100 m from the nearest housing or commercial development.

■ Compilation of a Dolomite Risk Management Plan

An appropriate Dolomite Risk Management Plan is to be compiled in accordance with SANS 1936. The Dolomite Risk Management Plan is to be site specific and based on all data gathered until that time, taking cognisance of final precautionary measures, site layout and shall also contain the final Monitoring Designations. The Dolomite Risk Management Plan shall outline the responsibilities and actions of the relevant Authority and the Client Department. It is a compulsory requirement for the appointed professional service provider to prepare a site specific Dolomite Risk Management

Plan (DRMP) for the development in accordance with the requirements of SANS 1936-4.

5 WATER BALANCE

A monthly water balance was setup in Microsoft Excel spreadsheet format, to estimate the volumes of water for the project. The water balance has been setup to simulate the average yearly, average dry and average wet season volumes. This section details the water balance which has been prepared in accordance with the Best Practice Guideline G2: Water and Salt Balances.

5.1 Objectives

The objectives of the water balance included the following:

- Estimate the monthly runoff volumes from the working or active area of the TSF;
- Estimate the monthly volumes of water that would be pumped to the Driefontein No. 2 Plant;
- Estimate the potable water requirements for employees; and
- Estimate the required storage capacity of the slurry collection sump.

5.2 Process Flow and Water Balance Components

Water required to reclaim the Libanon TSF will be obtained from dewatering from the Kloof Shaft 10# as well as from return water pumped from the RTSF. According to the Kloof Mine 2021 water balance, approximately 14 736 875 m^3/annum (40 375 m^3/day) is dewatered from the Kloof Shaft 10#, of which the FWGR are authorised to use 9 487 500 m^3/annum. The Libanon TSF will be sectioned off into paddocks to ensure that runoff from rainfall is contained on the TSF footprint. Only the working area, which is the area where the TSF is being reclaimed (assumed to be 5 % of the TSF footprint area at any given time), will contribute runoff to the slurry collection sump from the high-pressure water monitors, as well as from any rainfall. A penstock (pipe) will convey the slurry from the collection sump to the pump station, from where it will be pumped to the Driefontein No. 2 Plant. The entrance of the penstock at the collection sump will be fitted with a flapper valve, which can be shut closed under high rainfall events, to contain stormwater runoff from the working area on the TSF, which will be released in a controlled manner to the pump station. A lined catchment paddock will be constructed to capture any emergency spills from the pump station. The catchment paddock will be operated empty, by pumping back into the process or onto the TSF.

Potable water will be purchased from Rand Water Board or the Municipality, and will most likely be stored in JoJo tanks at the site.

The water balance components include the following:

- Water inflows:
  - Runoff from rainfall from the working area at the TSF;
  - Runoff from the high-pressure water cannons/monitors; and

- Potable water supply from municipal sources.

- Water outflows:
  - Evaporation and seepage; and
  - Water in the slurry pumped to the Driefontein No. 2 Plant.

5.3 Hydraulic Reclamation Water Requirements

The estimated water requirements and planned water supply for the various projects that form part of the WRTRP were provided by Kongiwe and are indicated in Table 5-1. The Libanon TSF will require 17 363 m^3/day (6 337 495 m^3/annum) to undertake reclamation activities. This will be supplied from dewatering from the Kloof Shaft 10# and return water from the RTSF. According to Table 5-1, the Kloof Shaft 10# will supply 13 851 m^3/day (5 055 615 m^3/annum), whilst the RTSF can supply 69 551 m^3/day (25 386 115 m^3/annum). It is assumed that the Kloof Shaft 10# will supply the bulk of the required water with remaining amount being supplied from the RTSF.

Table 5-1: Estimated water requirements and planned water supply

Facility	Requirement (m^3/d)	Planned Supply (m^3/d)
Supply to Driefontein 3 TSF	16,696	
Supply to Kloof 1 TSF	8,683	
Supply to Libanon TSF	17,363	
Supply to Venterspost North TSF	8,672	
Supply to Venterspost South TSF	8,872	
Supply to Cooke 2 TSF	17,869	
Supply to Cooke 4 South TSF	11,399	
Supply to DP2	2,669	
Supply to CPP	46,812	
Ezulwini Shaft		13,487
Return from RTSF		69,551
Make-up from Driefontein 10 Shaft		8,733
Make-up from Kloof 10 Shaft		13,851
Make-up from Cooke Shaft 1, 2 and 3		14,164
Return from Inherent Moisture within TSFs		15,599
Total	**139,035**	**135,385**

5.4 Assumptions and Limitations

The water balance is based on the following assumptions:

- Calculations are based on the values, assumptions and data sources in Table 5-2;
- The working area i.e. the active area at the TSF where hydraulic reclamation is taking place, was estimated to be 5 % of TSF footprint area. It is assumed that runoff from the remaining area of the TSF will be contained and will not report to the pump station;
- Estimated runoff coefficients were fixed for all months of the year;
- The lined catchment paddock will be operated empty;

- It has been assumed that 80 % of the monthly water used for hydraulic reclamation would run off as slurry and that 20 % would be lost;
- It has been assumed that 50 % of the average monthly rainfall from the working area will run off to the slurry sump;
- The wet season scenario is the average volumes for the three wettest months (November, December and January), whilst the dry season scenario is the average volumes for the three driest months (June, July and August). The average yearly scenario are the average volumes over a 12 month period;
- The Kloof Shaft 10# will supply the bulk of the required water with remaining amount being supplied from the RTSF;
- 100 L of potable water per an onsite employee per day has been assumed;
- No water is needed for sanitation purposes as chemical toilets will be used; and
- Any dust suppression requirements were not included in the water balance calculations.

5.5 Input Parameters

The parameters and assumptions/sources used in the water balance calculations are provided in Table 5-2.

Table 5-2: Parameters and assumptions/sources used in the water balance calculations

Parameter	Value	Units	Assumption/Source
TSF area	1 348 000	m²	TSF footprint area
Reclamation working area	67 400	m²	Assumed to be 5 % of the TSF area
Slurry collection sump area	3 000	m²	Assumed
Working area rainfall-runoff coefficient	0.5	-	Assumed 50% of monthly rainfall runs off from the working area to the collection sump
Reclamation water runoff coefficient	0.8	-	Assumed 80% of water used for reclamation runs off as slurry. 20 % losses
Monthly water volume required for hydraulic reclamation	528 125	m³/month	Based on information provided by Kongiwe, 17 363 m³/day of water is required for hydraulic reclamation.
Operational phase	72	months	Project description
Number of employees	10	-	Obtained from Kongiwe

Potable water provision per employee	0.1	m^3/day	Assumed 100 litres per employee per day

5.6 Water Balance Results

The average yearly, average wet and average dry season scenario water balance for the Libanon TSF is indicated in Figure 5-1. The following provides a summary:

- The reclamation water requirement is 6 337 495 m^3/annum. This water will be sourced from the Kloof Shaft 10# (5 055 615 m^3/annum), whilst the RTSF can supply up to 25 386 115 m^3/annum;
- Runoff from reclamation activities reporting to the collection sump is expected to be in the order of 5 070 000 m^3/annum (422 500 m^3/month);
- On average, 5 089 296 m^3/annum (424 108 m^3/month) is estimated to report to the reclamation pump station, which will be pumped to the Driefontein No. 2 Plant; and
- The potable water requirement was calculated to be 372 m^3/annum (31 m^3/month).

5.7 Slurry Sump and Lined Catchment Paddock Sizing

The slurry sump has been sized to contain the 1:50 year runoff for the 24 hour storm event from the working area at the TSF, using the SCS method. This was calculated to be 1 370 m^3. The slurry sump should be operated to always have an additional 1 370 m^3 available on top of normal operational volumes in the sump, in order to cater for the 1:50 year runoff, and to comply with GN R704 regulations.

The lined catchment paddock should be sized to contain slurry within the process at the pump station, as well as within the penstock, should any emergency spills occur, or if these facilities need to be drained for maintenance purposes. The lined paddock should be operated empty to ensure sufficient capacity at all times.

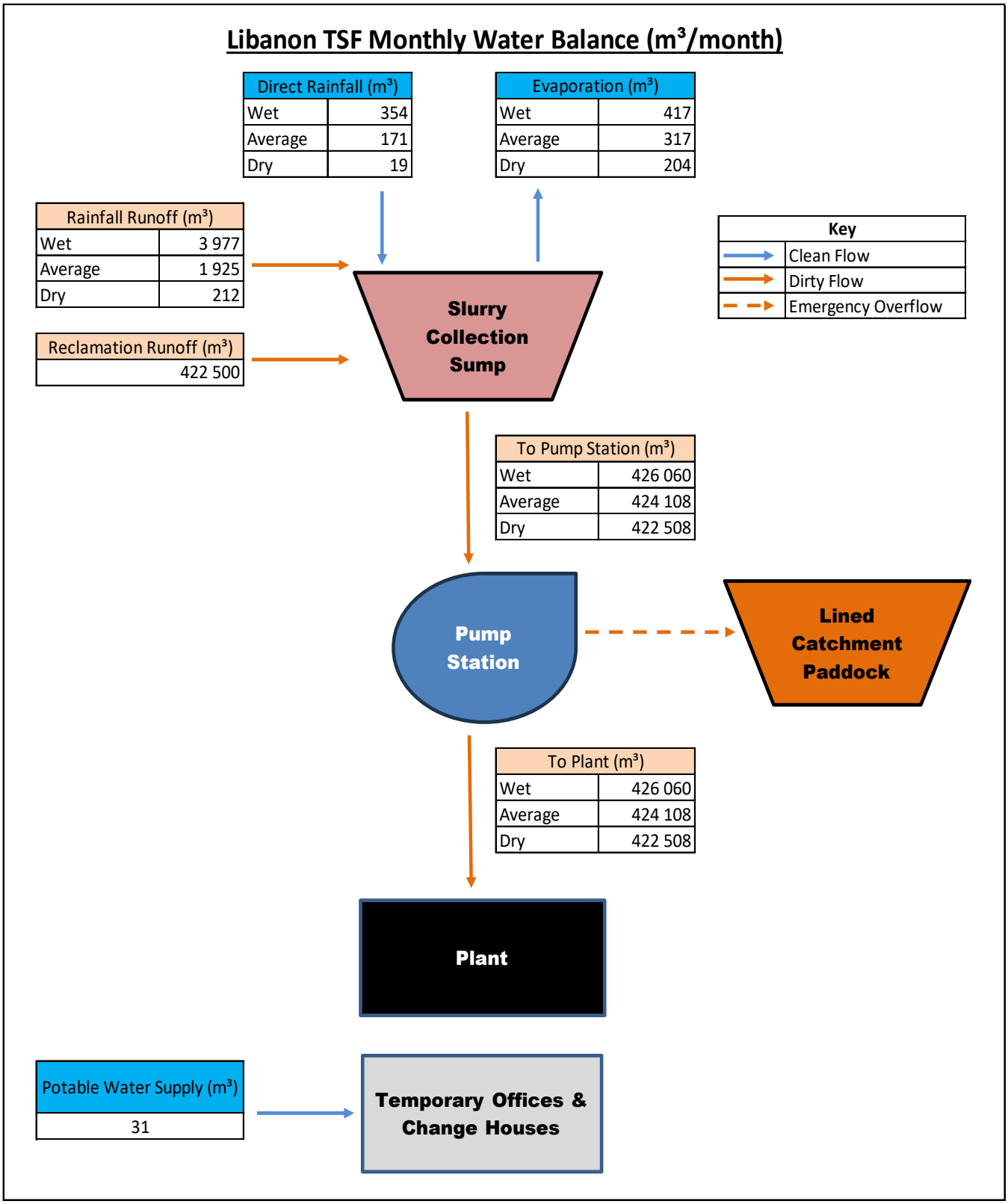

Figure 5-1: Average monthly water balance for the Libanon TSF

6 SURFACE WATER IMPACT ASSESSMENT

6.1 Project Activities Assessed

The following key activities are likely to occur during the different phases of the project, and are assessed in the impact assessment:

6.1.1 Construction Phase

- Site clearance and the construction of minor infrastructure.

6.1.2 Operational Phase

- Hydraulic reclamation activities.

6.1.3 Closure and Rehabilitation Phase

- Rehabilitation activities.

6.2 Methodology

The impact significance rating process serves to highlight the critical impacts requiring consideration in the management and approval process. The impact significance rating system is presented in Table 6-1, Table 6-2 and Table 6-3, and involves three parts:

- **Part A**: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale/population and duration;
- **Part B**: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A; and
- **Part C**: Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from **Part B**) and the probability of occurrence.

These are discussed in further detail below.

6.2.1 Part A: Defining Consequence in Terms of Magnitude, Duration and Spatial Scale

Table 6-1 is used to determine the impact consequence characteristics for magnitude, spatial scale/population and duration.

Table 6-1: Consequence rating definitions

IMPACT CHARACTERISTICS	DEFINITION	CRITERIA
Magnitude	Major -	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded
	Moderate -	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded

IMPACT CHARACTERISTICS	DEFINITION	CRITERIA
	Minor -	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded
	Minor +	Minor improvement; change not measurable; or threshold never exceeded
	Moderate +	Moderate improvement; within or better than the threshold; or no observed reaction
	Major +	Substantial improvement; within or better than the threshold; or favourable publicity
Spatial scale or population	Site or local	Site specific or confined to the immediate project area
	Regional	May be defined in various ways, e.g. cadastral, catchment, topographic
	National/ International	Nationally or beyond
Duration	Short term	Up to 18 months.
	Medium term	18 months to 5 years
	Long term	Longer than 5 years

6.2.2 Part B: Determining the Consequence Rating

Once the impact consequence characteristics have been determined from Table 6-1, they are applied to Table 6-2 to obtain the consequence rating.

Table 6-2: Consequence rating

			SPATIAL SCALE/ POPULATION		
			Site or Local	**Regional**	**National/ international**
MAGNITUDE					
Minor	**DURATION**	**Long term**	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	**DURATION**	**Long term**	Medium	High	High
		Medium term	Medium	Medium	High
		Short term	Low	Medium	Medium
Major	**DURATION**	**Long term**	High	High	High

			SPATIAL SCALE/ POPULATION		
			Site or Local	Regional	National/ international
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High

6.2.3 Part C: Determining Significance Rating

The probability of the impact occurring is assessed as either being definite, possible or unlikely, and is selected in Table 6-3. The consequence rating determined from Table 6-2, is then used to obtain the significance of the impact in Table 6-3.

Table 6-3: Significance rating

		CONSEQUENCE		
		Low	Medium	High
PROBABILITY (of exposure to impacts)	Definite	Medium	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

The significance rating of the impact is determined prior to mitigation (without mitigation), as well as after mitigation measures have been implemented.

6.3 Impact Assessment and Mitigation

6.3.1 Construction Phase

During the construction phase, vegetation will be cleared and temporary infrastructure will be erected. The construction phase will be approximately 1 year. The activities and impacts that are likely to occur during the construction phase are summarised in Table 6-4.

Table 6-4: Summary of activities and impacts for the construction phase

Activity	Impact Description
Removal of vegetation and alteration to the topography.	Erosion and wash off of exposed soils leading to siltation in down gradient watercourses.

The ratings and proposed mitigation measures for the construction phase are provided in Table 6-5.

Table 6-5: Significance rating for the construction phase

NATURE OF IMPACT: The removal of vegetation will expose soils to water erosion that may lead to a deterioration in water quality		
	Impact Rating without Mitigation	**Impact Rating with Mitigation**
Extent *(Local, Regional, International)*	Regional	Local
Duration *(Short term, Medium term, Long term)*	Short term	Short term
Magnitude *(Major, Moderate, Minor)*	Moderate	Minor
Probability *(Definite, Possible, Unlikely)*	Possible	Possible
Calculated Significance Rating (Low, Medium, High)	**Medium**	**Low**
Impact Status: (positive or negative)	Negative	Negative
Reversibility: (Reversible or Irreversible)	Irreversible	
Irreplaceable loss of resources: (Yes or No)	No	
Can impacts be enhanced: (Yes or No)	Yes	
Residual impacts • None foreseen		
Mitigation measures • Clearance of vegetation must be limited as far as possible; • Temporary erosion measures such as sediment nets should be employed around exposed working areas; • The SWMP must be implemented as a first step during the construction phase; and • Water quality monitoring must be implemented upstream and downstream of construction sites.		

6.3.2 Operational Phase

During the operational phase, hydraulic reclamation will take place. The operational phase will be approximately 6 years.

The mixing of water with the tailings material during hydraulic mining, will add water and oxygen to the material, which could potentially result in acidic water, with leaching of metals and salts. It is therefore imperative that dirty water is kept within the TSF footprint through the implementation of a closed SWMP.

Poor maintenance of stormwater infrastructure such as the silting up of paddocks, as well as the erosion of berms, can result in spills from the operation. It is therefore important that stormwater infrastructure is regularly monitored and maintained as outlined in section 7.2.

The activities and impacts that could potentially occur during the operational phase are summarised in Table 6-6.

Table 6-6: Summary of activities and impacts for the operational phase

Activity	Impact Description
Uncontained runoff from the operational areas at the TSF.	**Impact 1:** Runoff into the downslope watercourses impacting on water quality.
Poor maintenance of stormwater infrastructure.	**Impact 2:** Silted paddocks and channels as well as eroded berms which lead to spills into the downslope watercourses impacting on water quality.

The ratings and proposed mitigation measures for the operational phase are indicated in Table 6-7 and Table 6-8.

Table 6-7: Significance rating of operational impact 1

NATURE OF IMPACT 1: Uncontained runoff from the operational area at the TSF running off into the downslope watercourses impacting on water quality		
	Impact Rating without Mitigation	**Impact Rating with Mitigation**
Extent *(Local, Regional, International)*	Regional	Local
Duration *(Short term, Medium term, Long term)*	Medium term	Medium term
Magnitude *(Major, Moderate, Minor)*	Major	Moderate
Probability *(Definite, Possible, Unlikely)*	Definite	Possible
Calculated Significance Rating (Low, Medium, High)	**High**	**Medium**
Impact Status: (positive or negative)	Negative	Negative
Reversibility: (Reversible or Irreversible)	Irreversible	
Irreplaceable loss of resources: (Yes or No)	No	
Can impacts be enhanced: (Yes or No)	Yes	
Residual impacts • None, as the impact will cease provided that rehabilitation is done appropriately.		

NATURE OF IMPACT 1: Uncontained runoff from the operational area at the TSF running off into the downslope watercourses impacting on water quality
Mitigation measures • Implementation of the proposed SWMP. It must be ensured that stormwater measures are designed, constructed and operated, to ensure that stormwater does not spill more than once in 50 years, in order to be compliant with GN R704 regulations; and • Water quality monitoring must be implemented upstream and downstream of the mining activities.

Table 6-8: Significance rating of operational impact 2

NATURE OF IMPACT 2: Poor maintenance of stormwater infrastructure resulting in silted channels, paddocks and eroded berms, leading to spills into the downslope watercourses impacting on water quality		
	Impact Rating without Mitigation	**Impact Rating with Mitigation**
Extent *(Local, Regional, International)*	Regional	Local
Duration *(Short term, Medium term, Long term)*	Long term	Medium term
Magnitude *(Major, Moderate, Minor)*	Major	Moderate
Probability *(Definite, Possible, Unlikely)*	Possible	Possible
Calculated Significance Rating (Low, Medium, High)	**High**	**Medium**
Impact Status: (positive or negative)	Negative	Negative
Reversibility: (Reversible or Irreversible)	Irreversible	
Irreplaceable loss of resources: (Yes or No)	No	
Can impacts be enhanced: (Yes or No)	Yes	
Residual impacts • None, as the impact will cease provided that rehabilitation is done appropriately.		
Mitigation measures • Implementation of the stormwater monitoring plan detailed in this report.		

6.3.3 Closure and Rehabilitation Phase

As reclamation progresses to ground level, the TSF footprint will continue to be sectioned off into paddocks. This will be a short-term measure to prevent contaminated runoff from flowing offsite. The area will be assessed for contamination (particularly in terms of radiation).

Contaminated soil will be removed and backfilled with uncontaminated soil. The land will be levelled to its original functioning topography and will be re-vegetated.

The activities and impacts that are likely to occur during the closure and rehabilitation phase are summarised in Table 6-9.

Table 6-9: Summary of activities and impacts for the closure and rehabilitation phase

Activity	Impact Description
Exposure of potential contaminated soils during the closure and rehabilitation phase once the TSF has been removed.	Erosion and wash off of contaminated soils resulting in water quality issues in the surrounding watercourses.

The ratings and proposed mitigation measures for the closure and rehabilitation phase are indicated in Table 6-10.

Table 6-10: Significance rating of closure impact 1

NATURE OF IMPACT: Erosion and wash off of potential exposed contaminated soils resulting in water quality issues in the surrounding watercourses		
	Impact Rating without Mitigation	**Impact Rating with Mitigation**
Extent *(Local, Regional, International)*	Regional	Local
Duration *(Short term, Medium term, Long term)*	Long term	Medium term
Magnitude *(Major, Moderate, Minor)*	Major	Minor
Probability *(Definite, Possible, Unlikely)*	Possible	Possible
Calculated Significance Rating (Low, Medium, High)	**High**	**Low**
Impact Status: (positive or negative)	Negative	Negative
Reversibility: (Reversible or Irreversible)	Irreversible	
Irreplaceable loss of resources: (Yes or No)	No	
Can impacts be enhanced: (Yes or No)	Yes	
Residual impacts • Possible, unless potential spills are rehabilitated.		
Mitigation measures • Runoff must be contained onsite through the implementation of paddocks until any contaminated soils are removed;		

NATURE OF IMPACT: Erosion and wash off of potential exposed contaminated soils resulting in water quality issues in the surrounding watercourses
• Once contaminated soils are removed, the area must be backfilled with uncontaminated soils, and levelled to its original functioning topography and re-vegetated; and • Water quality monitoring must continue upstream and downstream until the site has been fully rehabilitated.

6.3.4 Post Closure Phase

Should rehabilitation be successfully implemented, then it is unlikely that any negative impacts will occur during the post closure phase. The removal of the TSF will result in a long-term positive impact on the surrounding watercourses, provided that rehabilitation is successfully implemented.

6.4 Cumulative Impacts

Cumulative impacts are impacts that result from the incremental impact of the proposed activities on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.

The project is located in a catchment that is highly impacted by mining and urban activities. The implementation of a sound SWMP is crucial to contain contaminated runoff from the operational area. The monitoring and maintenance of the implemented SWMP is of utmost importance, to ensure that dirty water is contained at the site. The removal of the TSF and the implementation of a rehabilitation plan that ensures that the site is returned to its original topography and re-vegetated, could enhance the catchment water quality. Should the above not be done, then in the long term, the proposed project has the potential to cumulatively add to the already deteriorated water quality of the Wonderfoneinspruit catchment.

The cumulative impact of the proposed project on the surface water quality of the catchment is rated in Table 6-11.

Table 6-11: Cumulative impact rating for surface water quality

NATURE OF IMPACT: Should dirty water runoff not be contained during the operational phase, and an appropriate rehabilitation plan not successfully implemented post-mine closure, then the proposed project has the potential to add cumulatively to the already deteriorated surface water quality of the catchment		
	Impact Rating without Mitigation	**Impact Rating with Mitigation**
Extent *(Local, Regional, International)*	Regional	Local
Duration *(Short term, Medium term, Long term)*	Long term	Medium term

NATURE OF IMPACT: Should dirty water runoff not be contained during the operational phase, and an appropriate rehabilitation plan not successfully implemented post-mine closure, then the proposed project has the potential to add cumulatively to the already deteriorated surface water quality of the catchment		
Magnitude *(Major, Moderate, Minor)*	Major	Minor
Probability *(Definite, Possible, Unlikely)*	Possible	Unlikely
Calculated Significance Rating (Low, Medium, High)	**High**	**Low**
Impact Status: (positive or negative)	Negative	Negative
Reversibility: (Reversible or Irreversible)	Irreversible	
Irreplaceable loss of resources: (Yes or No)	No	
Can impacts be enhanced: (Yes or No)	Yes	
Residual impacts • None, provided that the tailings material is removed, and appropriate rehabilitation is undertaken.		
Mitigation measures • Effective stormwater management that captures and contains all site runoff; • Removal of all tailing's material and successful rehabilitation of the area to a vegetated and free draining area; and • Water quality monitoring upstream and downstream of the proposed project until rehabilitation is successfully completed.		

6.5 Impact Summary Table

The impacts and mitigation measures are summarised in Table 6-12.

Table 6-12: Summary of the potential surface water impacts and proposed mitigation measures

Impact No.	Activity	Impact Description	BEFORE MITIGATION					Mitigation measures / Recommendations	AFTER MITIGATION				
			Magnitude	Duration	Spatial Scale	Probability	SIGNIFICANCE		Magnitude	Duration	Spatial Scale	Probability	SIGNIFICANCE
Construction Phase													
1	Removal of vegetation and alteration to the topography.	Erosion and wash off of exposed soils leading to siltation in down gradient watercourses.	*Moderate -*	*Short Term < 18 months*	*Regional*	*Possible*	Medium	• Clearance of vegetation must be limited as far as possible; •Temporary erosion measures such as sediment nets should be employed around exposed working areas; • The SWMP must be implemented as a first step during the construction phase; and • Water quality monitoring must be implemented upstream and downstream of construction sites.	*Minor -*	*Short Term < 18 months*	*Site or Local*	*Possible*	Low
Operational Phase													
1	Uncontained runoff from the operational area at the TSF.	Runoff into the downslope watercourses impacting on water quality.	*Major -*	*Long Term > 5 years*	*Regional*	*Possible*	High	• Implementation of a closed SWMP that captures and contains all dirty water runoff from the site. It must be ensured that stormwater measures are designed, constructed and operated, in order to ensure that stormwater does not spill more than once in 50 years, to be compliant with GN R704 regulations; and • Water quality monitoring must continue upstream and downstream of the proposed project.	*Moderate -*	*Long Term > 5 years*	*Site or Local*	*Possible*	Medium
2	Poor maintenance of stormwater infrastructure.	Silted paddocks and eroded berms can lead to spills in the downslope watercourses.	*Major -*	*Long Term > 5 years*	*Regional*	*Possible*	High	• Implementation of the stormwater monitoring plan detailed in this report.	*Moderate -*	*Long Term > 5 years*	*Site or Local*	*Possible*	Medium

Impact No.	Activity	Impact Description	BEFORE MITIGATION					Mitigation measures / Recommendations	AFTER MITIGATION				
			Magnitude	Duration	Spatial Scale	Probability	SIGNIFICANCE		Magnitude	Duration	Spatial Scale	Probability	SIGNIFICANCE
Closure & Rehabilitation Phase													
1	Exposure of potential contaminated soils during the closure and rehabilitation phase once the TSF has been removed.	Erosion and wash off of contaminated soils resulting in water quality issues in the surrounding watercourses.	*Major -*	*Long Term > 5 years*	*Regional*	*Possible*	High	• Runoff must be contained onsite through the implementation of paddocks until contaminated soils are removed; • Once contaminated soils are removed, the area must be backfilled with uncontaminated soils, and levelled to its original functioning topography and re-vegetated; and • Water quality monitoring must continue upstream and downstream until the site has been fully rehabilitated.	*Minor -*	*Medium Term > 18 months < 5 years*	*Site or Local*	*Possible*	Low
Cumulative Impacts													
1	Unsuccessful containment of dirty water runoff from the operation during the operational phase, as well as unsuccessful rehabilitation of the site post-mining.	The proposed project has the potential to cumulatively impact on the already deteriorated surface water quality of the catchment.	*Major -*	*Long Term > 5 years*	*Regional*	*Possible*	High	• Effective stormwater management that captures and contains all site runoff; • Removal of all tailings material and successful rehabilitation of the area to a free draining area that is vegetated; and • Water quality monitoring upstream and downstream of the proposed project until rehabilitation is successfully completed.	*Moderate -*	*Long Term > 5 years*	*Site or Local*	*Unlikely*	Low

7 MONITORING PLANS

7.1 Surface Water Quality

A surface water quality monitoring programme is essential as a management tool to detect negative water quality impacts as they arise and to ensure that the necessary mitigation measures are implemented. Should the project be approved, it is recommended that sampling points SW4 and SW5 in Table 3-3, form part of the water quality monitoring programme and that the parameters specified in Table 3-4 are monitored.

Water quality sampling should be done in accordance with the DWS Best Practice Guideline G3: Water Monitoring Systems. Samples must be kept cool (+-4°C), out of direct sunlight, and should be transported immediately to an accredited laboratory for water quality analysis within 24 hours of sampling. The impacts on water quality should be determined by comparing the monitoring results against the guideline limits provided in Table 3-4 (or as specified by the DWS), and importantly against previous results, to determine any deviations in trends over time. If the trend analysis indicates any deviations to the baseline monitoring, in terms of deteriorating water quality, then an immediate investigation must be undertaken to determine whether the operation may be responsible. If responsible, urgent action must be undertaken to implement mitigation measures to prevent further contamination.

Reporting should be done on a quarterly basis (or as recommended by the DWS). It is recommended that monitoring reports include trend analyses. It is further recommended that the water quality from upstream monitoring points is compared to downstream monitoring points.

7.2 Stormwater Infrastructure

Water infrastructure (paddocks, channels, berms and slurry sumps) should be monitored on a monthly basis during the dry season, and on a weekly basis during the wet season. They should further be monitored immediately after any large storm events. Should blockages, silted up structures or breaches occur, immediate action should be undertaken to remove debris and repair breaches. monitoring should be undertaken by the onsite environmental control officer or maintenance manager. Inspections should be recorded and should include the following:

- Date of inspection;
- Rainfall amount received prior to inspection;
- Photographs of blockages, silted up structures or breaches witnessed;
- What action was undertaken to fix issues, and the amount of time taken to address them; and
- Photographs post action taken.

Inspection reports should be kept ready and supplied to the DWS when requested, or as part of the WUL conditions.

8 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the most important aspect to prevent negative impacts from a surface water perspective, is to ensure that a sound SWMP is implemented prior to the commencement of reclamation activities, in accordance with the conditions stipulated in GN R704. Monitoring and maintenance of stormwater measures is of utmost importance and should be conducted as outlined in this report. The removal of the TSF is expected to have a positive long-term impact on the surrounding watercourses, provided that rehabilitation is successfully implemented.

Based on the findings of this report, the project can commence provided that the mitigation measures and monitoring plans are implemented.

9 REFERENCES

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APPENDIX A: WATER QUALITY LABORATORY CERTIFICATE

APPENDIX B: CURRICULUM VITAE

HYDROSPATIAL

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Curriculum Vitae – Andy Pirie – Hydrologist

Details

Name and Surname:	Andy Pirie
Occupation:	Senior Hydrologist
Company:	Hydrospatial (Pty) Ltd
Address:	17 Sonop Place, Randpark, Johannesburg, 2194
Nationality:	South African
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Andy Pirie is a senior hydrologist at Hydrospatial (Pty) Ltd. Andy graduated with a Master of Science (M.Sc.) in Water Resource Management (cum laude). He is registered as a Professional Natural Scientist (Pr.Sci.Nat.) in Water Resources Science with the South African Council for Natural Scientific Professions (SACNASP). He has worked on projects in South Africa, Cameroon, Senegal, Mali, Democratic Republic of the Congo (DRC), Botswana, Zambia and Namibia, for clients such as Assmang, Anglo American, Randgold Resources (now Barrick Gold), Sibanye-Stillwater, Birimian, Exxaro, Sasol, Eskom, Assore and SAFCOL. He has more than 9 years' experience in hydrological assessments and Geographical Information Systems (GIS). His expertise include the following:

- Floodline determinations;
- Mine water and salt balance modelling;
- Stormwater management plans;
- Surface water quality monitoring and assessment;
- Rainfall - runoff modelling;
- Catchment yield assessments;
- Sizing of dams and channels;
- Crop water requirement calculations;
- Environmental flow requirement calculations;
- Surface water impact assessments; and
- GN704 Regulation audits.

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Education

- 2013: M.Sc. Water Resource Management, cum laude (University of Pretoria).

Membership in Professional Associations

- Registered as a Professional Natural Scientist (Pr.Sci.Nat.) in Water Resources Science with the South African Council for Natural Scientific Professions (SACNASP). Registration number: 114988.

Employment

- March 2018 – Present: Senior Hydrologist at Hydrospatial (Pty) Ltd.
- June 2012 – February 2018: Hydrologist and GIS specialist at Digby Wells Environmental.

Selected Project Experience

Company	Position	Project Location	Client	Project	Responsibilities
Hydrospatial (Pty) Ltd	Senior Hydrologist	Gauteng	Sibanye Gold	Hydrological Study for the Sibanye Driefontein Operations EMP and WULA Update	• Baseline hydrological assessment. • Water quality assessment. • Stormwater management plan update. • Water and salt balance update. • GN704 and GN509 exemption assessment.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Mpumalanga South Africa	SAFCOL	Streamflow Reduction Modelling of the Genus Exchange Ratio of Eucalyptus for Pine at the SAFCOL Berlin Plantations	• Setup of the WRSM/Pitman model. • Calculation of the allowable genus exchange area using the Gush Tables. • Reporting. • Presentation of study and hand over of reports.

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Company	Position	Project Location	Client	Project	Responsibilities
Hydrospatial (Pty) Ltd	Senior Hydrologist	Mpumalanga South Africa	Transvaal Gold Mining Estates	Hydrological Study for the Proposed Theta Mine Project	• Calculation of the water use freed up through the proposed removal of pine, eucalyptus and wattle in the Blyde River catchment for an offset strategy for the mine. • Baseline hydrological study. • Surface water impact assessment. • Water quality sampling and analysis. • Setup of a water monitoring network and programme. • Stormwater structure placement and sizings of structures. • Development of a water balance model. • Terrain modelling and catchment delineation using ArcGIS software. • Land use and soil assessment. • Determination of Peak flows for the 1:50 and 1:100 year storm event. • Hydraulic modelling to determine the 1:50 and 1:100 year floodlines. • Reporting.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo, South Africa	Lunsklip Farming	Hydrological Study for the Lunsklip Irrigation Dam	• Catchment runoff modelling using the WRSM/Pitman model which included afforested areas. • Calculation of the farm irrigation requirements. • Quantification of the irrigation dam water balance.

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Company	Position	Project Location	Client	Project	Responsibilities
Hydrospatial (Pty) Ltd	Senior Hydrologist	Mpumalanga South Africa	Anglo American	Surface Water Assessment for the Proposed Leslie 1 Coal Mine	• Baseline hydrological study. • Surface water impact assessment. • Water quality sampling and analysis. • Setup of a water monitoring network and programme. • Stormwater structure placement and sizings of structures. • Development of a water balance model. • Terrain modelling and catchment delineation using ArcGIS software. • Land use and soil assessment. • Determination of Peak flows for the 1:50 and 1:100 year storm event. • Hydraulic modelling to determine the 1:50 and 1:100 year floodlines. • Reporting.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo South Africa	Assmang	GN704 Legal Compliance Audit of the Dwarsrivier Chrome Mine	• Site audit of the mine to GN704 regulations. • Reporting on findings and recommendations for improvement to comply with GN704 regulations.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo South Africa	Assmang	Floodline Determination for the Resource and Reserve Drilling Project at the Dwarsrivier Chrome Mine	• Catchment delineation. • Hydrological assessment to calculate the 1:50 and 1:100 year peak flows. • Hydraulic modelling of 18 river reaches to determine the 1:50 and 1:100 year flood water elevations.

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Company	Position	Project Location	Client	Project	Responsibilities
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo South Africa	Assore	GN704 Legal Compliance Audit of the Rustenburg Minerals Development Company Chrome Mine	• Site audit of the mine to GN704 regulations. • Reporting on findings and recommendations for improvement to comply with GN704 regulations.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Gauteng South Africa	Fry's Metals	Stormwater Management Plan for the Fry's Metal Factory	• Audit of site stormwater infrastructure. • Calculation of peak flows and stormwater volumes. • Calculation of stormwater channel capacities to assess whether capacities comply with regulatory requirements.
Hydrospatial (Pty) Ltd	Senior Hydrologist	North West South Africa	Assore	Hydrological Study for the Wonderstone Mine	• Baseline hydrological study. • Surface water impact assessment. • Water quality Assessment. • Development of a stormwater. management plan. • River diversion assessment.
Hydrospatial (Pty) Ltd	Senior Hydrologist	KwaZulu-Natal, South Africa	The Biodiversity Company	Water Quality Monitoring and Assessment for the Edendale Bulwer Housing Development	• Setup of a water monitoring network. • Surface water sampling. • Assessment of water quality results.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Gauteng South Africa	Eskom	Hydrological Assessment of a Tributary of the Braamfonteinspruit near Sandton, Johannesburg	• Site assessment. • Peak flow calculations. • Storm event assessment. • Hydraulic structure assessment. • Assessment of gabion retaining wall failure.

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Company	Position	Project Location	Client	Project	Responsibilities
					• Hydraulic modelling of watercourse.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo South Africa	Assore	GN704 Legal Compliance Audit of the Zeerust Chrome Mine	• Site audit of the mine to GN704 regulations. • Reporting on findings and recommendations for improvement to comply with GN704 regulations.
Digby Wells Environmental	Hydrologist	Mali	Birimian	Hydrological Study for the Environmental and Social Impact Assessment for the Goulamina Lithium Project	• Baseline hydrological study. • Development of a water and salt balance. • Modelling of catchment flood hydrology. • Calculation of storm rainfall depths. • Stormwater management plan. • Surface water impact assessment.
Digby Wells Environmental	Hydrologist	Senegal	Randgold Resources	Hydrological Study for the Randgold Massawa Gold Project ESIA	• Baseline hydrological study. • Floodline determination. • Development of a water and salt balance. • Modelling of catchment hydrology. • Environmental flow requirement calculations. • Stormwater management plan. • Surface water impact assessment.
Digby Wells Environmental	Hydrologist	Cameroon	Caminex SA	Hydrological Study for the Environmental	• Baseline hydrological study. • Surface water impact

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Company	Position	Project Location	Client	Project	Responsibilities
				and Social Impact Assessment for the Ntem Iron Ore Project	assessment.
Digby Wells Environmental	Hydrologist	Gauteng South Africa	Sibanye-Stillwater	Sibanye Gold Millsite TSF Reclamation Project EIA	• Audit of existing stormwater management controls. • Development of a stormwater management plan to satisfy GN704 Regulation requirements. • Development of a stormwater control monitoring programme. • Water conservation and water demand management plan
Digby Wells Environmental	Hydrologist	Gauteng South Africa	Sibanye-Stillwater	Sibanye Gold Kloof Floodline Determination	• Site visit to assess channel and floodplains and to measure hydraulic structures. • DEM creation from lidar dataset. • Catchment delineation. • Catchment assessment of soils, vegetation, slope and land cover to obtain suitable runoff coefficients. • Calculation of peak flows using Rational and SDF methods. • Hydraulic modelling in HEC-RAS for approximately 25 river reaches to determine the 1:50 and 1:100 year surface water elevations.
Digby Wells Environmental	Hydrologist	Free State South Africa	Bothma and Son Transport	Stormwater management plan for the Bothma Sand	• Audit of existing stormwater management structures.

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Company	Position	Project Location	Client	Project	Responsibilities
				Mine	• Rainfall assessment. • Sizing of channels. • Development of a stormwater management plan to satisfy GN704 conditions. • Development of a stormwater structure monitoring programme. • Development of a PCD rehabilitation action plan. • Reporting.
Digby Wells Environmental	Hydrologist	Free State South Africa	Sasol Mining	Sasol Defunct Mines Surface Flow Analysis	• Project manager. • Creation of detailed DEMs from Lidar data for 4 of Sasol's defunct subsided collieries. • Modelling of surface water flow directions and accumulations to determine areas that are not free draining.
Digby Wells Environmental	Hydrologist	Gauteng South Africa	DRD Gold	DRD Gold Stormwater Management Plans for the Ergo Elsburg & Van Dyk Tailings Dams	• Project manager. • Site visit audit of stormwater management structures. • Flood peak calculations. • Stormwater structure sizing. • Management measures to ensure that stormwater structures are maintained. • Reporting.
Digby Wells Environmental	Hydrologist	Mpumalanga South Africa	Exxaro	Exxaro Surface Water Study for the Environmental Authorisation for the Proposed Schoonoord	• Baseline hydrological study. • Surface water impact assessment. • Water quality sampling and analysis of results.

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Company	Position	Project Location	Client	Project	Responsibilities
				Underground Mine, Arnot Coal, Mpumalanga	• Setup of a water monitoring network and programme. • Stormwater structure placement and sizings of structures. • Terrain modelling and catchment delineation using ArcGIS software. • Land use and soil assessment. • Determination of Peak flows for the 1:50 and 1:100 year storm event. • Hydraulic modelling using the HEC-RAS model to determine the 1:50 and 1:100 year floodlines. • Reporting.
Digby Wells Environmental	Hydrologist	Limpopo South Africa	Exxaro	Exxaro Floodline Determination for the Closure Environmental Management Plan for the Tshikondeni Coal Mine	• Catchment assessment of rainfall, topography, soils and land cover. • Determination of the 1:50 and 1:100 year peak flows. • Hydraulic modelling using HEC-RAS to determine the 1:50 and 1:100 year floodlines. • Reporting on catchment characteristics, methods and results obtained.
Digby Wells Environmental	Hydrologist	Botswana, Zambia and Namibia	Botswana Government	Kazungula Bridge Project Surface Water Quality Monitoring	• Setup of a water quality monitoring network and programme. • Monthly water sampling from the Zambezi and Chobe Rivers over a 6 year period to determine whether the construction and operation of

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Company	Position	Project Location	Client	Project	Responsibilities
					the Kazungula Bridge is impacting on the water quality. • Analysis of water quality results. • Monthly monitoring reports describing the water quality for the month and identifying possible sources of pollution as well as providing mitigation measures.
Digby Wells Environmental	Hydrologist	Free State South Africa	Sibanye-Stillwater	Sibanye Beatrix ESIA	• Baseline hydrological study. • Surface water impact assessment. • Water quality and trend analysis.
Digby Wells Environmental	Hydrologist	Mpumalanga South Africa	Anker Coal	Anker Coal Elandsfontein Colliery Stormwater Management Plan	• Site visit audit of stormwater structures. • Review of existing stormwater management plan. • Recommendations for the improvement of existing stormwater management plan
Digby Wells Environmental	Hydrologist & GN704 Auditor	Northern Cape, South Africa	Assmang	GN704 Legal Compliance Audit for the Khumani Iron Ore Mine	• Project manager. • Preparation of an audit checklist. • Audit of the mine to GN704 regulations. • Reporting on findings and recommendations for improvement to comply with GN704 regulations.
Digby Wells Environmental	Hydrologist	Okavango, Botswana	Botswana Government	Mohembo Bridge Surface Water Baseline and Monitoring Programme	• Setup of a surface water quality monitoring network and programme. • Surface water quality sampling and analysis of results. • Analysis of streamflows from the Mohembo

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Company	Position	Project Location	Client	Project	Responsibilities
					discharge gauging station. • Climate assessment.
Digby Wells Environmental	Hydrologist	Mpumalanga South Africa	Sasol Mining	Sasol Surface Water Study for the Environmental Authorisation for the Imvula Coal Mining Project	• Baseline hydrological study. • Surface water impact assessment. • Terrain modelling and catchment delineation using ArcGIS software. • Land cover and soil hydrological assessment. • Surface water report writing and compilation.
Digby Wells Environmental	Hydrologist	North-west South Africa	Sun International	Sun City Drinking Water Quality Analysis	• Sampling of drinking water at Sun City. • Interpretation of water quality results. • Reporting.
Digby Wells Environmental	Hydrologist	Limpopo South Africa	De Groote Boom Minerals	Surface Water Study for the Mining Permit Application for the De Groote Boom Project	• Baseline hydrological study. • Surface water impact assessment. • Water quality sampling and assessment of water quality results. • Setup of a water quality monitoring programme. • Reporting.
Digby Wells Environmental	Hydrologist	South Africa	Fountain Capital	Floodline Determination for Proposed Development of an Open Pit Coal Mine and Associated Infrastructure near Bronkhorstspruit, Gauteng	• Catchment assessment of rainfall, topography, soils and land cover. • Determination of the 1:50 and 1:100 year peak flows. • Hydraulic modelling using HEC-RAS to determine the 1:50 and 1:100 year floodlines. • Reporting on catchment

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Company	Position	Project Location	Client	Project	Responsibilities
					characteristics, methods and results obtained.
Digby Wells Environmental	Hydrologist	Limpopo South Africa	Pamish Investments No. 39	Floodline Determination for the Proposed Open Pit Magnetite Mine and Concentrator Plant, Mokopane, Limpopo Province	• Catchment assessment of rainfall, topography, soils and land cover. • Determination of the 1:50 and 1:100 year peak flows. • Hydraulic modelling using HEC-RAS to determine the 1:50 and 1:100 year floodlines. • Reporting on catchment characteristics, methods and results obtained.
Digby Wells Environmental	Hydrologist	Mpumalanga South Africa	Eskom	Eskom Surface Water Study for the Mashala Resourses 22kV Power Line	• Baseline hydrological study • Surface water impact assessment. • Hydraulic modelling using HEC-RAS to determine the 1:50 and 1:100 year floodlines. • Reporting.

Hydrospatial (Pty) Ltd (2018/059188/07)
17 Sonop Place, Randpark, 2194
Cell: 084 441 9539
Email: andypirie82@gmail.com

Company	Position	Project Location	Client	Project	Responsibilities
Digby Wells Environmental	Hydrologist	Mpumalanga South Africa	Msobo Coal	Msobo Coal Surface Water Study for the Sara Buffels A and B: IWULA and IWWMP for Opencast and Underground Mining Activities	• Surface water impact assessment. • Terrain modelling and catchment delineation using ArcGIS software. • Land use and soil assessment. • Determination of Peak flows for the 1:50 and 1:100 year storm event. • Hydraulic modelling using the HEC-RAS model to determine the 1:50 and 1:100 year floodlines. • Reporting.
Digby Wells Environmental	Hydrologist	Mali	Randgold Resources	Randgold Surface Water Study for the Morila Gold Mine Agri-Assessment Project	• Review of reports, mine layout plan and water quality data. • Classification of clean and dirty water areas based on the above. • Recommendations on water sources and areas for agri-business post mine closure.

APPENDIX C: STORMWATER MASTER PLAN

KONGIWE

Far West Gold Recoveries (Pty) Ltd

FWGR Phase 2 Expansion: Libanon

Stormwater Management Plan

December 2024

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Report Information

Project:	FWGR Phase 2 Expansion: Libanon
Report Title:	Stormwater Management Plan
Client:	Far West Gold Recoveries (Pty) Ltd
Project No:	DRDG#037

Project Approval

Name	Designation	Task	Signature	Date
Hilton Sparks	Professional Engineer	Report compiler		04 December 2024
Gerlinde Wilreker	Kongiwe: Technical Director	Report review		04 December 2024
Bradly Thornton	Kongiwe: CEO	Report approval		04 December 2024

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DECLARATION OF INDEPENDENCE

I, Hilton Sparks declare that:

a) I act as the independent specialist in this application;
b) I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
c) I declare that there are no circumstances that may compromise my objectivity in performing such work;
d) I have the expertise in conducting the specialist study relevant to this application, including knowledge of the various Acts, regulations and any guidelines that have relevance to the proposed project;
e) I will comply with the Acts, regulations and all other applicable legislation;
f) I have not, and will not engage in, conflicting interests in the undertaking of the activity;
g) I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
h) All the particulars furnished by me in this form are true and correct; and,
i) I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of Section 24F of the Act.

Hilton David Neville Sparks
Civil Engineer
Pr.Eng (Reg No. 740604)

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SPECIALIST REPORT GUIDELINE

A Specialist Report Checklist Table has been compiled in accordance with the guideline as set out in Appendix 6 of the EIA Regulations. Appendix 6 relays the specific information required as per the guideline is given in the second column of the Table.

Table 1-1 - Specialist Checklist

Specialist Report Guideline: Appendix 6 GNR 982 EIA Regulations 4 December 2014 as amended	
Details to be included in the Report	**Section in Report**
Details of	
Specialist who prepared the report	Section 1.3
Expertise of the specialist	Section 1.3
CV of the specialist	Annexure A
Declaration that the Specialist is Independent in a form as may be specified by the CA	Declaration of Independence
An indication of the Scope of and the Purpose for which the report was prepared	Section 2
An indication of the Quality and Age of base data used for the specialist report	Section 3.3
A Description of existing impacts on the site, cumulative impacts of the proposed development, and levels of acceptable change	Section 5.4
The Duration, Date, and Season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3.1
A Description of the Methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 3
Details of an Assessment of the specific identified Sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Sections 7
An identification of any areas to be avoided including buffers	Section 7
A Map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided including buffers	Section 4.7
A Description of any Assumptions made and any Uncertainties or Gaps in Knowledge	Section 4
A Description of the Findings and Potential implications of such findings on the Impact of the proposed activity, including identified Alternatives on the environment, or activities	Section 7
Any Mitigation Measures for inclusion in the EMPr	Section 5
Any Conditions for inclusion in the Environmental Authorisation	Section 7.7
Any Monitoring Requirements for inclusion in the EMPr or Environmental Authorisation	Section 7.7
As to whether the proposed activity/ activities or portions thereof should be authorised	Section 7
Regarding the acceptability of the proposed activity or activities	Section 7.7

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Specialist Report Guideline: Appendix 6 GNR 982 EIA Regulations 4 December 2014 as amended	
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management, and mitigation measures that should be included in the EMPr and where applicable the closure plan	Section 7.7
A Description of any Consultation Process that was undertaken during the course of preparing the specialist report	None required
A Summary and copies of any comments received during any consultation process and where applicable all responses thereto	None required
Any other information requested by the CA	None required

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EXECUTIVE SUMMARY

Introduction and Background

Far West Gold Recoveries (Pty) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSFs are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto Driefontein 4 TSF, until such stage as the Regional Tailings Storage Facility (RTSF) construction is completed and the TSF is commissioned.

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant. Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised .

The Libanon project will reclaim material at 600 000 tons per month . Required infrastructure will include:

- Pumpstation;
- Process water from Kloof Shaft 10#;
- Pollution paddock;
- Access road;
- Laydown area; and,
- Powerlines.

An Environmental Authorisation (EA) and a Water Use Licence (WUL) are therefore required for the Libanon project to proceed.

Scope of Work

The scope of work includes the following:

- Undertake site investigations to locate and assess the current stormwater measures, as well as to assess areas where stormwater measures may be required at the Libanon TSF;
- Delineate the clean and dirty water areas;
- Provide stormwater measures and recommendations for areas that require interventions; and
- Provide conceptual sizing's for the proposed stormwater measures in line with GN R704 regulations.

Baseline Hydrology

The area has a Mean Annual Precipitation (MAP) of 711 mm. Rainfall is highest over the months of October to March, and lowest over the months of April to September.

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The project area has a Storm Rainfall Depth of 126.3 mm for a 24 hour storm duration and a 1 in 50 year return period. The calculated 1 in 50 year peak flow is 3.333 m^3/s for the Libanon East catchment, 0.770 m^3/s for the Libanon West catchment and 1.073 m^3/s for the Libanon TSF catchment.

Conceptual Stormwater Management Plan

A conceptual Stormwater Management Plan (SWMP) was designed for the Libanon TSF area to ensure that clean and dirty water are adequately separated, in accordance with GN R704 regulations. The SWMP was designed to ensure that clean water is diverted away from dirty areas, and that dirty water runoff from the operation is captured, contained and managed.

Conclusions and Recommendations

In conclusion, the most important aspect to prevent negative impacts from a surface water perspective, is to ensure that a sound SWMP is implemented prior to the commencement of pumping activities, in accordance with the conditions stipulated in GN R704. Monitoring and maintenance of stormwater measures is of utmost importance and should be conducted as outlined in this report

The following is recommended:

- The existing berm/channel system around the TSF are reinstated where damaged, and maintained. This system acts as the barrier between the clean and dirty water;
- The “clean” runoff from the high lying areas above the Libanon TSF is deviated away from the Libanon TSF by an earth berm constructed immediately to the south of Bridges Avenue, up to the existing culvert under Bridges Avenue to the east of the Libanon TSF. The existing culvert is in a poor state of repair and will have to be reinstated; and,
- A dolomitic stability investigation be carried out around the Libanon TSF to confirm that the proposed reclamation method and stormwater containment on top of the TSF and in paddocks around the TSF is acceptable and in accordance with SANS 1936, and a dolomitic risk management plan be developed.

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Table of Contents

1 INTRODUCTION AND BACKGROUND 1
1.1 Project Description 1
1.1.1 Locality 1
1.1.2 Access 1
1.2 Legal Requirements and Guidelines 4
1.3 Details of the Specialist 4
2 SCOPE OF WORK 5
3 METHODOLOGY AND DATA SOURCES 6
3.1 Site Investigations 6
3.2 Elevation Data 6
3.3 Climatic Data 6
3.4 Terminology 7
3.5 Design Philosophy 7
3.6 Sizing of Stormwater Measures 9
3.6.1 Peak Flows and Volumes 9
3.6.2 Channel Sizing's 10
3.7 Developments on Dolomitic Land 11
3.8 Stormwater Drainage on Dolomitic Land 13
3.8.1 Concentrated Stormwater 13
3.8.2 Surface Ponds 13
3.8.3 Stormwater retention and attenuation structures 13
3.8.4 Precautionary Measures 13
4 Assumptions and Limitations 14
5 Hydrological Setting 14
5.1 Climate 14
5.1.1 Rainfall 14
5.1.2 Evaporation 14
5.1.3 Storm Rainfall Depths 15
5.2 Topography and Drainage 16
5.3 Soils Characteristics and Drainage 17

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5.4 Environmental Sensitivities and Implications for Stormwater Management 18
6 PROPOSED RECLAMATION METHOD 22
7 CONCEPTUAL STORMWATER MANAGEMENT PLAN 24
7.1 Stormwater Catchment Areas 24
7.2 Characteristics of contributing areas 26
7.2.1 Libanon East 26
7.2.2 Libanon West 26
7.2.3 Libanon TSF 26
7.2.4 Libanon TSF Paddocks 26
7.3 Factors used in Rational Formula Calculations 26
7.4 Calculated storm peak flows 27
7.4.1 Rational Formula 27
7.5 Dirty Water Runoff under 1:50 Condition 28
7.5.1 Libanon TSF 28
7.5.2 Libanon Paddocks 28
7.6 Identified Stormwater Issues 28
7.6.1 Libanon East 28
7.6.2 Libanon West 28
7.6.3 Libanon TSF 29
7.6.4 Libanon Paddocks 29
7.7 Proposed Stormwater Measures 29
7.7.1 Libanon East and West 29
7.7.2 Libanon TSF 32
7.7.3 Libanon Paddocks 33
8 RECOMMENDATIONS 35
9 REFERENCES 36

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Figures

Figure 1-1 - Location of the project 2
Figure 1-2 - Layout of 7L1 Pump Station 3
Figure 3-1 – Berm/culvert around Libanon TSF 8
Figure 3-2 – Existing paddocks at toe of Libanon TSF 8
Figure 3-3: Typical proposed design for clean and dirty water channels 10
Figure 3-4 – Schematic cross-section through the Libanon TSF 12
Figure 5-1 - Mean monthly rainfall for the area 14
Figure 5-2 – Drainage system on Bridges Avenue 17
Figure 5-3 – Blocked culvert under Bridges Avenue 17
Figure 5-4 - Topography 19
Figure 5-5 – Land Use 20
Figure 5-6 - Soils Classification 21
Figure 6-1 Mobile tracked hydraulic monitor on a tailings facility in South Africa 22
Figure 6-2 Typical bench widths proposed for a gold reclamation project (Source: www.drdgold.com/investors-and-media/circulars/cpr-samrec-wrtrp-26022018.pdf). 23
Figure 7-1 - Contributing Stormwater Catchment Areas 25
Figure 7-2 - Earth Berm Detail 29
Figure 7-3 – Proposed stormwater solution 31

Tables

Table 1-1 - Specialist Checklist ii
Table 5-1 - Evaporation for the area 15
Table 5-2 – Six closest rainfall stations to the Project 15
Table 5-3 - Storm rainfall depths for the area 16
Table 7-1 – Factors used in Rational Formula Calculations 26
Table 7-2 – Calculated storm peak flows in m^3/s (Rational Formula) – Clean water areas 27

Annexures

Annexure A: CV of H D N Sparks
Annexure B: Rational Method

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Abbreviations

CA	Competent Authority
CEO	Chief Executive Officer
DMRE	Department of Mineral Resources and Energy
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMPr	Environmental Management
EMP	Environmental Management Plan
FWGR	Far West Gold Recoveries (Pty) Ltd
HSE	Health Safety and Environmental
IWULA	Integrated Water Use Licence Application
IWWMP	Integrated Water Waste Management Plan
Kongiwe	Kongiwe Environmental (Pty) Ltd
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No 28 0f 2002)
Mt/a	Million tonnes per annum
NEM:WA	National Environmental Management : Waste Act, 2008 (Act No 59 of 2008)
NEMA	National Environmental Management Act, 1998 (Act No 107 of 1998)
NWA	National Water Act, 1998 (Act No 36 of 1998)
PEP	Project Execution Plan
PPE	Personal Protective Equipment
PPP	Public Participation Process
SoW	Scope of Works
TSF	Tailings Storage Facility
WUL	Water Use Licence
WULA	Water Use Licence Application

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1 INTRODUCTION AND BACKGROUND

Kongiwe Environmental (Pty) Ltd (Kongiwe) was appointed to prepare a stormwater masterplan for the Libanon and associated infrastructure (hereafter referred to as the project). This report provides the surface water study for the Environmental Impact Assessment (EIA) and Water Use Licence Application (WULA) processes.

1.1 Project Description

Far West Gold Recoveries (Pty) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSFs are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF).

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant. Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised).

The Libanon project will reclaim material at 600 000 tons per month . Required infrastructure will include:

- Pumpstation;
- Process water from Kloof Shaft 10#;
- Pollution paddock;
- Access road;
- Laydown area; and,
- Powerlines.

An Environmental Authorisation (EA) and a Water Use Licence (WUL) are therefore required for the Libanon project to proceed.

1.1.1 Locality

The Libanon TSF is located approximately 4 km west of Westonaria. Figure 1-1 shows that TSF is located on the Remaining Extent of Libanon or Witkleigat 283 IQ.

1.1.2 Access

Major routes around the mine dump are the N12 which runs 2km to the South of the TSF and Bridges Avenue which runs parallel to the southern edge of the TSF.

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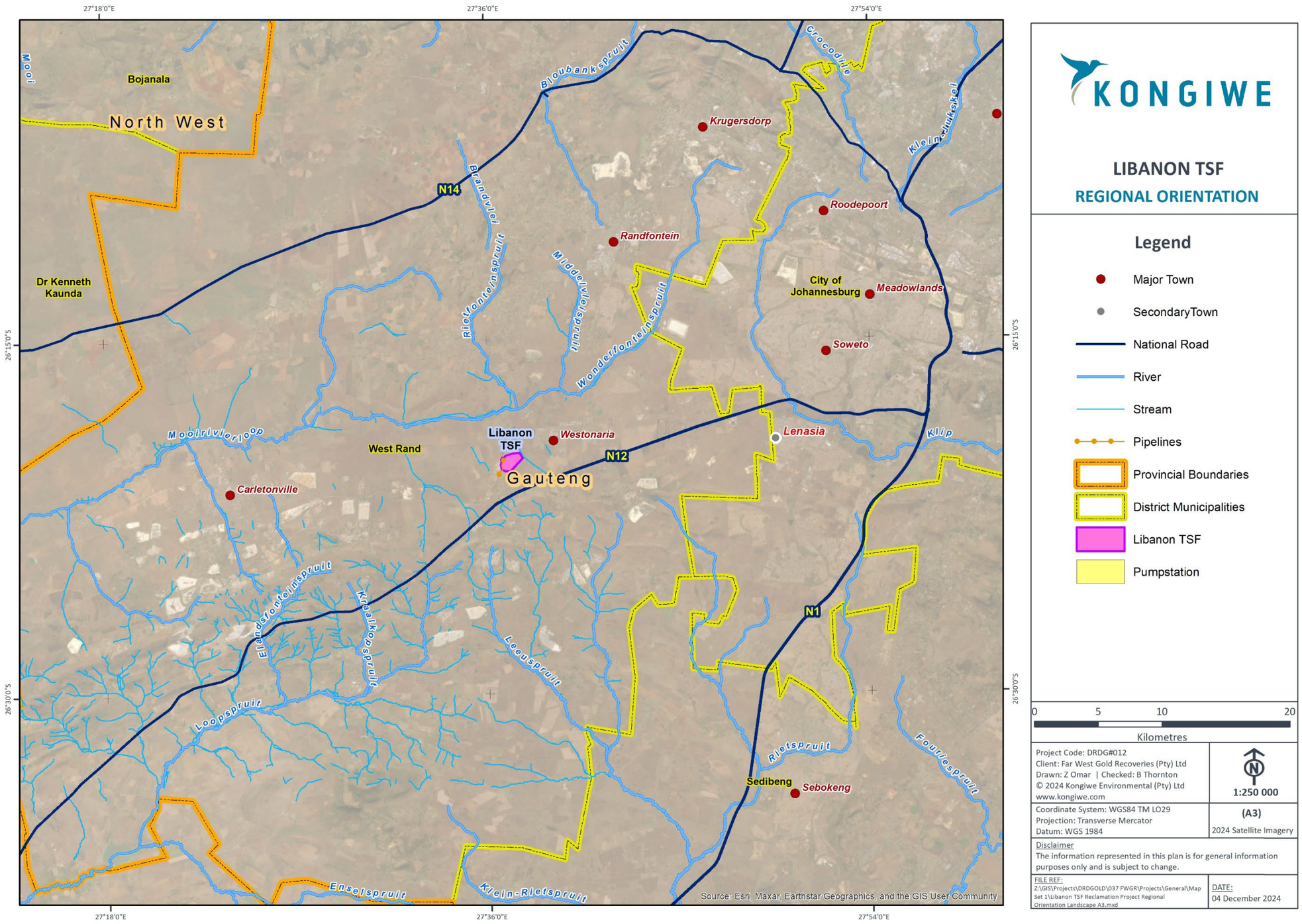

KONGIWE

LIBANON TSF

REGIONAL ORIENTATION

Legend

- Major Town
- SecondaryTown
- National Road
- River
- Stream
- Pipelines
- Provincial Boundaries
- District Municipalities
- Libanon TSF
- Pumpstation

0 5 10 20

Kilometres

Project Code: DRDG#012 Client: Far West Gold Recoveries (Pty) Ltd Drawn: Z Omar | Checked: B Thornton © 2024 Kongiwe Environmental (Pty) Ltd www.kongiwe.com	1:250 000
Coordinate System: WGS84 TM LO29 Projection: Transverse Mercator Datum: WGS 1984	(A3) 2024 Satellite Imagery
Disclaimer The information represented in this plan is for general information purposes only and is subject to change.	
FILE REF: Z:\GIS\Projects\DRDGOLD\037 FWGR\Projects\General\Map Set 1\Libanon TSF Reclamation Project Regional Orientation Landscape A3.mxd	DATE: 04 December 2024

Figure 1-1 - Location of the project

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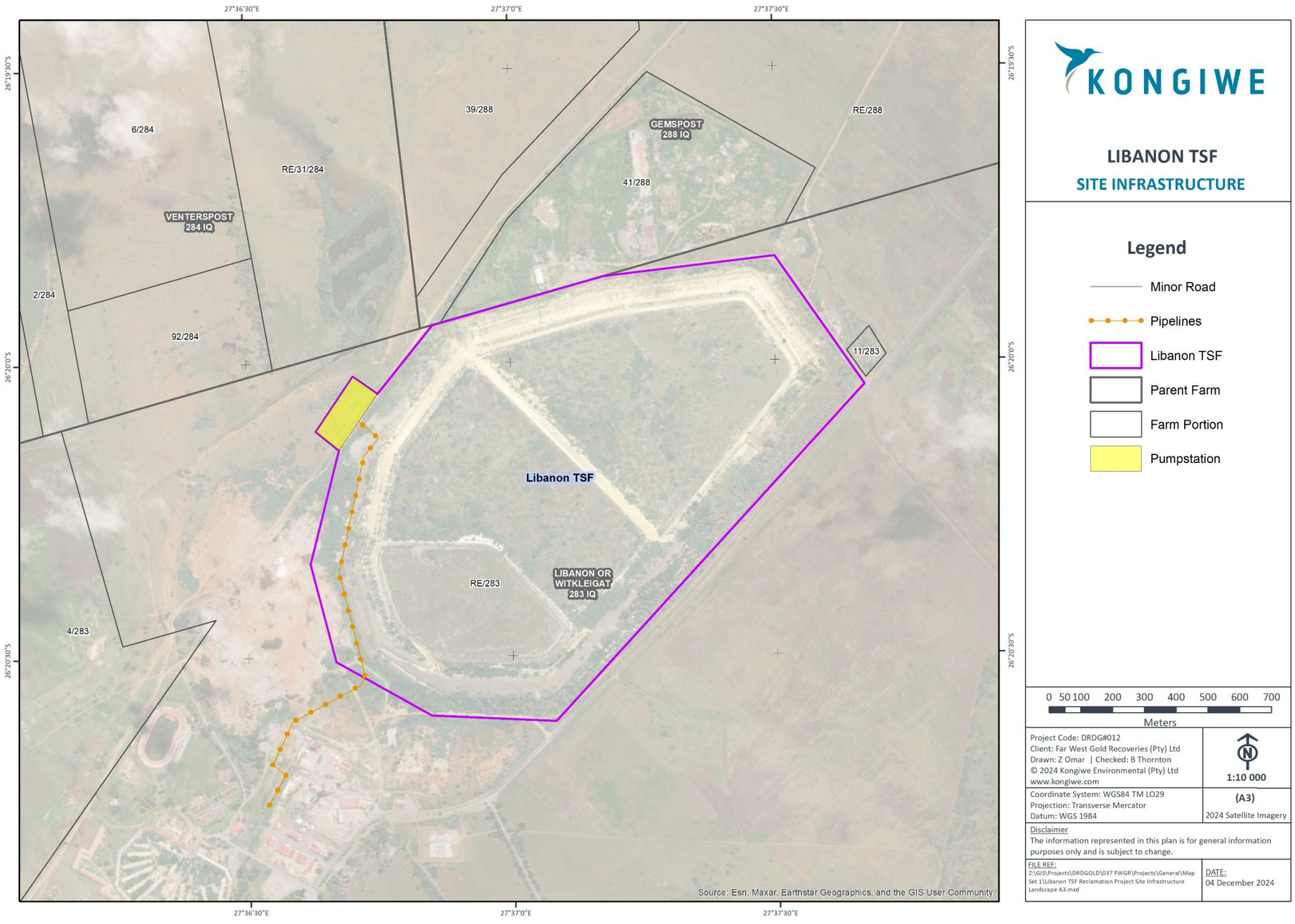

Figure 1-2 - Layout of 7L1 Pump Station

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1.2 Legal Requirements and Guidelines

The following key legislative requirements and guidelines are applicable to this study:

- National Water Act (Act No. 36 of 1998) (NWA);
- Regulations on the Use of Water for Mining and Related Activities aimed at the Protection of Water Resources (published under Government Notice 704 (GN R704) in Government Gazette 20119, on 4 June 1999). In particular:
  - Regulation 6: Which describes the capacity requirements of clean and dirty water systems. Clean and dirty water systems must be kept separate and must be designed, constructed, maintained and operated to ensure conveyance and/or containment of flows of a 1:50 year recurrence event. Clean and dirty water systems should not spill into each other more frequently than once in 50 years. Any dirty water dams should have a minimum freeboard of 0.8 m above full supply level; and,
  - Regulation 7: Which refers to measures which must be taken to protect water resources. All dirty water or substances which may cause pollution of a water resource (through spillage, seepage, erosion, etc.), must be prevented from doing so. Additionally, dirty water should be recycled and reused as far as practicable.
- Department of Water and Sanitation (DWS) Best Practice Guideline (BPG) documents, particularly, BPG G1: Storm Water Management.

1.3 Details of the Specialist

The study was undertaken by Hilton David Neville Sparks who is a Professional Engineer at Kongiwe. Hilton graduated with a Bachelor of Science (BSc) in Engineering in 1969. He is registered as a Professional Engineer (PrEng) (Registration Number 740604) with the Engineering Council of South Africa (ECSA) and as a Professional Construction Project Manager (PrCPM) (Registration Number D/202/2004) with the South African Council for the Project and Construction Management Professions (SACPCMP). Work experience includes rainfall – runoff modelling, floodline determinations, attenuation dam analysis, water network analysis, water and sanitation master plans, and development of stormwater management plans, as well as general engineering work. Hilton has more than 54 years' experience and has worked on projects around South Africa.

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2 SCOPE OF WORK

The scope of work includes the following:

- Undertake site investigations to locate and assess the current stormwater measures, as well as to assess areas where stormwater measures may be required at the Libanon TSF site;
- Delineate the clean and dirty water areas;
- Provide stormwater measures and recommendations for areas that require interventions; and,
- Provide conceptual sizing's for the proposed stormwater measures in line with GN R704 regulations.

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3 METHODOLOGY AND DATA SOURCES

3.1 Site Investigations

A site investigation of the Libanon TSF site was undertaken on 8th May 2024, and a follow up on 9th December 2024.

The purpose of the site investigation was to locate and assess the current stormwater measures, as well as to assess areas where stormwater measures may be required.

This study was undertaken as a once-off study and relies on historical hydrological and climate data for the site; as well as recognized hydrological and water resource databases for South Africa. Data generated during the time of this study is not seasonally bound as average yearly data was applied where required and as scientifically acceptable.

3.2 Elevation Data

Elevation data was obtained from National Geospatial Information Website, the date of the data is 2016.

3.3 Climatic Data

Monthly rainfall between October 1941 – September 2008, was sourced from South African Weather Service (SAWS) station: Blyvooruitzicht (station number: 0474684 W) and was used to describe the seasonal rainfall at Libanon TSF. There are other weather stations located closer to the Libanon TSF, but the records are of short duration. Due to the flat topography of the region, the rainfall does not vary much, and therefore, the Blyvooruitzicht weather station was used to represent the rainfall at the Libanon TSF.

The storm rainfall depths, which are required to calculate the peak flows, were extracted using the Design Rainfall Estimation in South Africa software programme (Smithers and Schulze, 2002). The programme uses the six closest rainfall stations to a user specified coordinate, to calculate the storm rainfall depths for that site. Storm rainfall depths were extracted at Libanon TSF (26° 20’ S, 27° 37’ E).

According to the WR2012 study, Libanon TSF is located within evaporation zone 10A. Symon’s Pan (S-Pan) evaporation was obtained from the DWS Naauwpoort weather station (C2E009) at the Boskop Dam, which is also located within evaporation zone 10A. Monthly evaporation was available for the period of 1969 – 2019. S-Pan evaporation measurements tend to be higher than evaporation from natural open water bodies. To convert S-Pan measurements to open water evaporation, monthly conversion factors were used, which were obtained from the WR90 study.

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3.4 Terminology

The following definitions are relevant to the SWMP. These are provided here for clarity, as they are commonly referred to in this section of the report:

- **Clean area**: This refers to any area at or near a mine or activity, which is not impacted by mining activities, but has the potential to become contaminated if not managed appropriately;
- **Clean water system**: This includes any dam, other form of impoundment, canal, works, pipeline and any other structure or facility constructed for the retention or conveyance of clean unpolluted water;
- **Dam**: This includes any return water dam, settling dam, tailings dam, evaporation dam, catchment or barrier dam and any other form of impoundment used for the storage of unpolluted water or water containing waste (i.e. contain polluted water);
- **Dirty area**: This refers to any area at a mine or activity which causes, has caused or is likely to cause pollution of a water resource (i.e. generate polluted water);
- **Dirty water system**: This includes any dam, other form of impoundment, canal, works, pipeline, residue deposit and any other structure or facility constructed for the retention or conveyance of water containing waste; and,
- **Watercourse**: This is defined in the NWA as -

    - A river or spring;
    - A natural channel in which water flows regularly or intermittently;
    - A wetland, lake or dam into which, or from which, water flows; and,
    - Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

3.5 Design Philosophy

The following design philosophy was adopted to guide the development of the SWMP and is based on GN R704 regulations and the DWS BPG G1: Storm Water Management:

- Confine or divert any unpolluted water to a clean water system, away from a dirty area;
- Runoff from dirty areas must be captured and contained and should as far as possible be recycled and reused;
- Clean and dirty water systems must be designed and constructed to prevent cross contamination;
- Clean and dirty water systems must convey or contain runoff from the 1:50 year storm event; and,
- Appropriate maintenance and management of stormwater related infrastructure should always be ensured.

The above design philosophy is applied as follows:

1. The catchment area upstream of the Libanon TSF extends up to the N12 Highway. The clean water from this catchment currently flows directly onto the TSF. There is a berm/channel system around the TSF (see Figure 3-1) which seperates the clean/dirty water, however the drainage ditch is siltedup and overgrown in places, and the berm breached in sone instances. These berms/channels

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must be reinstated and maintained to divert stormwater away from the Libanon TSF, however this concentrates the runoff at the south eastern and south western corners of the TSF.

Figure 3-1 – Berm/culvert around Libanon TSF

A new earth berm immediately to the south of Bridges Avenue extending over the full length of the Libanon TSF up to the existing culvert crossing Bridges Avenue to the east of the Libanon TSF, is proposed. This berm will deviate all stormwater runoff from the upstream areas to this culvert, which will have to be reinstated as it is in a poor state of repair;

2. Rainfall onto the top of the Libanon TSF will be retained on top of the TSF using earth berms, and the runoff will be allowed to infiltrate and evaporate. This is in line with FWGR's current strategy for the remining of existing TSFs, and has been used at other TSFs located in dolomitic areas;
3. Runoff from the side slopes of the Libanon TSF will be captured, contained and managed in paddocks immediately adjacent to the TSF (see Figure 3-2), and will be allowed to evaporate/infiltrate appropriately. The berm on the outside edge of the paddocks must be reinstated/maintained to ensure that dirty water is contained in the paddocks;

Figure 3-2 – Existing paddocks at toe of Libanon TSF

4. Dirty water will, as far as possible, be recycled and reused;

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5. Clean and dirty water systems must convey/contain runoff from the 50 year storm event, and should not lie within the 100 year floodline or within a horizontal distance of 100 m from any watercourse, whichever is the greater of the two; and
6. Appropriate maintenance and management of stormwater related infrastructure should be ensured at all times.

3.6 Sizing of Stormwater Measures

3.6.1 Peak Flows and Volumes

GN R704 regulations require that clean and dirty water systems are sized so that they do not spill more than once in 50 years.

3.6.1.1 Rational Method

The Rational method is used to calculate the peak flows. The Rational method is based on the following equation:

$$Q_T = \frac{C\ I\ A}{3.6}$$

where:

Q_T = Peak flow for a recurrence interval e.g. a 1:100 year flood (m^3/s);
C = Runoff coefficient (dimensionless);
I = Average rainfall intensity over the catchment (mm/hour);
A = Catchment area contributing to the peak flow (km^2); and,
3.6 = Conversion factor

The runoff coefficient "C" is calculated by specifying the percentage area covered by different physical characteristics of the contributing catchment. This includes the vegetation, slope, soil permeability and land use characteristics.

The average rainfall intensity "I" was calculated by dividing the gridded storm rainfall depths obtained from Smithers and Schulze (2002) by the time of concentration (T_c). The T_c is the amount of time it takes for water to travel from the hydraulically most remote point in the contributing catchment to the catchment outlet. It is essentially the amount of time for runoff in the catchment to contribute to the peak flow.

The contributing catchment area "A" was calculated by delineating a catchment from the point where the watercourse exits the Project area.

A Microsoft Excel spreadsheet was used to perform the calculations based on the South African National Roads Agency Limited (SANRAL) procedure (SANRAL, 2013) (Attached as Annexure B).

The Rational Method is based on the following assumptions:

- Rainfall has a uniform area distribution across the total contributing catchment;

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- Rainfall has a uniform time distribution for at least a duration equal to the Tc;
- The peak discharge occurs when the total catchment contributes to the flow occurring at the end of the critical storm duration, or Tc;
- The runoff coefficient "C" remains constant for the storm duration, or Tc; and
- The return period of the peak flow is the same as that of the rainfall intensity.

3.6.2 Channel Sizing's

The Manning's equation was used to calculate the channel sizes required to convey the 1:50 year peak flows. The Manning's equation is provided below:

$$Q = A\frac{1}{n}R^{2/3}S^{1/2}$$

Where:

Q = Peak flow (m^3/s)

A = Cross sectional area of the channel (m^2)

R = Hydraulic radius (m)

S = Longitudinal slope of channel (m/m)

n = Manning's roughness coefficient 'n'

Calculations were undertaken using a Microsoft Excel spreadsheet. The typical proposed design for clean and dirty water channels is shown in Figure 3-1.

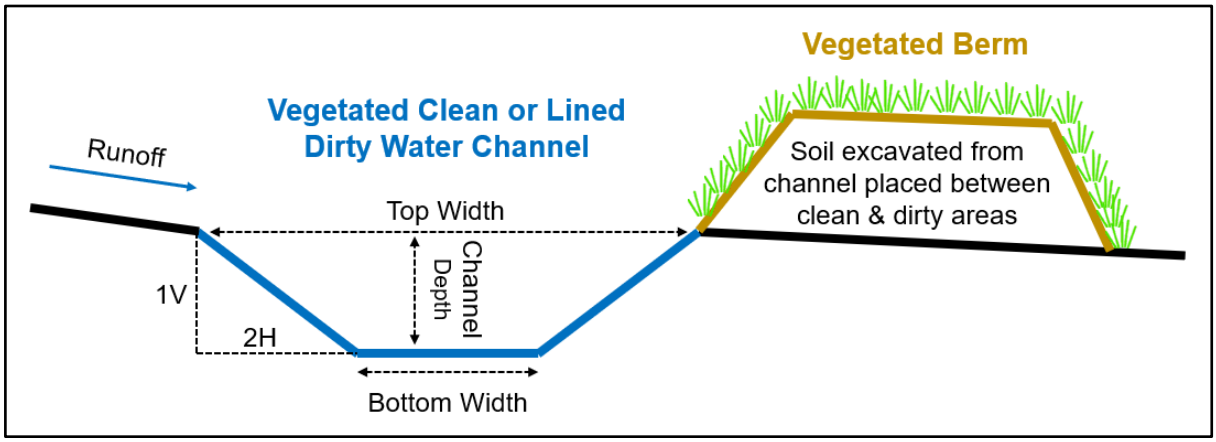

Figure 3-3: Typical proposed design for clean and dirty water channels

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3.7 Developments on Dolomitic Land

Sinkholes and subsidences are mostly caused by water ingress/seepage or a lowering of the ground water table.

Sinkholes are generated by a change in the moisture regime in the soils constituting the arch over the upward migrating void. This change in the state of the soil leads to the arch ravelling and the void moving upward towards ground surface. The void will eventually daylight and manifests as a sinkhole. Often paleo sinkholes are reactivated by groundwater level draw down. Paleo sinkholes are ancient features infilled over time by transported soil material, e.g. wind-blown, aeolian sands. These materials may extend below the original groundwater level. In such instances, lowering of the groundwater level leads to a change in the moisture regime of the soils that re-activates the sinkhole.

Seepage of water most commonly occurs from leaking water bearing services such as sewers, water pipes, stormwater systems etc. The leaking water erodes the soil covering the dolomite rock and carries the material down into the underlying cave systems resulting in the formation of a cavity below ground surface. A sinkhole results when this cavity daylights. Sinkholes and subsidences may occur soon after installation of services because of poor workmanship or use of inferior materials or after a period of time due to continual consolidation of poorly compacted materials. Obviously, as the condition of water bearing services deteriorate with time, the frequency of leaks increases and so does the likelihood of a sinkhole occurring.

The groundwater level drops when boreholes are used to pump water from underground aquifers. The groundwater level can also be lowered when mines pump water out of groundwater compartments to keep their underground workings dry. Groundwater level lowering leads to lowering of porewater pressure, which lowers, ground bearing capacity or draining of subsurface cavities, which may result in sinkhole or subsidence formation.

The dolomitic environment is often characterised by zones of deep weathering and preferential leaching. This process of preferential weathering is particularly well advanced within the shear zones of faults. Subsurface karst valleys up to 200 m in depth may develop in these shear zones.

Spectacular representations of these features are located on the **Far West Rand in the Gauteng Province**. In many of these areas, the groundwater level is located above the bedrock, in residual soils. These residual materials are essentially composed of wad and ferroan soil. The artificial lowering of the groundwater level may produce significant ground movement at the surface. This process manifests as a subsidence at ground surface.

Dolomite Stability Investigations (DSI) are conducted to determine the Inherent Hazard characterisation of dolomite land as well as the Dolomite Area Designations and shall be undertaken under the direction of one or more Competent Persons (geo-professionals). Geotechnical site investigations on dolomite land shall comprise investigations, as relevant, relating to:

a) the identification of hazards that impact upon the development of the land;
b) the determination of the Inherent Hazard; and,

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c) the stability of the dolomite land for various types of development, and the foundations for buildings and structures.

In their report "Technical Report on Moisture Levels of the Kloof 1, Libanon and Venterspost North Tailings Storage Facilities", The RVN Group found the base of the Libanon TSF (from 42 to 54 m below the top surface) to be wet under the present conditions (ie a "dormant" state) (See Figure 3-4). They recommend:

- The authors recommend drilling be completed on all TSFs, obtaining up-to-date data, and commissioning a hydrogeological study;
- Furthermore, the authors recommend that the RC drilling technique is utilized so that wet or watery samples can be recovered and the TSF bases can be intersected and defined;
- The authors recommend that larger TSFs like Libanon and Venterspost North should undergo an initial geotechnical assessment. This assessment can involve a visit to the site by professionals and a desktop study utilizing satellite data.
- The authors recommend that FWGR consider incorporating the latest monitoring technologies for TSFs as a sustainable long-term measure. The authors suggest exploring the technology currently being developed and tested at numerous operational and decommissioned TSFs worldwide.

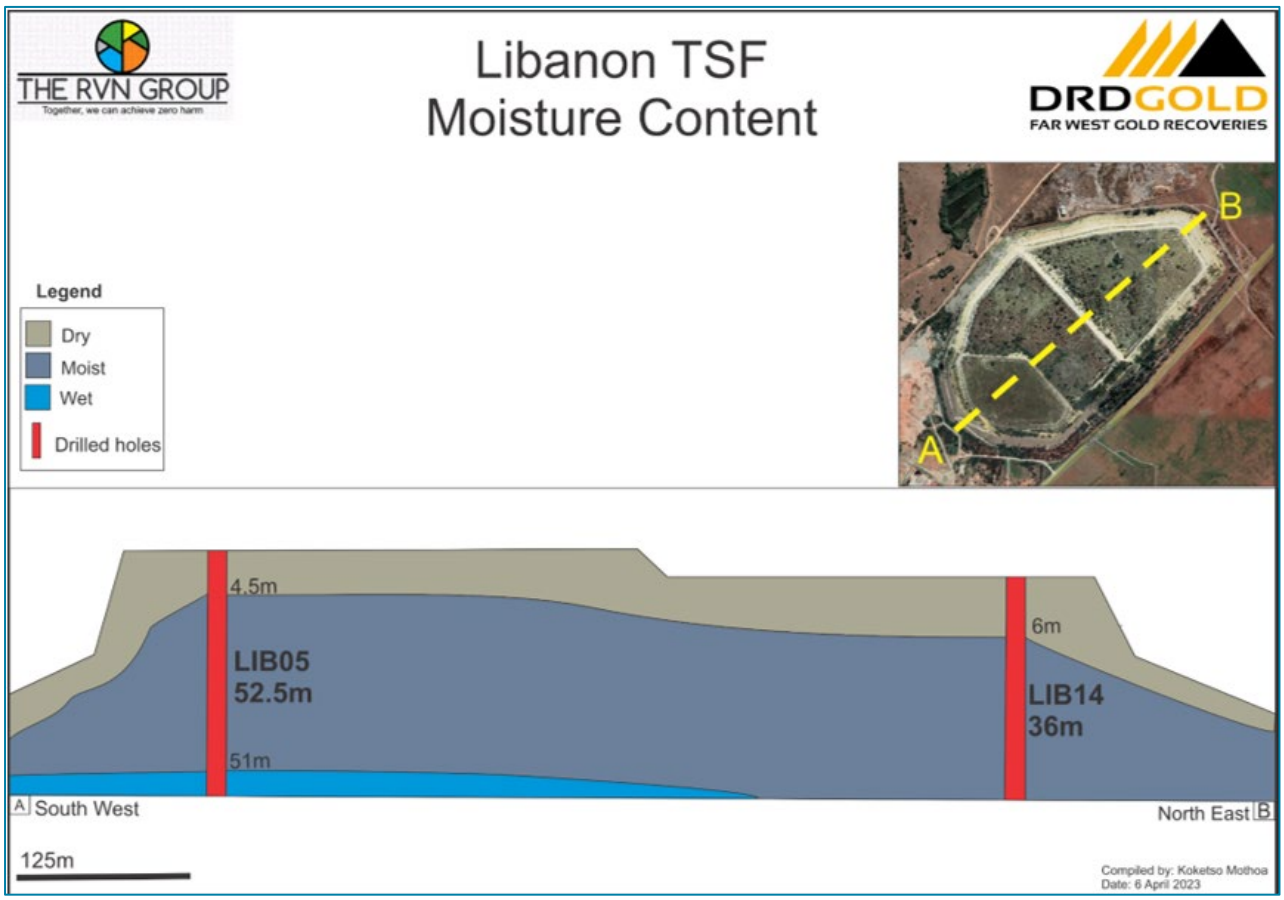

Figure 3-4 – Schematic cross-section through the Libanon TSF

The general requirements for such investigations are described in SANS 1936-2 and comprise the following:

a) Feasibility-level Dolomite Stability Investigation

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a. The first phase of investigation requires fieldwork to enable the land to be characterized in terms of its stability. This phase of investigation forms the basis of development planning.

b) Design-level Dolomite Stability Investigation
   a. Such investigation, including footprint investigation, where necessary, entails further investigations to provide specific information for design purpose of structures, facilities, infrastructure or bulk services.

c) Investigations during Installation of Services
   a. This investigation is undertaken during the installation of services and entails observations and further investigations as are necessary to confirm the Inherent Hazard characterization of dolomite land or Dolomite Area Designations (or both) determined during the feasibility-level investigation.

The safe development of a site located on dolomite involves:

a) careful geotechnical assessment of the delineated area;
b) appropriate planning and appropriate design of structures and services; as well as,
c) the perpetual management thereof.

In addition, a dolomitic risk management plan must be developed.

3.8 Stormwater Drainage on Dolomitic Land

3.8.1 Concentrated Stormwater

Concentrated stormwater shall not be disposed of other than in natural water courses unless the land upon which it is discharged is:

- not dolomite land; or
- dolomite land categorised as having a Dolomitic Area Designation D1 (refer to SANS 1936-1).

3.8.2 Surface Ponds

Stormwater drainage shall be such that no surface water ponds other than in natural watercourses save for that associated with the attenuation of stormwater for a period not exceeding **6 hours**;

3.8.3 Stormwater retention and attenuation structures

Stormwater retention and attenuation structures should preferably not be constructed on land of Dolomite Area Designation D4 in accordance with SANS 1936. Dolomite Area Designation D4 (Inherent Hazard Classes 5, 6, 7 and 8) may only be considered provided the conditions as prescribed in SANS 1936 are met; and,

3.8.4 Precautionary Measures

Appropriate precautionary measures should be specified for Dolomite Area Designation D3 (Inherent Hazard Classes 1, 2, 3 and 4).

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4 Assumptions and Limitations

The following are assumptions and limitations for the conceptual SWMP:

- The SWMP is based on the project description and infrastructure layout. Should the project description or infrastructure layout change, then the SWMP will need to be revised;
- The capacities calculated for proposed containment facilities, do not include any additional volumes other than the 1:50 year runoff.

5 Hydrological Setting

5.1 Climate

5.1.1 Rainfall

Rainfall data for the area was obtained from the Blyvooruitzicht rainfall station (Station No. 0474684 W). The station is located 4 km south of Carletonville and 14 km west of the Libanon TSF. The mean monthly rainfall is indicated in Figure 3-2. The area has a Mean Annual Precipitation (MAP) of 711 mm. Rainfall is highest over the months of October to March, and lowest over the months of April to September.

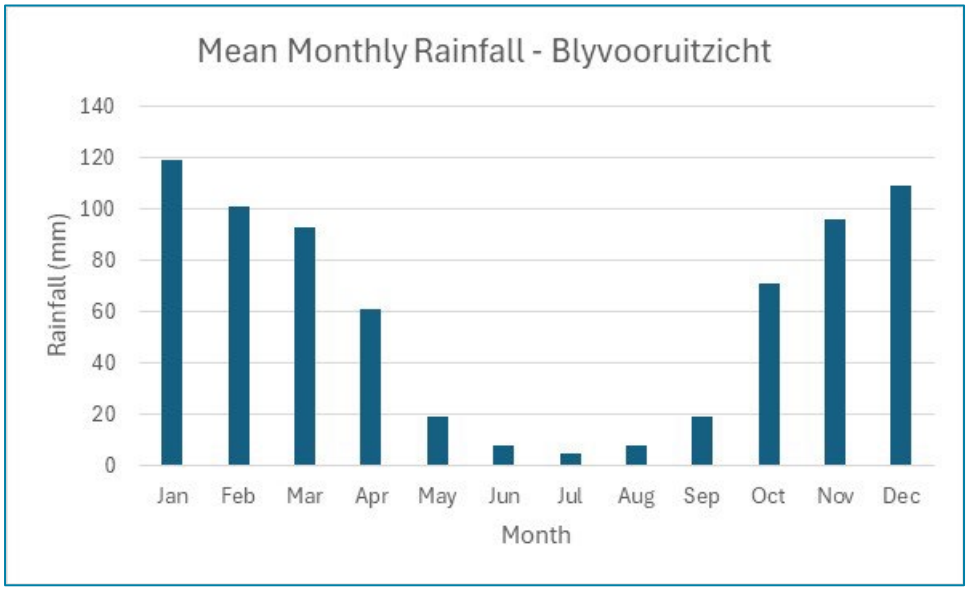

Figure 5-1 - Mean monthly rainfall for the area

5.1.2 Evaporation

According to the WR2012 study, the Libanon area is mostly located within evaporation zone 10A. Symon's Pan (S-Pan) evaporation was obtained from the DWS Naauwpoort weather station (C2E009) at the Boskop Dam, which is also located within evaporation zone 10A. Monthly evaporation was available for the period of 1969 – 2019. S-Pan evaporation measurements tend to be higher than evaporation from natural open water bodies. To convert S-Pan measurements to open water evaporation, monthly conversion factors were used, which were obtained from the WR90 study. The monthly evaporation for the project is indicated in Table 5-1. The open water Mean Annual Evaporation (MAE) is 1 454 mm, which is double the MAP of the

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area. Evaporation is highest over the warmer months of September to March, and lowest over the cooler months of April to August.

Table 5-1 - Evaporation for the area

Month	S-Pan Evaporation	Open Water Evaporation Factor	Open Water Evaporation (mm)
January	190	0.84	159
February	161	0.88	142
March	149	0.88	131
April	116	0.88	102
May	96	0.87	83
June	77	0.85	65
July	86	0.83	71
August	120	0.81	97
September	160	0.81	130
October	187	0.81	152
November	191	0.82	156
December	201	0.83	166
Total	1732		1454

5.1.3 Storm Rainfall Depths

The storm rainfall depths for the centre point of the Libanon TSF were extracted for the catchments from the Design Rainfall Estimation in South Africa software programme (Smithers and Schulze, 2002). The programme uses the six closest rainfall stations to a user specified position to calculate the storm rainfall depths. The storm rainfall depths were extracted at 26° 20’ S and 27° 37’ E. The six closest rainfall stations are indicated in Table 5-2

Table 5-2 – Six closest rainfall stations to the Project

Station Name	Station No.	Distance from Site (km)	Record (Years)	Latitude	Longitude	MAP (mm)	Altitude (mamsl)
Venterspos (Old Homestead)	0475227_W	5.7	43	26°17S	27°38E	655	1 555
Kloof (GM)	0475174_W	8.0	33	26°24S	27°35E	695	1 723
Bank (SAR)	0475019_W	13.1	57	26°18S	27°30E	603	1 530
Leeuwpoort	0475056_W	14.1	64	26°26S	27°32E	644	1 580
Luipaardsvlei	0475404_W	16.6	50	26°14S	27°44E	651	1 603
Eldorado	0475477_W	19.1	47	26°27S	27°45E	590	1 557

The extracted storm rainfall depths for the project are indicated in Table 5-3.

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Table 5-3 - Storm rainfall depths for the area

Storm Duration	Return Period / Storm Rainfall Depth (mm)						
mm/hr/day	1:2 yr	1:5 yr	1:10yr	1:20yr	1:50 yr	1:100 yr	1:200 yr
5 min	8.9	11.8	13.8	15.7	18.2	20.1	22.0
10 min	12.8	17.1	20.0	22.7	26.4	29.1	31.9
15 min	15.9	21.2	24.8	28.2	32.8	36.2	39.6
30 min	20.3	27.1	31.6	36.1	41.8	46.2	50.6
45 min	23.4	31.3	36.5	41.6	48.3	53.3	58.4
1 hr	25.9	34.6	40.4	46.0	53.4	59.0	64.6
1.5 hr	29.9	39.9	46.6	53.1	61.6	68.1	74.5
2 hr	33.1	44.2	51.6	58.8	68.2	75.3	82.5
4 hr	39.4	52.5	61.3	69.8	81.0	89.5	98.0
6 hr	43.5	58.0	67.8	77.2	89.6	98.9	108.3
8 hr	46.7	62.3	72.8	82.9	96.2	106.3	116.4
10 hr	49.4	65.9	76.9	87.6	101.7	112.3	123.0
12 hr	51.7	68.9	80.5	91.7	106.4	117.5	128.7
16 hr	55.5	74.0	86.4	98.5	114.3	126.2	138.2
20 hr	58.7	78.2	91.3	104.1	120.8	133.4	146.1
24 hr	61.4	81.8	95.6	108.9	126.3	139.5	152.8
1 day	53.2	70.9	82.8	94.3	109.5	120.9	132.4
2 day	65.4	87.2	101.9	116.1	134.7	148.8	162.9
3 day	73.9	98.5	115.0	131.0	152.0	167.9	183.9
4 day	80.2	106.9	124.9	142.3	165.1	182.3	199.7
5 day	85.5	114.0	133.1	151.7	176.0	194.4	212.8
6 day	90.1	120.1	140.2	159.8	185.4	204.8	224.2
7 day	94.1	125.5	146.6	167.0	193.8	214.0	234.4

5.2 Topography and Drainage

The elevation of the Libanon area varies from a high of 1 765 metres above mean sea level (mamsl) at the ridge located to the south to a low of 1546 at the Wonderfonteinspruit in the north. The topography of the area is flat, with an average slope of 1.5 %. The only areas where steep slopes occur, are along the sides of the TSFs and in the high lying ridge along the south edge of the area.

The Wonderfonteinspruit and its tributaries are the primary surface water system near the project site, forming part of a broader watershed that ultimately flows into larger water bodies downstream. During peak rainfall events, these watercourses can experience significant flow increases, carrying stormwater runoff from both natural and anthropogenic sources. The proximity of the Libanon TSF to these watercourses necessitates stringent controls to prevent contaminated stormwater from reaching the Wonderfonteinspruit, where it could impact downstream water quality, ecosystems, and local communities. (See Figure 5-4).

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There is a tarred road (Bridges Avenue) located on the southern side of the TSF. This road has no formal stormwater drainage system (see Figure 5-2, although there is an unformed channel draining to a culvert immediately to the east of the TSF, however the inlet to the culvert is completely blocked (see Figure 5-3).

Figure 5-2 – Drainage system on Bridges Avenue

Figure 5-3 – Blocked culvert under Bridges Avenue

5.3 Soils Characteristics and Drainage

Soils in the vicinity of the Libanon TSF are generally composed of a thin layer of sandy or silty material overlying dolomitic bedrock, with low to moderate permeability. This composition poses dual challenges: the soils have limited capacity to absorb large volumes of water during intense storms, contributing to increased runoff, while the dolomitic bedrock below is vulnerable to infiltration if water accumulates or ponds. To prevent destabilization of the ground, it is essential to design drainage systems that route stormwater away from critical areas and toward safe discharge points. (See Figure 5-4).

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Information available indicates that a dolomitic stability investigation has NOT been conducted in the area of the Libanon TSF.

It must also be recorded that in the process of carrying out the groundwater study for this project, one of the boreholes drilled in close proximity to the Libanon TSF encountered a cavity.

5.4 Environmental Sensitivities and Implications for Stormwater Management

Given the site's dolomitic conditions, hydrological characteristics, and proximity to watercourses, the stormwater management strategy must be designed to:

- Limit infiltration to avoid ground subsidence and sinkhole formation;
- Ensure contaminated runoff from the TSF does not reach local watercourses or groundwater systems; and,
- Control erosion and sediment transport to protect the stability of the TSF and the quality of nearby aquatic habitats.

Overall, the presence of dolomite adds a critical layer of complexity to stormwater management for this project, requiring specialized infrastructure and best practices to protect both environmental and structural integrity.

SANS 1936 states the following:

The requirements for **dams**, reservoirs and public swimming pools (including **attenuation dams**) shall comply with the requirements of SANS 1936-2, Annex A (A.8). The investigation shall also include the following:

- a gravity survey over the site at 30 m grid spacing with a minimum of three lines;
- additional investigations for alternative sites in the event that Inherent Hazard Class 3, 5, 6, 7 and 8 conditions (refer to SANS 1936) are encountered;
- inspection of the excavation to verify the stability zonation and to check for paleokarst structures;
- investigation of potential paleosinkhole structures wherever they are exposed; and,
- where justified, supplementary geotechnical site investigation.

A proposed site for dams and reservoirs (attenuation dam) should be at least 100 m from the nearest housing or commercial development.

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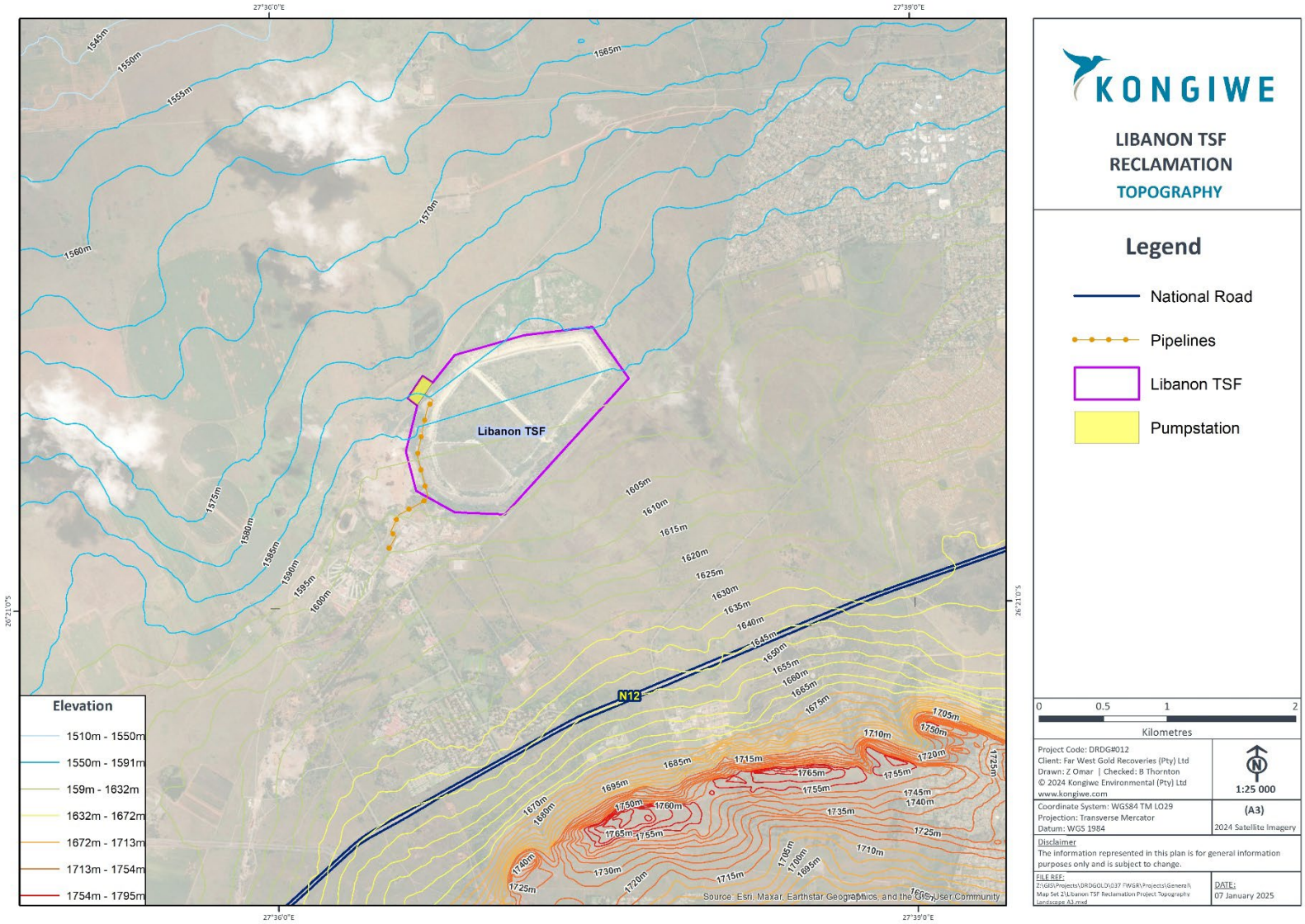

Figure 5-4 - Topography

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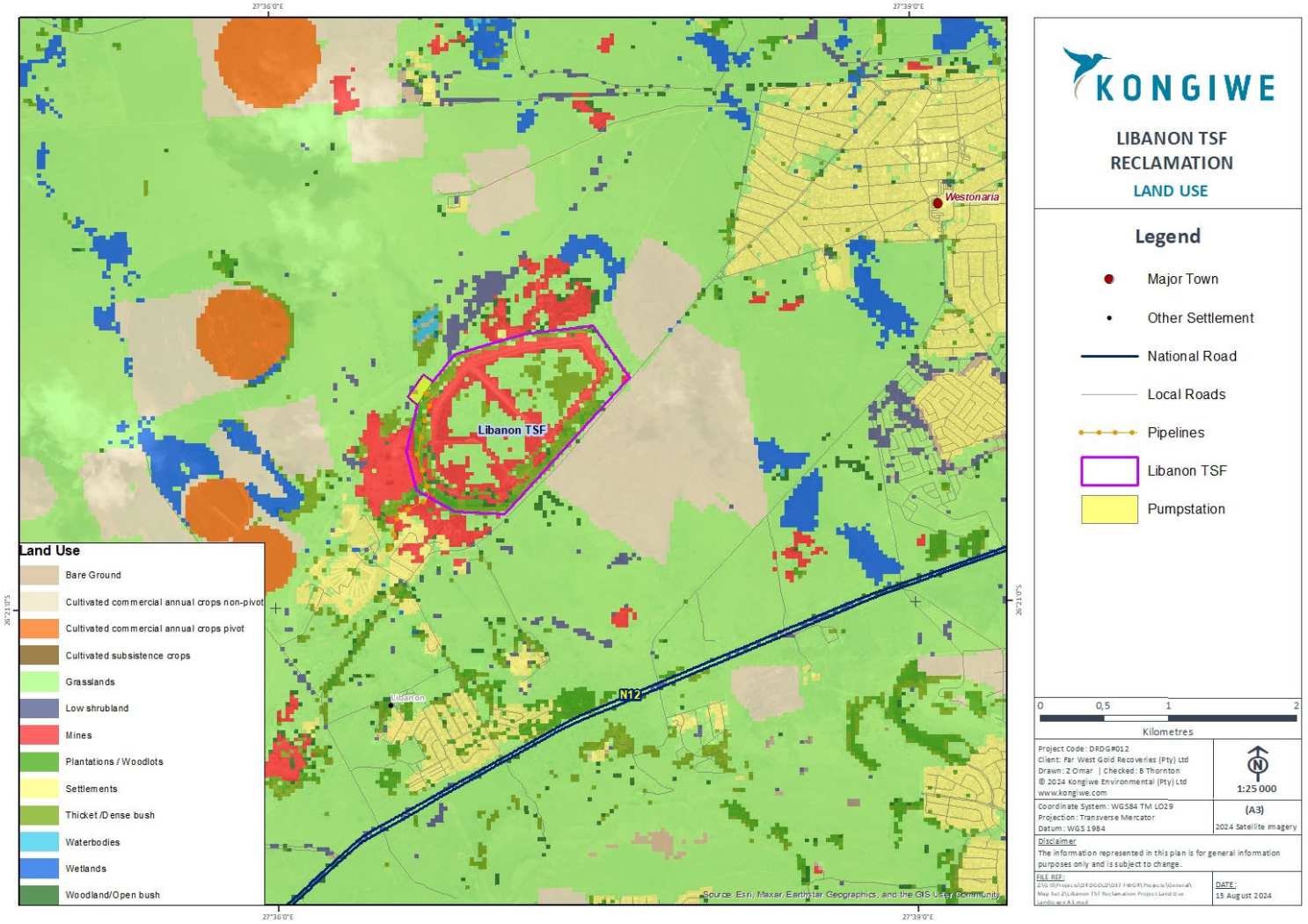

Figure 5-5 – Land Use

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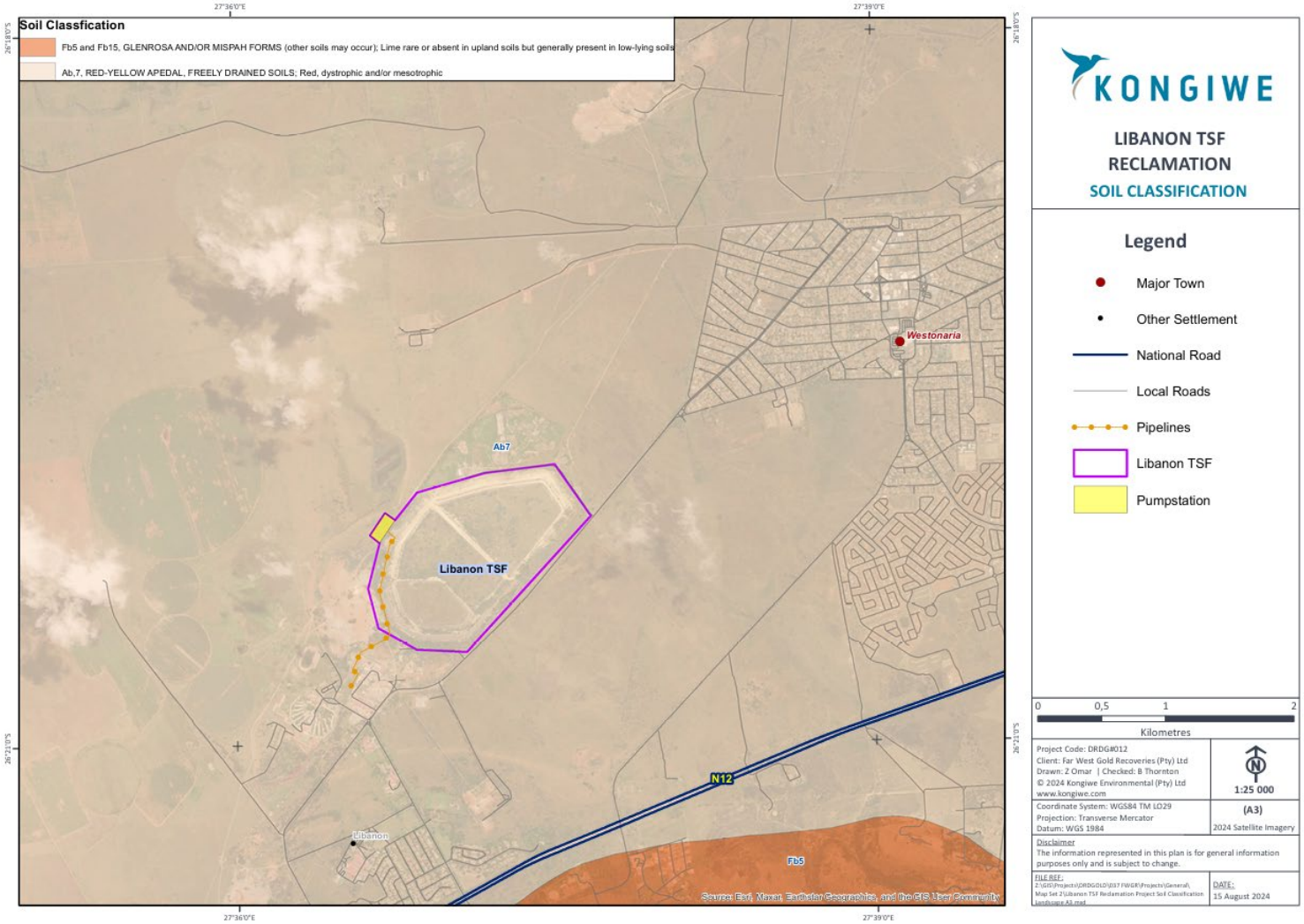

Figure 5-6 - Soils Classification

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6 PROPOSED RECLAMATION METHOD

The proposed method which will be used to remove the TSF is referred to as top-down hydraulic reclamation. This technique uses high-pressure water monitors (or mobile tracked hydraulic monitors) to deliver a high-pressure water jet to excavate unconsolidated tailings material within the TSF hydraulically. The water from the cannon mixes with the tailings and forms a slurry with a high solids content. The slurry then flows under gravity along trenches at the base of the TSF to a collection sump which is positioned at the lowest elevation of the bench being reclaimed. At the sump, finger screens remove any debris that may impact pumping operations, and a penstock will control water flow into the sump. The position of the collection sump will change as the reclamation progresses. From the collection sump, the slurry reports to a reclamation station. To control the volume of water reporting to the reclamation station, flapper valves are used to hold, and release slurry contained in the collection sump. This slurry is then pumped via pipelines to the Driefontein No. 2 Plant. At the Driefontein No. 2 Plant, the slurry is prepared and treated for gold extraction and beneficiation.

Figure 6-1 Mobile tracked hydraulic monitor on a tailings facility in South Africa

Reclamation will take place in predetermined benches (or ‘cuts’) and will move unidirectionally until the entire TSF has been reclaimed. Generally, 30 m cuts are made for reclamation as per Figure 2-4 below.

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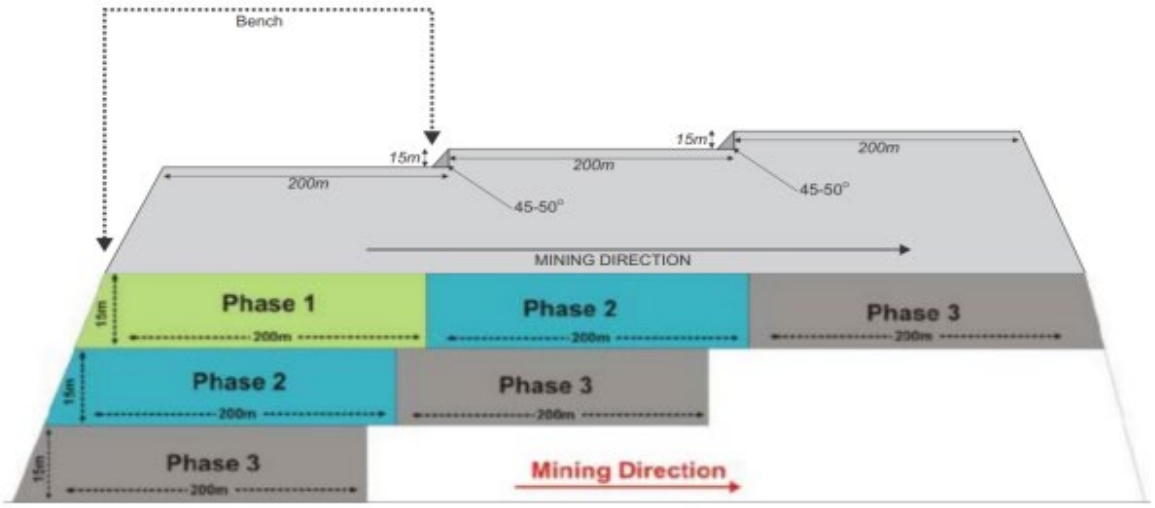

Figure 6-2 Typical bench widths proposed for a gold reclamation project (Source: www.drdgold.com/investors-and-media/circulars/cpr-samrec-wrtrp-26022018.pdf).

An earth berm is constructed on the outer edge of the benches to prevent stormwater and dirty water from contaminating the areas adjacent to the TSF.

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7 CONCEPTUAL STORMWATER MANAGEMENT PLAN

The purpose of the conceptual SWMP is to ensure that clean and dirty water are adequately separated, by diverting clean water away from dirty areas, and ensuring that dirty water from the operation is captured, contained and managed appropriately in accordance with GN R704 regulations and DWS best practice guidelines.

7.1 Stormwater Catchment Areas

The Libanon TSF has 3 catchment areas contributing stormwater runoff to it (see Figure 7-1):

- Clean water areas:
  - Libanon East – the biggest area commencing on the high lying ridge to the south, flowing northwards and concentrating at the eastern corner of the Libanon TSF; and,
  - Libanon West – commencing at the N12 to the south, flowing northwards and concentrating at the western corner of the Libanon TSF;
- Dirty water areas:
  - Libanon TSF – the TSF footprint where stormwater will be contained on the TSF by earth berms constructed as part of the reclamation process; and,
  - Paddocks constructed at the toe of the TSF, to contain stormwater runoff from the side slopes of the TSF and allowing the ponded “dirty” water to either evaporate or infiltrate.

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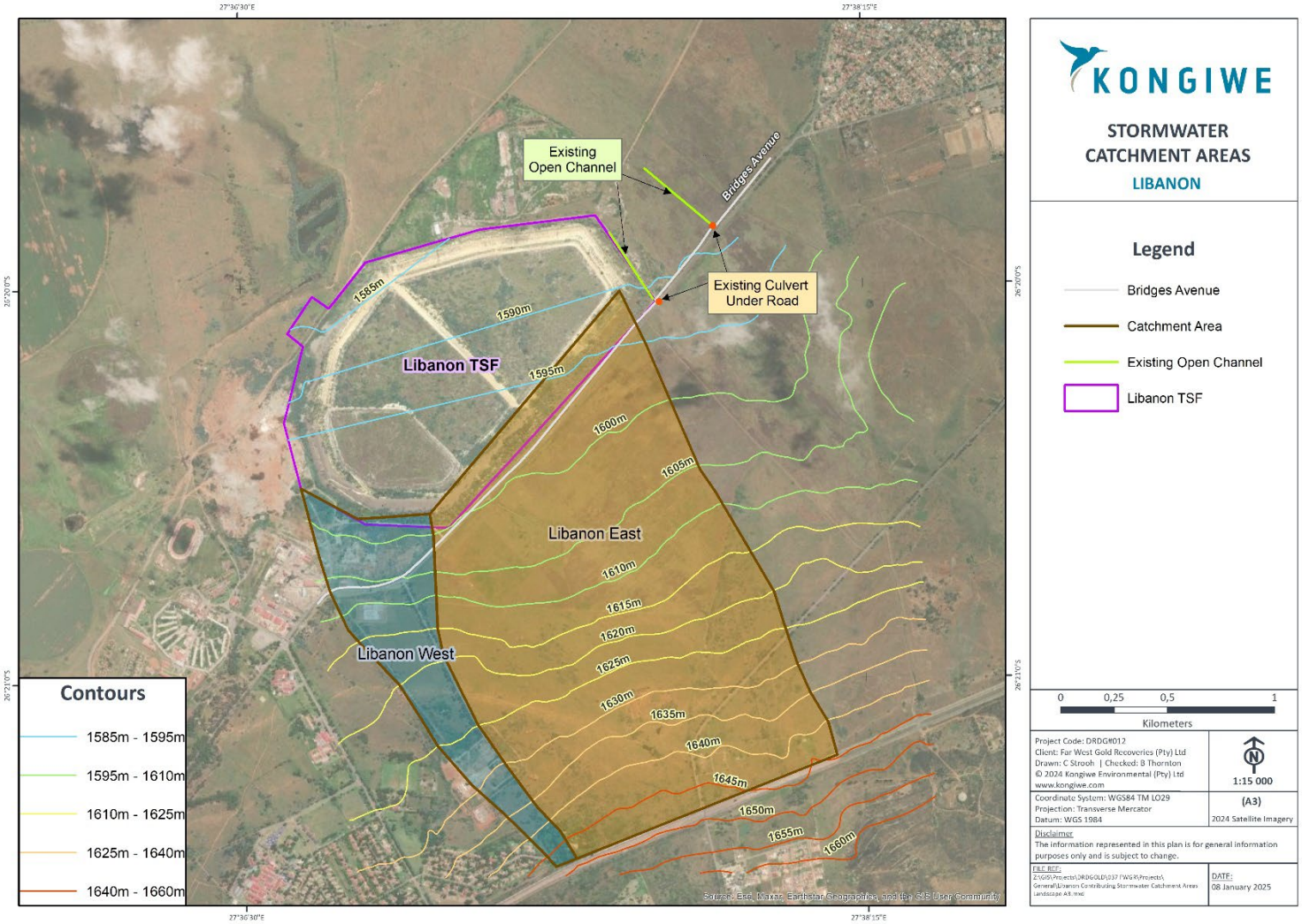

Figure 7-1 - Contributing Stormwater Catchment Areas

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7.2 Characteristics of contributing areas

7.2.1 Libanon East

- Catchment Area: 2.79 km2
- Longest watercourse: 2.597 km
- Average slope: 2.926%
- Dolomitic area: 100%

7.2.2 Libanon West

- Catchment Area: 0.54 km2
- Longest watercourse: 2.08 km
- Average slope: 2.69%
- Dolomitic area: 100%

7.2.3 Libanon TSF

- Catchment Area: 0.97 km2
- Longest watercourse: 1.21 km
- Average slope: 0.88%
- Dolomitic area: 100%

7.2.4 Libanon TSF Paddocks

- Catchment Area: 0.37 km2
- Longest watercourse: 0.07 km
- Average slope: 24.3%
- Dolomitic area: 100%

7.3 Factors used in Rational Formula Calculations

Table 7-1 – Factors used in Rational Formula Calculations

Area	Factor	Value	Comment
Libanon East	Dolomite	100%	Underlain by Malmani dolomitic subgroup
	Surface slope	Flat (1% - 10%)	
	Permeability	Permeable (B/C)	Moderate to slow rate of water transmission
	Vegetation	Grassland	See land use
	Roughness coefficient	0.3	Sparse grass over fairly rough surface

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Area	Factor	Value	Comment
	Initial saturation	Adjustment factor for flat and permeable catchments	
Libanon West	Dolomite	100%	Underlain by Malmani dolomitic subgroup
	Surface slope	Flat (1% - 10%)	
	Permeability	Permeable (B/C)	Moderate to slow rate of water transmission
	Vegetation	Grassland	See land use
	Roughness coefficient	0.3	Sparse grass over fairly rough surface
	Initial saturation	Adjustment factor for flat and permeable catchments	
Libanon TSF	Dolomite	100%	Underlain by Malmani dolomitic subgroup
	Surface slope	Vlei and pans (<3%) – 90%, Steep slopes (>30%) - 10%.	
	Permeability	Permeable (B/C)	Moderate to slow rate of water transmission
	Vegetation	Grassland	See land use
	Roughness coefficient	0.3	Sparse grass over fairly rough surface
	Initial saturation	Adjustment factor for flat and permeable catchments	
Libanon Paddocks	Dolomite	100%	Underlain by Malmani dolomitic subgroup
	Surface Slope	Steep >30%	
	Permeability	Permeable (B/C)	Moderate to slow rate of water transmission
	Vegetation	No vegetation	
	Roughness Coefficient	0.26	
	Initial saturation	Adjustment factor for steep and impermeable catchments	

7.4 Calculated storm peak flows

7.4.1 Rational Formula

Table 7-2 – Calculated storm peak flows in m^3/s (Rational Formula) – Clean water areas

Return Period	Libanon East	Libanon West
2 year	1.009	0.172
5 year	1.480	0.256
10 year	1.903	0.324
20 year	2.415	0.411

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Return Period	Libanon East	Libanon West
50 year	3.470	0.594
100 year	4.613	0.791
200 year	5.045	0.865

7.5 Dirty Water Runoff under 1:50 Condition

7.5.1 Libanon TSF

The volume of dirty water contained within the berm at the top of the Libanon TSF is calculated as follows:

- 1:50 year 24 hr Storm rainfall depth 126.3 mm
- Area of Libanon TSF (top area excluding the side slopes) 96.9 ha
- Rational C factor 0.281
- Runoff volume contained on Libanon TSF 34 390 m^3

7.5.2 Libanon Paddocks

The volume of dirty water from the slopes of Libanon TSF and the paddock area is calculated as follows:

- 1:50 year 24 hr Storm rainfall depth 126.3 mm
- Area of Libanon Paddocks 37.3 ha
- Rational C Factor 0.497
- Runoff volume contained on Libanon TSF 23 414 m^3

7.6 Identified Stormwater Issues

7.6.1 Libanon East

The runoff concentrates at the north eastern corner of the catchment area (corner of Libanon TSF). Under the 1 in 50 year condition and the average slope of the land of 2% (Google Earth), the flow width will be 3.926 m and the velocity of flow is 13 m/s. This far exceeds the acceptable maximum velocity for earth of 1.2 m/s, so excessive erosion will occur. The high flow velocity will also be harmful to life.

7.6.2 Libanon West

The runoff concentrates at the north western corner of the catchment area (corner of Libanon TSF). Under the 1 in 50 year condition and the average slope of the land of 1% (Google Earth), the flow width will be 2.742 m and the velocity of flow is 7.3 m/s. However, inspections on site indicate that the land is degraded after previous developments in the area, and the flow will scatter across the area, thus reducing the velocity.

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7.6.3 Libanon TSF

With the proposed reclamation method, the stormwater runoff is being collected within the berm on top of the Libanon TSF and allowed to infiltrate or evaporate. In effect this is a dam on top of the Libanon TSF on top of underlying dolomites, so SANS 1936 must be complied with.

7.6.4 Libanon Paddocks

The stormwater runoff from the TSF side slopes and the paddocks is collected in the paddocks and allowed to infiltrate or evaporate. In effect this is a dam on top of the underlying dolomites, so SANS 1936 must be complied with.

7.7 Proposed Stormwater Measures

7.7.1 Libanon East and West

7.7.1.1 Earth Berm along Southern side of Bridges Avenue

The proposed stormwater attenuation measure for the Libanon East and West catchments are shown in Figure 7-3.

It is proposed to construct an earth berm immediately to the south of Bridges Avenue adjacent to the Libanon TSF to the existing culvert under Bridges Avenue, described as follows:

a. An earth berm top width 1 m, side slopes 1 vertical to 2 horizontal, 1 m high from point A to point B, a length of 1 845 m;

The berm detail is shown in Figure 7-2 below:

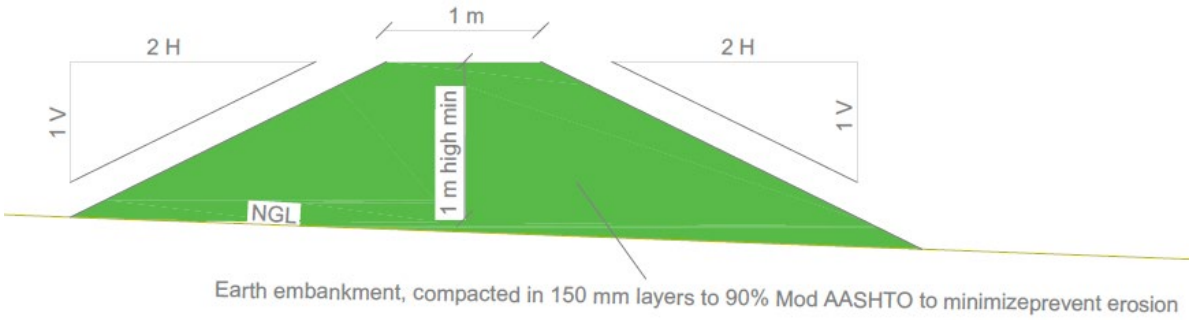

Figure 7-2 - Earth Berm Detail

The above structure will collect all the runoff from the Libanon East catchment, and 60% of the runoff from the Libanon West catchment.

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The existing culvert under Bridges Avenue must be cleaned out and reinstated to its original design state. The size of the culvert could not be ascertained, but normally these structures are designed to handle the 1 in 5 year incident. In the event of the 1 in 50 year storm, the balance of the water not going through the culvert will flow across the road surface.

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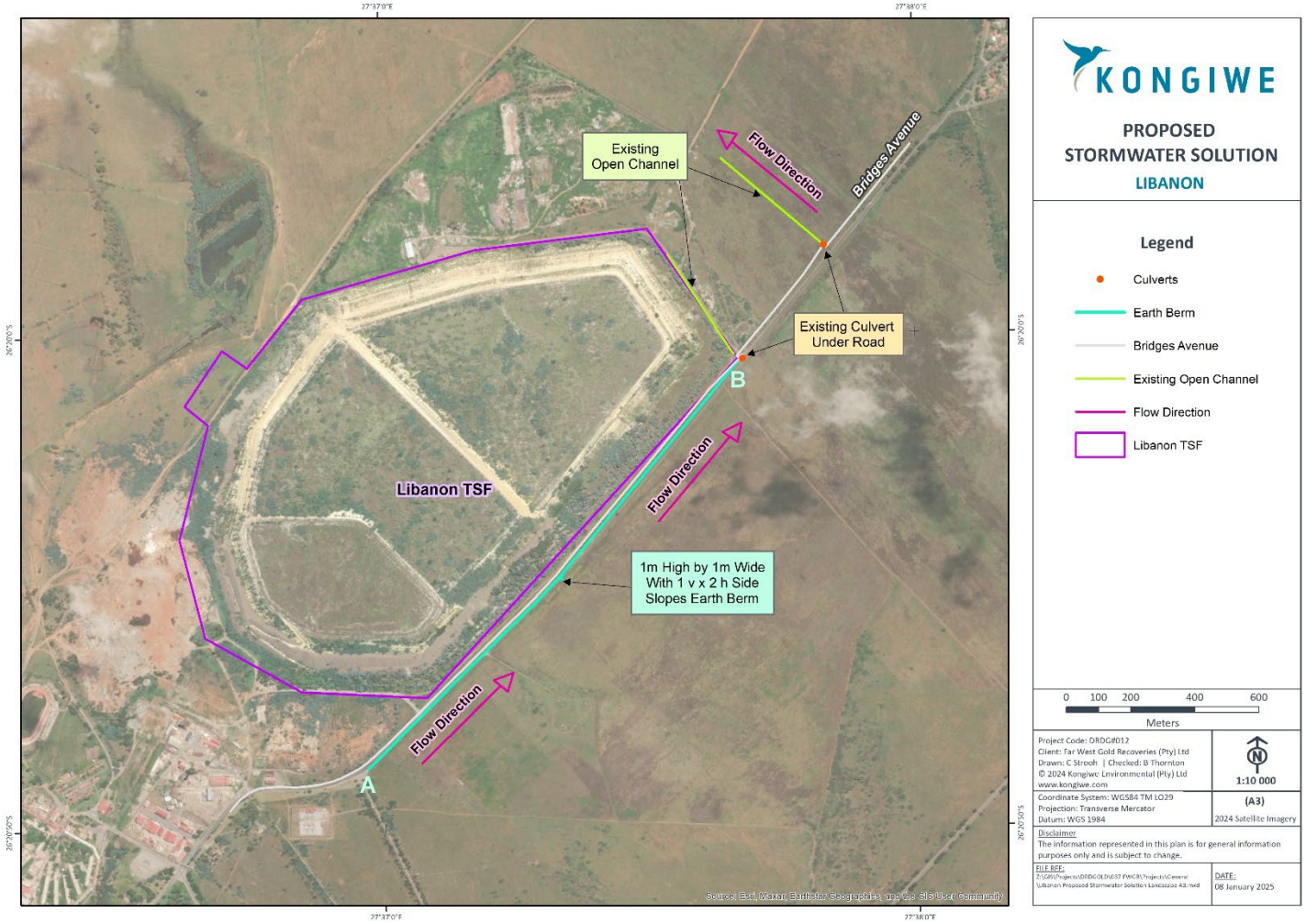

Figure 7-3 – Proposed stormwater solution

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7.7.2 Libanon TSF

It is proposed to contain all stormwater falling on the top surface of the TSF within a berm located on the outside edge of the TSF top surface.

Due to the underlying dolomitic condition, the requirements of SANS 1936 must be adhered to. This will require the following to be carried out:

1. Dolomitic stability investigation
    - General
        - Investigations shall conform to the requirements of SANS 1936-2 (4.3.2 and 4.3.3). The investigator/Competent Person (geo-professional) shall, during the investigation, confirm and refine the Inherent Hazard Zone and the associated Dolomite Area Designations and confirm that the mandatory precautions associated with a designation have been observed;
        - The investigator/Competent Person (geo-professional) shall, as a minimum to comply with the above requirements, interact with suitably qualified professionals and the person responsible for the development of the parcel of land or the relevant portions thereof concerning appropriate planning, design of infrastructure, buildings, and structures; and,
        - The investigator/Competent Person (geo-professional) shall develop a risk management plan strategy specific to the development in accordance with the requirements of SANS 1936;
    - Report
        - The investigator/Competent Person (geo-professional) shall prepare a report including the following:
            - a method description of the work undertaken;
            - a drawing indicating the location of the points profiled in the service trenches;
            - records of all profiles, boreholes and tests;
            - records of any geotechnically problematic conditions intercepted, such as paleokarts structures, sinkholes etc.;
            - a description of any additional geotechnical investigations undertaken;
            - a description of any precautionary or remedial measures applied to problematic conditions identified during the design-level inspections;
            - a site/development layout drawing which confirms the Inherent Hazard Classes and Dolomite Area Designations, in accordance with the requirements of SANS 1936;
            - an indication where the dolomite designations have been changed and provide a motivation for such changes;
            - a comprehensive list and description of any ongoing monitoring required;

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- an identification of monitoring area designations where a risk management plan has been developed; and,
- an indication that amended water precautionary measures shall apply;

- Additional Requirements for **Attenuation Dams, Retention Dams, Reservoirs** and Public Swimming Pools:
  - The requirements for dams, reservoirs and public swimming pools shall comply with the requirements of SANS 1936-2, Annex A (A.8). The investigation shall also include the following:
    - a gravity survey over the site at 30 m grid spacing with a minimum of three lines;
    - additional investigations for alternative sites in the event that Inherent Hazard Class 3, 5, 6, 7 and 8 conditions (refer to SANS 1936) are encountered;
    - inspection of the excavation to verify the stability zonation and to check for paleokarst structures;
    - investigation of potential paleosinkhole structures wherever they are exposed; and,
    - where justified, supplementary geotechnical site investigations.

Note 1: The proposed site for dams and reservoirs should be at least 100 m from the nearest housing or commercial development.

2. Compilation of a Dolomite Risk Management Plan

An appropriate Dolomite Risk Management Plan is to be compiled in accordance with SANS 1936. The Dolomite Risk Management Plan is to be site specific and based on all data gathered until that time, taking cognisance of final precautionary measures, site layout and shall also contain the final Monitoring Designations. The Dolomite Risk Management Plan shall outline the responsibilities and actions of the relevant Authority and the Client Department. It is a compulsory requirement for the appointed professional service provider to prepare a site specific Dolomite Risk Management Plan (DRMP) for the development in accordance with the requirements of SANS 1936-4.

7.7.3 Libanon Paddocks

It is proposed to contain all stormwater falling on the slopes of the TSF and in the paddocks at the toe of the side slopes of the TSF within these paddocks.

Due to the underlying dolomitic condition, the requirements of SANS 1936 must be adhered to. This will require the following to be carried out:

1. Dolomitic stability investigation:
   - General

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- Investigations shall conform to the requirements of SANS 1936-2 (4.3.2 and 4.3.3). The investigator/Competent Person (geo-professional) shall, during the investigation, confirm and refine the Inherent Hazard Zone and the associated Dolomite Area Designations and confirm that the mandatory precautions associated with a designation have been observed;
- The investigator/Competent Person (geo-professional) shall, as a minimum to comply with the above requirements, interact with suitably qualified professionals and the person responsible for the development of the parcel of land or the relevant portions thereof concerning appropriate planning, design of infrastructure, buildings, and structures; and,
- The investigator/Competent Person (geo-professional) shall develop a risk management plan strategy specific to the development in accordance with the requirements of SANS 1936;

o Report
- The investigator/Competent Person (geo-professional) shall prepare a report including the following:
  - a method description of the work undertaken;
  - a drawing indicating the location of the points profiled in the service trenches;
  - records of all profiles, boreholes and tests;
  - records of any geotechnically problematic conditions intercepted, such as paleokarts structures, sinkholes etc.;
  - a description of any additional geotechnical investigations undertaken;
  - a description of any precautionary or remedial measures applied to problematic conditions identified during the design-level inspections;
  - a site/development layout drawing which confirms the Inherent Hazard Classes and Dolomite Area Designations, in accordance with the requirements of SANS 1936;
  - an indication where the dolomite designations have been changed and provide a motivation for such changes;
  - a comprehensive list and description of any ongoing monitoring required;
  - an identification of monitoring area designations where a risk management plan has been developed; and,
  - an indication that amended water precautionary measures shall apply.

o Additional Requirements for **Attenuation Dams, Retention Dams, Reservoirs** and Public Swimming Pools
- The requirements for dams, reservoirs and public swimming pools shall comply with the requirements of SANS 1936-2, Annex A (A.8). The investigation shall also include the following:
  - a gravity survey over the site at 30 m grid spacing with a minimum of three lines;

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- additional investigations for alternative sites in the event that Inherent Hazard Class 3, 5, 6, 7 and 8 conditions (refer to SANS 1936) are encountered;
- inspection of the excavation to verify the stability zonation and to check for paleokarst structures;
- investigation of potential paleosinkhole structures wherever they are exposed; and,
- where justified, supplementary geotechnical site investigations.

Note 1: The proposed site for dams and reservoirs should be at least 100 m from the nearest housing or commercial development.

2. Compilation of a Dolomite Risk Management Plan

   An appropriate Dolomite Risk Management Plan is to be compiled in accordance with SANS 1936. The Dolomite Risk Management Plan is to be site specific and based on all data gathered until that time, taking cognisance of final precautionary measures, site layout and shall also contain the final Monitoring Designations. The Dolomite Risk Management Plan shall outline the responsibilities and actions of the relevant Authority and the Client Department. It is a compulsory requirement for the appointed professional service provider to prepare a site specific Dolomite Risk Management Plan (DRMP) for the development in accordance with the requirements of SANS 1936-4.

8 RECOMMENDATIONS

The following is recommended:

- The existing berm/channel system around the TSF are reinstated where damaged, and maintained. This system acts as the containment of the dirty water from the Libanon TSF side slopes;
- The “clean” runoff from the high lying areas above the Libanon TSF is deviated away from the Libanon TSF by an earth berm constructed immediately to the south of Bridges Avenue, up to the existing culvert under Bridges Avenue to the east of the Libanon TSF. The existing culvert is in a poor state of repair and will have to be reinstated; and,
- A dolomitic stability investigation be carried out around the Libanon TSF to confirm that the proposed reclamation method and stormwater containment on top of the TSF and in paddocks around the TSF is acceptable and in accordance with SANS 1936, and a dolomitic risk management plan be developed.

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Smithers J.C. and Schulze R.E. 2002. Design Rainfall and Flood Estimation in South Africa. WRC Project No. K5/1060.

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APPENDIX A:
Curriculum Vitae : H D N Sparks

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Name	**Sparks Hilton D N**
Profession:	Civil Engineer
Date of Birth:	1 August 1947
Nationality:	South African
ID number:	4708015052081

Membership in Professional Societies:

- Professional Engineer Pr Eng 740604;
- Professional Construction Project Manager D/202/2004;
- Member of the South African Institute of Civil Engineers; and,
- Member of South African Institute of Municipal Engineers.

KEY QUALIFICATIONS

Has vast experience in many of the disciplines related to the provision, design, operation and maintenance of civil engineering municipal infrastructure, bulk water supply system design and assessment, risk assessment related to bulk water distribution, project management of large infrastructure projects, management, construction management, formulating and implementing strategies, research and development, bulk sanitation services and knowledge of OHS and environmental matters.

EDUCATION:

- B Sc (Eng), University of Natal – 1969;
- Diploma in Business Management, Damelin – 1977; and,
- NQF 7 Labour Intensive Construction.

PUBLICATIONS:

- "The IDT Capital Subsidy Scheme in the Transvaal - 30 months later" - Housing in Southern Africa, May 1994;
- Layout Planning and Stormwater Management, Afritech Conference, SA Development Bank, June 1992;
- Managing the Environmental Impact of Current and Future Development, Low-Cost Housing and Urbanization Conference, September 1994;
- Katorus: Repairs to Houses Damaged in Unrest, Housing for Africa International Conference, August 1997;
- Katorus wins Impumelelo Award, Housing in Southern Africa, December 2000; and,
- A housing project brings some peace to Katorus and is rewarded with an Impumelelo Award, IMIESA Journal, February 2001.

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AWARDS

- Masimanyane Award for innovation and excellence in engineering – Repairs to Damaged Houses Project, Katorus – 1997; and,
- Impumelelo Award for innovative dedicated work in the field of poverty reduction and community development – Repairs to Damaged Houses Project, Katorus – 2000.

ADDITONAL COURSES

Has attended many courses over the period, most relevant are:

1. Project Management Professional, SAACE course, Johannesburg;
2. Epanet Course, University of Johannesburg; and,
3. NQF 7 Labour Intensive Construction, Johannesburg.

EXPERIENCE RECORD:

January 2024 to date - Kongiwe Environmental (Pty) Ltd

Responsible for the investigation, design (civil works) and the overall project management of environmental projects:

- Surface Water Studies – 7L1 Pump Station, Libanon TSF and Kloof Venterspost TSF;
- Project Management systems for all active Environmental projects; and,
- As-Built drawings – Harmony Gold Mining Free State Operations.

September 2020 to December 2023 - Consultant to Impofu Engineering

Responsible for the investigation, design (civil works) and the overall project management during the design phase in respect of a range of multi-disciplinary engineering projects:

- Project Management of Proposed Gauteng Disaster Management Centre, R2 billion, on hold pending acquisition of land, Gauteng Department of Infrastructure Development;
- Project Manager and Water Engineer for Restoration of Water to Amajuba District Council, KZN Department of Corporate Governance and Traditional Affairs;
- Technical Manager for Construction of Lehae Clinic, Cultura School and Father Smangaliso School, Gauteng Department of Infrastructure Development; and,
- Project Manager for Construction of Marapong Housing Development, Limpopo Department of Corporate Governance and Traditional Affairs.

December 2010 to January 2020 - Scriptio (Pty) Ltd

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- Programme management of Orange Farm projects for City of Johannesburg Project Management Unit; and,
- Stormwater management and irrigation usage computerised model at Golf Course for Johannesburg Country Club;
- Surface Water Resource Study for Johannesburg Country Club.

January 1994 to December 2010 - Phumaf Consulting Engineers

January 1985 to January 1994 - Brain Leech Associates

January 1980 to January 1985 - Hill Kaplan Scott

Responsible for the investigation, design (civil works) and the overall project management during the design phase in respect of a range of multi-disciplinary engineering projects:

- Township Infrastructure in many high-income residential townships:
  - Randparkrif Ext 25 - 700 erven; Hurlingham Ext 5 - 600 erven; Benmore Gardens Ext 3 - 250 erven; The Orchards Ext 13 - 350 erven; The Orchards Ext 16 - 240 erven; Sunward Park Ext's 3, 4 and 5 - 1 000 erven; Wilgeheuwel Ext 3 - 250 erven; Jukskeipark Ext 5 - 250 erven; Bloubosrand Ext 2 - 250 erven;
- Stormwater drainage layouts at planning and detail design stages for numerous townships;
- Hydraulic design for numerous pipe networks for township water supplies;
- Floodlines for numerous streams;
- Analysis of Randburg Northern Areas Water Master Plan, and design of 350/400/450/600 mm Kya Sand Bulk Water Main for Randburg Town Council;
- Sewerage Master Plan for Randburg Northern Areas for Randburg Town Council;
- Engineering services for Moffat View Ext 4 for City of Johannesburg;
- Engineering services for Atteridgeville Ext 19 and Capital Park for City of Tshwane;
- Engineering services for City Deep Extensions 26 and 28 for JOSHCO;
- Township infrastructure in industrial and commercial townships:
  - Rustivia Ext 3, Germiston; Strydom Park Ext 21, Randburg; Alrode Ext 19, Alberton; Sandown Ext 52, Sandton;
- Container Depot at Nelspruit;
- Engineering design and contract documentation for numerous golf courses and golf course estates for Gary Player Group;
- Design of 1 200 mm diameter deviation of Johannesburg Cydna Outfall Sewer through Falcon Crest property;
- Township infrastructure in low-income residential townships for Gauteng Department of Housing, including:
  - Phola Extension, Ogies - 1 340 erven; Vosloorus Ext 25 - 1 800 erven; Vosloorus Ext 9 - 1 436 erven; Vosloorus Ext 26 - 350 erven; Moleleki Ext's 1 & 2 - 1 346 erven; Dobsonville Gardens - 1 000 erven; Mabopane Unit M - 1 500 erven; Tembisa Ext 12 –480 erven; Phuthaditjhaba Unit

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L - 350 erven; Magagula Heights –800 erven; Soshanguve South Ext's 11, 12 and 13 – 5 000 erven;

- Township infrastructure in low income residential townships for Qwaqwa Department of Housing, in Phuthaditjhaba Unit L - 350 erven;
- Report on water supply to Ogies Area, including assessment of existing purification works for Gauteng Department of Housing;
- Assessment of existing sewer network at Steve Bikoville for Gauteng Department of Housing;
- Bulk services to Phola Extension township including potable water ground reservoir and rising main, elevated water tower and sewage Pump Station for Gauteng Department of Housing;
- Project management of SAFA House construction for South African Football Association;
- Project Management of Soccer City Stadium for 2010 World Cup;
- Project management of staff village for Nissan employees - 300 houses;
- Project management of construction of Buhlebemfundo Secondary School in Tsakane using emerging contractors for Gauteng Department of Education;
- Project management of engineering component of Alexandra Renewal Project for Gauteng Department of Housing;
- Project management of repairs to violence damaged houses in Katorus - 2 400 houses for Gauteng Department of Housing;
- Project management of repairs to violence damaged houses in the balance of Gauteng - 400 houses for Gauteng Department of Housing;
- Housing functional coordinator for Katorus Special Presidential Project for Gauteng Department of Housing;
- Project management of Regional Professional Team for Gauteng Department of Housing for implementation of housing backlog in the Tshwane and Metsweding areas;
- Project management of Professional Resource Team for Gauteng Department of Housing for implementation of housing backlog in the Tshwane and Metsweding areas; and,
- Co-ordinating Technical Consultant for Transvaal IDT capital subsidy scheme.

January 1970 to December 1979 - Rand Water Board

Responsible for the investigation, design (civil works) and the overall project management during the design phase in respect of a range of multi-disciplinary engineering projects:

- Engineer in charge of Rand Water Board construction team, involved in many types of work from weirs on rivers to Pump Stations to pipelines;
- Project Manager for 800 Ml/d capacity water purification works at Zuikerbosch Pump Station for Rand Water Board;
- Project coordination and critical path planning of 600 Ml/d capacity water purification works at Zuikerbosch Pump Station for Rand Water Board;
- Design of measuring weirs on numerous rivers flowing into the Vaal River Barrage Catchment for Rand Water Board;
- Model filter tests to ascertain the effectiveness of dual media (anthracite/sand) filter beds as opposed

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to normal single media (sand) filter beds for Rand Water Board;

- Design of "Crump" weir between abutments of railway bridge on Klip River for Rand Water Board;
- Hydraulic and structural design of 2 100 mm diameter steel pipeline, 80 km long for Rand Water Board;
- Hydraulic and structural design of 3 500 mm diameter steel pipeline to carry raw water from Vaal Dam to purification works for Rand Water Board;
- Hydraulic and structural design of 800 mm/ 900 mm/ 1 200 mm diameter steel pipeline for Rand Water Board;
- Tests on strength of in-situ cement mortar lining to steel pipelines, especially when subjected to water hammer surges for Rand Water Board;
- Structural design of wall section for Sasolburg Reservoir for Rand Water Board;
- Structural design of underground coal bunker, Vereeniging Pump Station for Rand Water Board;
- Structural design, 60 No hopper bottomed sedimentation tanks, Zuikerbosch Pump Station for Rand Water Board;
- Structural design, 3 500 mm diameter steel pipeline including tests to confirm design for Rand Water Board.

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APPENDIX B:
Rational Method Stormwater Peak Flow Calculations

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Rational Method

Description of catchment :	Libanon East	Road Chainage :	
River detail :			
Calculated by :	Hilton Sparks	Date:	06-Nov-24

Physical characteristics

Size of catchment (A)	2.7900	km^2	Mean annual Rainfall (MAP)	711	mm
Longest watercourse (L)	2.597	km	2-year return period rainfall (M)		mm
$H_{85\%}$	1649	MSL	Days of thunder per year (R)		days/year
$H_{10\%}$	1592	MSL	Weather Service station	Springs	
Average slope (S_{av})	0.02926	m/m	Weather Service number	476736	
Over landflow length	3	km	Area distribution factors		
$H_{100\%}$	1649	MSL	Rural (α)	Urban (β)	Lakes (γ)
$H_{0\%}$	1592	MSL	100%	0%	0%
Average slope (S_{av})	0.01900	m/m	Notes:	Libanon East Catchment Area	
Roughness coefficient (r)	0.3				
Dolomite area ($D_{\%}$)	100	%			

Rural

Surface slope	%	Factor	C_s
Vleis and pans (< 3%)	0%	0.01	0
Flat areas (3% - 10%)	100%	0.06	0.06
Hilly (10% - 30%)	0%	0.12	0
Steep areas (> 30%)	0%	0.22	0
Total	**100%**		**0.06**
Permeability	%	Factor	C_p
Very permeable (A)	0%	0.03	0
Very Permeable (A/B)	0%	0.04	0
Permeable (B)	0%	0.06	0
Permeable (B/C)	100%	0.08	0.08
Semi-permeable (C)	0%	0.12	0
Semi-permeable (C/D)	0%	0.16	0
Impermeable (D)	0%	0.21	0
Total	**100%**		**0.08**
Vegetation	%	Factor	C_v
Thick bush and plantation	0%	0.03	0
Light bush and farm-lands	0%	0.07	0
Grassland	100%	0.17	0.17
Cultivated land, contoured	0%	0.07	0
Cultivated land	0%	0.17	0
No vegetation	0%	0.26	0
Total	**100%**		**0.17**
Total (C_1)			**0.310**

Urban

Description	%	Factor	C_2
Lawns			
Sandy, flat (<2%)	0%	0.100	0.000
Sandy, Steep (>7%)	0%	0.200	0.000
Heavy soil, flat (<2%)	0%	0.170	0.000
Heavy soil, Steep (>7%)	0%	0.350	0.000
Residential areas			
Houses	0%	0.500	0.000
Flats	0%	0.700	0.000
Industry			
Light industry	0%	0.800	0.000
Heavy industry	0%	0.900	0.000
Business			
City centre	0%	0.950	0.000
Suburban	0%	0.700	0.000
Streets	0%	0.950	0.000
Maximum Flood	0%	1.000	0.000
	0%		
Total (C_2)			**0.000**

Time of Concentration (Tc)

Overland flow

$$T_C = 0{,}604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0{,}467}$$

1.451 Hours

Defined watercourse

$$T_C = \left(\frac{0{,}87L^2}{1000S_{av}}\right)^{0{,}385}$$

0.539 Hours

Notes: Working area assumed to be paved

$T_{C\text{ - TOTAL}}$	**1.45**	Hours	V=	**0.50**	m/s

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Description of catchment :	Libanon East		Road Chainage :				
Run-off Coefficient							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Run-off coefficient C_1 ($C_1=C_s+C_p+C_v$)	0.310	0.310	0.310	0.310	0.310	0.310	0.310
Adjusted for dolomitic areas, C_{1D} ($=C_1(1-D_{\%})+C_1D_{\%}(sum(D_{factor} \times C_{S\%}))$	0.062	0.062	0.062	0.062	0.062	0.062	0.062
Adjusted factor for initial saturation, F_t	0.500	0.550	0.600	0.670	0.830	1.000	1.000
Adjusted run-off coefficent, C_{1T} ($=C_{1D} \times F_t$)	0.031	0.034	0.037	0.042	0.051	0.062	0.062
Combined run-off coefficient C_T ($=\alpha C_{1T}+\beta C_2+\gamma C_3$)	*0.031*	*0.034*	*0.037*	*0.042*	*0.051*	*0.062*	*0.062*
Rainfall							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point Rainfall - SCS data (mm) P_T	61.400	81.800	95.600	108.900	126.300	139.500	152.800
Point intensity (mm/h) $P_{iT}=(P_T/T_C)$	42.324	56.386	65.899	75.067	87.061	96.160	105.328
Area reduction factor (%) ARF_T	100	100	100	100	100	100	100
Average intensity (mm/h) $I_T=(P_{iT} \times ARF_T)$	*42.000*	*56.000*	*66.000*	*75.000*	*87.000*	*96.000*	*105.000*
Peak Flow (m^3/s) $Q_T=C_TI_TA/3,6$	***1.009***	***1.480***	***1.903***	***2.415***	***3.470***	***4.613***	***5.045***

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Rational Method

Description of catchment :	Libanon West	Road Chainage :	
River detail :			
Calculated by :	Hilton Sparks	Date:	06-Nov-24

Physical characteristics

Size of catchment (A)	0.5400	km^2	Mean annual Rainfall (MAP)	711	mm
Longest watercourse (L)	2.08	km	2-year return period rainfall (M)		mm
$H_{85\%}$	1657	MSL	Days of thunder per year (R)		days/year
$H_{10\%}$	1615	MSL	Weather Service station	Blyvooruitzicht	
Average slope (S_{av})	0.02692	m/m	Weather Service number	474684	
Over landflow length	2	km	Area distribution factors		
$H_{100\%}$	1657	MSL	Rural (α)	Urban (β)	Lakes (γ)
$H_{0\%}$	1615	MSL	100%	0%	0%
Average slope (S_{av})	0.02100	m/m	Notes:	Libanon West Catchment Area	
Roughness coefficient (r)	0.3				
Dolomite area ($D_{\%}$)	100	%			

Rural

Surface slope	%	Factor	C_s
Vleis and pans (< 3%)	0%	0.01	0
Flat areas (3% - 10%)	100%	0.06	0.06
Hilly (10% - 30%)	0%	0.12	0
Steep areas (> 30%)	0%	0.22	0
Total	**100%**		**0.06**
Permeability	%	Factor	C_p
Very permeable (A)	0%	0.03	0
Very Permeable (A/B)	0%	0.04	0
Permeable (B)	0%	0.06	0
Permeable (B/C)	100%	0.08	0.08
Semi-permeable (C)	0%	0.12	0
Semi-permeable (C/D)	0%	0.16	0
Impermeable (D)	0%	0.21	0
Total	**100%**		**0.08**
Vegetation	%	Factor	C_v
Thick bush and plantation	0%	0.03	0
Light bush and farm-lands	0%	0.07	0
Grassland	100%	0.17	0.17
Cultivated land, contoured	0%	0.07	0
Cultivated land	0%	0.17	0
No vegetation	0%	0.26	0
Total	**100%**		**0.17**
Total (C_1)			**0.310**

Urban

Description	%	Factor	C_2
Lawns			
Sandy, flat (<2%)	0%	0.100	0.000
Sandy, Steep (>7%)	0%	0.200	0.000
Heavy soil, flat (<2%)	0%	0.170	0.000
Heavy soil, Steep (>7%)	0%	0.350	0.000
Residential areas			
Houses	0%	0.500	0.000
Flats	0%	0.700	0.000
Industry			
Light industry	0%	0.800	0.000
Heavy industry	0%	0.900	0.000
Business			
City centre	0%	0.950	0.000
Suburban	0%	0.700	0.000
Streets	0%	0.950	0.000
Maximum Flood	0%	1.000	0.000
	0%		
Total (C_2)			**0.000**

Time of Concentration (Tc)

Overland flow

$$T_C = 0{,}604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0{,}467}$$

1.173 Hours

Defined watercourse

$$T_C = \left(\frac{0{,}87L^2}{1000S_{av}}\right)^{0{,}385}$$

0.469 Hours

Notes:

$T_{C\text{ - TOTAL}}$	**1.64**	Hours	V=	**0.35**	m/s

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Description of catchment :	Libanon West		Road Chainage :				
Run-off Coefficient							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Run-off coefficient C_1 ($C_1=C_s+C_p+C_v$)	0.310	0.310	0.310	0.310	0.310	0.310	0.310
Adjusted for dolomitic areas, C_{1D} ($=C_1(1-D_{\%})+C_1D_{\%}(\text{sum}(D_{factor} \times C_{S\%}))$	0.062	0.062	0.062	0.062	0.062	0.062	0.062
Adjusted factor for initial saturation, F_t	0.500	0.550	0.600	0.670	0.830	1.000	1.000
Adjusted run-off coefficent, C_{1T} ($=C_{1D} \times F_t$)	0.031	0.034	0.037	0.042	0.051	0.062	0.062
Combined run-off coefficient C_T ($=\alpha C_{1T}+\beta C_2+\gamma C_3$)	*0.031*	*0.034*	*0.037*	*0.042*	*0.051*	*0.062*	*0.062*
Rainfall							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point Rainfall - SCS data (mm) P_T	61.400	81.800	95.600	108.900	126.300	139.500	152.800
Point intensity (mm/h) $P_{iT}=(P_T/T_C)$	37.403	49.831	58.237	66.339	76.939	84.980	93.082
Area reduction factor (%) ARF_T	100	100	100	100	100	100	100
Average intensity (mm/h) $I_T=(P_{iT} \times ARF_T)$	*37.000*	*50.000*	*58.000*	*66.000*	*77.000*	*85.000*	*93.000*
Peak Flow (m^3/s) $Q_T=C_TI_TA/3,6$	***0.172***	***0.256***	***0.324***	***0.411***	***0.594***	***0.791***	***0.865***

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Rational Method

Description of catchment :	Libanon TSF	Road Chainage :	
River detail :			
Calculated by :	Hilton Sparks	Date:	06-Nov-24

Physical characteristics

Size of catchment (A)	1.3400	km^2	Mean annual Rainfall (MAP)	711	mm
Longest watercourse (L)	1.21	km	2-year return period rainfall (M)		mm
$H_{85\%}$	1630	MSL	Days of thunder per year (R)		days/year
$H_{10\%}$	1622	MSL	Weather Service station	Blyvooruitzicht	
Average slope (S_{av})	0.00882	m/m	Weather Service number	474684	
Over landflow length	0.8	km	Area distribution factors		
$H_{100\%}$	1627	MSL	Rural (α)	Urban (β)	Lakes (γ)
$H_{0\%}$	1622	MSL	100%	0%	0%
Average slope (S_{av})	0.00625	m/m	Notes:	Libanon TSF Catchment Area	
Roughness coefficient (r)	0.3				
Dolomite area ($D_{\%}$)	100	%			

Rural

Surface slope	%	Factor	C_s
Vleis and pans (< 3%)	90%	0.01	0.009
Flat areas (3% - 10%)	0%	0.06	0
Hilly (10% - 30%)	0%	0.12	0
Steep areas (> 30%)	10%	0.22	0.022
Total	**100%**		**0.031**
Permeability	%	Factor	C_p
Very permeable (A)	0%	0.03	0
Very Permeable (A/B)	0%	0.04	0
Permeable (B)	0%	0.06	0
Permeable (B/C)	100%	0.08	0.08
Semi-permeable (C)	0%	0.12	0
Semi-permeable (C/D)	0%	0.16	0
Impermeable (D)	0%	0.21	0
Total	**100%**		**0.08**
Vegetation	%	Factor	C_v
Thick bush and plantation	0%	0.03	0
Light bush and farm-lands	0%	0.07	0
Grassland	100%	0.17	0.17
Cultivated land, contoured	0%	0.07	0
Cultivated land	0%	0.17	0
No vegetation	0%	0.26	0
Total	**100%**		**0.17**
Total (C_1)			**0.281**

Urban

Description	%	Factor	C_2
Lawns			
Sandy, flat (<2%)	0%	0.100	0.000
Sandy, Steep (>7%)	0%	0.200	0.000
Heavy soil, flat (<2%)	0%	0.170	0.000
Heavy soil, Steep (>7%)	0%	0.350	0.000
Residential areas			
Houses	0%	0.500	0.000
Flats	0%	0.700	0.000
Industry			
Light industry	0%	0.800	0.000
Heavy industry	0%	0.900	0.000
Business			
City centre	0%	0.950	0.000
Suburban	0%	0.700	0.000
Streets	100%	0.950	0.950
Maximum Flood	0%	1.000	0.000
	100%		
Total (C_2)			**0.950**

Time of Concentration (Tc)

Overland flow

$$T_C = 0{,}604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0{,}467}$$

1.015 Hours

Defined watercourse

$$T_C = \left(\frac{0{,}87L^2}{1000S_{av}}\right)^{0{,}385}$$

0.475 Hours

Notes:

$T_{C\text{ - TOTAL}}$	**1.49**	Hours	V=	**0.23**	m/s

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Description of catchment :	Libanon TSF		Road Chainage :				
Run-off Coefficient							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Run-off coefficient C_1 ($C_1=C_s+C_p+C_v$)	0.281	0.281	0.281	0.281	0.281	0.281	0.281
Adjusted for dolomitic areas, C_{1D} ($=C_1(1-D_{\%})+C_1D_{\%}(sum(D_{factor} \times C_{S\%}))$	0.039	0.039	0.039	0.039	0.039	0.039	0.039
Adjusted factor for initial saturation, F_t	0.500	0.550	0.600	0.670	0.830	1.000	1.000
Adjusted run-off coefficent, C_{1T} ($=C_{1D} \times F_t$)	0.020	0.022	0.024	0.026	0.033	0.039	0.039
Combined run-off coefficient C_T ($=\alpha C_{1T}+\beta C_2+\gamma C_3$)	*0.020*	*0.022*	*0.024*	*0.026*	*0.033*	*0.039*	*0.039*
Rainfall							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point Rainfall - SCS data (mm) P_T	61.400	81.800	95.600	108.900	126.300	139.500	152.800
Point intensity (mm/h) $P_{iT}=(P_T/T_C)$	41.226	54.923	64.189	73.119	84.802	93.665	102.595
Area reduction factor (%) ARF_T	100	100	100	100	100	100	100
Average intensity (mm/h) $I_T=(P_{iT} \times ARF_T)$	*41.000*	*55.000*	*64.000*	*73.000*	*85.000*	*94.000*	*103.000*
Peak Flow (m^3/s) $Q_T=C_TI_TA/3,6$	***0.300***	***0.443***	***0.562***	***0.716***	***1.033***	***1.376***	***1.508***

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Rational Method

Description of catchment :	Libanon TSF	Road Chainage :	
River detail :			
Calculated by :	Hilton Sparks	Date:	06-Nov-24

Physical characteristics

Size of catchment (A)	0.3700	km^2	Mean annual Rainfall (MAP)	711	mm
Longest watercourse (L)	0.07	km	2-year return period rainfall (M)		mm
$H_{85\%}$	1630	MSL	Days of thunder per year (R)		days/year
$H_{10\%}$	1613	MSL	Weather Service station	Blyvooruitzicht	
Average slope (S_{av})	0.24286	m/m	Weather Service number	474684	
Over landflow length	0.07	km	Area distribution factors		
$H_{100\%}$	1630	MSL	Rural (α)	Urban (β)	Lakes (γ)
$H_{0\%}$	1613	MSL	100%	0%	0%
Average slope (S_{av})	0.24286	m/m	Notes:	Libanon TSF Catchment Area	
Roughness coefficient (r)	0.26				
Dolomite area ($D_{\%}$)	100	%			

Rural

Surface slope	%	Factor	C_s
Vleis and pans (< 3%)	30%	0.01	0.003
Flat areas (3% - 10%)	0%	0.06	0
Hilly (10% - 30%)	0%	0.12	0
Steep areas (> 30%)	70%	0.22	0.154
Total	**100%**		**0.157**
Permeability	%	Factor	C_p
Very permeable (A)	0%	0.03	0
Very Permeable (A/B)	0%	0.04	0
Permeable (B)	0%	0.06	0
Permeable (B/C)	100%	0.08	0.08
Semi-permeable (C)	0%	0.12	0
Semi-permeable (C/D)	0%	0.16	0
Impermeable (D)	0%	0.21	0
Total	**100%**		**0.08**
Vegetation	%	Factor	C_v
Thick bush and plantation	0%	0.03	0
Light bush and farm-lands	0%	0.07	0
Grassland	0%	0.17	0
Cultivated land, contoured	0%	0.07	0
Cultivated land	0%	0.17	0
No vegetation	100%	0.26	0.26
Total	**100%**		**0.26**
Total (C_1)			**0.497**

Urban

Description	%	Factor	C_2
Lawns			
Sandy, flat (<2%)	0%	0.100	0.000
Sandy, Steep (>7%)	0%	0.200	0.000
Heavy soil, flat (<2%)	0%	0.170	0.000
Heavy soil, Steep (>7%)	0%	0.350	0.000
Residential areas			
Houses	0%	0.500	0.000
Flats	0%	0.700	0.000
Industry			
Light industry	0%	0.800	0.000
Heavy industry	0%	0.900	0.000
Business			
City centre	0%	0.950	0.000
Suburban	0%	0.700	0.000
Streets	100%	0.950	0.950
Maximum Flood	0%	1.000	0.000
	100%		
Total (C_2)			**0.950**

Time of Concentration (Tc)

Overland flow

$$T_C = 0{,}604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0{,}467}$$

0.129 Hours

Defined watercourse

$$T_C = \left(\frac{0{,}87L^2}{1000S_{av}}\right)^{0{,}385}$$

0.015 Hours

Notes:

$T_{C\text{ - TOTAL}}$	**0.25**	Hours	V=	**0.08**	m/s

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Description of catchment :	Libanon TSF		Road Chainage :				
Run-off Coefficient							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Run-off coefficient C_1 ($C_1=C_s+C_p+C_v$)	0.497	0.497	0.497	0.497	0.497	0.497	0.497
Adjusted for dolomitic areas, C_{1D} ($=C_1(1-D_{\%})+C_1D_{\%}(sum(D_{factor} \times C_{S\%}))$	0.189	0.189	0.189	0.189	0.189	0.189	0.189
Adjusted factor for initial saturation, F_t	0.750	0.800	0.850	0.900	0.950	1.000	1.000
Adjusted run-off coefficent, C_{1T} ($=C_{1D} \times F_t$)	0.142	0.151	0.161	0.170	0.179	0.189	0.189
Combined run-off coefficient C_T ($=\alpha C_{1T}+\beta C_2+\gamma C_3$)	*0.142*	*0.151*	*0.161*	*0.170*	*0.179*	*0.189*	*0.189*
Rainfall							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point Rainfall - SCS data (mm) P_T	61.400	81.800	95.600	108.900	126.300	139.500	152.800
Point intensity (mm/h) $P_{iT}=(P_T/T_C)$	245.600	327.200	382.400	435.600	505.200	558.000	611.200
Area reduction factor (%) ARF_T	100	100	100	100	100	100	100
Average intensity (mm/h) $I_T=(P_{iT} \times ARF_T)$	*246.000*	*327.000*	*382.000*	*436.000*	*505.000*	*558.000*	*611.000*
Peak Flow (m^3/s) $Q_T=C_TI_TA/3,6$	***3.581***	***5.078***	***6.303***	***7.617***	***9.312***	***10.831***	***11.860***

Appendix D3
Groundwater

2024

Libanon TSF Reclamation Project. Groundwater Report

12 December 2024

Groundwater Abstract (Pty) Ltd
Enterprise Number: 2017/489367/07
Rietfontein
Pretoria, 0084
www.wells.*africa*

LIBANON TSF RECLAMATION PROJECT. GROUNDWATER REPORT

Ergo Mining (Pty) Ltd

Report compiled by:

Groundwater Abstract Pty Ltd

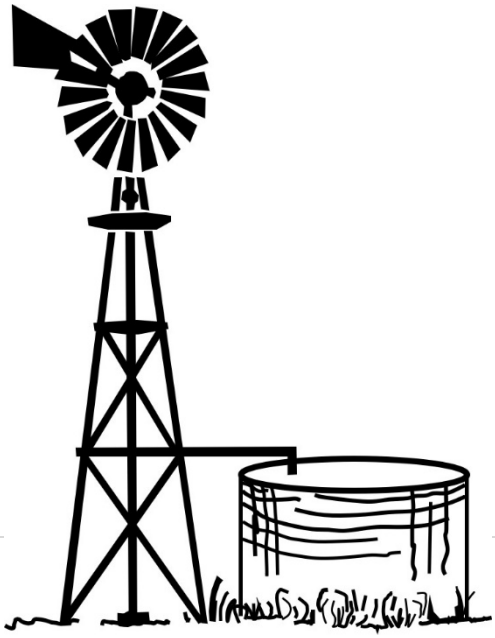
Lucas Smith and Irene Lea

Principal Hydrogeologists –

M.Sc. and Pr. Sci. Nat.

On behalf of:

Kongiwe Environmental (Pty) Ltd



Declaration of Independence

We, Lucas Smith and Irene Lea, declare that –

General declaration:

- *I act as the independent Hydrogeology practitioner in this application;*
- *I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;*
- *I declare that there are no circumstances that may compromise my objectivity in performing such work;*
- *I have expertise in conducting hydrogeological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;*
- *I will comply with the Act, Regulations and all other applicable legislation;*
- *I have no, and will not engage in, conflicting interests in the undertaking of the activity;*
- *I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;*
- *I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;*
- *I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not;*
- *All the particulars furnished by me in this form are true and correct;*
- *I will perform all other obligations as expected from a hydrogeological practitioner in terms of the Act and the constitutions of my affiliated professional bodies; and*
- *I realise that a false declaration is an offence in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.*

Disclosure of Vested Interest

- *I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.*

CONTACT PERSON: Lucas Smith

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Email: lucas@wellsafrica.com

SIGNATURES:

_____ _____

LA Smith I Lea

03 December 2024

INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the authors' best scientific and professional knowledge as well as available information. The report is based on assessment techniques, which are limited by information available, time and budgetary constraints relevant to the type and level of investigation undertaken, and Groundwater Abstract (Pty) Ltd, supported by Irene Lea Environmental and Hydrogeology cc (ILEH) reserve the right to modify aspects of the report including the recommendations if and when new information may become available from on-going research, monitoring and further work in this field pertaining to the investigation.

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Executive Summary

Far West Gold Recoveries (Proprietary) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSF are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF).

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant, or any other future plant. Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised. An estimated amount of 600 000 tons/month of slurry is expected to be pumped from the TSF via existing pipelines to the Driefontein 2 Plant for beneficiation.

Libanon TSF is situated approximately 2 km west of Westonaria, in the Rand West City Local Municipality. Libanon TSF is approximately 170 hectares in extent and located on the farm Witkleigat 283 IQ 87IR. The project is in a regional gold mining area within the Kloof Mineral Rights Area.

The anticipated life span of the project is approximately 12 years. It is expected that there would be a 1-year construction and ramp-up period which would include the placement of infrastructure and site preparation, a 6-year Life of Operation, a 2-year ramp-down period and 3 years to rehabilitate the reclaimed site. Upon completion of reclamation, the footprint area will be assessed for contamination, particular in terms of radiation. Contaminated soils will be removed, and the land will be levelled to its original topography.

The proposed reclamation method which will be used to remove the TSF is referred to as top-down hydraulic reclamation. This technique uses high-pressure water monitors / cannons to deliver a high-pressure water jet to excavate unconsolidated tailings material within the TSF hydraulically. The water from the cannon mixes with the tailings and forms a slurry with a high solids content. The slurry then flows under gravity along trenches at the base of the TSF to a collection sump which is positioned at the lowest elevation of the bench being mined.

Kongiwe Environmental (Pty) Ltd (Kongiwe) has been appointed by Far West Gold Recoveries (Pty) Ltd, as the independent Environmental Service Provider (EAP) tasked with conducting the Scoping and Environmental Impact Assessment (S&EIA) process which is aimed at critically evaluating the potential environmental and social impacts of the proposed reclamation of the Libanon TSF.

Environmental Setting:

The project is situated on a relatively flat plain that dips in a northerly direction towards the Wonderfonteinspruit. The flat plain is associated with dolomitic and Karoo Sequence outcrops. The undulating and hilly ground south of the TSF is formed by outcrops of the Timeball Hill and Rooihoogte Formations (Pretoria Group).

The Venterspost Eye is located approximately 3.6 km north of Libanon TSF, close to the Wonderfonteinspruit. This eye is dry at present because the dolomitic compartment in which it is situated has been dewatered by gold mines.

Libanon TSF falls in the Wonderfonteinspruit catchment, in the C23D quaternary catchment, forming part of the Vaal Water Management Area.

The Mean Annual Precipitation for the Blyvooruitsig weather station is 711 mm. The open water Mean Annual Evaporation is 1 454 mm, which is double the MAP of the area.

Regionally the geology consists of formations of the Karoo, Transvaal, Ventersdorp and Witwatersrand Supergroups. The Black Reef quartzite, which is present at the base of the Transvaal Supergroup, outcrops north of the project area. Of the Transvaal Supergroup Formations, the Chuniespoort Group are of most significance, as the Libanon TSF is located on outcropping Malmani dolomite. The dolomite varies in thickness regionally from around 200 to 1500 m. Underneath the Libanon TSF, the base of the dolomite is at an elevation of 1000 to 800 mamsl and dips in a southerly direction (Jones and Wagener, 2013).

South of Libanon TSF, formations of the Pretoria Group outcrop, including ferruginous shale and quartzite of the Timeball Hill Formation, Hekpoort lavas, as well as shale outcrops of the Strubenkop and Silverton Formations.

Some Karoo sediments have remained as inliers above the dolomite, delineated as the Vryheid Formation.

In addition to the regional post-Transvaal faults, regional diabase (dolerite) dykes have intruded into some of the north-easterly striking faults. Many of these faults penetrated the full Transvaal sequence as well as the underlying Ventersdorp and Witwatersrand Supergroups. These dykes have subdivided the dolomites in watertight compartments. The Libanon TSF is located on the western edge of the Venterspost Compartment and possibly to some extent on the Bank Compartment. The eastern boundary of the Venterspost Compartment is formed by the Gemsbokfontein No 2 Dyke and the western boundary by the Venterspost Dyke, which transects the western boundary of the Libanon TSF. The northern boundary of the dolomitic compartments is formed by the outcrop of the dolomite against the Black Reef Quartzite. The southern boundary is formed by the overlying Transvaal sediments.

Site Investigations:

Three sets of shallow and deep monitoring boreholes were drilled and tested as part of this project. The results of the drilling program indicate the presence of thick residual dolomite, referred to as wad underneath the Libanon TSF footprint. This material has very low permeabilities and act largely as an aquitard. One of the deeper boreholes intersected a cavity in the dolomitic formation, which complicated the drilling process.

Hydrocensus:

A hydrocensus was conducted across the study area during August 2024. The survey included the Libanon TSF property, plus accessible properties within a 4.5 km radius, and concentrated on identifying existing boreholes to enhance the knowledge of the groundwater systems and current groundwater use. Only one borehole was identified on one of the properties on the ridge to the south, but a groundwater level could not be measured due to security measures installed.

Locally surface drainage and possibly groundwater flow will be towards the Wonderfonteinspruit.

Information presented in Jones & Wagener (2013) indicates that there is a 77% correlation between groundwater level and topographical elevations in the weathered dolomitic aquifer. The 77% correlation suggests that there is some relationship between groundwater elevation and topography in the weathered dolomitic aquifer, but that dewatering has lowered groundwater levels significantly in places, thus skewing this correlation.

Borehole Drilling:

Based on a geophysical survey, three drilling positions were identified around the footprint area of Libanon TSF. The percussion drilling program was carried out during October 2024, by Redirile Drilling.

Two groundwater characterisation and monitoring boreholes were drilled at each of the 3 target areas. The one borehole was drilled to a depth of 80 m below surface, with the aim of characterising and monitoring the deeper fractured aquifer. The second borehole was drilled 30 m deep, with the aim of monitoring potential groundwater flow, quality and possible connection between the deeper fractured aquifer and the shallow weathered aquifer in the area.

Two of the 6 new percussion boreholes produced a measurable groundwater level, post drilling (boreholes Lib BH3s and Lib BH3d). The other four boreholes produced no water and remained dry post closure. There were no measurable blow yields with only seepage water observed for boreholes Lib BH3s and Lib BH3d.

The set of shallow and deep boreholes that contained some groundwater are located on a comparatively fresh dolomitic pinnacle, based on the gravity survey, which is probably associated with the position of the Venterspost Dyke. In the deep borehole, the groundwater level is deeper than 70m below surface, reflecting the regional impact of the dewatered compartment. The fact that a groundwater level could be measured in this position probably attributed to the percolation of rainwater into the dolomitic pinnacle and the presence of increased porosity to facilitate storage of this groundwater.

In the shallow borehole, the depth to groundwater is around 20 m, which also suggests percolation of rainwater from surface as well as infiltration from the Libanon TSF that is retarded in the vertical flow direction by the presence of the thick wad. This groundwater probably sits on a pocket of low permeability wad as a perched aquifer near surface.

Aquifer Testing:

Following completion of the drilling programme, an aquifer test programme was initiated to determine the hydrogeological characteristics of the local aquifers, where possible. VSA Leboa Consulting was appointed by Water Hunters to conduct yield testing of the newly drilled boreholes. Only 5 of the 6 boreholes were available for yield testing. Borehole Lib BH1d (deep borehole) intercepted a cavity at depth and was not tested.

For this project maximum drawdown pump tests were conducted on the two water yielding boreholes (boreholes Lib BH3s and Lib BH3d), followed by a recovery test after each test. Slug tests were conducted on three of the dry boreholes (slug in / infiltration tests) (Lib BH1s, Lib BH2s and Lib BH2d). VSA Leboa Consulting concluded that the slug test analysis shows some heterogeneity in the aquifer

system, with hydraulic conductivity (k-value) values ranging from 0.000003 m/d to 0.0035 m/d. The average k-value is 0.001 m/d, based on the model fits, was determined from the slug test. Large variations in the k-values were observed, mostly due to the analytical solutions fitting the data and heterogeneity in die geology formations.

It is shown that the permeabilities of the residual dolomite are very low, on average 9.93E-4 m/d and varying between 1.4E-4 and 2.5E-3 m/d. All three boreholes on which tests could be completed were dry with residual dolomite extending at least to an average depth of 26 m.

During the Aquifer tests on boreholes Lib-BH3s and Lib-BH3d, the shallow borehole was pumped dry within 16 minutes at a rate of 0.18 L/s (648 L/hr) but recovered by 81% in 20 hours. The deep borehole was pumped dry in 40 minutes at a rate of 0.03 L/s (108 L/hr) and only recovered by 6% in 3 hours. This suggests that the residual dolomite underneath the Libanon TSF has a very low yield, but that some groundwater seeps into the comparatively fresh dolomite pinnacle in this position over time, thus recharging the aquifer. This groundwater probably originates from within the lateral extent of the dolomite pinnacle and is stored in what is perceived to be significant storage capacity contained in secondary porosity as a result of karstification of the weathered dolomite.

On a local scale perched aquifer conditions are expected in the residual dolomite, as rainwater percolates into the karstified aquifer.

The pumping test data is used during the calibration of the groundwater numerical model.

Groundwater Qualities:

During the August 2024 hydrocensus only one borehole was identified, and a groundwater sample was collected (borehole Lib 1). Another two groundwater samples were collected during the aquifer test program. The water samples were submitted to Aquatico Laboratories for analysis. Aquatico is a SANAS accredited laboratory.

Based on the water quality results the following conclusions were drawn (SANS 241:2015 comparison):

- Chronic Health effects:
    - Total Iron – An elevated iron concentration (exceeding the chronic health limits) was recorded for borehole Lib-BH3s (7.62 mg/L), with the SANS limit set at 2 mg/L. The concentration of dissolved iron in water is also dependent on the occurrence of other heavy metals or could be related to the local Karoo and dolomite geology or leaching from the TSF.

      Borehole Lib-BH3s is on the downstream side (west) from Libanon TSF. The total iron concentrations were below the detection limit for the other two sampled sites.

    - Manganese – Borehole Lib-BH3s measured a manganese concentration that could result in chronic health effects (22.2 mg/L). The health impact limit is set at 0.4 mg/L.

      The manganese concentration could be related to the local Karoo and dolomite geology or leaching from the TSF. The manganese concentrations were below detection limit or the SANS aesthetic limit for the other two sampled sites.

    - Sulphate – Borehole Lib-BH3s exceeds the health guideline limits for sulphate with a measured concentration of 1623 mg/L. The health limit set at 500 mg/L).

The sulphate concentrations were below detection limit or the SANS aesthetic limit for the other two sampled sites.

- Nickel – An elevated nickel concentration was recorded for Lib-BH3s (0.136 mg/L). The maximum SANS guideline health limit is 0.07 mg/L. The nickel concentrations were below the detection limit for the other two sampled sites.

- Aesthetic / Operational effects:
  - Ammonium – The ammonium concentration for borehole Lib-BH3s exceeds the aesthetic limits for drinking water (13.0 mg/L) with the aesthetic limit set at 1.5 mg/L.
  - Total hardness – Very hard total hardness values were measured at the two downstream boreholes at Libanon TSF – Lib-BH3s and Lib-BH3d.

In terms of major cations and anions, sulphate is by far the most significant element of concern, with a concentration of above 1500 mg/l for Lib-BH3s. Elevated sulphate concentrations are typical of the impact of gold tailings on groundwater quality, as it is a product of sulphide oxidation.

In terms of metals, manganese and iron concentrations are significantly elevated. Manganese concentrations exceeding 20 mg/L are probably more reflective of the geochemical character of the residual dolomite (wad) than the impact of the Libanon TSF on groundwater quality. Manganese is one of the byproducts of dolomite dissolution, as discussed earlier. Iron is also to some extent a byproduct of dolomite dissolution, but it is also a characteristic element of the oxidation of sulphide minerals. For this reason, sulphate and iron will be used as the two indicator elements for this impact assessment.

The hydrocensus was completed during August 2024 during the dry, winter season in Gauteng. The 2024 fieldwork programme was completed between October and November 2024, which represents the end of the dry season conditions.

Groundwater Numerical Model:

The objectives of the numerical modelling are based on the requirements of the EIA process and the water use licence application requirements. The following objectives are reported:

- Estimate the impact of the proposed Libanon TSF Reclamation Project at the end of the construction and operational phases of the project on groundwater quality. No significant impacts on groundwater levels are expected.
- Predict the long-term impact of the project on groundwater quality post closure and rehabilitation.
- Evaluate the effect that tailings removal and footprint rehabilitation would have on groundwater quality.
- Develop a groundwater monitoring program based on the outcome of the impact prediction study.
- Develop a groundwater management program geared at reducing the impacts on groundwater quality identified.

The outcome of the simulations is presented as sulphate and iron concentration contour maps that delineate the anticipated plumes for the three scenarios tested. These are based on the source term discussed earlier. The three operational scenarios tested are:

- **Best case scenario**: comparatively good quality seepage during reclamation and low seepage infiltration, equivalent to dry conditions, to the underlying aquifers.
- **Likely scenario**: measured quality seepage during reclamation and moderate seepage infiltration rates, equivalent to average conditions, to the underlying aquifers.
- **Worst case scenario**: comparatively poor quality leachate during reclamation with higher seepage infiltration, equivalent to wet conditions, to the underlying aquifers. This scenario is also presented as an indication of long-term impacts if the Libanon TSF is not removed, i.e. the No Project option.

The impact assessment was completed for the residual and weathered dolomitic aquifers. Since vertical flow will be prominent underneath the TSF and in the absence of attenuation in the unsaturated zone, potential contamination from surface is likely to affect both aquifers over time.

Simulated zones of impact on groundwater quality are presented for operational as well as for the anticipated post-closure long-term conditions below. Operational impacts for the three scenarios tested are similar due to the comparatively short period during which tailings will be reclaimed, the low aquifer permeabilities and the perceived latent impacts of historical tailings deposition. For this reason, impacts associated with the likely operational conditions are presented.

To facilitate comparison between long-term impacts, the simulated sulphate and iron plumes that delineate the zones of significant impact on groundwater quality are overlain on a single map for sulphate and iron. To incorporate the level of uncertainty with regards to groundwater flow conditions in the residual and weathered dolomitic aquifers, the estimated zone impact in terms of drinking water standards is presented for the potential worst case only.

The estimated zone of impact in terms of drinking water standards therefore presents the maximum zone of impact post closure, following the precautionary principle. Groundwater within this zone is likely to exceed drinking water standards for sulphate and iron, making the groundwater potentially unfit for use. For sulphate, this zone is delineated by the 250 mg/L concentration contour and the 0.3mg/L concentration contour for iron. These are indicated in a dashed line with yellow fill.

The zones of significant impact delineate areas where the concentrations of sulphate and iron, and by implication other salts and metals, are likely to exceed concentrations that could pose a health risk if ingested. Groundwater in these zones will therefore not be fit for use. For sulphate, this zone is delineated by the 1000 mg/L concentration contour and for iron the 1 mg/L concentration contour. These are indicated in a red line with red fill.

The extent of the contours is based on domestic use guidelines after DWAF (1996). This approach is taken to enable delineation zones of significant risk to health associated with the project.

General Outcome for all Scenarios:

The overall outcome of the simulations is summarised as follows:

- Simulations suggest that the private borehole south of the Libanon TSF fall outside the anticipated groundwater impact zones delineated for the project. This borehole will therefore not be affected by the tailings reclamation project.
- The plumes are expected to migrate regionally in a north-westerly direction towards the Wonderfonteinspruit in the residual and weathered dolomitic aquifers. It is highly unlikely that plumes associated with the Libanon TSF could reach this stream, even in the long-term. This is because aquifer permeabilities are low and the plumes are anticipated to move less than 50 m per year. In addition, vertical groundwater flow to the level of dewatering in the compartment will prevail until underground dewatering ceases and groundwater levels have regionally rebounded. Previous studies completed on the Kloof underground workings estimate that groundwater levels could recover within 20 years after pumping ceases to an elevation of 1560 mamsl. This is the elevation of the Venterspost Eye from which the compartment is expected to decant into the Wonderfonteinspruit once groundwater levels reach this elevation. Under these conditions the residual dolomitic aquifer underneath the Libanon TSF is expected to remain dewatered, as the current groundwater level in Lib-BH3s is at 1581 mamsl. The deeper weathered aquifer may however recover to 1560 mamsl, thus rewatering Lib-BH3d by approximately 40 m.
- On a local scale, groundwater flow will be towards the two non-perennial streams northeast and southwest of the Libanon TSF. It is likely that groundwater impacted by the TSF has already reached the stream 200 m northeast of the TSF.
- Flow in the residual and weathered dolomitic aquifers will be controlled by the presence and extent of dolomitic grykes and pinnacles, which was delineated based on a gravity survey completed for the aquifer. Preferential flow is expected in the dolomitic pinnacles. The grykes are expected to be significantly more clay-rich and therefore have lower permeabilities and groundwater flow conditions.
- A small northwestern portion of the Libanon TSF is located within the adjacent Bank Dolomitic Compartment. The boundary between the Venterspost and Bank Compartments is formed by the Venterspost Dyke that transects the northwestern edge of the Libanon TSF. Groundwater levels on the eastern edge of this compartment are not lowered significantly, based on the available dataset (Figure 8). Preferential flow is therefore likely to take place in this area, as the dolomitic aquifer is not as significantly dewatered compared to the Venterspost Compartment.
- The shape of the plumes is affected by the aquifer parameters as well as the calculated dispersion in the formations. Of most significance is the presence and extent of dolomitic grykes as well as regional post-Transvaal age dykes and faults. Dispersion especially plays a role in the extent to which lower concentrations of sulphate and iron would spread from the TSF. Dispersion can account for the spread of contamination that is not necessarily driven by groundwater flow.
- The zones of significant risk to groundwater quality delineated by the 1000 mg/L sulphate and the 1 mg/L iron concentration contours are expected to be restricted mainly to the footprint of the Libanon TSF. The extent of the zones of significant risk to groundwater reduces for Scenarios 2 and 3. This highlights the importance of implementing a sound water balance during operations and controlling the quality of leachate associated with the TSF. It is noted that FWGR has already committed to measures to control the factors and for this reason, long-term impacts are expected to approximate the likely scenario.
- The historical impact of tailings deposition is expected to continue to affect groundwater quality associated with the project areas in the long-term, even if FWGR removes the tailings as part of the proposed project. This is because the contamination already present in the

aquifers will continue to move slowly down gradient, away from the TSF along groundwater flow patterns. For this reason, the shape of the plumes remains similar for the three scenarios tested. The difference is the concentration of contaminants within the plumes and a reduction in the extent of the zone of unacceptable impact after tailings reclamation, as mentioned.

- The extent of the iron plume is larger compared to that of sulphate. This is because lower water quality objectives are imposed on manganese compared to sulphate.

Impact at the end of the Operational Phase:

The impact of tailings reclamation at the end of the operational phase is presented for iron and sulphate in the residual and weathered dolomitic aquifers in Figure 16. The simulations indicate the following:

- The zone of impact in terms of drinking water standards is not expected to extend more than 200 m from the TSF for sulphate and not more than 500 m for iron concentrations. No private borehole is present in this zone of impact. It is likely that the plume has reached the non-perennial stream northwest of the TSF. Groundwater near to or entering the stream as baseflow is not expected to exceed concentrations that would signify significant impacts.
- The zone of significant impact on groundwater quality is expected to be restricted mainly to the footprint of the TSF. It is acknowledged that portions of the residual and weathered aquifer within the TSF footprint is likely to be dewatered. From an impact assessment perspective, it was assumed that groundwater is likely to be affected over the entire footprint area.

Based on the impact assessment discussed above, the consequence rating for the operational phase, within the context of historical pre-existing impacts, is presented as follows:

- Magnitude: Moderate –
- Spatial scale: Site or local
- Duration: Medium term
- Probability: Possible

Long-Term Scenarios:

As discussed earlier, the long-term impact of three operational scenarios were tested as part of impact predictions completed. The outcome of these is presented in Figure 17 for sulphate and iron for a period 100 years after rehabilitation of the TSF footprint. The following is concluded from the information presented:

- The zone of impact delineated in terms of drinking water standards is expected to expand in the long-term and migrate towards the two non-perennial streams on either side of the TSF. Groundwater flow and the extent of the zones of impact on groundwater quality will be controlled by the location of the Venterspost dyke as well as the dolomitic grykes. Preferential

flow is anticipated in comparatively fresh dolomitic pinnacles compared to the grykes. The dyke will form a boundary to groundwater flow in the dolomitic aquifer.

- The sulphate plume is not expected to migrate more than 500 m from the TSF. The iron plume may extend further from the TSF mainly because it is delineated by much lower concentrations compared to sulphate. It is possible that the iron plume may migrate a further 500 m from the estimated operational plume in the long-term.
- The zone of significant impact on groundwater quality are compared for the three scenarios in the figure. As discussed earlier, the worst-case scenario can also be used to approximate the "Do Nothing" option. Under the conditions of aquifer conceptualisation, it is likely that the plume delineated by the 1000 mg/L sulphate concentrations contour could extend more than 200 m from the TSF footprint for this case. The worst-case scenario iron plume is also expected to extend approximately 350 m beyond the TSF footprint. No private boreholes are located within the zone of significant risk to groundwater quality. It is also unlikely that these zones would reach the non-perennial stream northwest of the TSF. There is a small risk that the zone of significant impact may however reach the northeastern stream.
- The most significant outcome of the likely and best-case scenarios is a reduction in the zone of significant impact on groundwater quality. Simulations suggest that both the sulphate and iron plumes could be reduced to within the TSF footprint area in the long-term. As discussed earlier, FWGR has developed stormwater management measures to at least achieve the conditions of the likely scenario. For this reason, long-term impacts on groundwater quality are anticipated to be restricted to the TSF footprint area and therefore not significantly impact on water resources.

Based on the impact assessment discussed above, the consequence rating for the worst-case scenario is presented as follows:

- Magnitude: Major –
- Spatial scale: Site or local
- Duration: Long-term
- Probability: Possible

A preliminary groundwater monitoring network is presented in Table 30. If additional private boreholes are identified within a 1 km radius, they must be included in the monitoring programme.

Soil and groundwater assessments of the TSF footprint area are recommended after removal of the tailings material to define the status of these environments and determine mitigation, management and monitoring requirements, post-removal.

DRDGOLD must ensure that an effective surface water collection and retention system is in place to ensure that all flow and collected water is directed towards the paddocks and not allowed to drain freely away from the TSF areas. Pooling of water must not be allowed on open surfaces, except if lined.

The reclaimed slurry and any water must be removed from the exposed surfaces (immediately) to avoid seepage of contaminated water into the shallow weathered and deeper fractured and karst aquifers.

Ensure that paddocks are designed to contain all dirty water generated during the reclamation process to prevent overflows and spillages.

Recommendations listed in Table 29 and Table 31, plus Section 15 to Section 17 need to be followed.

Reasoned Opinion:

It is the opinion of the project hydrogeologists that the reclamation of the Libanon TSF can proceed, provided that good surface water / storm water management measures are put in place and maintained throughout the life of the project. No ponding over exposed areas must be allowed. The project must further commit to complete tailings removal and not undertake selective tailings reclamation. Overall, the project will deliver a long-term positive impact on groundwater quality if the TSF is removed, and footprint areas are rehabilitated.

Table of Contents

1 Introduction 1
1.1 Project Description 4
1.1.1 Access 4
1.1.2 Power and Water 4
1.1.3 Life of Operation 4
1.1.4 Infrastructure Proposed for the Project 4
1.1.5 Reclamation Method 5
1.1.6 Rehabilitation 5
2 Groundwater Assessment Framework 6
2.1 Groundwater Study Objectives 6
2.2 Compliance Framework 6
2.3 Alternatives Considered 6
2.4 Groundwater Assessment Team 7
2.5 Report Structure 7
3 Key Findings from the Scoping Report 8
4 Environmental Setting 8
4.1 Catchment 9
4.2 Climate and Rainfall 9
4.3 Geology 9
4.3.1 Structural Geology 12
5 Site Investigations 13
5.1 Desktop Study 13
5.2 Hydrocensus 13
5.3 Geophysical Survey 15

5.3.1 Magnetometer Survey 15
5.3.2 The Electromagnetic Method 16
5.4 Drilling Program 18
5.5 Aquifer Testing 20
5.6 Groundwater Availability Assessment 23
5.7 Groundwater Quality 23
5.8 Date and Season of the Investigation 28
6 Hydrogeology 28
6.1 Regional Geology 28
6.2 Geochemistry 29
6.2.1 Acid Generation Capacity 29
6.3 Hydrogeological Conceptualisation 30
6.3.1 Monitoring Boreholes 30
6.3.2 Unsaturated Zone 31
6.3.3 Saturated Zone 32
6.3.4 Hydraulic Conductivity and Transmissivity of the Aquifers 33
6.3.5 Groundwater Levels 35
6.3.6 Groundwater Potential Contaminants 37
6.4 Aquifer Characterisation and Vulnerability 38
7 Conceptual Hydrogeological Model 39
8 Source Term 40
8.1 Seepage Quality 40
8.2 Operational Seepage Volume 41
9 Potential Pathways and Receptors 41
10 Key Assumptions and Literature-Based Data Inputs 42
11 Groundwater Modelling 44

11.1 Numerical Modelling Objectives 44
11.2 Model Construction 44
11.3 Groundwater Elevation and Gradient 46
11.4 Conceptual Groundwater Model 46
11.5 Numerical Model 46
11.5.1 Model Input Files and Integration 46
11.6 Calibration Results 48
11.6.1 Model Sensitivity 53
11.6.2 Assessment of Uncertainties 53
11.7 Results of the Model 55
12 Hydrogeological Impacts 55
12.1 Preamble 55
12.2 Plume Delineation 55
12.3 Rehabilitation Measures Considered 57
12.4 General Outcome for all Scenarios 57
12.5 Impact Prediction 58
12.5.1 Impact at the end of the Operational Phase 58
12.5.2 Long-Term Scenarios 59
12.6 Cumulative Impacts 62
12.7 Risk of Decant 62
13 Groundwater Impact Assessment 62
13.1 Part A: Defining Consequence in Terms of Magnitude, Duration and Spatial Scale 62
13.2 Part B: Determining Consequence Rating 63
13.3 Part C: Determining Significance Rating 64
13.4 Construction Phase 64
13.5 Operational Phase - Reclamation 66

13.5.1 Groundwater Quality 66
13.5.2 Groundwater Quantity 67
13.6 Decommissioning and Closure 69
13.6.1 Groundwater Quality 69
13.6.1 Groundwater Quantity 71
14 Cumulative Impacts 72
15 Groundwater Management Measures 73
15.1 Over-arching Groundwater Management Measures 73
15.2 Measures to Address Impacts on Groundwater Availability 74
15.3 Measures to Address Impacts on Groundwater Quality 75
16 Post Closure Management 75
16.1 Remediation of Physical Activity 75
16.2 Remediation of Storage Facilities 75
16.3 Remediation of Environmental Impacts 76
16.4 Remediation of Water Resources Impacts 76
16.5 Backfilling of Pits 76
17 Groundwater Monitoring 76
17.1 Monitoring Locations 76
17.2 Monitoring Requirements 77
17.3 Groundwater Monitoring Reports 78
17.4 Quality Assessment and Quality Control 78
18 Reasoned Opinion 79
19 Conclusions and Recommendations 79
20 References 89

List of Tables

Table 1. Summary of the details of the rainfall stations 9

Table 2. 2024 Hydrocensus data 15

Table 3. Proposed drill targets 16

Table 4. Drilling summary October 2024 19

Table 5. Summary of the aquifer parameters (hydraulic conductivity in m/day) based on the slug tests 21

Table 6. Summary table of the yield testing results 22

Table 7. DWS water quality "fitness for use" classes 25

Table 8. Groundwater quality – 2024 26

Table 9. Summary of monitoring borehole information 31

Table 10. Summary of site-specific aquifer parameters obtained from field data 33

Table 11. Literature-based aquifer parameters used to conceptualise regional aquifers 35

Table 12. Concentrations of indicator element in groundwater 38

Table 13. Source term: Long-term leachate quality 40

Table 14. Source term: Leachate volume 41

Table 15. Pathways and receptors 42

Table 16. Assumed timeline used during simulations 47

Table 17. Calibration criteria 48

Table 18. Calibration results 52

Table 19. Health risks associated with indicator elements (after DWAF, 1996) 56

Table 20. Consequence rating methodology 63

Table 21. Consequence rating methodology 64

Table 22. Significance rating methodology 64

Table 23. Construction Phase water quality impacts 65

Table 24. Operational Phase water quality impacts 68

Table 25. Operational Phase water quantity impacts 69
Table 26. Decommissioning and Closure Phase water quality impacts 70
Table 27. Decommissioning and Closure Phase water quantity impacts 71
Table 28. Cumulative impact rating 72
Table 29. General groundwater management measures 74
Table 30. Proposed groundwater monitoring positions 77
Table 31. Groundwater monitoring requirements 77

List of Figures

Figure 1. Libanon project locality map 2
Figure 2. Libanon TSF master layout 3
Figure 3. Project area geology 11
Figure 4. Geomorphology of the weathered dolomite aquifer (Jones & Wagener, 2013) 12
Figure 5. Geophysical survey layout 17
Figure 6. Comparison between pH and EC in groundwater samples 30
Figure 7. Estimated extent of grykes in the weathered dolomitic aquifer 34
Figure 8. Schematic cross section showing groundwater levels in the dolomitic compartments 35
Figure 9. Comparison of major and trace elements in groundwater 38
Figure 10. Schematic cross section through the project area 40
Figure 11. Model grid 45
Figure 12. Calibrated groundwater levels in the residual dolomitic aquifer 49
Figure 13. Calibrated groundwater levels in the deeper weathered dolomitic aquifer 50
Figure 14. Calibration results 52
Figure 15. Sensitivity analysis 54
Figure 16. Simulated sulphate and iron plumes at the end of reclamation 60

Figure 17. Anticipated long-term sulphate and iron plumes 61

Abbreviations

Abbreviation	Description
AMD	Acid Mine Drainage
Bh	Borehole
BPG	Best Practice Guideline
CV	Curriculum Vitae
DTM	Digital Terrain Model
DWAF	Department of Water Affairs and Forestry (now DWS)
DWS	Department of Water and Sanitation
EA	Environmental Authorisations
EAP	Environmental Assessment Practitioner
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FDEM	Frequency Domain Electro-magnetic
FWGR	Far West Gold Recoveries (Pty) Ltd
GPS	Global Positioning System
ha	Hectares
iLEH	Irene Lea Environmental and Hydrogeology
IWULA	Integrated Water Use Licence Application
IWWMP	Integrated Water and Waste Management Plan
K	Hydraulic conductivity (unit: m/d)
km	kilometre
LOO	Life of Operations \
L/hr	Litres per hour
L/s	Litre per second
m	metre
m/day	metre per day
m^2/day	Metre square per day
MAE	Mean Annual Evaporation
mamsl	metres above mean sea level
MAP	Mean Annual Precipitation

m bgl	metres below ground level
mg/L	milligrams per litre
ml	millilitre
mm	millimetre
mm/a	millimetre per annum
mS/m	milliSiemens per meter
NEMA	National Environmental Management: Waste Act, 2008 (Act No 59 of 2008)
NWA	National Water Act, 1998
RTSF	Regional Tailings Storage Facility
S	Specific storage
S&EIA	Scoping and Environmental Impact Assessment
SANAS	South African National Accreditation System
SANS	South African National Standards
T	Transmissivity
TDS	Total Dissolved Solids
TSF	Tailings Storage Facility
WMA	Water Management Area
WRC	Water Research Commission
WRTRP	West Rand Tailings Retreatment Project

1 INTRODUCTION

Far West Gold Recoveries (Proprietary) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSF are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF).

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant, or any other future plant. Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised. Reprocessed tailings will be deposited on the RTSF. Required infrastructure will include:

- Pumpstation;
- Connecting pipelines for process water from Kloof Shaft 10#;
- Connecting slurry pipelines to existing pipelines;
- Pollution control paddock;
- Access roads;
- Laydown area; and
- Powerlines.

The proposed reclamation activity will require authorisation in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) for Section 21 water uses, the National Environmental Management Act, 1998 (Act No 107 of 1998) (NEMA) and the National Environmental Management: Waste Act, 2008 (Act No 59 of 2008), Category B Activities. An Integrated Water Use Licence Application (IWULA) will be prepared and submitted in accordance with the Water Use Licence Application and Appeals Regulations 2017 published in GNR 267 on 24 March 2017 and will be supported by a Technical Report and Integrated Water and Waste Management Plan (IWWMP).

Kongiwe Environmental (Pty) Ltd (Kongiwe) has been appointed by Far West Gold Recoveries (Pty) Ltd, as the independent Environmental Service Provider (EAP) tasked with conducting the Scoping and Environmental Impact Assessment (S&EIA) process which is aimed at critically evaluating the potential environmental and social impacts of the proposed reclamation of the Libanon TSF.

In terms of regional setting, Libanon TSF is situated approximately 2 kilometres (km) west of Westonaria, in the Rand West City Local Municipality (Figure 1). Libanon TSF is approximately 170 hectares (ha) in extent and located on the farm Witkleigat 283 IQ 87IR (Figure 2). The project is in a regional gold mining area within the Kloof Mineral Rights Area and in the vicinity of South Deep, Cooke and Driefontein Gold Mines.

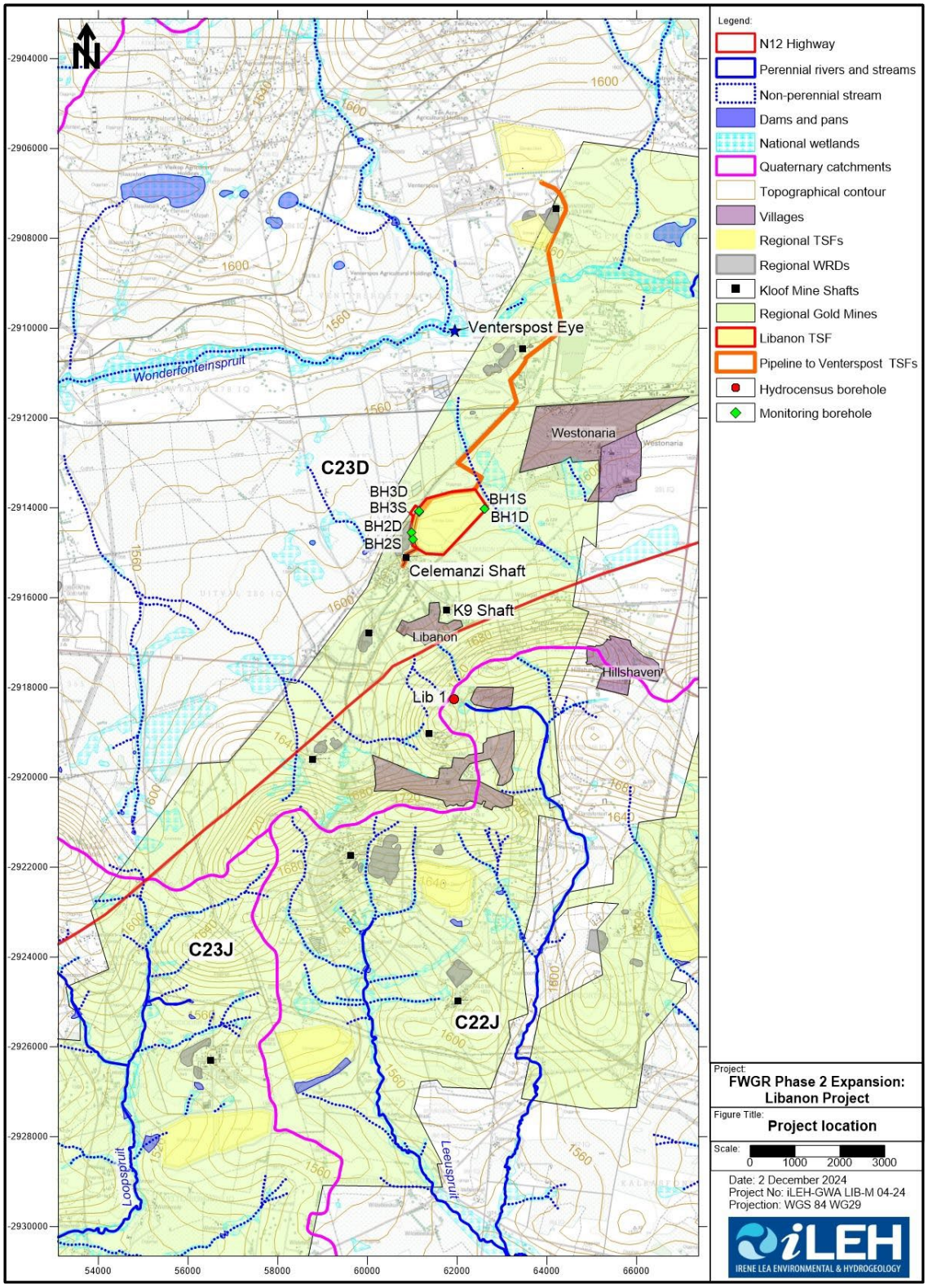


Figure 1. Libanon project locality map

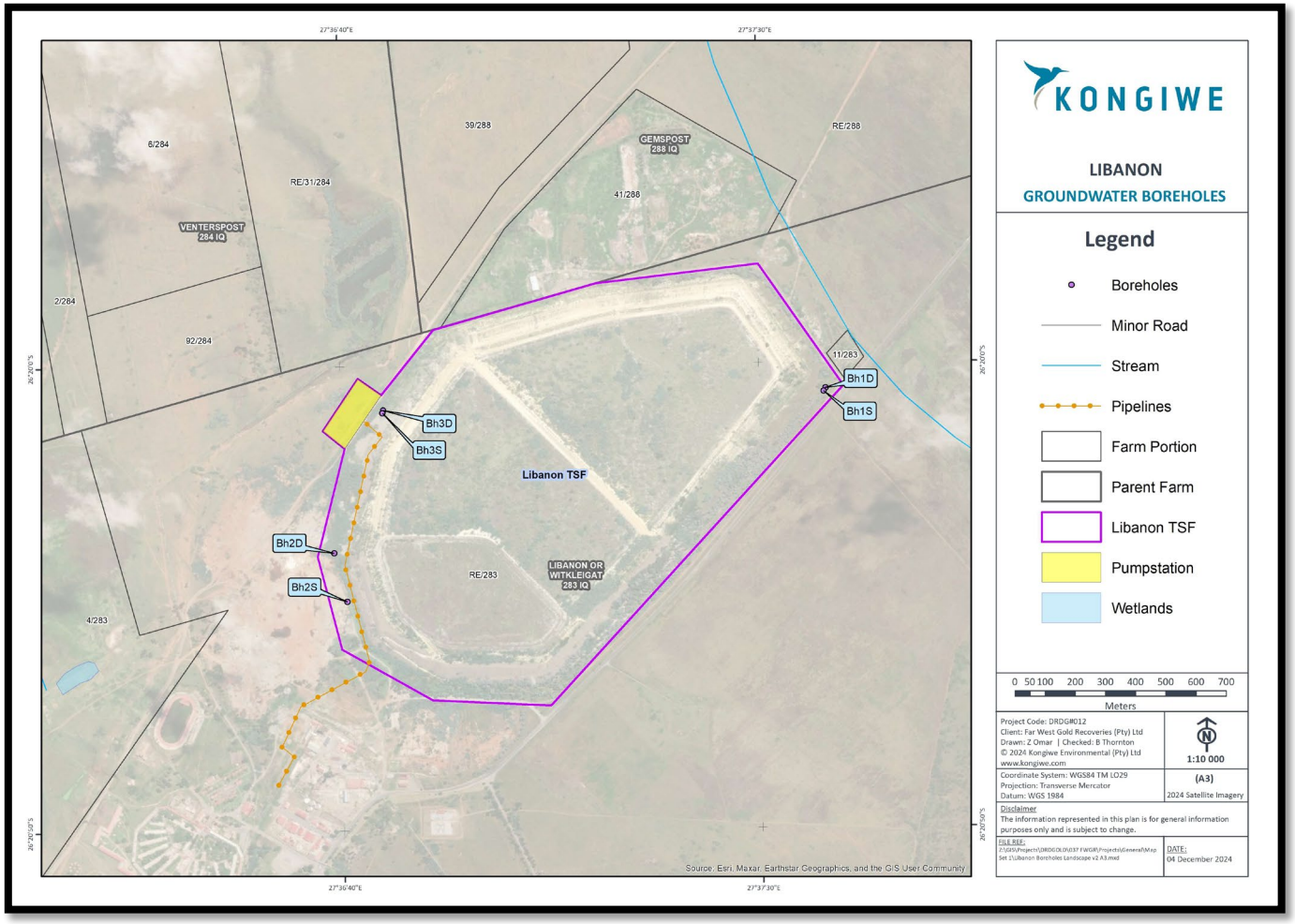


Figure 2. Libanon TSF master layout

1.1 Project Description

Libanon TSF is surrounded by open areas, areas cleared of mining infrastructure and the closed Libanon Gold Mine. The N12 runs 2 km to the south of Libanon TSF.

1.1.1 Access

The main access route is off Bridges Avenue which runs parallel to the south of the TSF (Figure 2). As far as possible, existing access roads will be utilised, and where this is not possible, these will be constructed. Where access roads are to be constructed, these will be 4 meters (m) wide gravel roads with mitre drains to protect the road structure from flood damage. Intersections will be properly designed to provide safe entry and exit in and out of the reclamation area. Approvals from the Provincial Roads authorities will be obtained where necessary.

1.1.2 Power and Water

The proposed reclamation activity will require 3 kVA of electricity.

Power will be supplied by Eskom and potable water will be purchased from Rand Water Board or the Municipality, with a contingency for portable JoJo tanks or connection to existing water pipeline infrastructure.

In terms of process water, the water cycle operates as a closed circuit, meaning that limited make-up water will be required for the reclamation of the TSF. Water required for the reclamation activity will be sourced from the Kloof Shaft 10# and conveyed through existing process water pipeline to the project site for reuse in a closed-circuit system.

Stormwater management will consider water infrastructure and stormwater systems, the existing catchment paddock on the TSF footprint and a pollution control paddock.

1.1.3 Life of Operation

An estimated amount of 600 000 tons/month of slurry is expected to be pumped from the TSF via existing pipelines to the Driefontein 2 Plant for beneficiation.

The anticipated life span of the project is approximately 12 years. It is expected that there would be a 1-year construction and ramp-up period which would include the placement of infrastructure and site preparation, a 6-year Life of Operation (LOO) where active hydraulic reclamation and mechanical removal would take place, a 2-year ramp-down period and 3 years to rehabilitate the reclaimed site.

Upon completion of reclamation, the footprint area will be assessed for contamination, particular in terms of radiation. Contaminated soils will be removed, and the land will be levelled to its original topography. Following rehabilitation, it is anticipated that the land will be returned to the landowner to use at their discretion.

1.1.4 Infrastructure Proposed for the Project

The following infrastructure will be utilised on site:

- Reclamation infrastructure consisting of a pump station which include:
  - Slurry sump;
  - Penstock;

  - Vibrating Screen;
  - Water tank;
  - Motor control centre;
  - Pump;
- A short connecting 600-millimetre (mm) pipeline for process water from Kloof Shaft 10#;
- A short connecting 550 mm pipeline to the slurry pipeline to Driefontein 2 Plant;
- Stormwater management infrastructure including:
  - Water infrastructure and stormwater systems;
  - Existing catchment paddocks on the TSF footprint; and
  - Pollution control paddock;
- An 11 kV overhead powerline capable of transmitting 3 kVA of electricity and electricity reticulation;
- Administration buildings, including change houses and ablution facilities;
- Access roads, routed from existing entry points; and
- Construction contractors' yards (temporary facilities).

1.1.5 Reclamation Method

The proposed reclamation method which will be used to remove the TSF is referred to as top-down hydraulic reclamation. This technique uses high-pressure water monitors / cannons to deliver a high-pressure water jet to excavate unconsolidated tailings material within the TSF hydraulically. The water from the cannon mixes with the tailings and forms a slurry with a high solids content. The slurry then flows under gravity along trenches at the base of the TSF to a collection sump which is positioned at the lowest elevation of the bench being mined.

At the sump, finger screens remove any debris that may impact pumping operations, and a penstock will control water flow into the sump. The position of the collection sump will change as the reclamation progresses. From the collection sump, the slurry reports to a reclamation station. To control the volume of water reporting to the reclamation station, flapper valves are used to hold, and release slurry contained in the collection sump. This slurry is then pumped via existing pipelines to the Driefontein No. 2 Plant. At the Driefontein No. 2 Plant, the slurry is prepared and treated for gold extraction and beneficiation.

Reclamation will take place in predetermined benches (or cuts) and will move unidirectionally until the entire TSF has been reclaimed. Generally, 30 m cuts are made for reclamation.

The reclaimed slurry will be deposited in the approved pipelines to the Regional TSF.

1.1.6 Rehabilitation

The property on which Libanon TSF is situated currently belongs to Sibanye. As such, the rehabilitation will need to be in line with Sibanye's closure plans. At present Sibanye's closure plan indicates that the area must be rehabilitated to wilderness.

Once the TSF has been reclaimed, rehabilitated, and cleared of radiation, the land will be shaped and revegetated to match the surrounding environment. The land will then be made available to Sibanye to use at their discretion.

This report represents the geohydrological specialist study completed for the Environmental Impact Assessment (EIA) phase of the application, for environmental authorization to reclaim the Libanon TSF. The information presented in the report will also be used in support of an Integrated Water Use Licence Application (IWULA).

2 GROUNDWATER ASSESSMENT FRAMEWORK

A thorough understanding of the hydrogeological environment is essential to understand the impact of the operations on the receiving environment and to help design a groundwater management plan that reduces or removes the risk of groundwater quality and quantity impacts.

2.1 GROUNDWATER STUDY OBJECTIVES

The groundwater impact assessment focussed on the following objectives:

- Define the current groundwater use in the Libanon TSF study area;
- Define the aquifers underlying the Libanon TSF, as well as current groundwater table depth, groundwater quality, and flow characteristics;
- Define what impact the reclamation activities might have on the groundwater environment; and
- Recommend an initial groundwater monitoring network that will effectively monitor the groundwater quality and level changes during the reclamation activities.

2.2 COMPLIANCE FRAMEWORK

This report is compiled based on the requirements of GNR 267 of the National Water Act (1998) (NWA). The report format is also based on the requirements of the Department of Water and Sanitation (DWS) Best Practice Guideline (BPG) G4 (2008).

The water quality assessment will be based on South African National Standard (SANS) 241-1:2015, Drinking Water.

2.3 ALTERNATIVES CONSIDERED

Kongiwe (2024a) have investigated project alternatives related to the property on which the project is located, the type, design and layout of the activity and the technology used. The operational aspects of the activity, and the "No-Go" alternative were considered in the Scoping Report.

The proposed project will investigate one pipeline route to link into existing authorised slurry pipelines to convey slurry from the TSF to the Driefontein No. 2 Plant for reprocessing; and return process water to the project site for reclamation. The pipeline configuration will consist of one 550 mm diameter slurry pipeline and, one 600 mm diameter process water pipeline.

Details regarding each alternative considered are provided in the Scoping Report (Kongiwe, 2024a). The outcome indicates that there is no project alternative; that TSF reclamation methodology discussed above is the preferred option in terms of the type of activity; the design and layout of the project id dictated by the existing location of the TSF and its associated infrastructure; that the

technology discussed above is the most efficient in terms of water use and water-related impacts; and that existing infrastructure will be used during the operation of the project. For this assessment, two scenarios will therefore be considered:

- Scenario 1: Tailings reclamation according to the project description above
- Scenario 2: The "No Project" option, which will entail leaving the TSF in situ. The tailings material is considered a source of groundwater and surface water pollution.

The proposed reclamation activity will require authorisation in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) for Section 21 water uses, the National Environmental Management Act, 1998 (Act No 107 of 1998) (NEMA) and the National Environmental Management: Waste Act, 2008 (Act No 59 of 2008), Category B Activities. An Integrated Water Use Licence Application (IWULA) will be prepared and submitted in accordance with the Water Use Licence Application and Appeals Regulations 2017 published in GNR 267 on 24 March 2017 and will be supported by a Technical Report and Integrated Water and Waste Management Plan (IWWMP).

2.4 Groundwater Assessment Team

The following hydrogeologists are involved in the Libanon TSF groundwater assessment:

- Lucas Smith (MSc Geohydrology) Pr.Sci.Nat:
  - Field work, data analysis, interpretations, and reporting.
- Irene Lea (MSc Geohydrology) Pr.Sci.Nat:
  - Data analysis, interpretations, numerical model and impact assessment.

Curricula Vitae (CVs) are appended to Appendix A.

2.5 Report Structure

The remainder of the report is structured as follow:

- Section 4 – Environmental Setting.
- Section 5 – Site Investigations.
- Section 6 – Hydrogeology.
- Section 7 – Conceptual Hydrogeological Model.
- Section 8 – Source Term.
- Section 9 – Potential Pathways and Receptors.
- Section 10 – Key Assumptions and Literature Based Inputs.
- Section 11 – Groundwater Modelling.
- Section 12 – Hydrogeological Impacts.
- Section 13 – Groundwater Impact Assessment.
- Section 14 – Cumulative Impacts.
- Section 15 – Groundwater Management Measures.
- Section 16 – Post Closure Management.
- Section 17 – Groundwater Monitoring.
- Section 18 – Reasoned Opinion.
- Sections 19 and 20 – Conclusions and Recommendations.

Appendices:

- Appendix A: Curricula Vitae.
- Appendix B: Geophysical Survey Data.
- Appendix C: Percussion Drill Logs.
- Appendix D: Aquifer Test Data.
- Appendix E: Water Laboratory Certificates.

3 KEY FINDINGS FROM THE SCOPING REPORT

Kongiwe (2024a) reports the following potential impacts on groundwater, associated with the project:

- The potential for further acid mine drainage (AMD) with increased heavy metal and sulphate concentrations in local surface water and groundwater if runoff from the operations is not adequately managed through efficient stormwater management structures.
- Water and groundwater contamination due to pipeline leaks/spillages if inadequate preventative measures are not implemented.
- Improved surface water and groundwater quality around the project area due to the removal of Libanon TSF.

The scoping report further concludes that the project and its associated infrastructure would pose minimal and short-term negative environmental impacts if adequate and appropriate mitigation measures are implemented. Positive long-term environmental impacts are expected once the project has been completed. It is reported that the removal of Libanon TSF would assist with the alleviation of a major pollution source.

4 ENVIRONMENTAL SETTING

The project is situated on a relatively flat plain that dips in a northerly direction towards the Wonderfonteinspruit (Figure 1). The flat plain is associated with dolomitic and Karoo Sequence outcrops. The undulating and hilly ground south and north of the TSF is formed by outcrops of the Black Reef quartzite and other West Rand formations (Witwatersrand Supergroup) in the far north, and Timeball Hill and Rooihoogte Formations (Pretoria Group) to the south.

A section of the Wonderfonteinspruit is diverted to prevent the stream from flowing into dewatered dolomitic compartments. Several springs, including the Venterspost Eye and the Wonderfontein Eye are located along the flow of the stream. The Venterspost Eye is located approximately 3.6 km north of Libanon TSF. This eye is dry at present because the dolomitic compartment in which it is situated has been dewatered by gold mines.

Over the footprint area, the topography dips north at elevations of between 1600 and 1580 meters above mean sea level (mamsl).

4.1 CATCHMENT

Libanon TSF falls in the Wonderfonteinspruit catchment, in the C23D quaternary catchment, forming part of the Vaal Water Management Area (WMA:5). The main drainage for the greater area is the Wonderfonteinspruit. Regionally, the Wonderfonteinspruit drains in a westerly direction into the Mooi River.

4.2 CLIMATE AND RAINFALL

The project area falls within a Highveld climatic zone. Rainfall occurs as thunderstorms during the summer months with a dry winter period.

Kongiwe (2024a) reports that the mean annual precipitation (MAP) for the Kloof weather station is 920 mm/a, based on data for the period December 2013 to February 2020 (Table 1). Older data over a longer period for this weather station reports a MAP of 697 mm/a between 1966 and 2012. This rainfall data will be used to complete the impact assessment.

Rainfall data from the Kloof and the Blyvooruitsig weather stations was not available for the period of 2008 to 2013. The driest year on record was 1945, where 415 mm was received. The two wettest years occurred recently, with the first being in 2014, where 1 145 mm was received, whilst the wettest year on record is 2016, where 1 534 mm was received. Rainfall is highest over the summer months of October to April, and lowest over the months of May to September. Due to the short record, as well as 2014 and 2016 being extremely wet years, the MAP for the Kloof weather station is skewed, and therefore, the Blyvooruitsig MAP of 711 mm was adopted, as it is more representative of the long-term annual rainfall of the area.

Table 1. Summary of the details of the rainfall stations

Station name	Station number	Station location	Rainfall record	MAP (mm)
Blyvooruitsig	0474684 W	4 km south of Carletonville	Oct 1941 – Sep 2008	711
Kloof	--	Located at the Kloof Operation	Dec 2013 – Feb 2020	920

According to the WR2012 study, Kloof is mostly located within evaporation zone 10A. Symon's Pan (S-Pan) evaporation was obtained from the DWS Naauwpoort weather station (C2E009) at the Boskop Dam, which is also located within evaporation zone 10A. Monthly evaporation was available for the period of 1969 to 2019. S-Pan evaporation measurements tend to be higher than evaporation from natural open water bodies. To convert S-Pan measurements to open water evaporation, monthly conversion factors were used, which were obtained from the WR90 study. The open water Mean Annual Evaporation (MAE) is 1 454 mm, which is double the MAP of the area. Evaporation is highest over the warmer months of September to March, and lowest over the cooler months of April to August.

4.3 GEOLOGY

The regional surface geology for the project area is presented in Figure 3. Regionally the geology consists of formations of the Karoo, Transvaal, Ventersdorp and Witwatersrand Supergroups. Gold mineralisation is present in conglomerates of the Witwatersrand Supergroup. The Ventersdorp Contact Reef, Kloof Reef and the Middelvlei Reef were extensively mined in the Kloof underground

workings. The Kloof Celemanzi (Kloof 10 Shaft) is located immediately southwest of the Libanon TSF, as indicated on Figure 3. The northern section of Kloof Mine was previously known as Venterspost and Libanon Mines. These northern sections have been mined out, but some of the Kloof Shafts remain open to dewater the old underground workings to preserve regional gold mining activities. The depth of the Ventersdorp Contact Reef in the underground workings is at least 800 to 1000 m below surface, with deeper mining associated with reefs lower in the geological succession. The lower units of the Witwatersrand Supergroup include the West Rand Group and the upper unit the Central Rand Group. The West Rand Group is divided into three subgroups including the Hospital Hill, Government Reef and Jeppestown Formations. These comprise mainly shale, quartzite, banded ironstone, tillite and intercalated lava flows. North of Libanon TSF, the Government Formation outcrops. The Ventersdorp Supergroup overlies the Wits formations and comprises mainly andesitic lavas and related volcanic pyroclastics.

The overlying Transvaal Supergroup formations are of specific interest to this study. The Black Reef quartzite, which is present at the base of the Transvaal Supergroup, outcrops north of the project area. Of the Transvaal Supergroup Formations, the Chuniespoort Group are of most significance, as the Libanon TSF is located on outcropping Malmani dolomite. The dolomite varies in thickness regionally from around 200 to 1500 m. Underneath the Libanon TSF, the base of the dolomite is at an elevation of 1000 to 800 mamsl and dips in a southerly direction (Jones and Wagener, 2013).

According to Parsons (1991), the two lower formations of the Malmani Subgroup is present in this area, namely the Oaktree and Monte Christo Formations. The Oaktree Formation consists of chert-poor homogenous dark-grey dolomite with interbeds of shale and numerous columnar stromatolites. The Oaktree Formation is conformably overlain on the Black Reef Formation with a transitional zone of carbonaceous, calcareous, argillaceous and arenaceous sediments. The Monte Christo Formation lies conformably on the Oaktree Formation and consists of alternating chert-rich and chert-poor dolomite. This formation consists of interlayered crystalline coarse-grained dolomite, calcareous shale and fine-grained white dolomite.

The dolomite forms a significant aquifer regionally. Dissolution of the dolomite encourages deep zones of weathering. The residues of the weathering are present as brown clays and wad, chert rubble and boulders. The depth of weathering can vary significantly with pinnacles of fresh dolomite often adjacent to deeply weathered zones. The depth of weathering is controlled by the presence of fractures and fissures in the dolomite along which water can infiltrate. In addition, cavities often form in fresh unweathered dolomite where dissolution has taken place along faults and fractures to depth. These cavities can be filled with water, which provides hydrostatic pressure and keeps the cavities stable. If the cavities are dewatered, the stability is removed and the probability of sinkhole development increases.

The geomorphology of the weathered dolomitic aquifer, which has relevance to the geohydrology of the Libanon TSF, is presented in Figure 4 (Jones and Wagener, 2013). This aquifer has specific significance to the project, as the TSF is located on outcropping dolomite. The base of this aquifer was identified by means of a gravity geophysical survey completed by the Council for Geoscience, as presented in Figure 4. The information indicates that the base of the weathered dolomites is highly irregular, with an average depth of 200 m.

South of Libanon TSF, formations of the Pretoria Group outcrop, including ferruginous shale and quartzite of the Timeball Hill Formation, Hekpoort lavas, as well as shale outcrops of the Strubenkop and Silverton Formations.

Some Karoo sediments have remained as inliers above the dolomite, delineated as the Vryheid Formation in Figure 3.

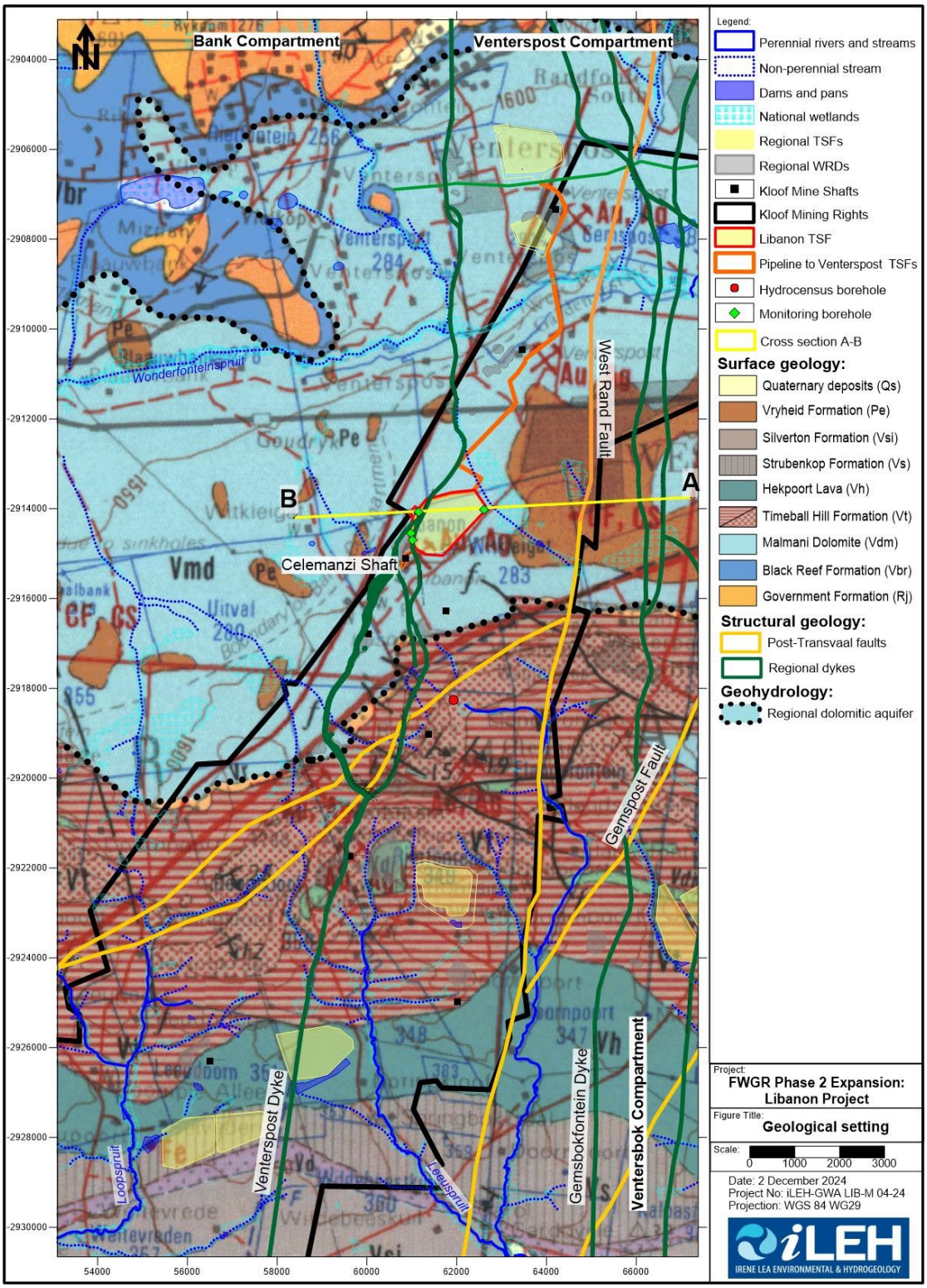


Figure 3. Project area geology

4.3.1 STRUCTURAL GEOLOGY

The structural geology forms an important component of the hydrogeological setting of the project and is complex in this region. The information presented here is based on work completed by Dr Marius van Biljon (Jones & Wagnener, 2013).

The structural geology governs aquifer development and regional groundwater flow patterns. The region is characterised by several folds, of which the southern limb of the east-west striking Rand Anticline transects Kloof Mine. This structure affects the deeper geological setting and the underground mining areas and is distorted by several north-south trending folds. The result is a regional geological structure interpreted as domes and cusps (basins). Within the dome structures, prominently deeply weathered grykes form from the dolomite surface. A gryke is a deep narrow slot filled with dolomite wad. Dolomitic aquifers are also typically formed within the dome structures. The cusp structures for the most efficient groundwater conduits at the intersections of the synclinal fold axes. Some of the cusp structures resulted in post-Transvaal age faults, which are younger in geological age than he dolomites. These faults link the underground mine workings with the weathered dolomite aquifer that can yield significant volumes of groundwater and increased seepage to the mining areas. The positions of the post-Transvaal faults in the project area are indicated on Figure 3. It is shown that none of these faults transect the Libanon TSF footprint.

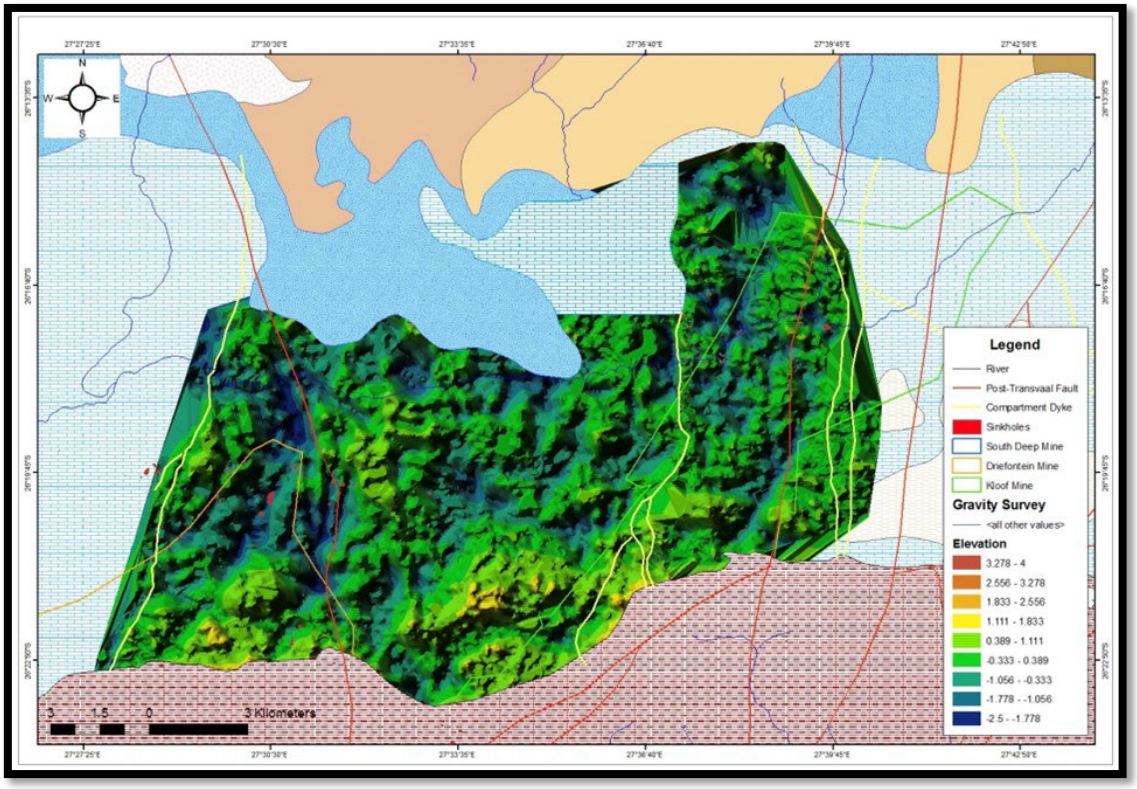


Figure 4. Geomorphology of the weathered dolomite aquifer (Jones & Wagener, 2013)

In addition to the regional post-Transvaal faults, regional diabase (dolerite) dykes have intruded into some of the north-easterly striking faults. Many of these faults penetrated the full Transvaal sequence as well as the underlying Ventersdorp and Witwatersrand Supergroups. These dykes have subdivided

the dolomites in watertight compartments. A number of these dolomitic compartments are present in the region, including the Gemsbokfontein, Venterspost and Bank compartments, as indicated on Figure 3.

The Libanon TSF is located on the western edge of the Venterspost Compartment and possibly to some extent on the Bank Compartment, as shown in Figure 3. The eastern boundary of the Venterspost Compartment is formed by the Gemsbokfontein No 2 Dyke and the western boundary by the Venterspost Dyke, which transects the western boundary of the Libanon TSF. The northern boundary of the dolomitic compartments is formed by the outcrop of the dolomite against the Black Reef Quartzite. The southern boundary is formed by the overlying Transvaal sediments.

Prior to mining, groundwater levels in the dolomitic compartments varied due to the impermeable nature of the compartment forming dykes. Mining activities have however punctured these dykes in places. The Venterspost Compartment is largely dewatered. The water level in the compartment is estimated to be around 1400 mamsl, which is more than 150 m below surface underneath the Libanon TSF. The dewatering rate is reported as 40.4 ML/d from the Celemanzi (Kloof No 10) Shaft (Kongiwe, email dated 6 November 2024).

5 Site Investigations

Three sets of shallow and deep monitoring boreholes were drilled and tested as part of this project. The locations of the boreholes are indicated on Figure 1 and Figure 2. The results of the drilling programme indicate the presence of thick residual dolomite, referred to as wad underneath the Libanon TSF footprint. This material has very low permeabilities and act largely as an aquitard. One of the deeper boreholes intersected a cavity in the dolomitic formation, which complicated the drilling process. This is discussed in more detail below.

Due to the presence of the residual dolomite and dewatered environment, aquifer tests could only be completed on two of the boreholes drilled. Slug tests were completed on three of the remaining boreholes. Groundwater samples were collected from two of the boreholes that contained groundwater at the end of the drilling and testing programs.

5.1 Desktop Study

A desktop study was completed with information made available for the project, including results from a hydrocensus conducted as part of this study. The list of documents assessed is presented in the references at the end of this report. All information that was used during the assessment is summarised in the report.

5.2 Hydrocensus

A hydrocensus was conducted across the study area during August 2024. The survey included the Libanon TSF property, plus accessible properties within a 4.5 km radius, and concentrated on identifying existing boreholes to enhance the knowledge of the groundwater systems and current groundwater use. Only one borehole was identified on one of the properties on the ridge to the south (Table 2).

During the hydrocensus the following information was collected for each site:

- Borehole position (X, Y, Z-coordinates).
- Information relating to equipment installed.
- Borehole construction details.
- Borehole yield – if known by the landowner.
- Groundwater level, if possible.
- Current use.

Fourteen properties that were visited had no boreholes. These include:

- Libanon TSF property.
- Landfill site north of Libanon TSF.
- Westonaria Cemetery.
- Hendrik Van Niekerk Waste Water Treatment Works.
- WESTCOL Westonaria - School.
- Westonaria High School.
- Westonaria Primary School.
- Gerrit Maritz Primary school.
- Rand Water Depot Westonaria.
- Klipfontein Guest House, Wagterskop.
- Libanon Mine Town.
- Eskom Distribution Libanon.
- Kos-Mos – Restaurant.
- Mr Oberholzer's farm west of Libanon Town.

A summary of the hydrocensus information is available in Table 2. All coordinates were taken with a hand-held Garmin GPS (Global Positioning System) (WGS84).

The extent of the study area, budget and time constraints, and land access limited the hydrocensus in terms of surveying every property in the area. The study aimed to cover the whole area to ensure a data set representative of the study area.

Only one borehole was identified during the hydrocensus, and a groundwater level could not be measured due to security measures installed to safeguard the borehole pump (Table 2). Detailed information in terms of borehole construction and yield, plus water strike depths are not known for the identified hydrocensus site. Time series groundwater level or quality data are also not available for the private borehole to determine seasonal groundwater changes for the area. A groundwater sample was collected from the one borehole (see Section 5.7).

Locally surface drainage and possibly groundwater flow will be towards the Wonderfonteinspruit. The groundwater table governs water flow and in similar geological terrains a relationship exists between the groundwater table and the topography. This correlation is known as the Bayesian relationship. The borehole collar elevation is plotted against the measured groundwater elevation to test if this relationship is applicable. This was not possible for the Libanon TSF area due to the lack of rest level data.

Generally, a groundwater mound occurs beneath a TSF because of seepage from the TSF, that recharges the underlying aquifer. This results in radial flow from the TSF footprint but assumes regional flow direction again as the distance increases from the TSF.

Table 2. 2024 Hydrocensus data

Site ID	Lib 1
Lat (WGS84)	26°22'21.26"S
Long	27°37'14.26"E
Elev (mamsl)	1732
Locality	Kobus Oberholzer farm
Water depth (mbgl)	sealed
Collar height (m)	0,15
Water elevation (mamsl)	--
BH depth (m)	100
Yield (L/hr)	good
Casing diameter (mm)	165
Sampled	yes
Pump type	submersible
Use	domestic, gardens
Notes	Only source of water

5.3 Geophysical Survey

A ground geophysical investigation was conducted to identify linear geological structures in the area which could act as preferential groundwater flow paths. The geophysical survey has been used in conjunction with the available remote sensing images and geological maps.

The geophysical survey was conducted on 14 and 15 October 2024 and included Magnetics and Electromagnetic (EM34-3) surveying only. The survey included 3 survey lines, and the line and station coordinates were marked in the field using a handheld Garmin GPS (Figure 5).

The interpretation of the data was done with care as the response of the instruments can be influenced by shallow weathered zones (e.g., clay) and cultural effects such as fences and buried objects.

5.3.1 Magnetometer Survey

Many geological formations by virtue of their content of magnetic minerals will behave like buried magnets and have associated with them a magnetic field. This local magnetic field will be superimposed on the normal magnetic field of the earth. Measurements of the magnetic field taken in the locality of such geological formations will show departures from the undisturbed earth's magnetic field in the vicinity of these formations. These changes, or anomalies as they are called, could be larger or smaller and could be either an increase or a decrease of the earth's field and will

depend on the depth of burial, degree and direction of magnetisation, and the attitude of formation in relation to the direction of the earth's field at that locality.

Many rocks and minerals are weakly magnetic or are magnetized by induction in the Earth's field and cause spatial anomalies in the Earth's main field.

The magnetometer survey reflects the physical process by which the magnetic field is measured. Proton procession instruments have a sensor filled with a hydrogen rich fluid (like kerosene). An inductor (geological unit such as a dyke) creates a strong magnetic field in the fluid resulting in the alignment of protons. When the inducted current is suspended, the relaxation rate, as the protons return to ambient magnetic conditions is recorded. This rate is directly proportional to the magnetic field.

The Magnetic survey was run in support of the EM survey and was run on the same survey lines as the EM survey, at 5 m reading intervals.

5.3.2 The Electromagnetic Method

Frequency Domain Electromagnetics (FDEM) techniques use a primary time-varying magnetic field produced in a transmitter coil to induce the flow of electrical current in subsurface conductors via electromagnetic induction. By measuring the secondary magnetic fields or response of these currents, electrical and magnetic properties of the subsurface or causative body can be deduced.

FDEM is effective at mapping major lateral changes in shallow subsurface electrical conductivity due to variations in water conductivity (salinity), water saturation, porosity, presence of clays, conductive minerals (graphite and massive sulphides) and man-made metallic objects. FDEM relies on a contrast in physical properties of materials.

The EM34 data was recorded every 10 meters, with coil separations of 20 m and 40 m used on each survey line.

The geophysical data is presented in Appendix B. The geophysical survey was successful in identifying three drilling targets (Table 3 and Figure 5).

Table 3. Proposed drill targets

Site number	Latitude (WGS84)	Longitude	Notes
Line 1, station 480	26°20'02.06"S	27°37'37.98"E	Upstream monitoring
Line 2, station 250	26°20'25.35"S	27°36'40.44"E	Downstream monitoring
Line 3, station 240	26°20'04.70"S	27°36'45.09"E	Downstream monitoring

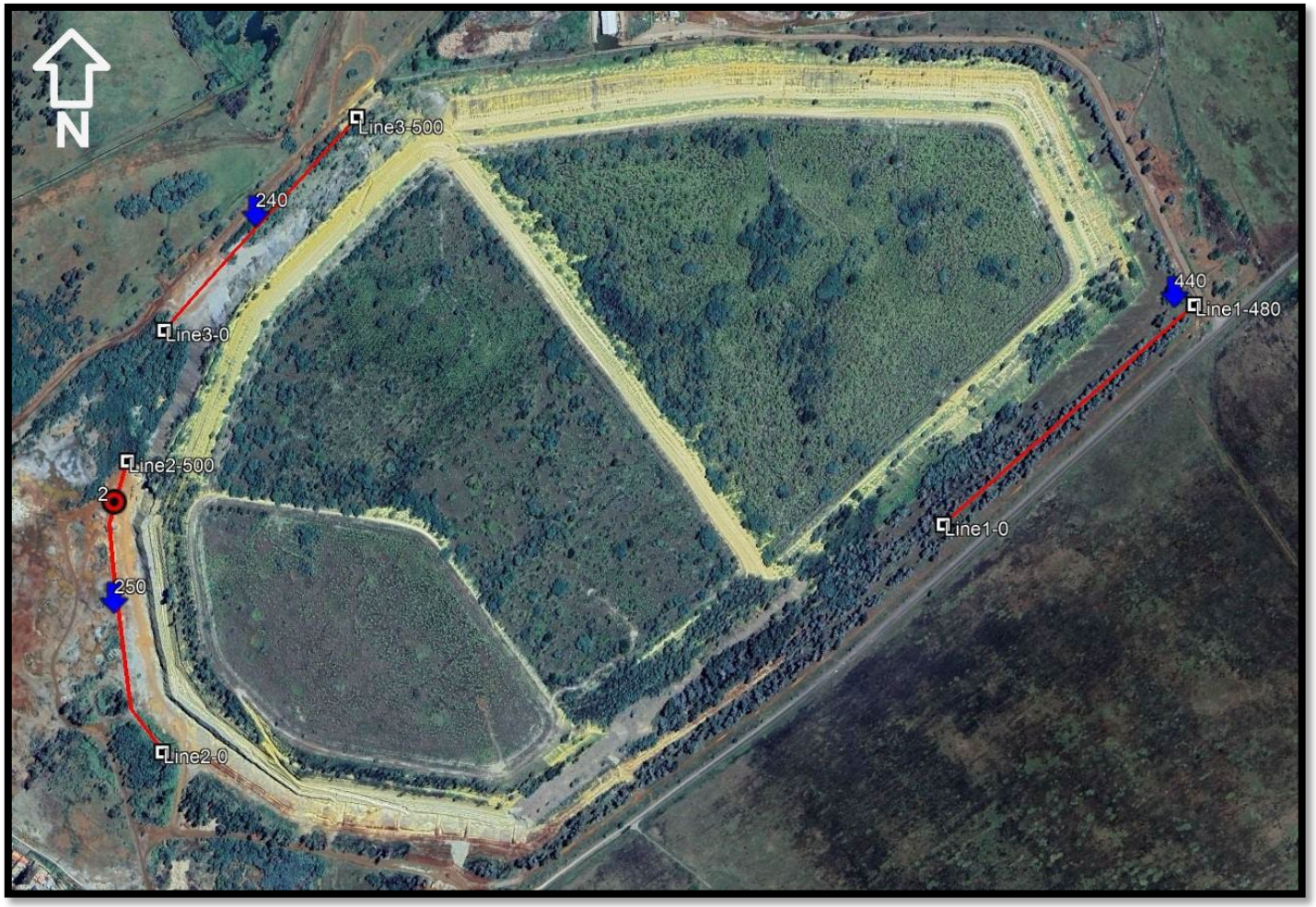


Figure 5. Geophysical survey layout

5.4 Drilling Program

Based on the geophysical survey, three drilling positions were identified around the footprint area of Libanon TSF (Table 4 and Figure 5). The percussion drilling program was carried out during October 2024, by Redirile Drilling.

Two groundwater characterisation and monitoring boreholes were drilled at each of the 3 target areas (Figure 5) – the one borehole was drilled to a depth of 80 m below surface, with the aim of characterising and monitoring the deeper fractured aquifer. The second borehole was drilled 30 m deep, with the aim of monitoring potential groundwater flow, quality and possible connection between the deeper fractured aquifer and the shallow weathered aquifer in the area.

Data collected include the recording of geological formations at 1 metre intervals, water strike depths, the cumulative final blow yield and final rest water level. A summary of the results is presented in Table 4.

The borehole construction details are as follows:

- Deep boreholes (80 m) – 177 mm diameter solid steel casing from surface to 30 m below surface. Beyond this depth the diameter of the borehole is 165 mm.
- Shallow boreholes (30 m) – drill diameter is 203 mm with 177 mm steel casing installed over the full depth of the borehole. The bottom 12 m was perforated.

The geological profiles intercepted by the percussion drilling program are presented in Appendix C.

Two of the 6 new percussion boreholes produced a measurable groundwater level, post drilling (boreholes Lib BH3s and Lib BH3d). The other four boreholes produced no water and remained dry post closure. There were no measurable blow yields with only seepage water observed for boreholes Lib BH3s and Lib BH3d (Table 4).

The depth of weathering varies between 25 and 35 m bgl (Table 4).

Table 4. Drilling summary October 2024

		Borehole ID	Lib-BH 1s	Lib-BH 1d	Lib-BH 2s	Lib-BH 2d	Lib-BH 3s	Lib-BH 3d
Borehole Location	WGS84	Latitude	26°20'03.12"S	26°20'02.78"S	26°20'25.33"S	26°20'20.09"S	26°20'05.07"S	26°20'04.77"S
		Longitude	27°37'37.77"E	27°37'38.00"E	27°36'40.63"E	27°36'39.13"E	27°36'45.05"E	27°36'45.14"E
		Elevation	1599 mamsl	1598 mamsl	1616 mamsl	1609 mamsl	1602 mamsl	1601 mamsl
Borehole Data	Borehole Depth (m)		30	60	18	50	30	80
	Blow Yield (L/hr)		Dry	Dry	Dry	Dry	Seepage	Seepage
	Water Strike depth (m)		None	None	None	None	None	None
	Main Strike Geology		--	--	--	--	--	--
	Borehole Geology		Clays, chert, dolomite	Quartzite, clays, dolomite Cavity at 48-60m	Quartzite, clays	Sandstone, quartzite, clays	Lava, sandstone, quartzite, clays	Lava, sandstone, quartzite, clays, dolomite
	Solid Steel Casing (170mm ID)		0 – 18m	0 - 48m	0 – 6m	0 - 30m	0 – 18m	0 - 48m
	Perforated Steel Casing (170mm ID)		18 – 30m	none	6 – 18m	none	18 – 30m	none
	Static Water Level (mbgl)		Dry	Dry	Dry	Dry	20.87	77.17
	Depth of Weathering (m)		25	30	18+	35	30+	32

5.5 AQUIFER TESTING

Following completion of the drilling programme, an aquifer test programme was initiated to determine the hydrogeological characteristics of the local aquifers, where possible.

VSA Leboa Consulting was appointed by Water Hunters to conduct yield testing of the newly drilled boreholes. Only 5 of the 6 boreholes were available for yield testing, consisting of shallow (30 m) and deep (80 m) boreholes. Borehole Lib BH1d (deep borehole) intercepted a cavity at depth and was not tested.

The aquifer test program includes defining:

- Borehole drawdown and recovery characteristics.
- Aquifer hydraulic parameters:
    - Transmissivity (T) defined as the product of the average hydraulic conductivity (K) and the saturated aquifer thickness. It is a measure of the rate of flow under a unit hydraulic gradient through a cross-section of unit width over the whole saturated thickness of the aquifer. The unit of measurement is m^2/day.
- Characterisation of aquifer flow boundaries such as low permeable, no-flow or recharge boundaries. No-flow or low permeable boundaries refer to a lower transmissive structure (e.g., fracture with a lower conductance or low permeable dyke) or aquifer boundary (limit of aquifer – no-flow boundary) that results in an increase in groundwater drawdown during borehole abstraction. Recharge boundaries relate often to leakage from surface water bodies.

Prior to the aquifer test, static groundwater levels are measured in the pumping boreholes to enable drawdown calculations during test pumping. During the test, the abstraction rate is continuously monitored by means of electronic flow meters and calibrated by manually measuring the time it takes to fill a container of known volume, with a stopwatch and drum.

The testing methodology and results were received from VSA Leboa Consulting, upon completion of the test program. The aquifer test data and drawdown graphs are presented in Appendix D.

For this project maximum drawdown pump tests were conducted on the two low yielding boreholes (boreholes Lib BH3s and Lib BH3d), followed by a recovery test after each test. Slug tests were conducted on three of the dry boreholes (slug in / infiltration tests) (Lib BH1s, Lib BH2s and Lib BH2d). These processes are discussed in more detail below.

A **slug test** is a controlled field experiment performed to estimate the hydraulic properties of aquifers and aquitards in which the water level in a control environment is caused to change suddenly (rise or fall) and the subsequent water-level response (displacement or change from static) is measured through time in the borehole. Slug tests are also referred to as rising-head or falling-head tests to describe the direction of water-level recovery in the borehole following test initiation (HydroSOLVE, Inc).

The goal of a slug test, as in any aquifer test, is to estimate hydraulic properties of an aquifer system such as hydraulic conductivity. Aquifer properties are estimated from a slug test by fitting mathematical models to displacement data using curve matching. Curve matching may involve fitting type curves or straight lines to the measured data (HydroSOLVE, Inc).

At Libanon TSF, three of the dry boreholes were tested by introducing a large volume of water in the dry hole and measuring the height of the water column inside the borehole after slug introduction and then measuring the rate of change in the water column height for at least 1 hour. VSA Leboa Consulting concluded that the slug test analysis shows some heterogeneity in the aquifer system, with hydraulic conductivity (k-value) values ranging from 0.000003 m/d to 0.0035 m/d (Table 5). The average k-value is 0.001 m/d, based on the model fits, was determined from the slug test. Large variations in the k-values were observed, mostly due to the analytical solutions fitting the data and heterogeneity in die geology formations.

Table 5. Summary of the aquifer parameters (hydraulic conductivity in m/day) based on the slug tests

BH ID	Slug In/Out	Aquifer properties (Slug Test)			
		Bouwer-Rice		KGS Model	
		K-value	*Yo-value*	*K-value*	*Ss-value*
BH2B	In	0.0035	4	0.000140	1.00E-02
BH2A	In	0.0025	0.7	0.0021	5.00E-04
BH1B	In	0.00057	3.2	0.00003	2.00E-04

The **maximum drawdown test** is a method developed as a rapid means of assessing the potential yield of boreholes. The results may indicate whether it is feasible to perform other tests on the borehole. The test involves measuring the water level response in a borehole to the rapid abstraction of water until pump inlet is reached. The flow rate / pumping rate is then reduced and continuously adjusted until a stable pumping level is maintained.

The **recovery test** follows directly after pump shut down, at the end of the SDT and CDT. The residual drawdown over time (water level recovery) is measured in production and observation boreholes until approximately 90% recovery is reached, or equal to test duration. Aquifer parameters and sustainable borehole yields can be derived from the time drawdown data by application of a variety of analytical methods.

Although these short-term tests cannot be considered as the ideal way of evaluating the long-term sustainability of a groundwater resource, it does provide a quick and simple way of evaluating the short-term performance characteristics of a borehole. It must be emphasised that calculations done from test pumping data are only representative of the aquifer characteristics in the immediate surrounding of the borehole. Factors such as aquifer transmissivity as well as the length of a test, will determine the area of influence reached during testing (the longer the test, the greater the area of influence and more accurate the predictions).

A summary of the test programme is given in Table 6. The pumping test data is used during the calibration of the groundwater numerical model.

The recovery of the groundwater table after abstraction, or introduction of the slug is a good indicator of the aquifer's transmissivity and recharge. The recovery data (for the tested boreholes) indicate that the recovery is slow, and that full recovery (100%) was not achieved within the predetermined testing timeframe (Table 6).

Table 6. Summary table of the yield testing results

Borehole ID	Lib-BH 1s	Lib-BH 1d	Lib-BH 2s	Lib-BH 2d	Lib-BH 3s	Lib-BH 3d
Borehole Depth (m)	30	60	18	50	30	80
Static Water Level (m bgl)	Dry	Dry	Dry	Dry	20.87	77.17
Test pump depth (m bgl)	No test. No water level. No slug test due to sinkhole	Slug Test (Slug In)	Slug Test (Slug In)	Slug Test (Slug In)	29.5	79.0
Available drawdown (m)					7.01	4.77
Steps (60 minutes)					1 (20 min)	1 (40 min)
Max step yield (L/hr)					648	108
Constant Discharge Duration (hrs)					--	--
Maximum drawdown					Full, 6.55 m	Full, 4.79 m
Pumping level at end of test					29 m below surface	79 m below surface
Slug test rise in water level (m) (Slug In)		3.1	0.76	5.40	--	--
Recovery Time		2% in 50 min.	25% in 1 hr	42% in 1 hr	81% in 20 hrs	6% in 3 hrs
Potential Yield		--	--	--	0 L/hr	0 L/hr
T value (m^2/day)		--	---	--	0.5	0.1
Bouwer-Rice K-value (m/d)		0.00057	0.0025	0.0035	--	--
Water Sample	No	No	No	No	Yes	Yes

Groundwater samples were collected from two of the new boreholes during the aquifer test programme. The results are presented in Section 5.7.

5.6 Groundwater Availability Assessment

No information could be recorded during the hydrocensus on the volumes of groundwater used in the borehole identified (Lib 1, see Figure 1).

The Libanon TSF is underlain by dolomite, which typically forms major aquifers. The former DWAF published 1:500 000 scale hydrogeological map borehole yield classification is summarised below. The map considers all available data, including blow yields. The regional distribution of borehole yield on the published maps indicates the following:

- Karst aquifers: Yields in these aquifers are often more than 5 litres per second (L/s). However, data from the boreholes drilled around the Libanon TSF suggest much lower yields – less than 0.5 L/s in the residual dolomite (wad) intersected.
- Intergranular and fractured aquifers: Groundwater occurs in intergranular interstices and in fractures, notably associated with crystalline rocks, but also with sedimentary rocks. These types of aquifers are associated with the Hekpoort andesite as well as the Timeball Hill and Strubenkop Formations. The yields of these aquifer typically vary between 0.5 to 2 L/s.

5.7 Groundwater Quality

During the August 2024 hydrocensus only one borehole was identified, and a groundwater sample was collected (borehole Lib 1) (Table 8). Another two groundwater samples were collected during the aquifer test program (Table 8).

A sterilized 500 millilitre (ml) sample bottle was used and filled to the top, for each borehole sampled. Samples were stored in a cooler box during the site assessment. The water samples were analysed for basic inorganic parameters and the results were compared against the SANS 241:2015 Drinking Water Standards.

The water samples were submitted to Aquatico Laboratories for analysis. Aquatico is a SANAS accredited laboratory (South African National Accreditation System). The water samples were analysed for basic inorganic parameters and the results were compared against the SANS 241:2015 Drinking Water Standards. The DWS's Drinking Water Standard was also considered.

The samples were taken using a single valve, decontaminated bailer, during the aquifer test program (prior to testing). The hydrocensus sample was collected from the pump discharge line.

The water quality results are presented in Table 8 and the laboratory certificates are presented in Appendix E. Refer to Figure 1 for borehole localities. Based on the water quality results the following conclusions were drawn (SANS 241:2015 comparison):

- Chronic Health effects:
    - Total Iron – The speciation of iron is also related to the pH and Eh of water. An elevated iron concentration (exceeding the chronic health limits) was recorded for

borehole Lib-BH3s (7.62 mg/L), with the SANS limit set at 2 mg/L (Table 8). The concentration of dissolved iron in water is also dependent on the occurrence of other heavy metals or could be related to the local Karoo and dolomite geology or leaching from the TSF.

Borehole Lib-BH3s is on the downstream side (west) from Libanon TSF. The total iron concentrations were below the detection limit for the other two sampled sites.

- Manganese – Manganese is a relatively abundant element, constituting approximately 0.1% of the earth's crust. Borehole Lib-BH3s measured a manganese concentration that could result in chronic health effects (22.2 mg/L) (Table 8). The health impact limit is set at 0.4 mg/L. Manganese tends to precipitate out of solution to form a black hydrated oxide which is responsible for staining problems.

  The manganese concentration could be related to the local Karoo and dolomite geology or leaching from the TSF. The manganese concentrations were below detection limit or the SANS aesthetic limit for the other two sampled sites.

- Sulphate – Sulphate forms salts with various cations such as potassium, sodium, calcium, magnesium, barium, lead and ammonium (DWAF, 1996). Sulphate is a common constituent of water and arises from the dissolution of mineral sulphates in soil and rock. Since most sulphates are soluble in water it tends to accumulate to progressively increasing concentrations. Contamination by sulphate is to be expected in waters contaminated by processing activities, due to the oxidation of sulphides in the ore and waste.

  Borehole Lib-BH3s exceeds the health guideline limits for sulphate with a measured concentration of 1623 mg/L. The health limit set at 500 mg/L) (Table 8).

  The sulphate concentrations were below detection limit or the SANS aesthetic limit for the other two sampled sites.

- Nickel – An elevated nickel concentration was recorded for Lib-BH3s (0.136 mg/L). The maximum SANS guideline health limit is 0.07 mg/L. The nickel concentrations were below the detection limit for the other two sampled sites.

- Aesthetic / Operational effects:
  - Ammonium – The chemistry of ammonia is very complex, especially where transition metals are present in water, and while ammonia itself is of relatively low toxicity, this is not necessarily the case for some of its organometallic complexes. Taste and odour complaints are likely to occur if the ammonia concentration exceeds 1.5 mg/L. High concentrations of ammonia can also give rise to nitrite, which is potentially toxic, especially to infants. The ammonium concentration for borehole Lib-BH3s exceeds the aesthetic limits for drinking water (13.0 mg/L) with the aesthetic limit set at 1.5 mg/L.
  - Total hardness – Very hard total hardness values were measured at the two downstream boreholes at Libanon TSF – Lib-BH3s and Lib-BH3d. Scaling is likely to occur in water heating appliances.

The DWS uses a water classification system where the water is defined in different classes based on a fitness for use classification (see Table 7). The element concentrations are like the SANS guideline limits, but with the DWS system a classification is assigned to the water sample, e.g., Class 2 water.

Table 7. DWS water quality "fitness for use" classes

Water use	Categorisation	Description
Domestic	Class 0	Water of ideal quality, which has no health or aesthetic effects, and which is suitable for lifetime use without negative effects. No treatment necessary.
	Class 1	Water of good quality, suitable for lifetime use with few health effects. Aesthetic effects may be apparent. Home treatment will usually be sufficient.
	Class 2	Water which poses a definite risk of health effects, following long term or lifetime use. However, following short-term or emergency use, health effects are uncommon and unusual. Treatment will be required in order to render the water fit for continued use.
	Class 3	Water is unsuitable for use, especially by children and the elderly, as health effects are common. Conventional or advanced treatment necessary

Based on the DWS classification system the sampled water is categorized as:

- Hydrocensus borehole Lib 1 – Class 0 water (Water of ideal quality).
- Libanon TSF Downstream borehole Lib-BH3s – Class 4 water (water is unsuitable for use) due to the sulphate and manganese concentrations and then Class 3 (water is unsuitable for use) due to the total iron concentration.
- Libanon TSF Downstream borehole Lib-BH3d – Class 1 (Water of good quality) due to the Total Hardness, and the calcium and fluoride concentrations. The rest of the parameters measured were in the Class 0 range.

The chemicals of concern for the Libanon TSF project area, associated with the recent sampled results are Manganese, Iron, Sulphate and Nickel. Based on the SANS241 drinking water guidelines and on the sampled water results, the groundwater from borehole Lib-BH3s is not fit for human consumption (unless treated).

A groundwater study by Rösner et al, 1998 (WRC Report K5/797/0/1) concluded that groundwater near tailings dams is affected by salt loads. The groundwater quality improved with increasing distance down gradient from the pollution source, mainly because of dilution and solid speciation. Once contaminants have migrated through the unsaturated zone, into the groundwater zone, the rate of lateral movement increases by orders of magnitude. The implication of this is that although there is a dilution effect because of contact with groundwater, the potential impact on the environment is extended in a spatial and temporal sense.

A TSF can potentially add sulphate, iron, chloride, calcium, magnesium, manganese and aluminium to the local groundwater system, if the management of contaminated water on site is not effective, but also through seepage to the underlaying aquifers. Metals like cobalt, copper, nickel and zinc are often elevated. In general, sulphate concentrations around the tailings complexes vary between 417 and 4700 mg/L.

Table 8. Groundwater quality – 2024

	DWS Drinking Water Guideline Limits					SANS241:2015 Drinking Water Standard Limits		LIB 1	Lib-BH3s	Lib-BH3d
	Class 0	Class 1	Class 2	Class 3	Class 4	Aesthetic effects	Chronic health effects			
pH	5-9.5	***4.5-5 or 9.5-10***	4-4.5 or 10-10.5	3-4 or 10.5-11	<3 or >11	≥5 to ≤9.7		6.92	6,24	8,28
Electrical Conductivity	<70	***70-150***	150-370	370-520	>520	Aesthetic ≤170		3.48	**317**	54,8
TDS	<450	***450-1000***	1000-2400	2400-3400	>3400	Aesthetic ≤1200		30.0	**2644**	318
Total Alkalinity								3.30	65,7	219
Bicarbonate Alk.								3.29	65,7	215
Total Hardness	<200	***200-300***	300-600	>600		more than 180 mg/l, very hard		7	**1489**	**276**
Total Nitrogen								1.41	27,2	1,18
Total Kjeldahl Nitrogen								<0.5	26,2	<0,5
Total oxidised nitrogen								1.41	0,996	1,12
Aluminium		***0 - 0,15***	0,15 - 0,5	>0,5		Operational ≤ 0,30		<0.002	<0.002	<0.002
Arsenic	<0,01	***0,01-0,05***	0,05-0,2	0,2-2	>2		Chronic health ≤0,01	<0.006	<0.006	<0.006
Calcium	<80	***80-150***	150-300	>300				0.92	**269**	**42,4**
Copper	<1	***1-1,3***	1,3-2	2-15	>15		Chronic health ≤2	<0.002	<0.002	<0.002
Total Iron	<0,5	***0,5-1***	1-5	5-10	>10	Aesthetic ≤0,3	Chronic health ≤2	<0.004	**7,62**	<0,004
Magnesium	<70	***70-100***	100-200	200-400	>400			1.14	**198**	41,2
Manganese	<0,1	***0,1-0,4***	0,4-4	4-10	>10	Aesthetic ≤0,1	Chronic health ≤0,4	<0.001	**22,2**	0,017
Potassium	<25	***25-50***	50-100	100-500	>500			<0.015	16,8	2,69
Sodium	<100	***100-200***	200-400	400-1000	>1000	Aesthetic ≤200		2.48	**181**	12,7
Chloride	<100	***100-200***	200-600	600-1200	>1200	Aesthetic ≤300		1.92	**275**	33
Fluoride	<0,7	***0,7-1***	1-1,5	1,5-3,5	>3,5		Chronic health ≤1,5	<0.263	0,635	**0,845**
Ammonium						Aesthetic ≤1,5		<0.008	13	0,059

	DWS Drinking Water Guideline Limits					SANS241:2015 Drinking Water Standard Limits		LIB 1	Lib-BH3s	Lib-BH3d
	Class 0	Class 1	Class 2	Class 3	Class 4	Aesthetic effects	Chronic health effects			
Un-ionized Ammonia	0 - 1	***1 - 2***	2 - 10	>10				<0.005	0,012	0,006
Nitrate	<6	***6 - 10***	10 - 20	20-40	>40		Acute health ≤11	1.40	0,938	1,1
Nitrite							Acute health ≤0,9	<0.065	<0,065	<0,065
Total organic carbon	<5	***5 - 10***	10 - 20	>20			Chronic health ≤10	1.67	3,21	2,2
Ortho Phosphate as P								0.332	<0,009	<0,009
Sulphate	<200	***200-400***	400-600	600-1000	>1000	Aesthetic ≤250	Acute health ≤500	<0.141	1623	38,7
Cadmium							Chronic health ≤0.003	<0.002	0,003	<0,002
Total Chrome	0 - 0,05		0,05 - 1	1 - 5	>5		Chronic health ≤0,05	<0.01	<0.01	<0.01
Nickel							Chronic health ≤0.07	<0.002	0,136	<0,002
Cobalt								<0.003	0,483	<0,003
Selenium							Chronic health ≤0.04	<0.002	<0,002	0,004
Uranium							Chronic health ≤0.03	<0.015	<0.015	<0.015
Zinc	0 - 5	**5 - 10**	10 - 50	50 - 700	>700	Aesthetic ≤5		<0.002	<0.002	<0.002
Boron							Chronic health ≤2.4	<0.013	<0.013	<0.013
Barium							Chronic health ≤0.7	<0.002	0,024	0,056
Beryllium								<0.005	<0.005	<0.005
Molybdenum								<0.004	0,223	0,073
Strontium								<0.007	1,21	0,082
Tungsten								<0.000001	0,0431	<0.000001
							DWS Classification	**0**	**4**	**1**

The pyrite present in the tailings and sand material is oxidised in the presence of oxygen and water to form ferrous sulphate and sulphuric acid. Both reactions result in an acidic pH, and high sulphate and metal concentrations, leading to Acid Mine Drainage; often measured in leachate from these TSFs. The rate at which pyrite oxidation takes place within the TSF varies and decreases with depth. The addition of lime during the gold recovery process raises the pH to neutral conditions when tailings are deposited on the facilities. Negative quality impacts are expected when the material is disturbed again and exposed to oxygen and water.

Libanon TSF is surrounded by mining, residential and agricultural areas. Many pollution sources (mining activities and poor waste and sanitation management) can contribute to groundwater contamination. It will be difficult to define the contaminants and concentration at all point sources in the area.

5.8 Date and Season of the Investigation

The hydrocensus was completed during August 2024 during the dry, winter season in Gauteng. The 2024 fieldwork programme was completed between October and November 2024, which represents the end of the dry season conditions.

6 Hydrogeology

This section presents a general understanding of the site conditions in terms of geology, groundwater occurrence, groundwater level and water quality. According to Barnard (2000) various aquifer types are found in the area i.e., weathered and fractured aquifers. The Transvaal Supergroup and the Witwatersrand formations present aquifers that have a combination of loose unconsolidated/ weathered material overlaying hard rock formations, in which fractures, fissures or joints potentially hold water. Groundwater is often encountered in both the saturated weathered material below the regional groundwater rest level and in the transition zone between weathered and fresh formations.

6.1 Regional Geology

The regional surface geology for the project area is presented in Figure 3. Regionally the geology consists of formations of the Karoo, Transvaal, Ventersdorp and Witwatersrand Supergroups. Gold mineralisation is present in conglomerates of the Witwatersrand Supergroup. The Ventersdorp Contact Reef, Kloof Reef and the Middelvlei Reef were extensively mined in the Kloof underground workings. The Kloof Celemanzi (Kloof 10 Shaft) is located immediately southwest of the Libanon TSF, as indicated on Figure 3. The northern section of Kloof Mine was previously known as Venterspost and Libanon Mines. These northern sections have been mined out, but some of the Kloof Shafts remain open to dewater the old underground workings to preserve regional gold mining activities. The depth of the Ventersdorp Contact Reef underground workings is at least 800 to 1000 m below surface with deeper mining associated with reefs lower in the geological succession. The lower unit of the Witwatersrand Supergroup comprises the West Rand Group and the upper unit the Central Rand Group. The West Rand Group is divided into three subgroups including the Hospital Hill, Government Reef and Jeppestown Formations. These comprise mainly shale, quartzite, banded ironstone, tillite and intercalated lava flows. North of Libanon TSF, the Government Formation outcrops. The Ventersdorp Supergroup overlies the Wits formations and comprises mainly andesitic lavas and related volcanic pyroclastics.

The overlying Transvaal Supergroup formations are of specific interest to this study. The Black Reef quartzite, which is present at the base of the Transvaal Supergroup outcrops north of the project area. Of the Transvaal Supergroup Formations, the Chuniespoort Group are of most significance, as the Libanon TSF is located on outcropping Malmani dolomite. The dolomite varies in thickness regionally from around 200 to 1500 m. Underneath the Libanon TSF, the base of the dolomite is at an elevation of 1000 to 800 mamsl and dips in a southerly direction (Jones and Wagener, 2013).

Refer to Section 4.3 for more details.

6.2 GEOCHEMISTRY

During tailings deposition and after closure, seepage from the tailings facility walls is largely removed by the drain systems. A study has shown that the top 3 metres of an old TSF indicate low element concentrations, as leaching from rainfall most probably flushed out the minerals. Deeper into the TSF the pH is much lower and element concentrations higher, but due to stable conditions that include low permeability and low oxygen levels, metal and salt leaching does not happen readily (Irene Lea, 2016). This could potentially change when the reclamation process introduces high volumes of water and oxygen.

The prerequisite for AMD is the generation of acid at a faster rate than it can be neutralised by any alkaline materials in the system, with pyrite being the most common mineral in AMD formation. The oxidation of pyrite occurs in the following steps:

$$2FeS_2 + 7O_2 + 2H_2O = 2Fe^{2+} + 4SO_4^{2-} + 4H^+ \quad (1)$$
$$4Fe^{2+} + 10H_2O + O_2 = 4Fe(OH)_3 + 8H^+ \quad (2)$$
$$2Fe^{2+} + O_2 + 2H^+ = 2Fe^{3+} + H_2O \quad (3)$$
$$FeS_2 + 14Fe^{3+} + 8H_2O = 15Fe^{2+} + 2SO_4^{2-} + 16H^+ \quad (4)$$

The intensity of acid generation is determined by chemical parameters such as pH, temperature and oxygen concentration in the different stages and the surface area of the exposed metal sulphides (Nengovhela, October 2006).

The reclaimed slurry and any water must be removed from the exposed surfaces (immediately) to avoid seepage of contaminated water into the shallow weathered aquifers.

6.2.1 ACID GENERATION CAPACITY

The potential for risk of acid mine drainage resulting in increased heavy metal and sulphate concentrations in local surface water and groundwater was flagged as a risk in the scoping report for the project (Kongiwe, 2024). It is thought that the risk of AMD would specifically be influenced if runoff from the tailings reclamation operations is not adequately managed through efficient stormwater management structures. To assess this risk, a comparison between electrical conductivity (EC) and pH in the three available groundwater samples was made and is presented in Figure 6. Electrical conductivity is an indication of the ability of water to conduct electrical current in the presence of dissolved ions. High electrical conductivity indicates elevated ion and by comparison salt content in the water and hence contamination. Also shown on Figure 6 are the SANS241:2015 drinking water standards for pH (>5; <9.7) and EC (170mS/m) for comparison.

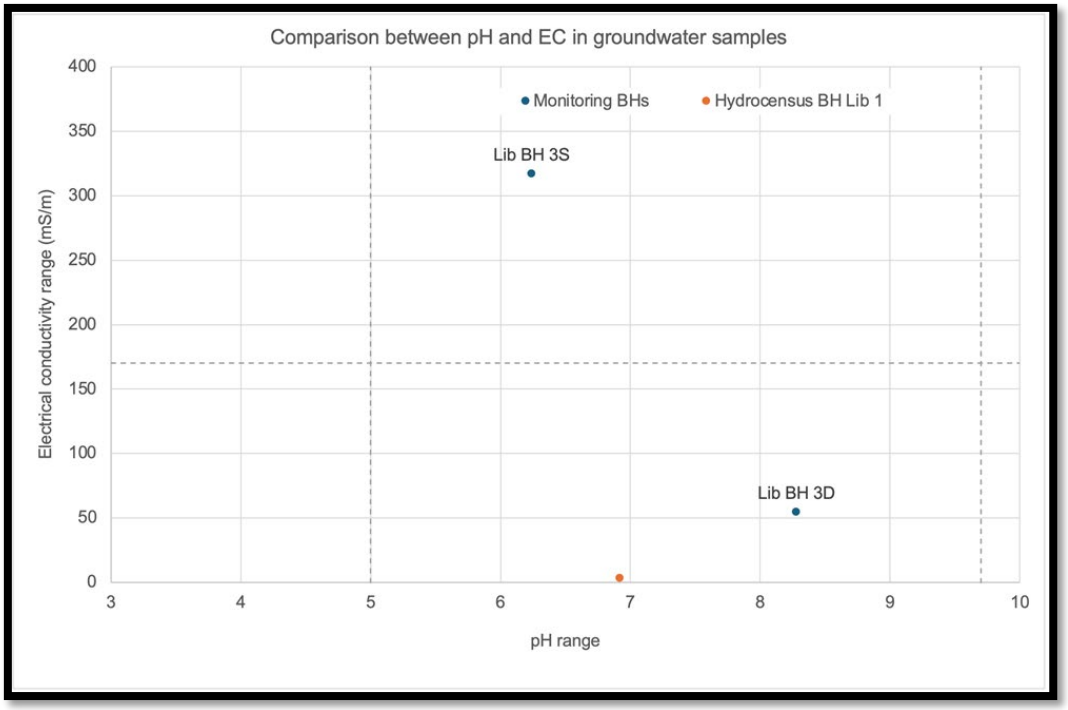


Figure 6. Comparison between pH and EC in groundwater samples

The results indicate that the hydrocensus borehole (Lib 1) and the deep monitoring borehole sampled at the Libanon TSF footprint (Lib BH3d) have good quality water with neutral to alkaline pH conditions and low dissolved salt content. The pH conditions are controlled by the effect of the dolomitic aquifer, which is alkaline in geochemical composition, on groundwater quality. The data suggests that groundwater not affected by tailings deposition has a low risk of acidification.

Borehole Lib BH3s, the shallow borehole located northwest of the Libanon TSF indicates the impact of the facility on groundwater quality. This borehole has a slightly acidic pH, but elevated dissolved salts. Groundwater quality pertaining to the modelling presented in this report are discussed later.

The information presented above are based on groundwater quality data and not acid base accounting of the tailings material. It is however noted that reclamation of the TSF will remove the potential source of acidification.

6.3 Hydrogeological Conceptualisation

6.3.1 Monitoring Boreholes

As discussed in Section 5, three sets of shallow and deep monitoring boreholes were drilled up and down gradient of the Libanon TSF during 2024. The locations of these boreholes are presented in Figure 1 and details obtained from the fieldwork programme are provided in Table 9.

Table 9. Summary of monitoring borehole information

Borehole ID	Lib BH1D	Lib BH1S	Lib BH2D	Lib BH2S	Lib BH3D	Lib BH3S
Borehole Depth (m)	60*	30	50*	18*	80	30
Depth of weathering (m)	±30	25	35	±18	32	±30
Static Water Level (m bgl)	Dry	Dry	Dry	Dry	71.17	20.87
Final drawdown during aquifer test (m)	Not tested	-	-	-	4.26	6.50
Recovery (%)	-	-	-	-	7.04	81.85
Potential Yield (L/s)	Cavity	-	Thick wad	-	0.01	0.03
Aquifer test transmissivity (m^2/d)	-	-	-	-	0.1 – 0.5	0.5 – 0.9
Slug test permeability (m/d)		5.7E-4 – 3E-4	2.5E-3 – 2.1E-3	3.5E-3 to 1.4E-4		

* Denotes borehole not drilled to the planned depth due to the presence of dolomitic cavities or thick residual dolomite (wad).

6.3.2 UNSATURATED ZONE

The depth to groundwater in this area is deep because the dolomitic aquifer is largely dewatered in the Venterspost Compartment. Jones & Wagener (2013) reports that the groundwater table in the dewatered compartments are more than 100 m below surface. The unsaturated zone on a regional scale therefore comprises of residual dolomite (wad) and weathered Karoo sediments located in deep solution cavities or grykes to relatively fresh fractured dolomite pinnacles between major solution cavities that extend to depth. It is further reported that the lag between rainfall events and a response in groundwater levels is between 12 and 18 months. This suggests that rainwater does percolate through the unsaturated zone towards the deeper regional groundwater table in the dewatered compartments.

The field data obtained from the newly drilled monitoring boreholes indicate that the weathered dolomitic aquifer underneath the Libanon TSF footprint is largely dewatered.

Field data from the three sets of shallow and deep monitoring boreholes confirms that the weathered dolomitic aquifer is dewatered to a depth of at least 60 m east and west of the Libanon TSF. Both the shallow and deep boreholes (Lib BH1 and Lib BH2) in these positions were dry. A dewatered dolomitic cavity was intersected from approximately 48 m below surface in Lib-BH1d. Above the cavity, thick residual dolomite (wad) is present to at least a depth of 30 m below surface. The drilling logs for Lib-BH2d does not indicate the presence of a cavity, but thick residual dolomite (wad) was intersected to a depth of at least 35 m in this area. It is likely that these boreholes were drilled into a gryke structure.

The groundwater table in Lib-BH3d is deeper than 70 m below surface. Residual dolomite is present to a depth of around 30 m in this borehole, but fresh dolomite was intersected below this depth. It is likely that Lib-BH3d and Lib-BH3s are in a pinnacle of fresh dolomite located between grykes that is associated with the Venterspost Dyke. Borehole Lib-BH3d is situated on the eastern side of the Venterspost Dyke and therefore possibly within the Bank Compartment rather than the Venterspost

Compartment. The Bank Compartment is not as significantly dewatered along its eastern edge (see Figure 8). It is unfortunately not possible to accurate estimate the regional extent of the gryke and fresh dolomitic pinnacle underneath the Libanon TSF. The gravity survey completed by the Council for Geoscience over the dolomitic aquifer (see Figure 3 (Jones & Wagener (2013)) was used to estimate these to some extent. To do this, the major grykes (blue shaded area) were traced as best possible and the remaining areas were assumed to be fresh dolomite pinnacles. The outcome of this is presented in Figure 7. It is shown that the major grykes are orientated roughly parallel to the main compartment-forming dykes and post-Transvaal faults. The hydraulic conductivity (permeability) of the residual dolomites intersected in the new monitoring boreholes is discussed in Section 6.3.4.

6.3.3 Saturated Zone

The information that will be used to characterise the local and regional dolomitic aquifer characteristics was inferred from the newly drilled monitoring boreholes around the Libanon TSF as well as from published information for Kloof Mine. The following aquifers are present:

- Weathered dolomitic aquifer: This aquifer was formed as a result of karstification. This happens when rainwater containing carbon dioxide taken up from the atmosphere (and which forms a weak acid) infiltrates along fractures, faults and joints in the dolomite. The weak acid leaches the carbonate minerals creating residual dolomite, wad, grykes and cavities. During the dissolution process, residues such as silica as well as manganese oxides and hydroxides remain behind, often forming thick brown to orange clay, referred to as wad. Karstification is further characterised by sinkholes and cavities, which are often filled with groundwater where the dolomitic compartments are not dewatered. Fault zones facilitate preferential weathering and create preferential flow conduits to groundwater. The vertical extent of the weathering is mostly controlled by the lithostratigraphy but is generally accepted that the base of the dolomite on average about 200 m below surface regionally. The aquifer comprises an extensive cover of residual solution debris and in places younger Karoo sediments. Karstification is however irregular and highly heterogeneous with hydraulic conditions varying from phreatic to confined, as indicated by the gravity survey presented in Figure 4 and its interpretation in Figure 7. There is general agreement that the weathered dolomitic aquifer is the significant source of water within the dolomites (Jones & Wagener, 2013). The Venterspost dolomitic compartment has however been largely dewatered, as discussed above. The depth of weathering underneath the Libanon TSF is at least 30 meters below surface and the groundwater table fluctuates significantly over short distances.
- Fractured dolomitic aquifer: It is anticipated that groundwater occurrence in fresh dolomite will mainly be along fractures and faults, similar to a fractured rock aquifer. At depth karstification will be less pronounced. The fractured aquifer is finely crystalline with little primary porosity. Due to this, the fractured dolomitic aquifer is expected to yield significantly less groundwater compared to the weathered dolomite. It is thought that the comparatively low storage capacity of this aquifer has led to the relatively rapid dewatering of the Venterspost Compartment (Jones & Wagener, 2013). Based on the information presented above, it will be assumed that this aquifer is present at an average depth of below 200 m below surface.
- Fractured Transvaal strata aquifer: This aquifer is located south of the Libanon TSF and is associated with the Hekpoort lavas and Timeball Hill, Strubenkop and Silverton shale (see Figure 3). Jones & Wagener (2013) reports that this aquifer is not hydraulically connected and act independently of the dolomitic aquifers. In addition, this aquifer will not affect

groundwater conditions at the Libanon TSF, which is located on the weathered dolomitic aquifer.

6.3.4 Hydraulic Conductivity and Transmissivity of the Aquifers

The aquifer transmissivities and hydraulic conductivities obtained from the field testing are summarised in Table 10. The availability of field measured aquifer parameters allows for the development of a site-specific groundwater model, which improves the confidence in the outcome of the simulations presented in this report. This data also enables more accurate conceptualisation of the geological and geohydrological features that will affect the outcome of the impact predictions presented in this report in this complex geological setting.

It is shown that the permeabilities of the residual dolomite are very low, on average 9.93E-4 m/d and varying between 1.4E-4 and 2.5E-3 m/d. All three boreholes on which tests could be completed were dry with residual dolomite extending at least to an average depth of 26 m.

Aquifer tests could be completed on boreholes Lib-BH3s and Lib-BH3d. During the tests, the shallow borehole was pumped drying within 16 minutes at a rate of 0.18 L/s (648 L/hr) but recovered by 81% in 20 hours. The deep borehole was pumped dry in 40 minutes at a rate of 0.03 L/s (108 L/hr) and only recovered by 6% in 3 hours. This suggests that the residual dolomite underneath the Libanon TSF has a very low yield, but that some groundwater seeps into the comparatively fresh dolomite pinnacle in this position over time, thus recharging the aquifer. This groundwater probably originates from within the lateral extent of the dolomite pinnacle and is stored in what is perceived to be significant storage capacity contained in secondary porosity as a result of karstification of the weathered dolomite. Borehole yields calculated from the field data vary between 0.01 and 0.03 L/s, which is well below the regional dolomitic aquifer average of 5 L/s.

Table 10. Summary of site-specific aquifer parameters obtained from field data

Borehole ID	Lib BH1d	Lib BH1s	Lib BH2d	Lib BH2s	Lib BH3d	Lib BH3s
Borehole Depth (m)	60*	30	50*	18*	80	30
Static Water Level (m bgl)	Dry	Dry	Dry	Dry	71.17	20.87
Aquifer test transmissivity (m^2/d)	-	-	-	-	0.1 – 0.5	0.5 – 0.9
Slug test permeability (m/d)		3E-4 - 5.7E-4	2.1E-3 - 2.5E-3	1.4E-4 - 3.5E-3		
Possible borehole yield (L/s)					0.01	0.03

In addition to the site-specific data, regional aquifer parameters are available from Jones & Wagener (2013). Regional aquifers present and information available for these are listed in Table 11. The incorporation of regional aquifer parameters allows for the integration of the regional hydrogeology with more accuracy during simulations.

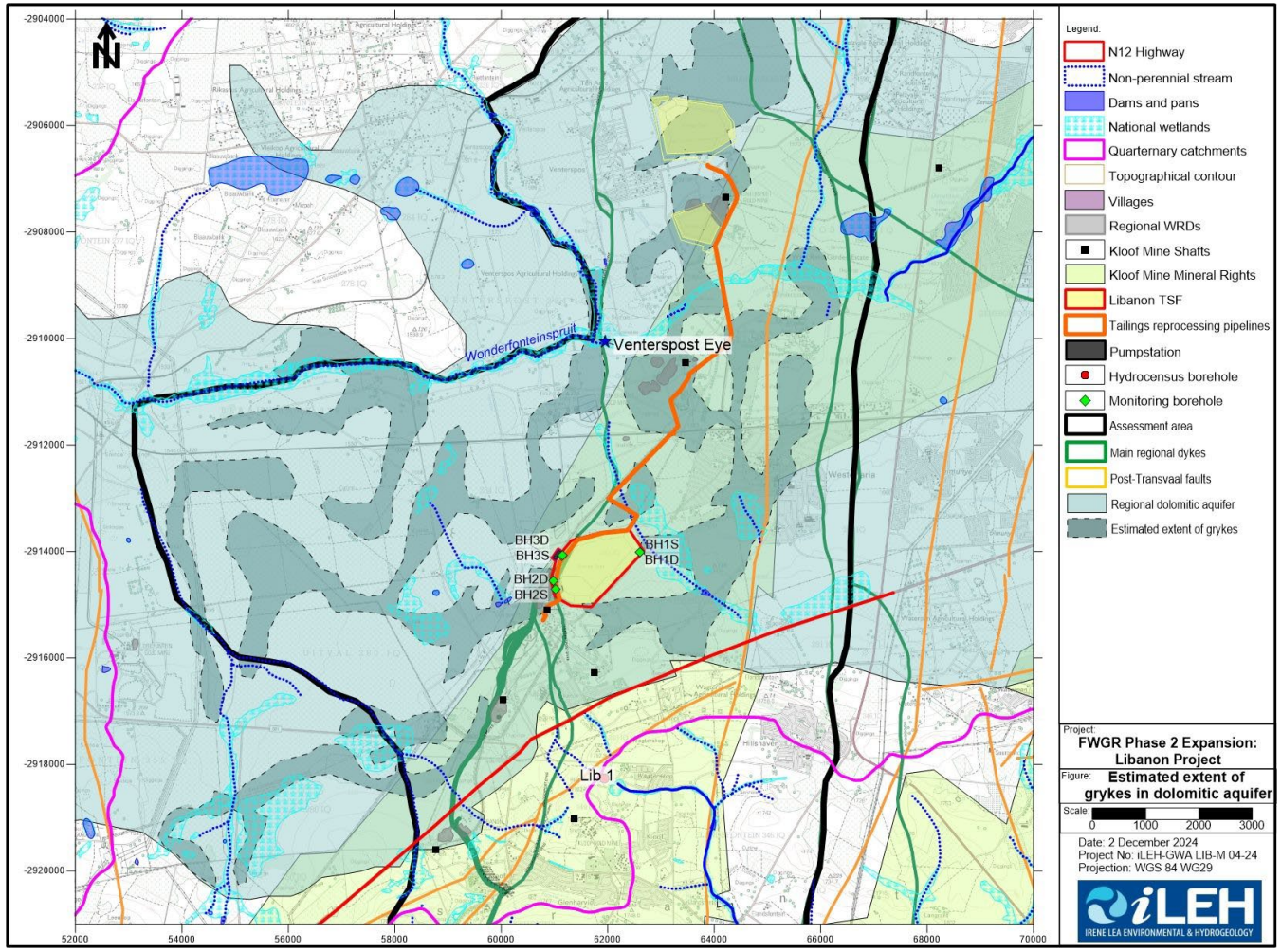


Figure 7. Estimated extent of grykes in the weathered dolomitic aquifer

Table 11. Literature-based aquifer parameters used to conceptualise regional aquifers

Aquifer	Horizontal permeability (m/d) or Transmissivity (m^2/d)	Porosity %)	Recharge rate (% of MAP)	Source
Weathered dolomite	Dyke contact: 0.02m/d Dyke contact: 0.75m^2/d Maximum: 1000m^2/d Average: 30m/d Oaktree Fm: 12m/d Monte Christo Fm: 40m/d	10	Venterspost Compartment: 8.5 – 27 Dolomitic aquifer: 12.7%	Jones & Wagener (2013)
Fractured dolomite	100m^2/d Average: 1m/d	0.1%		
Weathered Karoo	0.6			
Fractured Transvaal	1	6		

6.3.5 GROUNDWATER LEVELS

As discussed earlier, the Venterspost Compartment is dewatered, mainly from Kloof Mine. It is reported that the Celemanzi (Kloof No 10) Shaft pumps around 40 ML/d to maintain underground water levels at a depth that would enable regional gold mining in other mining areas. Groundwater levels in the various compartments are demonstrated in the schematic cross section in Figure 8 (from Jones & Wagener, 2013). Groundwater level data from the 1950's to the 1980's suggest a decline of between 80 m and 120 m in the water table in the weathered dolomitic aquifer underneath the Libanon TSF. It is estimated that the groundwater level in this compartment is around 1400 mamsl based on Figure 8. This means the depth to the regional groundwater table is more than 100 m below surface at the project location.

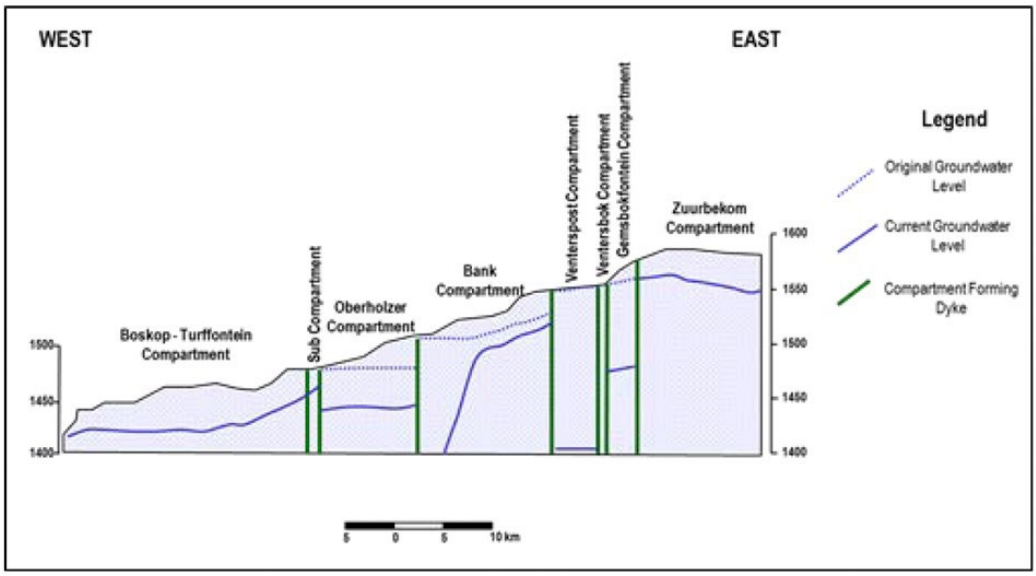


Figure 8. Schematic cross section showing groundwater levels in the dolomitic compartments

As discussed above and below, on a local scale perched aquifer conditions are expected in the residual dolomite, as rainwater percolates into the karstified aquifer.

Information presented in Jones & Wagener (2013) indicates that there is a 77% correlation between groundwater level and topographical elevations in the weathered dolomitic aquifer. If this correlation is high, it implies that groundwater flow patterns follow the topography and that groundwater discharges to local rivers and streams as baseflow. The 77% correlation suggests that there is still some relationship between groundwater elevation and topography in the weathered dolomitic aquifer, but that dewatering has lowered groundwater levels significantly in places, thus skewing this correlation. In comparison for example, the correlation between groundwater and topographical elevation in the Transvaal fractured aquifer to the south is 98%.

The Venterspost Eye is located north of the Libanon TSF. This eye is currently dry due to the dewatering of the compartment. In pre-mining conditions, the natural fountains formed where groundwater decanted from one dolomitic compartment to the next at the lowest topographical elevation. These eyes formed where the compartmentalising dykes pushes groundwater to surface, in the case of the Venterspost Eye, the Venterspost Dyke.

The dewatering of the compartment affects groundwater levels in the weathered dolomitic aquifer. Field data shows that the aquifer is largely dewatered at the Libanon TSF footprint. All but two of the boreholes drilled were dry. As discussed earlier, it is thought that the dry boreholes are in grykes that could be delineated to some extent from the gravity survey completed by the Council for Geoscience.

The set of shallow and deep boreholes that contained some groundwater are located on a comparatively fresh dolomitic pinnacle, based on the gravity survey, which is probably associated with the position of the Venterspost Dyke. In the deep borehole, the groundwater level is deeper than 70m below surface, reflecting the regional impact of the dewatered compartment. The fact that a groundwater level could be measured in this position probably attributed to the percolation of rainwater into the dolomitic pinnacle and the presence of increased porosity to facilitate storage of this groundwater.

In the shallow borehole, the depth to groundwater is around 20 m, which also suggests percolation of rainwater from surface as well as infiltration from the Libanon TSF that is retarded in the vertical flow direction by the presence of the thick wad. This groundwater probably sits on a pocket of low permeability wad as a perched aquifer near surface.

A groundwater level could not be measured in the hydrocensus borehole Lib 1 as it was welded shut.

With only two groundwater level measurements in one location, it is not possible to generate a groundwater flow map for the Libanon TSF. Groundwater is however expected to regionally flow with the topography in a northeasterly direction towards the Wonderfonteinspruit. Groundwater will also flow vertically down to the regional groundwater table controlled by the dewatering of the compartment.

On a local scale, the presence of shallow groundwater conditions and groundwater flow will be influenced by the presence of dolomitic grykes and pinnacles, the rate of recharge of rainwater, the presence of zones of increase porosity and the vertical retardation of groundwater flow because of the presence of thick zones of wad. This is expected to be a highly irregular pattern, which is difficult

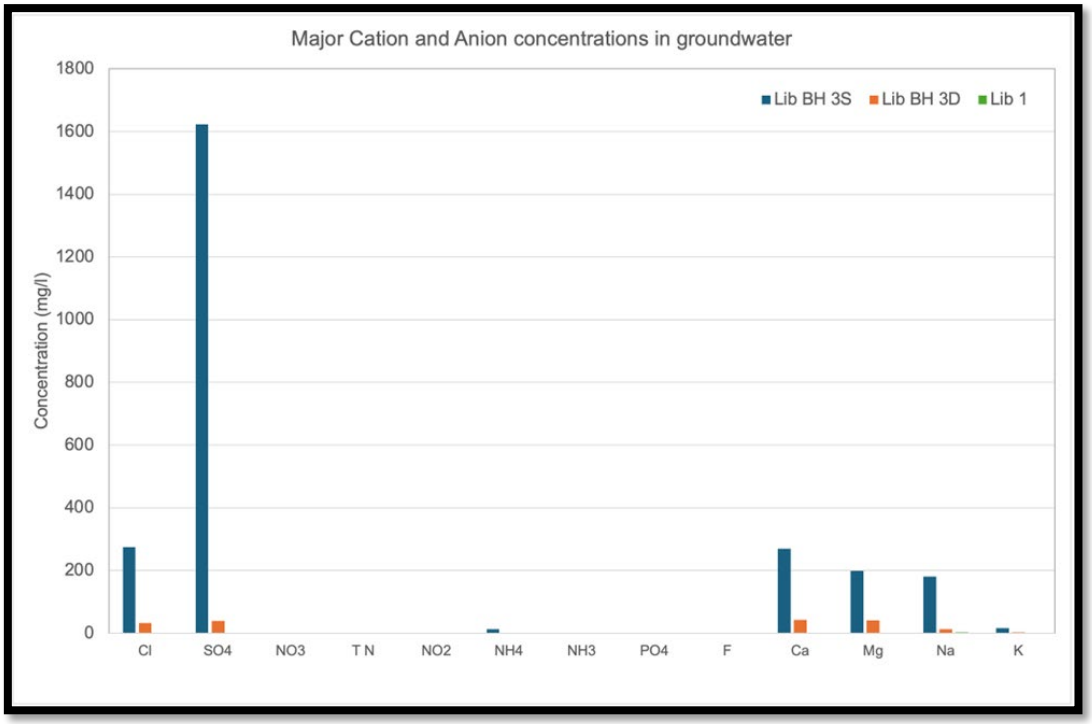
to accurately estimate. For this assessment, the extent of the dolomitic grykes and pinnacles as delineated in Figure 7, will be used to approximate this irregular pattern.

6.3.6 GROUNDWATER POTENTIAL CONTAMINANTS

To identify the potential contaminants to groundwater for this impact assessment, a comparison between major cations, anions, as well as trace metal concentrations for the three boreholes sampled is presented in Figure 9. Impacts on groundwater quality associated with the Libanon TSF is demonstrated by groundwater quality information for borehole Lib-BH3s.

In terms of major cations and anions, sulphate is by far the most significant element of concern, with a concentration of above 1500 mg/l for Lib-BH3s. Elevated sulphate concentrations are typical of the impact of gold tailings on groundwater quality, as it is a product of sulphide oxidation.

In terms of metals, manganese and iron concentrations are significantly elevated. Manganese concentrations exceeding 20 mg/L are probably more reflective of the geochemical character of the residual dolomite (wad) than the impact of the Libanon TSF on groundwater quality. Manganese is one of the byproducts of dolomite dissolution, as discussed earlier. Iron is also to some extent a byproduct of dolomite dissolution, but it is also a characteristic element of the oxidation of sulphide minerals. For this reason, sulphate and iron will be used as the two indicator elements for this impact assessment.



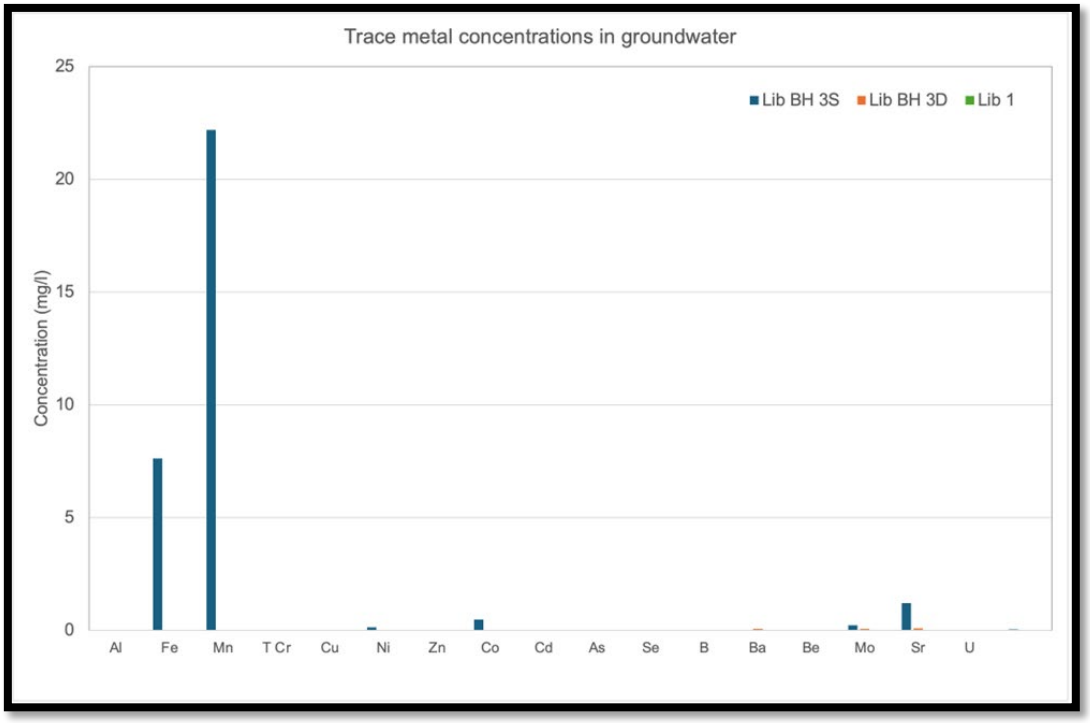


Figure 9. Comparison of major and trace elements in groundwater

The information presented in Table 13 will be used to conceptualise the source term for the impact assessment. This is discussed below.

The concentrations of iron and sulphate are compared to pH and Electrical conductivity levels in groundwater in Table 12. This information will be used to formulate the source term for the project.

Table 12. Concentrations of indicator element in groundwater

Element	pH	Electrical Conductivity (mS/m)	Iron (mg/L)	Sulphate (mg/L)
SANS241:2015 Drinking Water Standard	**5.0 - 9.7**	**170**	**0.3 - 2**	**250 - 500**
Lib1	6,92	3	0,004	0
Lib BH2S	6,24	317	7,620	1623
Lib BH3D	8,28	55	0,004	39

6.4 Aquifer Characterisation and Vulnerability

Based on aquifer classification methodology published in the Aquifer Classification Map Series of South Africa (DWS, 2012), the weathered dolomitic aquifer present in the project is classified as a major aquifer that is high-yielding and contains water of good quality.

This is however not the case at the Libanon TSF footprint, as newly drilled monitoring boreholes confirm that the weathered aquifer is dewatered with very low yields that are significantly below regional averages.

The project is also located in a zone delineated as aquifers that are most vulnerable and with a high susceptibility to contamination. Available information suggests that groundwater quality in shallow perched aquifer conditions at the Libanon TSF is impacted by historical tailings deposition, making the groundwater unfit for use. It is however noted that removal of the TSF will result in the elimination of the source to groundwater contamination and will therefore result in a positive long-term impact on groundwater in this zone delineated as most vulnerable.

Based on the information above, as well as the methodology described by Parsons (1995), the aquifer protection classification is rated as moderate. This is because groundwater has been impacted by mining activities and the dolomitic compartment is dewatered.

7 CONCEPTUAL HYDROGEOLOGICAL MODEL

The conceptual hydrogeological model is best demonstrated at the hand of the cross section presented Figure 10. The location of the figure is shown on Figure 3. This west-east cross section is taken across the Venterspost Compartment through the Libanon TSF. The following components of the conceptual hydrogeological model is indicated on the cross section:

- The Libanon TSF is located on outcropping residual dolomite. The depth of the residual dolomite is highly variable and cannot be predicted with accuracy. To the west of the TSF, a gryke structure is present, which is associated with the West Rand Fault zone. Dry boreholes drilled around the TSF (BH1s&d and BH2s&d) were drilled into gryke structures which are dewatered.
- A fresh dolomite pinnacle is present underneath the TSF footprint. Within this structure, the depth of weathering is shallower, measured to extend to around 30 m in the boreholes drilled.
- Perched aquifer conditions are likely in the upper 30 m of the residual dolomite around borehole Lib-BH3s. The presence of groundwater at this elevation is attributed to percolation of rainwater to pocket of increased porosity within the otherwise low permeable residual dolomite. The extent of this pocket cannot be estimated with certainty.
- Comparatively shallow groundwater conditions are present on the edge of the Venterspost Dyke, possibly within the Bank Compartment. No dolerite was intersected in borehole Lib-BH3d, which means it is likely that the borehole was drilled east of the near vertical dyke. The gravity survey completed in this area indicates the presence of a pinnacle of fresh dolomite, most likely associated with the Venterspost Dyke.
- The Venterspost Compartment is dewatered to a depth of approximately 1400 mamsl. Information on the base of the dolomitic aquifer presented in Jones & Wagener (2013) indicates that the base of the dolomite is at elevations of 900 to 1000 mamsl underneath the Libanon TSF.

Aquifer parameters that will be assigned to the components of the conceptual model are discussed above. The availability of this information will enable inclusion of the hydrogeological features and site characteristics into the model to achieve the most accurate impact predictions possible.

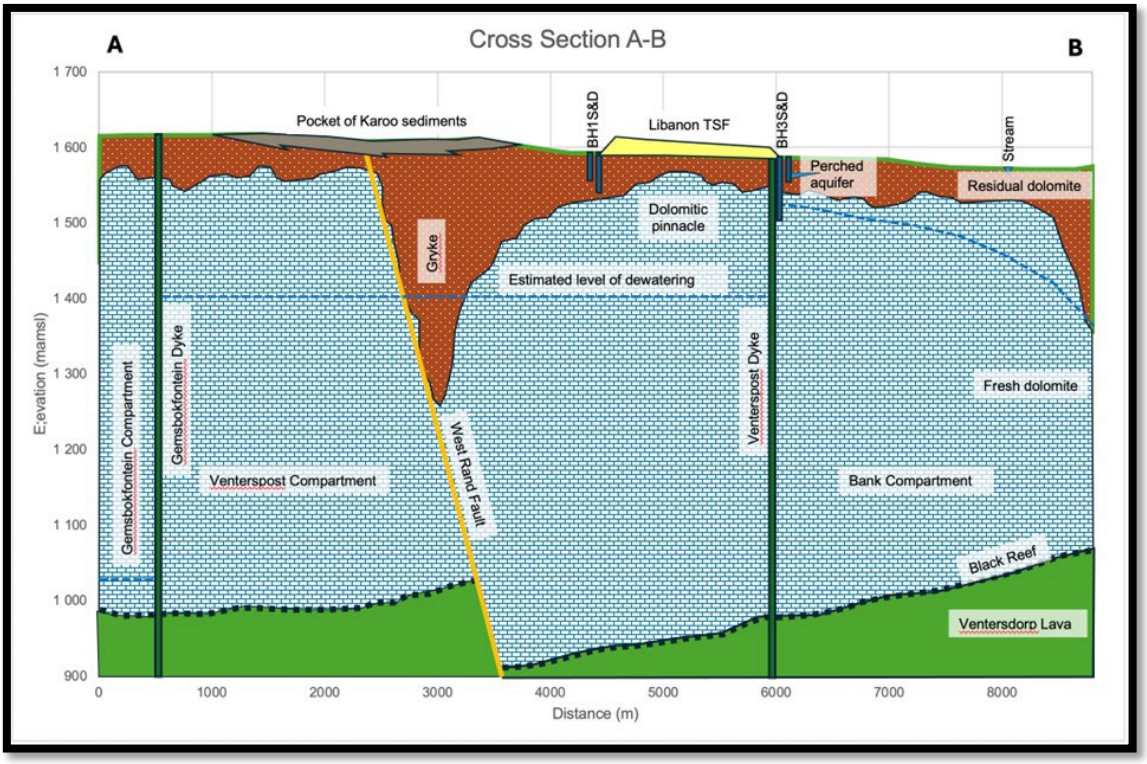


Figure 10. Schematic cross section through the project area

8 SOURCE TERM

8.1 SEEPAGE QUALITY

To account for the inherent uncertainty associated with numerical groundwater models, three seepage quality scenarios will be tested during simulations. These are based on geochemical simulations presented in Jones & Wagener (2013) for TSFs in the region, mainly associated with Kloof Mine, as well as the groundwater quality dataset for Lib-BH3s. This borehole reflects the impact of historical tailings deposition on groundwater quality.

Starting sulphate and iron concentrations based on this information is presented in Table 13. These concentrations will be adjusted during simulations to match field measured data.

Table 13. Source term: Long-term leachate quality

Scenario	Sulphate concentration (mg/L)	Iron concentration (mg/L
Best case	500	2
Likely case	1500	8
Worst case	3000	15

8.2 Operational Seepage Volume

The operational seepage volumes associated with the tailings reclamation project is based on information presented in Jones & Wagener (2013) on recharge rates and experience with similar reclamation projects elsewhere. These seepage volumes take into consideration that the tailings will be hydro-mined, which means that water will be introduced during the operational phase. It is noted that the reclamation projects are implemented with dedicated stormwater management measures to control and capture the runoff of dirty water. This will facilitate the recirculation of dirty water during the mining process.

The operational seepage volumes that will be applied take the stormwater management measures as well as the capture and re-use of dirty water into consideration. The volumes that will be applied during simulations are presented in Table 14. The rates are presented as a percentage of the mean annual precipitation.

Table 14. Source term: Leachate volume

Scenario	Estimated seepage rate (% of MAP)
Best case	1%
Likely case	4%
Worst case	10%

9 Potential Pathways and Receptors

Based on the available dataset, the following aquifer pathways are identified for the project:

- Vertical flow through the unsaturated horizon from the tailings reclamation area to the underlying weathered dolomitic aquifer.
- Vertical and horizontal flow through the weathered dolomitic aquifer over the tailings reclamation area. Groundwater is likely to flow preferentially within fresh dolomitic pinnacles over relatively short distances. Infiltration of this water will take place along zones of deeper weathering like grykes as well as along regional post-Transvaal age faults. There are however no post-Transvaal faults present underneath the Libanon TSF footprint or down gradient of it. This flow pattern will further be highly irregular.
- Preferential vertical flow will take place to the elevation of the regional groundwater table that will be controlled by the extent to which the Venterspost Compartment is dewatered. This vertical flow path will be highly irregular, and it is possible that seepage from the Libanon TSF may not reach the regional dewatered groundwater table as flow in the vertical direction is expected to be very slow.
- Perched aquifer conditions are expected in the upper 30 m of the residual dolomite where vertical flow is retarded by the presence of thick wad. These conditions will also be highly irregular and cannot be predicted with accuracy. One borehole intersected perched aquifer conditions, which are associated with a fresh dolomite pinnacle and the Venterspost Dyke.
- Regional compartmental forming dykes form impermeable barrier to groundwater flow. Within the project area, the Venterspost Dyke and the Gemsbokfontein Dyke form the boundaries of the Venterspost Compartment.

The following receptors were identified:

- The weathered dolomitic aquifer receives contaminated leachate that has historically infiltrated from the Libanon TSF.
- Groundwater flow in this weathered dolomitic aquifer is erratic, as the compartment is largely dewatered. Infiltration of seepage from the Libanon TSF may percolate vertically to the regional groundwater table controlled by underground dewatering. There is a small likelihood that this seepage eventually enters the Kloof underground workings. The pathway that could facilitate this is not clearly understood, as the Ventersdorp Contact Reef underground workings is at least 800 to 1000 m below surface. It is not likely that the Libanon TSF could contribute a measurable salt load to the underground workings.
- It is thought that groundwater flow will be on a regional scale towards the Wonderfonteinspruit. As groundwater flow is erratic and highly irregular in the dewatered Venterspost Compartment, it is unlikely that long-term contamination associated with the Libanon TSF could reach this stream.
- Two non-perennial streams with associated wetlands are located northeast and southwest of the TSF. It is likely that these streams will be the receptors of contaminated groundwater originating from the TSF. The locations of these streams and wetlands are indicated on Figure 1.

The potential pathways and receptors are summarised in Table 15.

Table 15. Pathways and receptors

Pathways	Receptors
Runoff and seepage	Non-perennial streams and wetlands northeast and southwest of the TSF
Fresh dolomite pinnacles in the weathered dolomitic aquifer	Low possibility of the Wonderfonteinspruit
Perched aquifer conditions in the upper 30 m of the residual dolomite	Low possibility of the Kloof underground workings

10 KEY ASSUMPTIONS AND LITERATURE-BASED DATA INPUTS

The numerical modelling used to complete the impact prediction for the project is based on the following assumptions:

- The geometry of the aquifers present was inferred from the published geological map presented in Figure 3. The regional structural geology as well as the extent of quaternary catchment boundaries were also considered in defining the assessment area.
- Aquifer conceptualisation was completed with the fieldwork dataset obtained from the six new monitoring boreholes drilled around the TSF footprint area as well as information obtained from a regional hydrocensus for the Libanon TSF as well as the Venterspost North TSF and Venterspost South TSF and the Kloof No 1 TSF. The other TSFs form part of a regional tailings reclamation project. Groundwater impact assessments for these will be considered in separate reports.

- The extent of the dolomitic pinnacles and grykes present in the residual dolomite underlying the Libanon TSF were inferred from the gravity survey completed by the Council for Geoscience (see Figure 4). The extent of the grykes were traced from this figure as accurately as possible. It was assumed that these structures extend to at least 30 m below surface in the vicinity of the TSF, based on the logs of the new monitoring boreholes. This is an important aspect of the project, as the flow of groundwater in the immediate vicinity of the TSF will be controlled by these weathering patterns as well as the position of the Venterspost Dyke. The latter is accurately mapped as presented and discussed in Jones & Wagener (2013).
- Aquifer parameters or borehole construction details were not available for the hydrocensus borehole. It was assumed that the Venterspost boreholes target the weathered dolomitic aquifer and the Kloof boreholes the Transvaal fractured aquifer.
- It was assumed that pinnacles of relatively fresh dolomite present between grykes form the preferential flow paths to groundwater in the immediate vicinity of the project area. This assumption is based on the 2024 field dataset. The presence of a comparatively shallow groundwater table in the vicinity of Lib-BH3s and Lib-BH3d is attributed to the presence of such a pinnacle. The impact of the Venterspost Dyke in this position is also noted and was considered during simulations.
- Regional aquifer parameters were obtained from published reports. The list of reports considered are presented in the references at the end of the report. Work completed by Jones & Wagner (2013) has specific relevance to this project. Regional aquifer parameters considered from this report are presented in Table 11.
- The extent of dewatering of the Venterspost Compartment is controlled by dewatering from Kloof Mine. It is understood that at present, approximately 40 ML/d is pumped from the Celemanzi (Kloof No 10) Shaft. This rate was used to calibrate the rate of recharge to the regional dolomitic aquifer based on the assumption that most of the water pumped from the compartment originates from recharge to the weathered dolomitic aquifer. It is acknowledged that the compartment-forming dykes have been mined out in places in the underground workings, thus reducing their effectiveness as groundwater flow barriers. Some water pumped from Kloof Mine may therefore originate from other dolomitic compartments, for example the Bank Compartment. The extent to which this takes place is not known with the current dataset. This interaction is however not expected to significantly impact the outcome of the predictions presented in this report.
- It is assumed that the Venterspost Compartment is dewatered to an elevation of approximately 1400 mamsl. This level was used in the model to simulate the dewatering of the dolomitic aquifer within the compartment.
- The source characterisation for the project is based on groundwater quality data obtained from groundwater quality in Lib-BH3s, which is representative of the impact of historical tailings deposition on groundwater quality. It is acknowledged that the quality of tailing seepage may be different to that measured in groundwater. For this reason, calibration of the source term against the groundwater monitoring data as well as a sensitivity analysis through scenario modelling will be completed.
- While monitoring boreholes drilled on the eastern and western side of the TSF are dry, it was assumed that current and future impacts on groundwater quality extend over the footprint area of the Libanon TSF. The TSF is mostly located on a dolomite pinnacle, which is likely to act as a preferential flow area for recharged rainwater. It is however acknowledged that groundwater flow in the Venterspost Compartment will ultimately be in a vertical direction to the level of dewatering.

- There is currently no information available to characterise the timeline of the historical tailings deposition and management in the project areas. For this reason, assumptions had to be made on when these TSF were established and how long they were operational. This information is considered tentative and should be revised if more specific information becomes available.
- Only advective transport of contaminants was simulated. Assumptions made regarding advection, are discussed below. While it is acknowledged that attenuation will take place in the soils and specifically the residual dolomite, there is currently insufficient information available to quantify the extent to which this takes place. As such, simulations are based on the precautionary principle and take the worst-case scenario into consideration.

11 GROUNDWATER MODELLING

11.1 NUMERICAL MODELLING OBJECTIVES

The objectives of the numerical modelling presented in this report are based on the requirements of the EIA process and the water use licence application requirements. The following objectives are therefore reported:

- Estimate the impact of the proposed Libanon TSF Reclamation Project at the end of the construction and operational phases of the project on groundwater quality. No significant impacts on groundwater levels are expected.
- Predict the long-term impact of the project on groundwater quality post closure and rehabilitation.
- Evaluate the effect that tailings removal and footprint rehabilitation would have on groundwater quality.
- Develop a groundwater monitoring program based on the outcome of the impact prediction study.
- Develop a groundwater management program geared at reducing the impacts on groundwater quality identified.

11.2 MODEL CONSTRUCTION

The numerical modelling was undertaken according to accepted industry principles and standards, including the South African Department of Water and Sanitation's Best Practice Guideline for Impact Prediction (DWS BPG G4, 2008).

The numerical model for the project was constructed using MODFLOW and MT3DS. MODFLOW is a modular three-dimensional groundwater flow model and MT3DS a modular three-dimensional solute transport model published by the United States Geological Survey. MODFLOW and MT3DS use finite difference discretization and flow codes to solve the governing equations. MODFLOW and MT3DS are a widely used simulation codes, which are well documented. MODFLOW is used to simulate groundwater flow rate and direction. MT3DS is superimposed on the MODFLOW simulation results and is used to predict the rate and direction of contaminant movement in the aquifers.

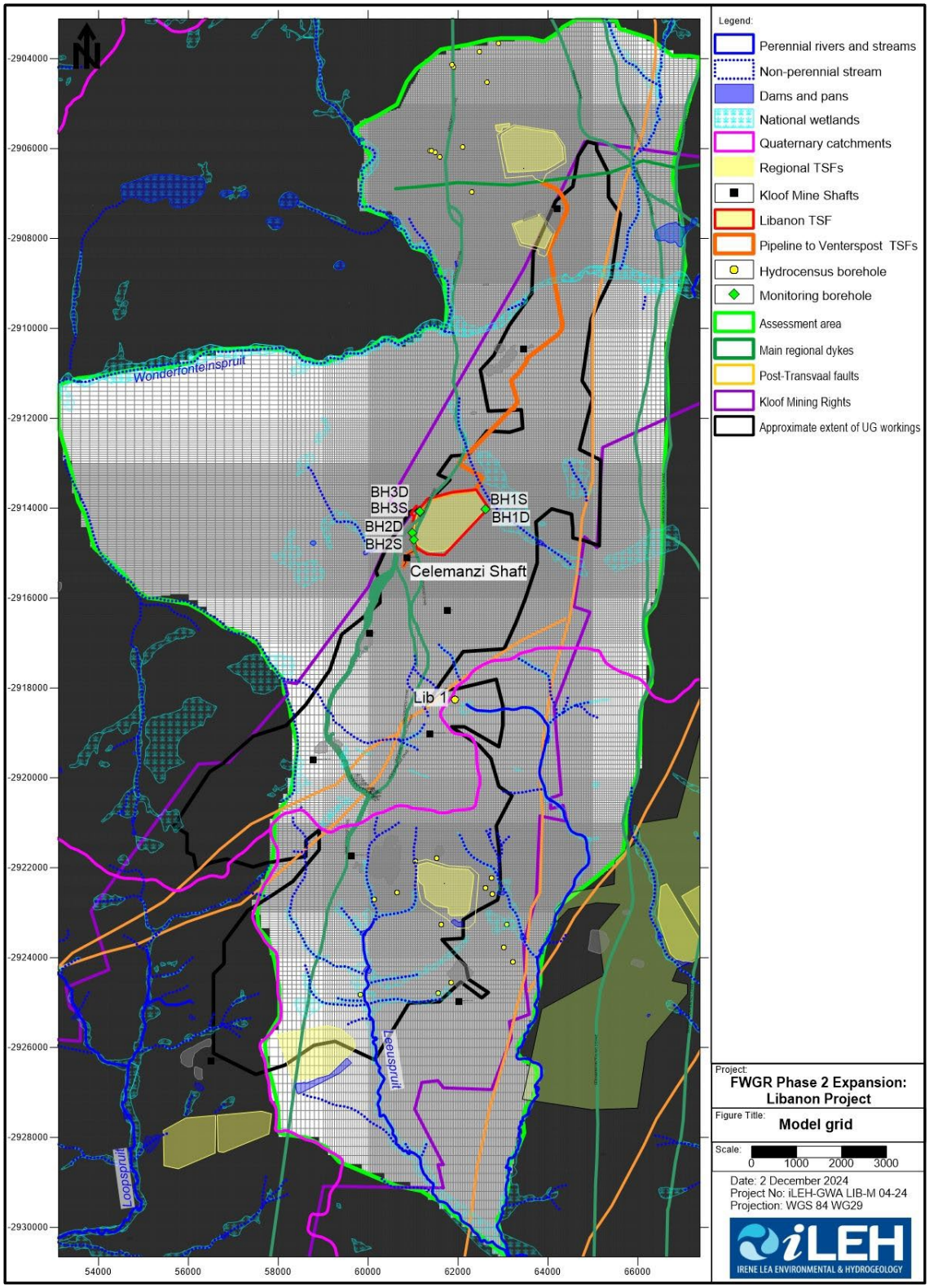


Figure 11. Model grid

To accommodate the regional assessment area over which simulations will be undertaken, the model area was refined into block cells of 25 m by 25 m around the project areas and the model grid size was gradually increased away from this area of interest to 200 m by 200 m (Figure 11). The finer grid allowed more detailed simulations around the areas of interest.

The positions where rivers and streams exit the model area were simulated as Dirichlet boundaries. The eastern model boundary coincides with the Gemsbokfontein Dyke, which was assumed to be a barrier to groundwater flow and was included as no-flow boundary. This dyke forms the eastern boundary of the Venterspost Compartment. Streams and rivers that form model boundaries are simulated as Neuman boundaries. Perennial rivers, streams and wetlands inside the model boundary were simulated as discrete zones.

Four layers were included in the model. The upper two layers presents residual dolomitic aquifer, as this aquifer is the main receiving water body for the TSF. The third layer represents the underlying weathered dolomitic aquifer, which is considered a major aquifer regionally. The lower layer represents the deeper fractured dolomitic aquifer and was also used to include the extent of dewatering of the Venterspost Compartment.

All units used during simulations were presented in metres (length) and days (time).

11.3 Groundwater Elevation and Gradient

The 2024 measured groundwater water levels in regional hydrocensus boreholes as well as the newly drilled monitoring boreholes were used to calibrate the model for this assessment. The locations of these boreholes are indicated on Figure 11. It is noted that the dolomitic aquifer is largely dewatered in the Venterspost Compartment. This complicates the numerical modelling process, as dry layers can lead to unstable modelling conditions. To mitigate this, pre-mining groundwater levels were generated as the starting water levels for the assessment area. This information was inferred from Jones & Wagener (2013).

During simulations, the dewatering of the dolomitic aquifer was calibrated through adjustments and water balance calculations to match the reported dewatering rate of 40 ML/d. This is discussed in more detail below. The extent of the underground workings was inferred from maps presented in Jones & Wagener (2013) as indicated on Figure 11, which indicates that the Libanon TSF is undermined at depth.

11.4 Conceptual Groundwater Model

The parameters that will be used during groundwater modelling, as derived from field data, assumed or obtained from literature, are presented in Table 10 and Table 11. These will be used as a starting point during model calibration for this phase of the project and will be adjusted to minimise the model calibration error, as discussed below.

11.5 Numerical Model

11.5.1 Model Input Files and Integration

The conceptual model discussed above was used to construct the numerical model for the project area. Aquifer parameters from the existing dataset were gradually adjusted during calibration, as discussed below, to enable a model representative of measured and observed conditions within the

general constraints of numerical modelling. A numerical model is an approximation of the real system based on aquifer conceptualisation. The level of accuracy depends on the data available, however groundwater models are inherently prone to uncertainty as it is not possible or practical to obtain field data for every aquifer variation that affects groundwater flow and contaminant movement in the aquifers. The field data set indicates a complex hydrogeological setting with significant variations in groundwater levels and aquifer conditions over very short distances superimposed on a regionally dewatered dolomitic aquifer. The occurrence and movement of groundwater will therefore be controlled by a complex set of factors, which were integrated into the model as best possible within the considerable time constraint under which this project had to be completed.

The geometry of the numerical model is based on the conceptualisation of the aquifers and on the regional geological setting. The geological formations are included as discrete zones in the model, as discussed above. This includes the regional dykes and faults that control groundwater availability in the compartment.

The topographical surface was interpolated from the Digital Terrain Model (DTM) and incorporated into the model to ensure that the elevations of the mechanisms used to simulate the streams reflect actual topography as best possible.

The initial water levels in the model layers were kriged from available information, including field measurements, pre-mining groundwater level conditions and the DTM.

During contaminant transport modelling it was assumed that horizontal and vertical transverse dispersivity is 0.01. The effective molecular diffusion coefficient is 8,64E-5 m^2/d and the longitudinal dispersivity is 50 m. The latter was calculated using the empirical equation developed by Neuman (1990) for the average travel distance of groundwater in this setting.

No chemical reaction was taken into consideration during simulations. As such the contaminant transport simulations are conservative and will therefore represent maximum anticipated travel distances for the plumes that are governed only by the groundwater flow rates. This approach complies with the principles of the precautionary principle.

The timelines considered during modelling are presented in Table 16. No detailed information is available to accurately reflect historical tailings deposition. Some of the dates are therefore assumptions. These are indicated with an asterisk (*).

Table 16. Assumed timeline used during simulations

Simulation period	Start date	End date	Time (years)	Description
1	1934	2000's*	>65 years	Historical operational phase
2	1955	Present day	70	Compartment dewatering phase
3	2025	2026	1	FWGR ramp-up period
4	2027	2039	10	FWGR operational period
5	2040	2041	1	FWGR ramp down and rehabilitation period
6	2042	2142	100	Long-term simulation

11.6 CALIBRATION RESULTS

Calibration of a numerical model refers to the demonstration that the model is capable of reproducing field-measured data, which are the calibration values. Calibration is achieved when a set of parameters, boundary conditions, source terms and stresses are found that produce simulated heads and concentrations that match field measured data within the calibration criteria set for the project. This is an important step in the modelling project, which ensures that model results are reliable.

Calibration was completed with groundwater level measurements in boreholes identified as part of the regional hydrocensus as well as those obtained from the newly drilled monitoring boreholes. The calibration criteria set for the project are presented in Table 17. The complexity of the model setup and the fact that the dolomitic aquifer is dewatered during simulations were taken into consideration in the calibration criteria. These conditions complicate numerical modelling, as discussed earlier.

Table 17. Calibration criteria

Requirement	Acceptability criteria	Compliance
Model convergence	Maximum change in head of 0,1 m	Complied with (see discussion below)
Water balance	Difference between inflow and outflow <1%	Complied with (see discussion below)
Root Mean Square Error	<8 m for targets	Complied with (see discussion below)
Calibration error	At least 80% of targets with <8 m error between simulated and measured head	Complied with (see discussion below)

The calibrated groundwater levels for the residual (shallow groundwater levels) and weathered dolomitic (deeper groundwater levels) aquifers are presented in Figure 12 and Figure 13. Areas where no contours are drawn indicated sections of the dolomitic aquifer that is dewatered. The contours are based on the conceptual model, including the anticipated groundwater flow in dolomitic grykes and pinnacles. As shown, groundwater flow patterns are irregular and vary significantly over short distances. This complicates the calibration process, especially within the significant time constraints in which to complete this project. The contours presented in Figure 12 and Figure 13 are however reflective of field measured groundwater levels and are therefore considered sufficient to complete this impact assessment.

The results of the model calibration process are presented in Figure 14 and Table 18. It is shown that the calibration error (the difference between measured and simulated head) is less than 8 m for all but 4 of the groundwater levels measured in the hydrocensus boreholes. This provides a calibration error target of 80%, which complies with the calibration criteria. This calibration error can be improved if more time is available to spend on model calibration. The sum of the residuals is -18.3 m, which suggests that the model slightly over-estimates groundwater levels. This can be improved by including the impact of dewatering on the Ventersdorp Compartment with more accuracy with more time available to do so.

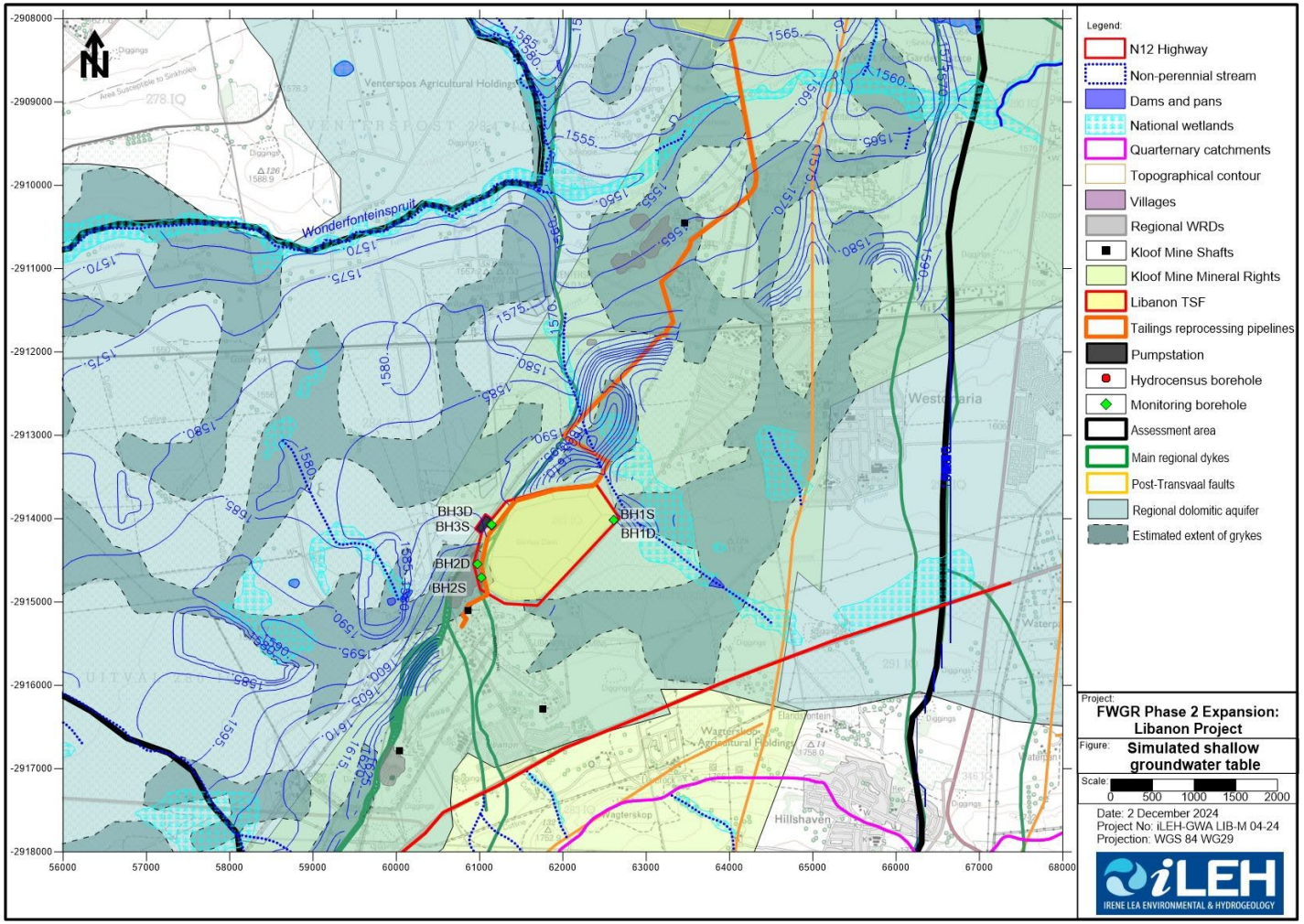


Figure 12. Calibrated groundwater levels in the residual dolomitic aquifer

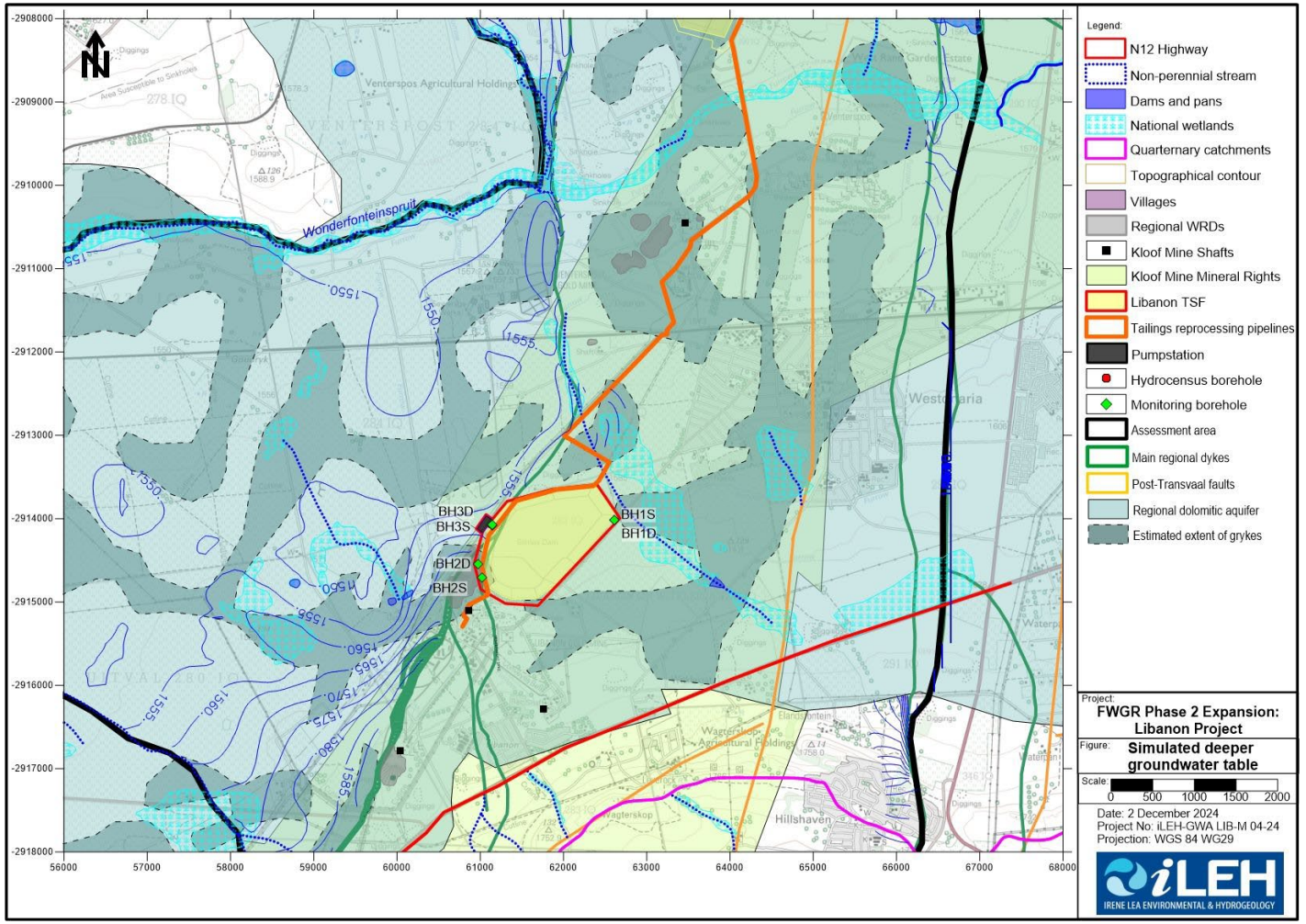


Figure 13. Calibrated groundwater levels in the deeper weathered dolomitic aquifer

The root mean square error, which provides an indication of the goodness of fit during calibration, is 7,59 m, which is within the criteria limit of 8 m.

The water balance error calculated with the numerical model is 0.1%, which also complies with the acceptable calibration criteria set.

Factors that influence the calibration process and results include the following:

- The time available to spend on model calibration. Due to the complexity of the hydrogeological setting, systematic adjustment of aquifer parameters as well as aquifer conceptualisation is time-consuming.
- Discrepancies in the elevations recorded for the hydrocensus borehole. The coordinates for the hydrocensus and monitoring boreholes were recorded with a hand-held GPS.
- The absence of borehole logs with which to characterise the aquifer conditions that the groundwater level in hydrocensus borehole represent.
- The way dewatering of the Venterspost Compartment was included is based on data from Jones & Wagener (2013) as well as a single 2024 dewatering rate received for the Kloof Celemanzi (Kloof No 10 Shaft). Since dewatering has a significant impact on groundwater levels and flow patterns in the immediate vicinity of the Libanon TSF, it is important to improve the accuracy of the dewatering process. This can be achieved by obtaining more accurate data to delineate the underground workings a well as an improved understanding of the history and extent of compartment dewatering.
- Limited groundwater level data is available around the TSF. This is due to the impact of dewatering of the dolomitic compartment and not because of poor field data. However, the lack of groundwater level data affects the accuracy with which modelling can be completed, as the depth to groundwater in dry boreholes is not known. This is mitigated to some extent through the fact that the level of dewatering in the compartment is known.
- The highly irregular groundwater flow patterns around the TSF are based on the complex geomorphology of the weathered dolomitic aquifer. The extent of dolomitic grykes and pinnacles could be inferred from the gravity survey completed by the Council for Geoscience, but there is a level of uncertainty in this approach.
- As mentioned earlier in this report, the modelling code assumes a continuous porous medium, which means that the aquifers are simulated using average parameters. The heterogeneity of the weathered dolomitic aquifer as well as the regional structural geology was incorporated as discrete zones during simulations, which counters the assumed continuous porous medium theory where data is available.

Table 18. Calibration results

Borehole ID	Measured head (mamsl)	Simulated head (mamsl)	Residual (m)
BH3D	1529,83	1537,32	-7,49
BH3S	1581,13	1586,23	-5,10
KG114	1661,32	1656,13	5,19
KG108	1628,38	1619,35	9,03
BH2 WRD1	1614,72	1618,24	-3,52
BH2 WRD1	1612,22	1618,46	-6,24
KG206	1570,84	1581,45	-10,61
BH2 WRD4	1588,27	1580,58	7,69
BH1 WRD4	1591,80	1581,56	10,24
KG111	1617,21	1609,56	7,65
DP104	1593,81	1598,98	-5,17
DP109	1591,02	1598,56	-7,54
KG105	1630,41	1624,35	6,06
KG106	1625,40	1623,57	1,83
Kloof2	1623,30	1621,36	1,94
KG119	1604,78	1611,37	-6,59
Ven 2	1610,66	1603,57	7,09
Ven 3b	1593,30	1600,38	-7,08
Ven 5	1582,10	1590,58	-8,48
Ven 6	1578,05	1585,26	-7,21

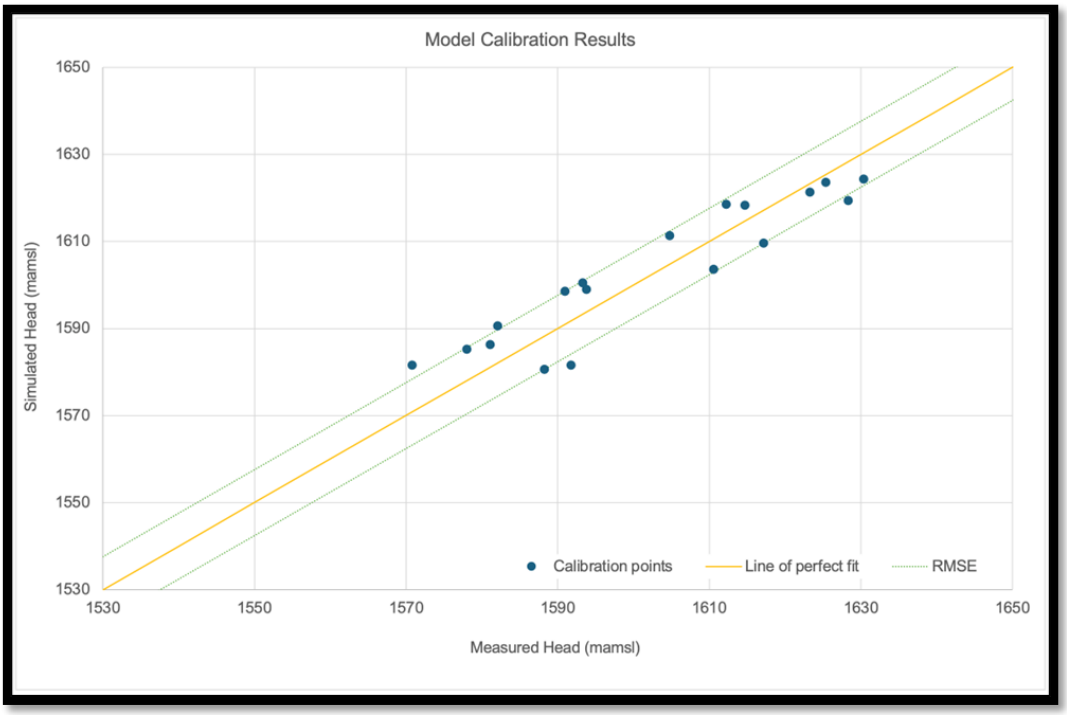


Figure 14. Calibration results

Model calibration can be improved once additional monitoring information becomes available from the proposed monitoring program. Sufficient time should also be allowed to complete model calibration to a high standard. Model-recalibration and verification can be undertaken with additional monitoring data as well as improved data on the mechanisms that affect compartment dewatering. Groundwater monitoring requirements are discussed later in this report.

11.6.1 Model Sensitivity

A sensitivity analysis was completed on the model parameters used to simulate the residual and weathered dolomitic aquifers. The purpose of the sensitivity analysis is to quantify the uncertainty in the calibrated model caused by uncertainty in the estimates of aquifer parameters, stresses and boundary conditions. The level of heterogeneity of the aquifer material can never be accurately measured with field data. The uncertainty of the impact of heterogeneity on simulations is therefore assessed as part of the sensitivity analysis.

The results of a sensitivity analysis can be used to identify data gaps and to plan for additional fieldwork, including monitoring requirements, once the modelling has been completed.

The comparative sensitivity for the parameters included during calibration is presented in Figure 15. The comparative sensitivity provides an indication of how sensitive the model is to changes in each parameter, compared to the other parameters tested. A low value indicates a low sensitivity and a high value a high sensitivity. The results indicate the following:

- The model is sensitive to changes in the rate of ambient recharge to the aquifers.
- The model is also sensitive to changes in the permeability of the residual and weathered dolomitic aquifers.
- The model is also sensitive to changes in the specific yield of the residual dolomitic aquifer as well as the storage coefficient for the weathered dolomitic aquifer, but to a lesser extent.

As discussed in the calibration section above, model sensitivity can be addressed through additional calibration with groundwater monitoring data that will become available from the operations once the monitoring program is implemented.

Data from the new monitoring boreholes were used to estimate the permeability of the residual and weathered dolomitic aquifers. It is however likely that this permeability may vary significantly over the project area, based on the depth of weathering, the presence of grykes and the clay content of the weathered zone.

The rate of recharge can be calculated from groundwater level monitoring data, which is analysed against on-site rainfall data. As part of this calculation, the storage coefficients can be estimated with more certainty.

11.6.2 Assessment of Uncertainties

The accuracy of the modelling project depends on the quality of the input data and the available information. Even with an unchanging environment, impacts are difficult to predict with absolute certainty. Predictions were undertaken with the calibrated flow model, which is a simplified version of reality. The model represents a tool that can be used to assess the impact of the proposed tailings reclamation activities on the aquifers and to identify data gaps. The calibration error is discussed above and is acceptable within the limitations of the study. The model should however be updated

and verified with site-specific monitoring information, when it becomes available. Calibration against hydrographs (groundwater level fluctuation with time) and on-site rainfall data will be of specific value in improving the current understanding of aquifer parameters.

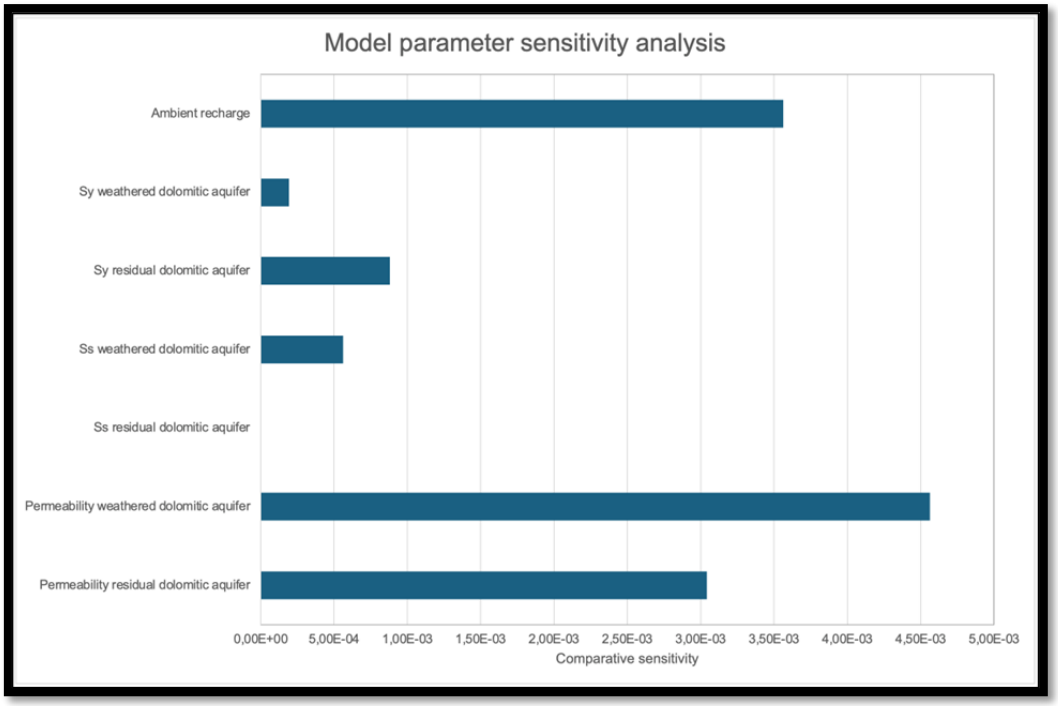


Figure 15. Sensitivity analysis

Uncertainties are approached conservatively, based on the precautionary principle, to ensure that the predictions and impact assessment in this report addresses the maximum potential impact of the proposed development. The uncertainties in the model include:

- **Uncertainties regarding borehole depth, construction and geology intersected**: This information is not available for the hydrocensus borehole. For this reason, it was assumed that the hydrocensus borehole targets the weathered quartzite aquifer.
- **Uncertainties regarding the borehole elevations**: The elevations used during simulations were inferred from hand-held GPS measurements and inaccuracies may occur.
- **Uncertainties regarding the mechanisms and extent of dewatering of the Venterspost Dolomitic Compartment**: The extent of underground mining and the depth of the dewatering in the compartment was approximated from literature-based information.
- **Mathematical modelling uncertainties**: It is not possible with the available information to quantify the heterogeneity present in the aquifers simulated. For this reason, there are inherent uncertainties in the model. The level of confidence in the model can be improved with the incorporation of additional monitoring data, as discussed above.

The uncertainties listed above can be reduced or eliminated through continuation of the groundwater monitoring program at the project. It can further be reduced by integrating the results of the groundwater monitoring program proposed in this study.

11.7 Results of the Model

The results of the modelling are presented below.

12 Hydrogeological Impacts

12.1 Preamble

There are positive and negative impacts reported for tailings reclamation. Lieferink (2012) provides the following positive impacts related to water resources, for this process:

- Removal will partially remove one of the sources of water pollution and ingress.
- Removal will expose the natural soil layer, allowing vegetation growth after rehabilitation.
- Significant long-term benefits, provided that the footprint is adequately rehabilitated and remediated.

Conversely, Lieferink (2012) reports that negative impacts will also manifest. From a water management perspective, the following is applicable:

- Not completing the reclamation of the project, thus leaving a portion of the source of contamination behind.
- Selective extraction of value from portions of a site and not rehabilitating the full extent of the footprint.
- Elevated levels of residual radioactivity in the soils, restricting reuse.
- Introduction of large volumes of water and oxygen into anaerobic tailings which exacerbates pollution. The process of reclamation therefore imposes a greater duty of care.

12.2 Plume Delineation

The outcome of the simulations is presented as sulphate and iron concentration contour maps that delineate the anticipated plumes for the three scenarios tested. These are based on the source term discussed earlier. The three operational scenarios tested are:

- **Best case scenario**: comparatively good quality seepage during reclamation and low seepage infiltration, equivalent to dry conditions, to the underlying aquifers.
- **Likely scenario**: measured quality seepage during reclamation and moderate seepage infiltration rates, equivalent to average conditions, to the underlying aquifers.
- **Worst case scenario**: comparatively poor quality leachate during reclamation with higher seepage infiltration, equivalent to wet conditions, to the underlying aquifers. This scenario is also presented as an indication of long-term impacts if the Libanon TSF is not removed, i.e. the No Project option.

The impact assessment was completed for the residual and weathered dolomitic aquifers. Since vertical flow will be prominent underneath the TSF and in the absence of attenuation in the unsaturated zone, potential contamination from surface is likely to affect both aquifers over time. As discussed earlier, it is acknowledged that attenuation is likely in the unsaturated zone. In the absence of geochemical data to quantify attenuation, only advective groundwater flow is considered. This is a conservative approach that tend towards maximum possible impact zones.

Simulated zones of impact on groundwater quality are presented for operational as well as for the anticipated post-closure long-term conditions below. Operational impacts for the three scenarios tested are similar due to the comparatively short period during which tailings will be reclaimed, the low aquifer permeabilities and the perceived latent impacts of historical tailings deposition. For this reason, impacts associated with the likely operational conditions are presented below.

To facilitate comparison between long-term impacts, the simulated sulphate and iron plumes that delineate the zones of significant impact on groundwater quality are overlain on a single map for sulphate and iron. To incorporate the level of uncertainty with regards to groundwater flow conditions in the residual and weathered dolomitic aquifers, the estimated zone impact in terms of drinking water standards is presented for the potential worst case only.

The estimated zone of impact in terms of drinking water standards therefore presents the maximum zone of impact post closure, following the precautionary principle. Groundwater within this zone is likely to exceed drinking water standards for sulphate and iron, making the groundwater potentially unfit for use. For sulphate, this zone is delineated by the 250 mg/L concentration contour and the 0.3mg/L concentration contour for iron. These are indicated in a dashed line with yellow fill.

The zones of significant impact delineate areas where the concentrations of sulphate and iron, and by implication other salts and metals, are likely to exceed concentrations that could pose a health risk if ingested. Groundwater in these zones will therefore not be fit for use. For sulphate, this zone is delineated by the 1000 mg/L concentration contour and for iron the 1 mg/L concentration contour. These are indicated in a red line with red fill.

The extent of the contours is based on domestic use guidelines after DWAF (1996), as detailed in Table 19. Where these differ from the SANS241:2015 Drinking Water Standards, the SANS standards were used. This approach is taken to enable delineation zones of significant risk to health associated with the project.

Table 19. Health risks associated with indicator elements (after DWAF, 1996)

Concentration range (mg/L)	Effects
Sulphate	
0 – 250	No health or aesthetic effects are expected
250 - 500	Tendency to develop diarrhoea in sensitive and some non-adaptive individuals. Slight taste noticeable
400 - 600	Diarrhoea in most non-adapted individuals. Definite salty or bitter taste
600 - 1000	Diarrhoea in most individuals. Pronounced salty or bitter taste
>1000	Diarrhoea in all individuals. Very strong salty and bitter taste
Iron	
0 – 0.3	No acute or chronic health effects. The groundwater is generally well tolerated
0.3 – 1	Adverse aesthetic effects (taste) and slimy coatings in plumbing. No health effects
1 - 10	Pronounced aesthetic effects (taste and slimy coatings) with slight health effects in young children and sensitive individuals
10 - 30	Chronic health effects with increasing risk of acute health effects. Severe aesthetic effects (taste and slimy coatings)

12.3 REHABILITATION MEASURES CONSIDERED

During the rehabilitation phase of the project, it was assumed that all tailings will be removed, that the soil will be shaped to create a free-draining surface and that all radiation will be removed. It is noted that this rehabilitation scenario will not reverse the cumulative impact of historical tailings deposition. For this reason, a residual impact will remain post-closure of the project in the long-term.

The rehabilitation will be completed down to a red earth footprint. As mentioned above, the area will be shaped for correct storm water management. During rehabilitation, all project infrastructure will be removed, and a final radiological survey will be undertaken. Thereafter the property will be handed over to the landowner. The final land use will be at the discretion of the landowner.

12.4 GENERAL OUTCOME FOR ALL SCENARIOS

The overall outcome of the simulations is summarised as follows:

- Simulations suggest that the private borehole south of the Libanon TSF fall outside the anticipated groundwater impact zones delineated for the project. This borehole will therefore not be affected by the tailings reclamation project.
- The plumes are expected to migrate regionally in a north-westerly direction towards the Wonderfonteinspruit in the residual and weathered dolomitic aquifers. It is highly unlikely that plumes associated with the Libanon TSF could reach this stream, even in the long-term. This is because aquifer permeabilities are low and the plumes are anticipated to move less than 50 m per year. In addition, vertical groundwater flow to the level of dewatering in the compartment will prevail until underground dewatering ceases and groundwater levels have regionally rebounded. Previous studies completed on the Kloof underground workings estimate that groundwater levels could recover within 20 years after pumping ceases to an elevation of 1560 mamsl. This is the elevation of the Venterspost Eye from which the compartment is expected to decant into the Wonderfonteinspruit once groundwater levels reach this elevation. Under these conditions the residual dolomitic aquifer underneath the Libanon TSF is expected to remain dewatered, as the current groundwater level in Lib-BH3s is at 1581 mamsl. The deeper weathered aquifer may however recover to 1560 mamsl, thus rewatering Lib-BH3d by approximately 40 m.
- On a local scale, groundwater flow will be towards the two non-perennial streams northeast and southwest of the Libanon TSF. It is likely that groundwater impacted by the TSF has already reached the stream 200 m northeast of the TSF.
- Flow in the residual and weathered dolomitic aquifers will be controlled by the presence and extent of dolomitic grykes and pinnacles, which was delineated based on a gravity survey completed for the aquifer. Preferential flow is expected in the dolomitic pinnacles. The grykes are expected to be significantly more clay-rich and therefore have lower permeabilities and groundwater flow conditions.
- A small northwestern portion of the Libanon TSF is located within the adjacent Bank Dolomitic Compartment. The boundary between the Venterspost and Bank Compartments is formed by the Venterspost Dyke that transects the northwestern edge of the Libanon TSF. Groundwater levels on the eastern edge of this compartment are not lowered significantly, based on the available dataset (Figure 8). Preferential flow is therefore likely to take place in this area, as the dolomitic aquifer is not as significantly dewatered compared to the Venterspost Compartment.

- The shape of the plumes is affected by the aquifer parameters as well as the calculated dispersion in the formations. Of most significance is the presence and extent of dolomitic grykes as well as regional post-Transvaal age dykes and faults. Dispersion especially plays a role in the extent to which lower concentrations of sulphate and iron would spread from the TSF. Dispersion can account for the spread of contamination that is not necessarily driven by groundwater flow.
- The zones of significant risk to groundwater quality delineated by the 1000 mg/L sulphate and the 1 mg/L iron concentration contours are expected to be restricted mainly to the footprint of the Libanon TSF. The extent of the zones of significant risk to groundwater reduces for Scenarios 2 and 3. This highlights the importance of implementing a sound water balance during operations and controlling the quality of leachate associated with the TSF. It is noted that FWGR has already committed to measures to control the factors and for this reason, long-term impacts are expected to approximate the likely scenario.
- The historical impact of tailings deposition is expected to continue to affect groundwater quality associated with the project areas in the long-term, even if FWGR removes the tailings as part of the proposed project. This is because the contamination already present in the aquifers will continue to move slowly down gradient, away from the TSF along groundwater flow patterns. For this reason, the shape of the plumes remains similar for the three scenarios tested. The difference is the concentration of contaminants within the plumes and a reduction in the extent of the zone of unacceptable impact after tailings reclamation, as mentioned.
- The extent of the iron plume is larger compared to that of sulphate. This is because lower water quality objectives are imposed on manganese compared to sulphate.

12.5 Impact Prediction

12.5.1 Impact at the end of the Operational Phase

The impact of tailings reclamation at the end of the operational phase is presented for iron and sulphate in the residual and weathered dolomitic aquifers in Figure 16. The simulations indicate the following:

- The zone of impact in terms of drinking water standards is not expected to extend more than 200 m from the TSF for sulphate and not more than 500 m for iron concentrations. No private borehole is present in this zone of impact. It is likely that the plume has reached the non-perennial stream northwest of the TSF. Groundwater near to or entering the stream as baseflow is not expected to exceed concentrations that would signify significant impacts.
- The zone of significant impact on groundwater quality is expected to be restricted mainly to the footprint of the TSF. It is acknowledged that portions of the residual and weathered aquifer within the TSF footprint is likely to be dewatered. From an impact assessment perspective, it was assumed that groundwater is likely to be affected over the entire footprint area.

Based on the impact assessment discussed above, the consequence rating for the operational phase, within the context of historical pre-existing impacts, is presented as follows:

- Magnitude: Moderate –
- Spatial scale: Site or local

- Duration: Medium term
- Probability: Possible

12.5.2 Long-Term Scenarios

As discussed earlier, the long-term impact of three operational scenarios were tested as part of impact predictions completed. The outcome of these is presented in Figure 17 for sulphate and iron for a period 100 years after rehabilitation of the TSF footprint. The following is concluded from the information presented:

- The zone of impact delineated in terms of drinking water standards is expected to expand in the long-term and migrate towards the two non-perennial streams on either side of the TSF. Groundwater flow and the extent of the zones of impact on groundwater quality will be controlled by the location of the Venterspost dyke as well as the dolomitic grykes. Preferential flow is anticipated in comparatively fresh dolomitic pinnacles compared to the grykes. The dyke will form a boundary to groundwater flow in the dolomitic aquifer.
- The sulphate plume is not expected to migrate more than 500 m from the TSF. The iron plume may extend further from the TSF mainly because it is delineated by much lower concentrations compared to sulphate. It is possible that the iron plume may migrate a further 500 m from the estimated operational plume in the long-term.
- The zone of significant impact on groundwater quality are compared for the three scenarios in the figure. As discussed earlier, the worst-case scenario can also be used to approximate the “Do Nothing” option. Under the conditions of aquifer conceptualisation, it is likely that the plume delineated by the 1000 mg/L sulphate concentrations contour could extend more than 200 m from the TSF footprint for this case. The worst-case scenario iron plume is also expected to extend approximately 350 m beyond the TSF footprint. No private boreholes are located within the zone of significant risk to groundwater quality. It is also unlikely that these zones would reach the non-perennial stream northwest of the TSF. There is a small risk that the zone of significant impact may however reach the northeastern stream.
- The most significant outcome of the likely and best-case scenarios is a reduction in the zone of significant impact on groundwater quality. Simulations suggest that both the sulphate and iron plumes could be reduced to within the TSF footprint area in the long-term. As discussed earlier, FWGR has developed stormwater management measures to at least achieve the conditions of the likely scenario. For this reason, long-term impacts on groundwater quality are anticipated to be restricted to the TSF footprint area and therefore not significantly impact on water resources.

Based on the impact assessment discussed above, the consequence rating for the worst-case scenario is presented as follows:

- Magnitude: Major –
- Spatial scale: Site or local
- Duration: Long-term
- Probability: Possible

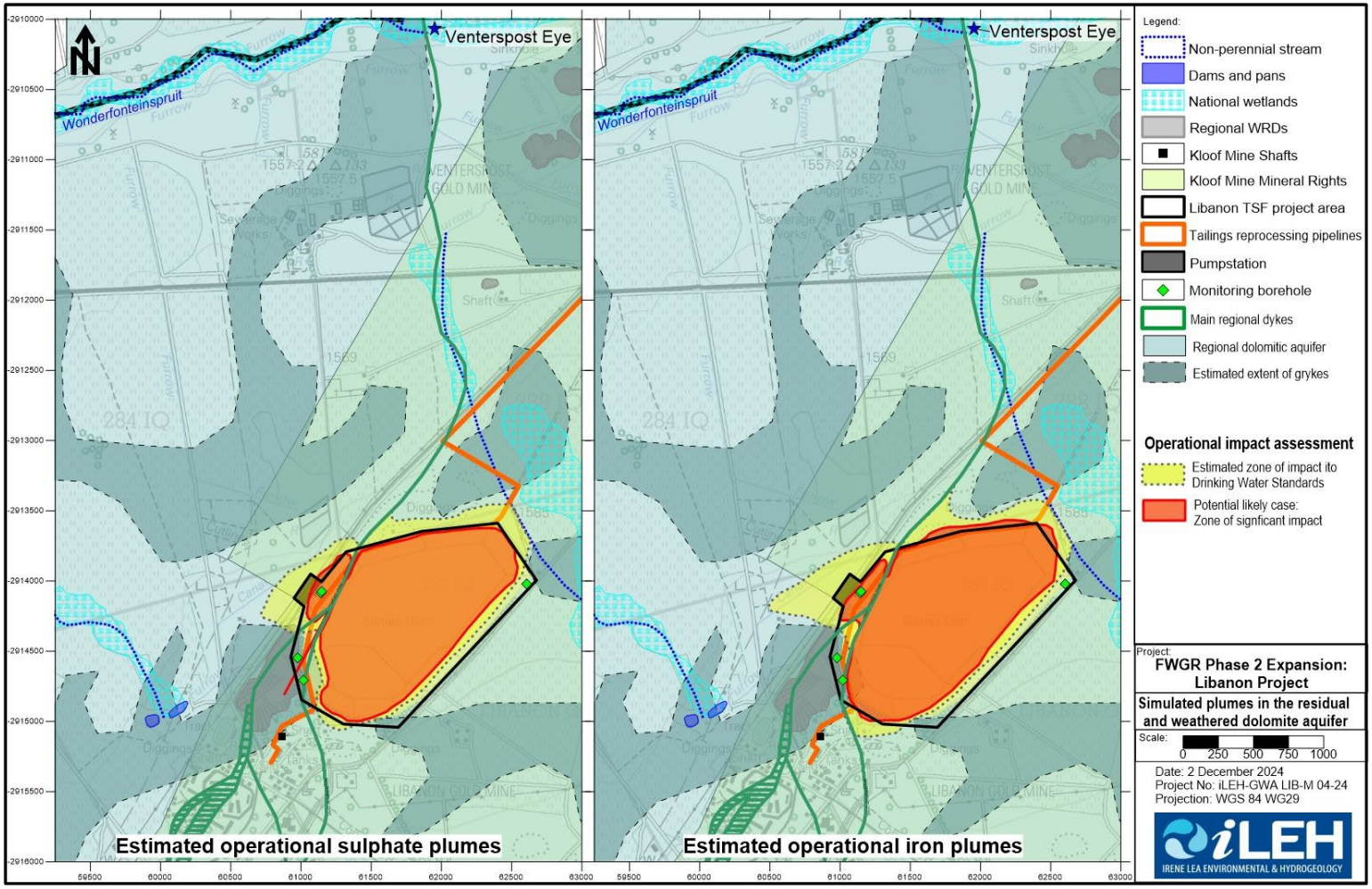


Figure 16. Simulated sulphate and iron plumes at the end of reclamation

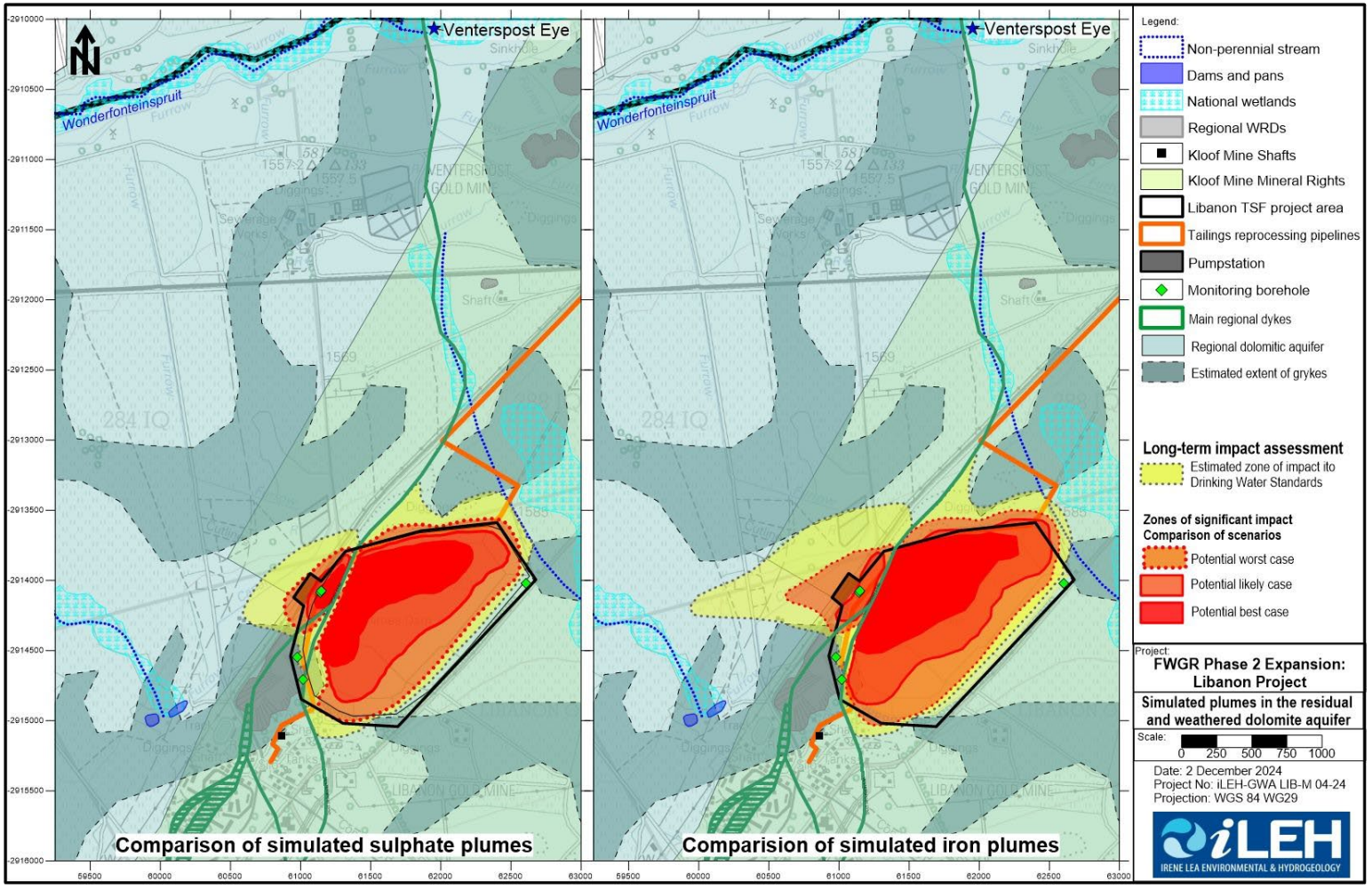


Figure 17. Anticipated long-term sulphate and iron plumes

12.6 CUMULATIVE IMPACTS

There are no other TSFs in the immediate vicinity of the Libanon TSF. For this reason, no cumulative impacts of tailings deposition could be considered. The project was however considered at the hand of regional gold mining activities and the impact of dolomitic compartment dewatering, as discussed above.

12.7 RISK OF DECANT

No risk of decant was flagged for this project.

13 GROUNDWATER IMPACT ASSESSMENT

The impact significance rating process serves two purposes: firstly, it helps to highlight the critical impacts requiring consideration in the management and approval process; secondly, it shows the primary impact characteristics, as defined above, used to evaluate impact significance.

The impact significance rating system is presented Table 20, Table 21 and Table 22 and involves three parts:

1. **Part A**: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale/ population and duration.
2. **Part B**: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A.
3. **Part C**: Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from Part B) and the probability of occurrence.

13.1 Part A: Defining Consequence in Terms of Magnitude, Duration and Spatial SCALE

The definitions in Table 20 are used to define the consequence in Part B.

Table 20. Consequence rating methodology

IMPACT CHARACTERISTICS	DEFINITION	CRITERIA
Magnitude	Major -	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded
	Moderate -	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded
	Minor -	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded
	Minor +	Minor improvement; change not measurable; or threshold never exceeded
	Moderate +	Moderate improvement; within or better than the threshold; or no observed reaction
	Major +	Substantial improvement; within or better than the threshold; or favourable publicity
Spatial scale or population	Site or local	Site specific or confined to the immediate project area
	Regional	May be defined in various ways, e.g., cadastral, catchment, topographic
	National/ International	Nationally or beyond
Duration	Short term	Up to 18 months
	Medium term	18 months to 5 years
	Long term	Longer than 5 years

13.2 Part B: Determining Consequence Rating

Rate consequence based on definition of magnitude, spatial extent and duration (Table 21).

Table 21. Consequence rating methodology

			SPATIAL SCALE/ POPULATION		
			Site or Local	Regional	National/ international
MAGNITUDE					
Minor	**DURATION**	**Long term**	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	**DURATION**	**Long term**	Medium	High	High
		Medium term	Medium	Medium	High
		Short term	Low	Medium	Medium
Major	**DURATION**	**Long term**	High	High	High
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High

13.3 Part C: Determining Significance Rating

Rate significance based on consequence and probability (Table 22).

Table 22. Significance rating methodology

Probability (of exposure to impacts)	**Consequence Negative**			**Consequence Positive**		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**
Definite	Medium	Medium	High	Medium	Medium	High
Possible	Low	Medium	High	Low	Medium	High
Unlikely	Low	Low	Medium	Low	Low	Medium

The impact assessment is based on the Kongiwe assessment methodology, as presented above. Groundwater management and mitigation options are presented in Chapter 15.

13.4 Construction Phase

Historical negative groundwater quality impacts have been observed in the new boreholes drilled at Libanon TSF during 2024. The groundwater presents salt and metal concentrations (e.g., Sulphate, Iron, Nickel and Manganese) that exceed SANS 241 Drinking Water Health Limits, as well as the DWS' Drinking Water Quality Objectives.

The prescribed groundwater monitoring program in this report must be implemented in the six new shallow and deep monitoring boreholes before reclamation commences and be maintained

throughout the life of the project. Based on good time-series monitoring data the impacts can be defined and delineated and additional mitigation measures implemented.

No additional impact is expected on the groundwater quantity and quality during the construction phase. Construction will be conducted in a relatively short period compared to the operational and post-closure phases. Additional impacts on the groundwater environment are therefore rated as Low (Table 23).

In the long term, the reclamation of the TSF will have a positive impact on the groundwater environment as the current negative pollution source will be removed and with time the contaminant concentrations will reduce.

Table 23. Construction Phase water quality impacts

NATURE OF THE IMPACT: I*mpact on the local groundwater quality*		
	Impact Rating Without Mitigation	**Impact Rating with Mitigation**
Impact Status: (positive or negative)	**Negative**	**Negative**
Extent *(Local, Regional, International)*	Local	Local
Duration *(Short term, Medium term, Long term)*	Short term	Short term
Magnitude *(Major, Moderate, Minor)*	Minor -	Minor -
Probability *(Definite, Possible, Unlikely)*	Possible	Possible
Calculated Significance Rating (Low, Medium, High)	**Low**	**Low**
Reversibility: (Reversible or Irreversible)	Reversible	
Irreplaceable loss of resources: (Yes or No)	No	
Cumulative impacts (yes or no)	Yes. Combined impact with other mining activities in the area, including landfill site activities and waste and sanitation management problems. Refer to Chapter 14.	

Mitigation measures

- Implement a groundwater monitoring program at Libanon TSF before reclamation starts to effectively measure the groundwater status and impacts of the reclamation activities on the groundwater environment and changes in groundwater qualities and levels. Refer to Section 17.1.
- Develop sound surface runoff management plans to ensure that all dirty runoff is contained and diverted to the paddocks. No pooling of water on surface allowed.
- Ensure that paddocks are designed to contain all dirty water generated during the reclamation process, to prevent overflows and spillages.

13.5 Operational Phase - Reclamation

The following impacts can be expected during the reclamation process:

13.5.1 Groundwater Quality

When the TSF is disturbed during reclamation, the water quality is expected to deteriorate due to the introduction of oxygen and water. There is a risk of acidification under these conditions. Historically the sources of pollution in the area include:

- Contaminated storm water runoff from the TSF and the landfill site and residential areas;
- Seepage water from the various slimes dams and paddocks, possibly containing high sulphates and metals; and
- Recharge of contaminated water by means of seepage from the TSF and any unlined storm water channels.

The impact of tailings reclamation at the end of the operational phase is presented in Section 12.5.1, for iron and sulphate in the weathered and fractured aquifers (Figure 16).

Groundwater quality will be negatively affected with a potential increase in salt loads, especially sulphate, manganese and iron concentrations during the reclamation activities. The old tailings material contains pyrite minerals and when exposed to oxygen and water during reclamation will result in the formation of acidic conditions. The risk of groundwater contamination during the hydraulic mining will be moderately negative in view of the existing impacts, if the surface water management and containment guidelines are followed during the reclamation process (Table 24).

The groundwater impact simulations, of tailings reclamation at the end of the operational phase indicate the following:

- The zone of impact in terms of drinking water standards is not expected to extend more than 200 m from the TSF for sulphate and not more than 500 m for iron concentrations. No private borehole is present in this zone of impact. It is likely that the plume has reached the non-perennial stream northwest of the TSF. Groundwater near to or entering the stream as baseflow is not expected to exceed concentrations that would signify significant impacts.
- The zone of significant impact on groundwater quality is expected to be restricted mainly to the footprint of the TSF. It is acknowledged that portions of the residual and weathered aquifer within the TSF footprint is likely to be dewatered. From an impact assessment

perspective, it was assumed that groundwater is likely to be affected over the entire footprint area.

- The historical impact of tailings deposition is expected to continue to affect groundwater quality associated with the project areas in the long-term, even if DRDGOLD removes the tailings as part of the proposed project. This is because contamination already present in the aquifers will continue to move downgradient, away from the site. With time, the concentrations will reduce if tailings reclamation proceeds, because of dilution from fresh rainwater in the catchment. The aquifers present underneath the TSF have low permeabilities and therefore transmit groundwater very slowly.
- The extent of the iron plume is larger compared to that of sulphate. This is because lower water quality objectives are imposed on iron compared to sulphate.

The implementation of sound housekeeping during the operational phase of the project, including the containment, reuse and recycling of stormwater, is expected to reduce impacts on groundwater quality, possibly resulting in an impact of medium significance. Groundwater mitigation measures proposed are listed below.

It is important that all tailings material is removed, and that selective tailings reprocessing does not take place. Partially removed TSF material would result in unacceptable long-term impacts on groundwater. Complete removal of the Libanon TSF should however have a long-term positive impact on the groundwater quality, as the source of contamination is removed. A significant reduction in long-term impacts can furthermore be achieved if the footprint soils are ameliorated to reduced salt and metal concentrations in the impacted soils to within tolerable interim targets, as set for the Wonderfonteinspruit water quality.

Monitoring of groundwater quality and water levels is recommended with continuous review and updating of the monitoring network based on the monitoring results. See Section 17.

13.5.2 Groundwater Quantity

The proposed TSF reclamation will not have any significant impacts on the groundwater quantity (

Table **25**). The reclamation activities will be driven by water jetting. Large volumes of water are used in the process. There is a possibility that water will seep into the underlaying formations, but the additional recharge should be negligible and should have no impact on the groundwater table elevation.

Table 24. Operational Phase water quality impacts

NATURE OF THE IMPACT: ***Groundwater pollution during reclamation***		
	Impact Rating Without Mitigation	**Impact Rating with Mitigation**
Impact Status: (positive or negative)	**Negative**	**Negative**
Extent *(Local, Regional, International)*	Regional	Local
Duration *(Short term, Medium term, Long term)*	Long term	Long term
Magnitude *(Major, Moderate, Minor)*	Major -	Moderate -
Probability *(Definite, Possible, Unlikely)*	Possible	Possible
Calculated Significance Rating (Low, Medium, High)	**High**	**Medium**
Reversibility: (Reversible or Irreversible)	Reversible	
Irreplaceable loss of resources: (Yes or No)	No	
Cumulative impacts (yes or no)	Yes. Combined impact with other mining activities in the area, including landfill site activities and waste and sanitation management problems. Refer to Chapter 14.	

Mitigation measures

- Develop sound surface runoff management plans to ensure that all dirty runoff is contained and diverted to the paddocks. No pooling of water on surface allowed.
- Commit to remove all tailings material and to monitor the quality of soils in the footprint areas. If soil monitoring suggests unacceptably high salt and metal concentrations, soil amelioration should be considered.
- Monitor groundwater quality in all boreholes identified. The groundwater monitoring network efficiency must be assessed and new monitoring boreholes drilled, if required. Additional mitigation measures need to be implemented if pollution is migrating off site.
- Ensure that paddocks can contain all dirty water generated during the reclamation process to prevent overflows and spillages.

Table 25. Operational Phase water quantity impacts

NATURE OF THE IMPACT: ***Reduction in aquifer yield***		
	Impact Rating Without Mitigation	**Impact Rating with Mitigation**
Impact Status: (positive or negative)	**Positive**	**Positive**
Extent *(Local, Regional, International)*	Local	Local
Duration *(Short term, Medium term, Long term)*	Medium Term > 18 months < 5 years	Medium Term > 18 months < 5 years
Magnitude *(Major, Moderate, Minor)*	Minor -	Minor +
Probability *(Definite, Possible, Unlikely)*	Possible	Possible
Calculated Significance Rating (Low, Medium, High)	**Low**	**Low**
Mitigation measures ❖ Develop sound surface runoff management plans to ensure that all dirty runoff is contained and diverted to the paddocks. No pooling of water on surface allowed. ❖ Ensure that paddocks can contain all dirty water generated during the reclamation process to prevent overflows and spillages. ❖ Monitor groundwater levels in all boreholes.		

13.6 DECOMMISSIONING AND CLOSURE

13.6.1 GROUNDWATER QUALITY

Groundwater quality is expected to improve over time as the source of contamination will be removed and the TSF footprint will be reinstated as far as possible (Table 26). This is with the assumption that all TSF material is removed, and efficient surface water management is maintained.

Due to the relatively short period over which decommissioning and closure will take place, the positive impacts may not be immediately visible in monitoring programmes. The anticipated improvements in groundwater quality are expected to occur post-closure, in the long-term.

The zone of impact over which sulphate or manganese concentrations would exceed acute health standards will reduce in the long-term but is not expected to dissipate. Historical groundwater

contamination will most likely continue to move through the aquifers. The removal of the TSFs is however expected to reduce the zone of impact in the long-term.

The reclamation impact is anticipated to be positive after the tailings material has been removed. Soil and groundwater assessment studies are recommended for the footprint areas, when all tailings material has been removed, to determine the status of these environments. The area over which groundwater quality would exceed unacceptable levels would be reduced. This is because of the removal of the source to groundwater contamination and flushing with clean rainwater recharge.

Rehabilitation of the soil in the footprint area of the historical TSF is required to stabilise the pH and minimise infiltration of contaminated water.

Table 26. Decommissioning and Closure Phase water quality impacts

NATURE OF THE IMPACT: ***Water quality impacts when TSF has been removed***		
	Impact Rating Without Mitigation	**Impact Rating with Mitigation**
Impact Status: (positive or negative)	**Positive**	**Positive**
Extent *(Local, Regional, International)*	Local	Local
Duration *(Short term, Medium term, Long term)*	Long term	Long term
Magnitude *(Major, Moderate, Minor)*	Minor +	Moderate +
Probability *(Definite, Possible, Unlikely)*	Possible	Possible
Calculated Significance Rating (Low, Medium, High)	**Medium**	**Medium**
Reversibility: (Reversible or Irreversible)	Reversible	
Irreplaceable loss of resources: (Yes or No)	No	
Cumulative impacts (yes or no)	Yes. Combined impact with other mining activities in the area, including landfill activities and waste and sanitation management problems. Refer to Chapter 14.	
Mitigation measures ❖ Monitor groundwater quality in all boreholes.		

- Maintain sound surface runoff management to ensure that all dirty runoff is contained and diverted to the paddocks.

13.6.1 Groundwater Quantity

There will be no impacts on the groundwater quantity during decommissioning and closure (Table 27). The reclamation activities and addition of water will have stopped and any form of seepage to the subsurface will reduce and ultimately stop, apart from precipitation.

Table 27. Decommissioning and Closure Phase water quantity impacts

NATURE OF THE IMPACT: ***Reduction in aquifer yield***		
	Impact Rating Without Mitigation	**Impact Rating with Mitigation**
Impact Status: (positive or negative)	**Positive**	**Positive**
Extent *(Local, Regional, International)*	Local	Local
Duration *(Short term, Medium term, Long term)*	Medium Term > 18 months < 5 years	Medium Term > 18 months < 5 years
Magnitude *(Major, Moderate, Minor)*	Minor +	Minor +
Probability *(Definite, Possible, Unlikely)*	Definite	Definite
Calculated Significance Rating (Low, Medium, High)	**Low**	**Low**
Reversibility: (Reversible or Irreversible)	Reversible	
Irreplaceable loss of resources: (Yes or No)	No	
Cumulative impacts (yes or no)	No	
Mitigation measures ❖ Monitor groundwater levels in all boreholes.		

14 CUMULATIVE IMPACTS

Cumulative impacts result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present, or reasonably foreseeable future activities (e.g., discharges of high salt or metal loads to a river that combine to cause a reduction in the use of the resource that is greater than the additive impacts of each pollutant). Cumulative impacts can occur from the collective impacts of individual minor actions over a period and can include both direct and indirect impacts.

The Libanon TSF project is near mining activities, a landfill site, agricultural activities and formal residential developments. Cumulatively all these activities contribute to the surface and groundwater quality impacts identified during the Libanon TSF study and could also impact the groundwater resources, especially in terms of quality (Table 28).

Establishing a groundwater monitoring program (Section 17) is required to assess the implications that reclamation will have on the aquifers and to identify if poor quality groundwater will reach a sensitive receptor. The monitoring data recorded as operations progress must be used to update the monitoring program.

Table 28. Cumulative impact rating

	OVERALL IMPACT OF THE PROJECT CONSIDERED IN ISOLATION	**CUMULATIVE IMPACT OF THE PROJECT AND OTHER PROJECTS IN THE AREA**
Impact Status: (positive or negative)	**Negative**	**Negative**
Extent *(Local, Regional, International)*	Local	Local
Duration *(Short term, Medium term, Long term)*	Long term	Long term
Magnitude *(Major, Moderate, Minor)*	Moderate	Major
Probability *(Definite, Possible, Unlikely)*	Definite	Definite
Calculated Significance Rating (Low, Medium, High)	Medium	Medium
Reversibility: (Reversible or Irreversible)	Reversible	Reversible
Irreplaceable loss of resources: (Yes or No)	No	No
Can impacts be enhanced: (Yes or No)	Yes	Yes
Mitigation measures ❖ Ensure that contaminated surface and groundwater from the adjacent mining and landfill activities are effectively managed and that polluted water is not allowed to enter the Wonderfonteinspruit.		

15 GROUNDWATER MANAGEMENT MEASURES

Based on the outcome of the information presented in this report, several groundwater management measures are proposed for the project. Adequate quality control measures are needed to ensure that the methodology conforms to specification and that management targets have been achieved. This requires environmental monitoring while reclamation is in progress. In addition, upon completion of the reclamation, additional monitoring and management activities may be necessary if contamination remains in any form on the site.

The following objectives and targets are proposed for groundwater management during and after completion of the Libanon TSF reclamation project:

- Implement a management plan aimed at reducing and/or eliminating adverse impacts on the receptors identified, including vertical flow to the residual and weathered dolomitic aquifers as well as horizontal flow to watercourses. The management plan must be earmarked at achieving conditions comparable to the at least likely case scenario presented in this report. Where possible, conditions applied for the best-case scenario should be planned for (Table 13 and Table 14).
- Track and record the progress of implementation of all groundwater management measures.
- Implement sufficient monitoring procedures to measure the effectiveness of groundwater management measures.
- Analyse the information obtained from all monitoring programmes against compliance targets to establish trends and to determine the need to trigger additional actions to reduce adverse impacts.
- Should the trends indicate adverse impacts on groundwater levels and/or quality, implement suitable measures within the shortest possible time to remediate and/or eliminate such adverse impacts identified.

15.1 OVER-ARCHING GROUNDWATER MANAGEMENT MEASURES

Several broad over-arching groundwater management measures should be implemented by FWGR for the project to minimise impacts on groundwater, as detailed in Table 29.

Table 29. General groundwater management measures

Construction Phase
A dedicated groundwater monitoring network must be established in the new boreholes.
Make provision for sufficient groundwater level and quality monitoring budget to implement the groundwater monitoring programme, before the reclamation starts.
Develop effective surface runoff management plans to ensure that all dirty runoff is contained and removed off site as soon as possible. Avoid ponding of water over exposed areas.
Ensure that cut-off trenches with sumps are designed to contain all dirty water generated during the desilting to prevent overflows and spillages.
Implement sound house-keeping measures to prevent and clean spills, address leaks and undertake regular inspections. Ensure that the record-keeping procedure is in place and that instructions given are carried out.
Measure rainfall on site.
A dedicated groundwater monitoring network must be established in the new boreholes.
Operational Phase
Complete regular inspections of trenches and sumps, specifically noting incidences of overflow and leakage. If the latter is identified, measures must be taken to rectify immediately.
Maintain sound house-keeping measures to prevent spills and leaks.
Continue with the groundwater monitoring program.
Measure rainfall on site.
Record all groundwater-related complaints and deal with each complaint within the agreed upon timeframe.
Decommissioning and Closure Phase
Complete all reclamation and rehabilitation to a satisfactory level, focussing specifically on the water drainage and collection system.
Ensure that all tailings material is removed from the footprint. Soils must be tested to identify potential risks to groundwater contamination post closure.
Continue with the groundwater monitoring period for a minimum of two years after completion of the rehabilitation. The continued need for groundwater monitoring will depend on the outcome of the final closure assessment.

The following specific groundwater management measures are recommended, based on the outcome of this assessment. The measures are related to two broad impacts, namely the availability of groundwater and the quality of groundwater.

15.2 Measures to Address Impacts on Groundwater Availability

It is noted that the weathered dolomitic aquifer is regionally dewatered, which significantly reduces groundwater availability in the area. Despite this, the following specific measures are recommended to minimise and/or eliminate the impacts on groundwater levels and availability:

- Groundwater levels must be monitored on a quarterly basis in the new monitoring boreholes to establish trends and to flag possible impacts. It is noted that the project is not expected to affect groundwater levels significantly.
- The private borehole identified during the hydrocensus is not located within the zones of impact delineated as part of this assessment.
- Ensure that an effective surface water collection and retention system is in place to ensure that all flow and collected water is directed towards the cut-off trenches with sumps and not allowed to freely drain away from the various silt holding areas. This will also reduce long-term impacts on groundwater quality, as discussed above.

15.3 Measures to Address Impacts on Groundwater Quality

The following specific measures are recommended to minimise and/or eliminate the impacts on groundwater quality:

- The following specific measures are recommended to reduce the risk of deterioration of effluent quality and the volume of leachate available for infiltration to the aquifers:
    - To minimise negative long-term impacts associated with the project, it is important that tailings reclamation must be completed to soil level at the site. All tailings must be removed.
    - No ponding must be allowed on exposed areas. Process water that is allowed to pond uncontrolled will increase the risk of infiltration to the underlying aquifers as well as the risk of deterioration in groundwater quality.
    - After rehabilitation, the footprint area must be made free draining to minimise infiltration of water to the aquifers.
    - Ensure that clean and dirty water is separated at the reclamation and drying areas, and that dirty water is contained. Contain dirty water in adequately sized and lined sumps. Prevent dirty water runoff from leaving the area.
- FWGR must implement a groundwater quality monitoring program in the new boreholes during reclamation. If the results of the monitoring indicate deterioration of quality to within the criteria specified for the worst-case scenario in this assessment, FWGR must investigate the sources of contamination and rectify any activity that results in acidification of leachate or ponding of leachate for extended periods of time. This will reduce the risk to groundwater quality in the long-term.
- A re-run of the contaminant transport simulations must be undertaken at least 5 years before closure once additional monitoring information is available, to improve long-term impact prediction and to ensure that closure groundwater management measures are effective.

16 Post Closure Management

16.1 Remediation of Physical Activity

The preferred remediation strategy for the Libanon TSF is to remove all tailings material. Once the footprint has been cleaned, it must be rehabilitated and made free draining.

Soil samples must be taken once rehabilitation has been completed for leach tests. The outcome of these tests must be used to confirm long-term risk of contamination to groundwater quality presented in this report.

16.2 Remediation of Storage Facilities

Not applicable.

16.3 Remediation of Environmental Impacts

As discussed above.

16.4 Remediation of Water Resources Impacts

Not applicable.

16.5 Backfilling of Pits

Not applicable.

17 Groundwater Monitoring

To monitor and prevent the spread of groundwater contamination, groundwater management procedures and practices must be implemented that are in line with accepted practices and in accordance with the requirements of the Environmental Management Plan (EMP). It is recommended to implement the groundwater monitoring program presented in this report to establish the extent of contamination in the shallow weathered and deeper fractured aquifers, during and after the reclamation activities. The key objectives of the groundwater monitoring program are to:

- Detect short and long-term trends;
- Recognise changes in groundwater quality and levels;
- Measure impacts and implement mitigation measures; and
- Develop improved monitoring systems.

Groundwater monitoring must be undertaken to establish the extent of contamination in the shallow weathered and deeper fractured aquifers, during and after the reclamation activities.

17.1 Monitoring Locations

A groundwater monitoring program must be implemented in the six new shallow and deep monitoring boreholes before reclamation commences and be maintained throughout the life of the project. It is not anticipated that additional monitoring boreholes will be required, based on the outcome of the impact assessment completed. The three sets of boreholes are close enough to the TSF to enable effective monitoring (Table 30). It is acknowledged that two sets of boreholes are currently dry. These should however continuously be checked and sampled if they are rewatered.

Table 30. Proposed groundwater monitoring positions

Monitoring ID	X Coordinate (WGTM 29)	Y Coordinate (WGTM 29)	Depth (m)	Purpose
Proposed new monitoring boreholes				
Lib1s and Lib1d* Lib2s and Lib2d* Lib3s and Lib3d	See Table 4			New monitoring boreholes, targeting shallow and deep aquifers immediately down gradient of the Libanon TSF

**Even though these boreholes are dry at present, continuous monitoring should be implemented, and the boreholes must be sampled for quality analyses if they are rewatered.*

17.2 MONITORING REQUIREMENTS

It is recommended that groundwater levels are monitored in all the boreholes listed in Table 30 on a quarterly basis. This information is important to improve the understanding of water level fluctuations and groundwater level rise and fall in response to rainfall. This information will be interpreted at the hand of on-site rainfall figures and will be used to improve the conceptual understanding of the aquifers.

The monitoring program must be used to establish sound baseline conditions against which future impact assessments can be evaluated. To keep continuity with the baseline information presented in this report, it is recommended that the elements listed in the groundwater quality analyses in this report are included in the monitoring program. These represents the most significant elements applicable to the project. The monitoring requirements are presented in Table 31.

Table 31. Groundwater monitoring requirements

Monitoring parameter	Element for analysis	Monitoring frequency	Monitoring trigger-response criteria
Depth to groundwater level in boreholes	Groundwater level	Quarterly	Variations by more than 3 m for 2 consecutive months should be investigated.
Water quality analysis in all boreholes and surface water monitoring positions listed in Table 30.	All elements included in the current analysis	Quarterly	Variations in concentrations by more than 15% for major cations and anions and more than 7% for metal concentrations for more than 2 consecutive months should be investigated. Any result that exceeds specified water quality objectives must be investigated when it occurs.
Rainfall	Rain depth (mm)	Daily on site	None

The monitoring trigger-response criteria listed in Table 31 must be reviewed on an annual basis and updated, based on the outcome of the monitoring programme results. All monitoring information must be entered into a spreadsheet for record keeping and analysis. Copies of the certificates of analyses must be kept on file for inspection. If significant exceedances are recorded during the monitoring programme, the following actions should be taken:

- Log the exceedances in the incident reporting system within 24-hours of it occurring.
- Undertake an investigation to identify causes of the exceedances.

- Implement the necessary remedial actions according to the outcome of the investigation and consultation with the affected parties.
- Report significant exceedances to the Environmental and General Managers as well as to the regulatory authority and track the incident until completion.

The results of the monitoring programme must be reported on a quarterly and annual basis for the purpose of internal FWGR water management. These reports must also be submitted to the authorities for review.

17.3 GROUNDWATER MONITORING REPORTS

Monitoring reports must contain the following information:

- Monitoring borehole location map;
- Geology map;
- All coordinates of the groundwater sampling sites;
- Certificates of analysis must be included for quality assurance. Monitoring results will be compared to South African National Standards (SANS241) and the Blesbokspruit catchment guideline limits;
- Time-series graphs for key indicator elements (e.g., pH, EC, TDS, Fe, Mn, Al, NO_3, SO_4);
- A discussion regarding observed trends and potential groundwater contamination; and
- Recommendations regarding possible amendments or additions to the groundwater monitoring programme, based on trends and other information observed.

17.4 QUALITY ASSESSMENT AND QUALITY CONTROL

Quality assurance means:

- Developing a system of activities to ensure that measurements meet defined standards of quality with a stated level of confidence;
- Defining monitoring objectives, quality control procedures to be followed and quality assessment;
- To define data quality objectives, including accuracy, precision, completeness, representativeness and comparability; and
- Designing a network, selecting sampling sites, selecting instruments and designing the sampling system, as discussed above.

All monitoring equipment must be maintained as required, and calibration must be undertaken on a regular basis.

To ensure that the Groundwater Monitoring Strategy complies with the above, it is important that analytical laboratories used should be accredited for each type of analysis required, to ensure that accurate analytical methods are used.

While only one or two of the common major ions found in waters may be specified as key indicators, it is necessary to analyse for the full suite of common ions for quality control purposes and to detect discrete events and long-term trends in anion composition.

Special attention must be paid to sampling methods and to preservation and handling of samples prior to analysis. pH and conductivity must be measured in the field.

Close attention must be given to siting, logging and construction of monitoring boreholes and assessment of their condition must be made quarterly.

The following sampling protocol is proposed:

- Sterilised plastic bottles, with a plastic cap and no liner within the cap are required for the sampling. Sample bottles should be marked clearly with the borehole name, date of sampling, water level depth and the sampler's name.
- Water levels should be measured prior to taking the sample, using a dip meter (m bgl).
- Each borehole to be sampled should be purged (to ensure sampling of the aquifer and not stagnant water in the casing) using a submersible pump or a clean, sterile bailer. At least three borehole volumes of water should be removed through purging; or through continuous water quality monitoring, until the electrical conductivity value stabilizes.
- The following field measurements should be recorded on a field form for each sampling point: pH, EC and temperature.
- Samples should be kept cool in a cooler box in the field and kept cool prior to being submitted to the laboratory.
- The pH and EC meter used for field measurements should be calibrated daily using standard solutions obtained from the instrument supplier.

18 Reasoned Opinion

It is the opinion of the project hydrogeologists that the reclamation of the Libanon TSF can proceed, provided that good surface water / storm water management measures are put in place and maintained throughout the life of the project. No ponding over exposed areas must be allowed. The project must further commit to complete tailings removal and not undertake selective tailings reclamation. In the short term there could be water quality impacts (increase in salts and metals) if water on the surface is not managed effectively. The risk of this impact will be confirmed through a dedicated groundwater monitoring programme in the new and hydrocensus boreholes. Analysis of the monitoring information must be considered as part of an updated risk assessment to be completed as part the closure application for the site. Overall, the project is expected to deliver a long-term positive impact on groundwater quality if the TSFs are removed and footprint areas are rehabilitated.

19 Conclusions and Recommendations

The Project:

In 2017, Sibanye Gold Limited, a subsidiary of Sibanye-Stillwater Limited, was granted the necessary approvals to execute a project known as the West Rand Tailings Retreatment Project (WRTRP). The project entails the reclamation of several historic tailings storage facilities in the West Rand, Gauteng. Tailings will be re-treated for gold recovery, with residue material being disposed onto the Regional TSF (RTSF). A commercial agreement was reached between DRDGOLD Limited and Sibanye resulting in the formation of Far West Gold Recoveries (Pty) Ltd (FWGR) in 2018.

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant, or any other future plant. Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised. An estimated amount of 600 000 tons/month of slurry is expected to be pumped from the TSF via existing pipelines to the Driefontein 2 Plant for beneficiation.

Libanon TSF is situated approximately 2 km west of Westonaria, in the Rand West City Local Municipality. Libanon TSF is approximately 170 hectares in extent and located on the farm Witkleigat 283 IQ 87IR. The project is in a regional gold mining area within the Kloof Mineral Rights Area.

The anticipated life span of the project is approximately 12 years. It is expected that there would be a 1-year construction and ramp-up period which would include the placement of infrastructure and site preparation, a 6-year Life of Operation, a 2-year ramp-down period and 3 years to rehabilitate the reclaimed site. Upon completion of reclamation, the footprint area will be assessed for contamination, particular in terms of radiation. Contaminated soils will be removed, and the land will be levelled to its original topography.

The proposed reclamation method which will be used to remove the TSF is referred to as top-down hydraulic reclamation. This technique uses high-pressure water monitors / cannons to deliver a high-pressure water jet to excavate unconsolidated tailings material within the TSF hydraulically. The water from the cannon mixes with the tailings and forms a slurry with a high solids content. The slurry then flows under gravity along trenches at the base of the TSF to a collection sump which is positioned at the lowest elevation of the bench being mined.

Environmental Setting:

The project is situated on a relatively flat plain that dips in a northerly direction towards the Wonderfonteinspruit. The flat plain is associated with dolomitic and Karoo Sequence outcrops. The undulating and hilly ground south of the TSF is formed by outcrops of the Timeball Hill and Rooihoogte Formations (Pretoria Group).

The Venterspost Eye is located approximately 3.6 km north of Libanon TSF, close to the Wonderfonteinspruit. This eye is dry at present because the dolomitic compartment in which it is situated has been dewatered by gold mines.

Libanon TSF falls in the Wonderfonteinspruit catchment, in the C23D quaternary catchment, forming part of the Vaal Water Management Area.

The Mean Annual Precipitation for the Blyvooruitsig weather station is 711 mm. The open water Mean Annual Evaporation is 1 454 mm, which is double the MAP of the area.

Regionally the geology consists of formations of the Karoo, Transvaal, Ventersdorp and Witwatersrand Supergroups. The Black Reef quartzite, which is present at the base of the Transvaal Supergroup, outcrops north of the project area. Of the Transvaal Supergroup Formations, the Chuniespoort Group are of most significance, as the Libanon TSF is located on outcropping Malmani dolomite. The dolomite varies in thickness regionally from around 200 to 1500 m. Underneath the Libanon TSF, the base of the dolomite is at an elevation of 1000 to 800 mamsl and dips in a southerly direction (Jones and Wagener, 2013).

South of Libanon TSF, formations of the Pretoria Group outcrop, including ferruginous shale and quartzite of the Timeball Hill Formation, Hekpoort lavas, as well as shale outcrops of the Strubenkop and Silverton Formations.

Some Karoo sediments have remained as inliers above the dolomite, delineated as the Vryheid Formation.

In addition to the regional post-Transvaal faults, regional diabase (dolerite) dykes have intruded into some of the north-easterly striking faults. Many of these faults penetrated the full Transvaal sequence as well as the underlying Ventersdorp and Witwatersrand Supergroups. These dykes have subdivided the dolomites in watertight compartments. The Libanon TSF is located on the western edge of the Venterspost Compartment and possibly to some extent on the Bank Compartment. The eastern boundary of the Venterspost Compartment is formed by the Gemsbokfontein No 2 Dyke and the western boundary by the Venterspost Dyke, which transects the western boundary of the Libanon TSF. The northern boundary of the dolomitic compartments is formed by the outcrop of the dolomite against the Black Reef Quartzite. The southern boundary is formed by the overlying Transvaal sediments.

Site Investigations:

Three sets of shallow and deep monitoring boreholes were drilled and tested as part of this project. The results of the drilling program indicate the presence of thick residual dolomite, referred to as wad underneath the Libanon TSF footprint. This material has very low permeabilities and act largely as an aquitard. One of the deeper boreholes intersected a cavity in the dolomitic formation, which complicated the drilling process.

Hydrocensus:

A hydrocensus was conducted across the study area during August 2024. The survey included the Libanon TSF property, plus accessible properties within a 4.5 km radius, and concentrated on identifying existing boreholes to enhance the knowledge of the groundwater systems and current groundwater use. Only one borehole was identified on one of the properties on the ridge to the south, but a groundwater level could not be measured due to security measures installed.

Locally surface drainage and possibly groundwater flow will be towards the Wonderfonteinspruit.

Information presented in Jones & Wagener (2013) indicates that there is a 77% correlation between groundwater level and topographical elevations in the weathered dolomitic aquifer. The 77% correlation suggests that there is some relationship between groundwater elevation and topography in the weathered dolomitic aquifer, but that dewatering has lowered groundwater levels significantly in places, thus skewing this correlation.

Borehole Drilling:

Based on a geophysical survey, three drilling positions were identified around the footprint area of Libanon TSF. The percussion drilling program was carried out during October 2024, by Redirile Drilling.

Two groundwater characterisation and monitoring boreholes were drilled at each of the 3 target areas. The one borehole was drilled to a depth of 80 m below surface, with the aim of characterising

and monitoring the deeper fractured aquifer. The second borehole was drilled 30 m deep, with the aim of monitoring potential groundwater flow, quality and possible connection between the deeper fractured aquifer and the shallow weathered aquifer in the area.

Two of the 6 new percussion boreholes produced a measurable groundwater level, post drilling (boreholes Lib BH3s and Lib BH3d). The other four boreholes produced no water and remained dry post closure. There were no measurable blow yields with only seepage water observed for boreholes Lib BH3s and Lib BH3d.

The set of shallow and deep boreholes that contained some groundwater are located on a comparatively fresh dolomitic pinnacle, based on the gravity survey, which is probably associated with the position of the Venterspost Dyke. In the deep borehole, the groundwater level is deeper than 70m below surface, reflecting the regional impact of the dewatered compartment. The fact that a groundwater level could be measured in this position probably attributed to the percolation of rainwater into the dolomitic pinnacle and the presence of increased porosity to facilitate storage of this groundwater.

In the shallow borehole, the depth to groundwater is around 20 m, which also suggests percolation of rainwater from surface as well as infiltration from the Libanon TSF that is retarded in the vertical flow direction by the presence of the thick wad. This groundwater probably sits on a pocket of low permeability wad as a perched aquifer near surface.

Aquifer Testing:

Following completion of the drilling programme, an aquifer test programme was initiated to determine the hydrogeological characteristics of the local aquifers, where possible. VSA Leboa Consulting was appointed by Water Hunters to conduct yield testing of the newly drilled boreholes. Only 5 of the 6 boreholes were available for yield testing. Borehole Lib BH1d (deep borehole) intercepted a cavity at depth and was not tested.

For this project maximum drawdown pump tests were conducted on the two water yielding boreholes (boreholes Lib BH3s and Lib BH3d), followed by a recovery test after each test. Slug tests were conducted on three of the dry boreholes (slug in / infiltration tests) (Lib BH1s, Lib BH2s and Lib BH2d). VSA Leboa Consulting concluded that the slug test analysis shows some heterogeneity in the aquifer system, with hydraulic conductivity (k-value) values ranging from 0.000003 m/d to 0.0035 m/d. The average k-value is 0.001 m/d, based on the model fits, was determined from the slug test. Large variations in the k-values were observed, mostly due to the analytical solutions fitting the data and heterogeneity in die geology formations.

It is shown that the permeabilities of the residual dolomite are very low, on average 9.93E-4 m/d and varying between 1.4E-4 and 2.5E-3 m/d. All three boreholes on which tests could be completed were dry with residual dolomite extending at least to an average depth of 26 m.

During the Aquifer tests on boreholes Lib-BH3s and Lib-BH3d, the shallow borehole was pumped drying within 16 minutes at a rate of 0.18 L/s (648 L/hr) but recovered by 81% in 20 hours. The deep borehole was pumped dry in 40 minutes at a rate of 0.03 L/s (108 L/hr) and only recovered by 6% in 3 hours. This suggests that the residual dolomite underneath the Libanon TSF has a very low yield, but that some groundwater seeps into the comparatively fresh dolomite pinnacle in this position over time, thus recharging the aquifer. This groundwater probably originates from within the lateral extent

of the dolomite pinnacle and is stored in what is perceived to be significant storage capacity contained in secondary porosity as a result of karstification of the weathered dolomite.

On a local scale perched aquifer conditions are expected in the residual dolomite, as rainwater percolates into the karstified aquifer.

The pumping test data is used during the calibration of the groundwater numerical model.

Groundwater Qualities:

During the August 2024 hydrocensus only one borehole was identified, and a groundwater sample was collected (borehole Lib 1). Another two groundwater samples were collected during the aquifer test program. The water samples were submitted to Aquatico Laboratories for analysis. Aquatico is a SANAS accredited laboratory.

Based on the water quality results the following conclusions were drawn (SANS 241:2015 comparison):

- Chronic Health effects:
    - Total Iron – An elevated iron concentration (exceeding the chronic health limits) was recorded for borehole Lib-BH3s (7.62 mg/L), with the SANS limit set at 2 mg/L. The concentration of dissolved iron in water is also dependent on the occurrence of other heavy metals or could be related to the local Karoo and dolomite geology or leaching from the TSF.

      Borehole Lib-BH3s is on the downstream side (west) from Libanon TSF. The total iron concentrations were below the detection limit for the other two sampled sites.
    - Manganese – Borehole Lib-BH3s measured a manganese concentration that could result in chronic health effects (22.2 mg/L). The health impact limit is set at 0.4 mg/L.

      The manganese concentration could be related to the local Karoo and dolomite geology or leaching from the TSF. The manganese concentrations were below detection limit or the SANS aesthetic limit for the other two sampled sites.
    - Sulphate – Borehole Lib-BH3s exceeds the health guideline limits for sulphate with a measured concentration of 1623 mg/L. The health limit set at 500 mg/L).

      The sulphate concentrations were below detection limit or the SANS aesthetic limit for the other two sampled sites.
    - Nickel – An elevated nickel concentration was recorded for Lib-BH3s (0.136 mg/L). The maximum SANS guideline health limit is 0.07 mg/L. The nickel concentrations were below the detection limit for the other two sampled sites.

- Aesthetic / Operational effects:
    - Ammonium – The ammonium concentration for borehole Lib-BH3s exceeds the aesthetic limits for drinking water (13.0 mg/L) with the aesthetic limit set at 1.5 mg/L.
    - Total hardness – Very hard total hardness values were measured at the two downstream boreholes at Libanon TSF – Lib-BH3s and Lib-BH3d.

In terms of major cations and anions, sulphate is by far the most significant element of concern, with a concentration of above 1500 mg/l for Lib-BH3s. Elevated sulphate concentrations are typical of the impact of gold tailings on groundwater quality, as it is a product of sulphide oxidation.

In terms of metals, manganese and iron concentrations are significantly elevated. Manganese concentrations exceeding 20 mg/L are probably more reflective of the geochemical character of the residual dolomite (wad) than the impact of the Libanon TSF on groundwater quality. Manganese is one of the byproducts of dolomite dissolution, as discussed earlier. Iron is also to some extent a byproduct of dolomite dissolution, but it is also a characteristic element of the oxidation of sulphide minerals. For this reason, sulphate and iron will be used as the two indicator elements for this impact assessment.

The hydrocensus was completed during August 2024 during the dry, winter season in Gauteng. The 2024 fieldwork programme was completed between October and November 2024, which represents the end of the dry season conditions.

Groundwater Numerical Model:

The objectives of the numerical modelling are based on the requirements of the EIA process and the water use licence application requirements. The following objectives are reported:

- Estimate the impact of the proposed Libanon TSF Reclamation Project at the end of the construction and operational phases of the project on groundwater quality. No significant impacts on groundwater levels are expected.
- Predict the long-term impact of the project on groundwater quality post closure and rehabilitation.
- Evaluate the effect that tailings removal and footprint rehabilitation would have on groundwater quality.
- Develop a groundwater monitoring program based on the outcome of the impact prediction study.
- Develop a groundwater management program geared at reducing the impacts on groundwater quality identified.

The outcome of the simulations is presented as sulphate and iron concentration contour maps that delineate the anticipated plumes for the three scenarios tested. These are based on the source term discussed earlier. The three operational scenarios tested are:

- **Best case scenario**: comparatively good quality seepage during reclamation and low seepage infiltration, equivalent to dry conditions, to the underlying aquifers.
- **Likely scenario**: measured quality seepage during reclamation and moderate seepage infiltration rates, equivalent to average conditions, to the underlying aquifers.
- **Worst case scenario**: comparatively poor quality leachate during reclamation with higher seepage infiltration, equivalent to wet conditions, to the underlying aquifers. This scenario is also presented as an indication of long-term impacts if the Libanon TSF is not removed, i.e. the No Project option.

The impact assessment was completed for the residual and weathered dolomitic aquifers. Since vertical flow will be prominent underneath the TSF and in the absence of attenuation in the unsaturated zone, potential contamination from surface is likely to affect both aquifers over time.

Simulated zones of impact on groundwater quality are presented for operational as well as for the anticipated post-closure long-term conditions below. Operational impacts for the three scenarios tested are similar due to the comparatively short period during which tailings will be reclaimed, the low aquifer permeabilities and the perceived latent impacts of historical tailings deposition. For this reason, impacts associated with the likely operational conditions are presented.

To facilitate comparison between long-term impacts, the simulated sulphate and iron plumes that delineate the zones of significant impact on groundwater quality are overlain on a single map for sulphate and iron. To incorporate the level of uncertainty with regards to groundwater flow conditions in the residual and weathered dolomitic aquifers, the estimated zone impact in terms of drinking water standards is presented for the potential worst case only.

The estimated zone of impact in terms of drinking water standards therefore presents the maximum zone of impact post closure, following the precautionary principle. Groundwater within this zone is likely to exceed drinking water standards for sulphate and iron, making the groundwater potentially unfit for use. For sulphate, this zone is delineated by the 250 mg/L concentration contour and the 0.3mg/L concentration contour for iron. These are indicated in a dashed line with yellow fill.

The zones of significant impact delineate areas where the concentrations of sulphate and iron, and by implication other salts and metals, are likely to exceed concentrations that could pose a health risk if ingested. Groundwater in these zones will therefore not be fit for use. For sulphate, this zone is delineated by the 1000 mg/L concentration contour and for iron the 1 mg/L concentration contour. These are indicated in a red line with red fill.

The extent of the contours is based on domestic use guidelines after DWAF (1996). This approach is taken to enable delineation zones of significant risk to health associated with the project.

General Outcome for all Scenarios:

The overall outcome of the simulations is summarised as follows:

- Simulations suggest that the private borehole south of the Libanon TSF fall outside the anticipated groundwater impact zones delineated for the project. This borehole will therefore not be affected by the tailings reclamation project.
- The plumes are expected to migrate regionally in a north-westerly direction towards the Wonderfonteinspruit in the residual and weathered dolomitic aquifers. It is highly unlikely that plumes associated with the Libanon TSF could reach this stream, even in the long-term. This is because aquifer permeabilities are low and the plumes are anticipated to move less than 50 m per year. In addition, vertical groundwater flow to the level of dewatering in the compartment will prevail until underground dewatering ceases and groundwater levels have regionally rebounded. Previous studies completed on the Kloof underground workings estimate that groundwater levels could recover within 20 years after pumping ceases to an elevation of 1560 mamsl. This is the elevation of the Venterspost Eye from which the compartment is expected to decant into the Wonderfonteinspruit once groundwater levels reach this elevation. Under these conditions the residual dolomitic aquifer underneath the Libanon TSF is expected to remain dewatered, as the current groundwater level in Lib-BH3s is at 1581 mamsl. The deeper weathered aquifer may however recover to 1560 mamsl, thus rewatering Lib-BH3d by approximately 40 m.

- On a local scale, groundwater flow will be towards the two non-perennial streams northeast and southwest of the Libanon TSF. It is likely that groundwater impacted by the TSF has already reached the stream 200 m northeast of the TSF.
- Flow in the residual and weathered dolomitic aquifers will be controlled by the presence and extent of dolomitic grykes and pinnacles, which was delineated based on a gravity survey completed for the aquifer. Preferential flow is expected in the dolomitic pinnacles. The grykes are expected to be significantly more clay-rich and therefore have lower permeabilities and groundwater flow conditions.
- A small northwestern portion of the Libanon TSF is located within the adjacent Bank Dolomitic Compartment. The boundary between the Venterspost and Bank Compartments is formed by the Venterspost Dyke that transects the northwestern edge of the Libanon TSF. Groundwater levels on the eastern edge of this compartment are not lowered significantly, based on the available dataset (Figure 8). Preferential flow is therefore likely to take place in this area, as the dolomitic aquifer is not as significantly dewatered compared to the Venterspost Compartment.
- The shape of the plumes is affected by the aquifer parameters as well as the calculated dispersion in the formations. Of most significance is the presence and extent of dolomitic grykes as well as regional post-Transvaal age dykes and faults. Dispersion especially plays a role in the extent to which lower concentrations of sulphate and iron would spread from the TSF. Dispersion can account for the spread of contamination that is not necessarily driven by groundwater flow.
- The zones of significant risk to groundwater quality delineated by the 1000 mg/L sulphate and the 1 mg/L iron concentration contours are expected to be restricted mainly to the footprint of the Libanon TSF. The extent of the zones of significant risk to groundwater reduces for Scenarios 2 and 3. This highlights the importance of implementing a sound water balance during operations and controlling the quality of leachate associated with the TSF. It is noted that FWGR has already committed to measures to control the factors and for this reason, long-term impacts are expected to approximate the likely scenario.
- The historical impact of tailings deposition is expected to continue to affect groundwater quality associated with the project areas in the long-term, even if FWGR removes the tailings as part of the proposed project. This is because the contamination already present in the aquifers will continue to move slowly down gradient, away from the TSF along groundwater flow patterns. For this reason, the shape of the plumes remains similar for the three scenarios tested. The difference is the concentration of contaminants within the plumes and a reduction in the extent of the zone of unacceptable impact after tailings reclamation, as mentioned.
- The extent of the iron plume is larger compared to that of sulphate. This is because lower water quality objectives are imposed on manganese compared to sulphate.

Impact at the end of the Operational Phase:

The impact of tailings reclamation at the end of the operational phase is presented for iron and sulphate in the residual and weathered dolomitic aquifers in Figure 16. The simulations indicate the following:

- The zone of impact in terms of drinking water standards is not expected to extend more than 200 m from the TSF for sulphate and not more than 500 m for iron concentrations. No private

borehole is present in this zone of impact. It is likely that the plume has reached the non-perennial stream northwest of the TSF. Groundwater near to or entering the stream as baseflow is not expected to exceed concentrations that would signify significant impacts.

- The zone of significant impact on groundwater quality is expected to be restricted mainly to the footprint of the TSF. It is acknowledged that portions of the residual and weathered aquifer within the TSF footprint is likely to be dewatered. From an impact assessment perspective, it was assumed that groundwater is likely to be affected over the entire footprint area.

Based on the impact assessment discussed above, the consequence rating for the operational phase, within the context of historical pre-existing impacts, is presented as follows:

- Magnitude: Moderate –
- Spatial scale: Site or local
- Duration: Medium term
- Probability: Possible

Long-Term Scenarios:

As discussed earlier, the long-term impact of three operational scenarios were tested as part of impact predictions completed. The outcome of these is presented in Figure 17 for sulphate and iron for a period 100 years after rehabilitation of the TSF footprint. The following is concluded from the information presented:

- The zone of impact delineated in terms of drinking water standards is expected to expand in the long-term and migrate towards the two non-perennial streams on either side of the TSF. Groundwater flow and the extent of the zones of impact on groundwater quality will be controlled by the location of the Venterspost dyke as well as the dolomitic grykes. Preferential flow is anticipated in comparatively fresh dolomitic pinnacles compared to the grykes. The dyke will form a boundary to groundwater flow in the dolomitic aquifer.
- The sulphate plume is not expected to migrate more than 500 m from the TSF. The iron plume may extend further from the TSF mainly because it is delineated by much lower concentrations compared to sulphate. It is possible that the iron plume may migrate a further 500 m from the estimated operational plume in the long-term.
- The zone of significant impact on groundwater quality are compared for the three scenarios in the figure. As discussed earlier, the worst-case scenario can also be used to approximate the “Do Nothing” option. Under the conditions of aquifer conceptualisation, it is likely that the plume delineated by the 1000 mg/L sulphate concentrations contour could extend more than 200 m from the TSF footprint for this case. The worst-case scenario iron plume is also expected to extend approximately 350 m beyond the TSF footprint. No private boreholes are located within the zone of significant risk to groundwater quality. It is also unlikely that these zones would reach the non-perennial stream northwest of the TSF. There is a small risk that the zone of significant impact may however reach the northeastern stream.
- The most significant outcome of the likely and best-case scenarios is a reduction in the zone of significant impact on groundwater quality. Simulations suggest that both the sulphate and iron plumes could be reduced to within the TSF footprint area in the long-term. As discussed earlier, FWGR has developed stormwater management measures to at least achieve the

conditions of the likely scenario. For this reason, long-term impacts on groundwater quality are anticipated to be restricted to the TSF footprint area and therefore not significantly impact on water resources.

Based on the impact assessment discussed above, the consequence rating for the worst-case scenario is presented as follows:

- Magnitude: Major –
- Spatial scale: Site or local
- Duration: Long-term
- Probability: Possible

A preliminary groundwater monitoring network is presented in Table 30. If additional private boreholes are identified within a 1 km radius, they must be included in the monitoring programme.

Soil and groundwater assessments of the TSF footprint area are recommended after removal of the tailings material to define the status of these environments and determine mitigation, management and monitoring requirements, post-removal.

DRDGOLD must ensure that an effective surface water collection and retention system is in place to ensure that all flow and collected water is directed towards the paddocks and not allowed to drain freely away from the TSF areas. Pooling of water must not be allowed on open surfaces, except if lined.

The reclaimed slurry and any water must be removed from the exposed surfaces (immediately) to avoid seepage of contaminated water into the shallow weathered and deeper fractured and karst aquifers.

Ensure that paddocks are designed to contain all dirty water generated during the reclamation process to prevent overflows and spillages.

Recommendations listed in Table 29 and Table 31, plus Section 15 to Section 17 need to be followed.

Reasoned Opinion:

It is the opinion of the project hydrogeologists that the reclamation of the Libanon TSF can proceed, provided that good surface water / storm water management measures are put in place and maintained throughout the life of the project. No ponding over exposed areas must be allowed. The project must further commit to complete tailings removal and not undertake selective tailings reclamation.

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Appendix A

CVs

Curriculum Vitae

Lucas Andries Smith (Pr.Sci.Nat)

Independent Hydrogeological Consultant

Principal Hydrogeologist

QUALIFICATIONS

MSc Geohydrology, IGS (UFS) Bloemfontein, South Africa, 2003.

Baccalaureus Technology Geology, Technicon Pretoria, South Africa, 1997.

National Diploma Geotechnology, Technicon Pretoria, South Africa, 1992.

EMPLOYMENT HISTORY

Department of Water and Sanitation – 17 years.

ERM Consulting – 3.5 years.

Digby Wells Environmental – 5.5 years.

ASST Group – 12 months.

Current – Director, Groundwater Abstract Pty Ltd

FIELDS OF SPECIAL COMPETENCE

- Water use assessments (hydrocensus)
- Geophysical investigations
- Borehole drilling and rehabilitation studies
- Aquifer testing
- Community water supply and resource management
- Mine dewatering, water supply and management programmes
- Groundwater quality assessments
- Groundwater, catchment and impact assessments
- Design and management of water monitoring programmes
- Integrated Water and Waste Management Plans
- Water Use License Applications and compliance assessments
- Geochemistry assessments and waste classification
- Staff management
- Project management

SUMMARY OF COMPETENCIES

Lucas has 27 years of experience in the field of hydrogeology. Before moving to environmental consulting he was a principal hydrogeologist at the Department of Water Affairs and Forestry (now Dept. Water and Sanitation) (South Africa) where he devoted 17 years to groundwater research and exploration programmes; rural water supply-, larger municipal water supply-, and government water supply schemes projects; artificial groundwater recharge projects; as well as borehole and aquifer development and remediation projects.

He executed and managed different hydrogeological projects, focussing on aspects such as community water supply programmes, geophysical investigations, characterisation of aquifers, pollution studies, in-stream flow requirements, hydraulic fracturing, dolomite and karst investigations and monitoring, chemical borehole rehabilitation (biofouling) and hydro-chemical analyses.

Over the past 10 years Lucas' environmental consulting experiences include the Southern African and Central- and West African mining sectors, as well as Energy sectors (Eskom and alternatives) where he manages groundwater and surface water resource evaluations and interaction, as well as conceptualising and quantification of groundwater flow/contaminant transport, ultimately for input to Environmental and Social Impact Assessments (ESIA), Environmental Management Programme reports (EMPr), Feasibility Studies and mine water management. Integrated water management is key to any business, mine, industry, or communities to ensure a sustainable resource for the environment and local communities to benefit from.

At Digby Wells Environmental Lucas was part of the EXCO committee; where he managed a team of 14 surface and groundwater specialists and several projects.

He served on the H&S Committee at ERM and Digby Wells where he also served as Chairperson for the H&S Committee for 1 year.

Lucas is a dedicated employee, husband, farther, patriot; and passionate about managing and protecting our natural resources and the environment.

RECENT RELEVANT PROJECT EXPERIENCE

During the 27 years in the Water Geosciences industry Lucas was involved in many projects where he served as team member on many field works and research programmes; he managed staff and various projects throughout Africa and even as far as Pakistan, and played a prominent role in being the overall Sponsor on projects, as well as acting as key client manager for clients like Sasol and Universal Coal.

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Groundwater Consulting Services – Water Unit Manager (Jan 1996 – Nov 2002)
CSIR – Staff Hydrogeologist (January 1992 – December 1995)

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B.Sc. Geology and Mathematics, University of Stellenbosch, 1988 - 1990
B.Sc. (Hons) Geology, University of Stellenbosch, 1992
M.Sc. Geohydrology, Institute for Groundwater Studies, University of the Free State, 1996 - 1997

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Recent Projects

Groundwater flow and contaminant transport modelling:

- AECI Modderfontein Industrial Complex, Groundwater Impact Assessment (SRK, 2012)
- Exxaro Arnot Colliery – Groundwater Impact Assessment (Golder and Associates, 2012)
- Transalloys Industrial site – Groundwater Impact Assessment (Jones & Wagener, 2012)
- Tschudi Copper Mine – Dewatering and groundwater supply (Jones & Wagener, 2012)
- Harmony Kalgold – Optimisation of abstraction boreholes and TSF EIA (Jones & Wagener, 2013)
- Fry Metals – Contaminant Transport Model to evaluate rehabilitation options (Rison, 2013)
- Assmang Chrome - Machadodorp Works Contaminant Transport Model (ESS, 2014)
- Sebilo Resources – Perth Manganese Numerical Groundwater Model (Sebilo Resources, 2014)
- Rand Gold Mali Loulo Mine – Updated Groundwater Impact Assessment (Digby Wells Environmental, 2015)
- South Deep – Numerical simulations for the closure of a Tailings Storage Facility (Rison, 2015)
- Dwarsrivier Mine – Groundwater flow and contaminant transport model (EnviroGistics, 2015)
- Withok Tailings Storage Facility – Numerical simulations for re-commissioning of TSF (Ergo Mining, 2015)
- Fry Metals – Contaminant Transport Model update (Rison, 2015)
- Tetra4 Virginia Gas Project – Groundwater specialist input and numerical modelling (EIMS, 2016)
- DRD Gold – Numerical groundwater model for Withok Tailings Storage facility (Beric Robinson Tailings, 2016)
- Tetra4 Virginia Gas Project – Follow-up numerical modelling (EIMS, 2017)
- City of Cape Town Kalbaskraal Waste Disposal Project – Numerical modelling (Cliffe Decker Hofmeyr, 2017)
- Lephalale Coal Mines – Geohydrological modelling (ASST, 2017)
- Dwarsrivier Mine – Follow-up numerical groundwater flow and contaminant transport model (Envirogistics, 2017)
- Prieska Copper Mine – Geohydrological impact assessment, including numerical modelling (ABS Africa, 2017)
- Umsimbithi eMakhazeni Project - Geohydrological impact assessment, including numerical modelling (Kongiwe, 2018)
- City of Cape Town Kalbaskraal Waste Disposal Project – Numerical modelling (Cliffe Decker Hofmeyr, 2018)
- Vardocube Mining – Geohydrological impact assessment, including numerical modelling (ABS Africa, 2018)
- Assmang Manganese Cato Ridge – Numerical groundwater flow and contaminant transport model (Assmang Manganese, 2018)
- eMakazeni Mining Project - Numerical groundwater flow and contaminant transport model (Kongiwe, 2018)
- Leslie 1 Project – Numerical groundwater flow and contaminant transport model (Kongiwe, 2018)
- City of Cape Town Kalbaskraal Waste Disposal Project – Numerical modelling (Cliffe Decker Hofmeyr, 2018)
- Dwarsrivier Mine –Numerical groundwater flow and contaminant transport model (Envirogistics, 2018)
- Assmang Chrome Machadodorp Works - Numerical groundwater flow and contaminant transport mod (Assmang, 2018)
- Assore – Numerical groundwater flow and contaminant transport model – RMDC and ZCM operations (Assore, 2019)
- Kranspan Colliery – Numerical groundwater flow and contaminant transport model (ABS Africa, 2019)
- DRD Gold – Numerical groundwater flow and contaminant transport modeling: Soweto Cluster and Marievale Projects (Kongiwe, 2019)
- South32 – Wolvekrans Mega Project – Geohydrological specialist study (NTC Group, 2019-2021)
- AEMFC – Vlakfontein Mine North Block Geohydrological Risk Assessment (EIMS, 2019)
- Envirogistics – Groundwater impact assessment – Wonderstone operations (Assore, 2020)
- Dwarsrivier Chrome Mine – Groundwater impact assessment – Historical TSF removal project (Dwarsrivier Chrome Mine, 2020)
- Prieska Copper and Zinc Mine – Groundwater impact assessment – Brine management scenarios (ABS Africa, 2020)
- Universal Coal Ubuntu Colliery – Numerical groundwater flow and contaminant transport modelling (Groundwater Abstract, 2020)
- Assore – Numerical groundwater flow and contaminant transport model updates: RMDS and ZCM operations (Assore, 2021)
- Dwarsrivier Chrome Mine – Annual numerical groundwater model update (Dwarsrivier Chrome Mine 2020 – 2023)
- ARM Machadodorp Works - Numerical groundwater flow and contaminant transport model update (ARM, 2021)
- eMakazeni Mining Project – Update of numerical groundwater modelling (Groundwater Abstract, 2021)
- Dwarsrivier Chrome mine – Khulu Tailings Storage Facility Project (Envirogistics, 2021 - 2022)
- DRD Reclamation of several TSF – Geohydrological impact assessment (Groundwater Abstract, 2022)
- Dwarsrivier Chrome Mine – Scavenger Borehole Implementation Strategy (Dwarsrivier Chrome Mine, 2022)
- Orion Limited – Okiep Flat Mines Project Geohydrological Impact Assessment (ABS Africa, 2022)
- Hlagisa Wildfontein Mine Closure Application – Geohydrological Specialist Study (ABS Africa, 2022)

Integrated Water and Waste Management:

- Sebilo Resources – Perth Manganese water use license application (Sebilo, 2014)
- Vantage Goldfields – Water Balance: Lily and Barbook Mines (Vantage Gold, 2015)
- Dwarsrivier Mine – Integrated Water Monitoring Programme (Assmang Chrome, 2015)
- RK Boerdery – Water balance for piggery (Batho Environmental, 2015)
- Sakura JV Indonesia – Groundwater study (Assmang Ltd, 2015)
- PMG Mining – Water balance of manganese mine (Globesight, 2016)
- Sebilo – Perth Manganese Mine – Water Use License Application (Sebilo, 2016)
- Transnet – Confidential technical report review (DMT Kai Batla, 2016)
- Tswane Metropolitan Municipality – Tswane Agri-Hub Baseline Hydrogeological Study (DMT Kai Batla, 2016)
- Afrisam South Africa – Ulco Cement Factory Hydrogeological Investigation (MojaTerre, 2016)
- City of Cape Town – Kalbaskraal Waste Disposal Facility Geohydrological Modelling (Cliffe Decker Hofmeyer, 2017)
- Sebilo Resources – Perth Mine Waste Classification (Sebilo Resources, 2017)
- Zeerust Chrome Mine – Tailings Waste Classification Study (AMTIT, 2017)
- Lephalale Coal and Power Project – Numerical groundwater flow and contaminant transport model (ASST, 2017)
- Beeshoek Iron Ore Mine – Water and Salt Balance (Envirogistics, 2017)
- Beeshoek Iron Ore Mine – Water Conservation and Demand Management Plan (Envirogistics, 2017)
- Machadorp Smelter – Water and Salt Balance (Assmang Ltd, 2017)
- Dwarsrivier Chrome Mine – Water Conservation and Demand Management Plan (Envirogistics, 2017)
- Dwarsivier Chrome Mine – Waste Classificaiton Study (DCM, 2017)
- New Kleinfontein Mine – Water and Salt Balance (NTC Group, 2017)
- Zeerust Chrome Mines – Basic Assessment Report -Groundwater (Envirogistics, 2018)
- Rustenburg Minerals Development Corporation – Basic Assessment Report – Groundwater (Envirogistics, 2018)
- Dwarsrivier Chrome Mine – Water Balance Study (Envirogistics, 2018)
- Beeshoek Mine -Water Balance Study (Envirogistics, 2018)
- Gold One New Kleinfontein Mine – Water Balance Study (NTC, 2018)
- Beeshoek Mine – Water and Salt Balance and Water Conservation and Demand Management Plan (Envirogistics, 2019)
- Dwarsrivier Mine – Water Conservation and Demand Management Plant (Envirogistics, 2019)
- ARM Alloys – Machadodorp Works Water and Salt Balance (ARM Alloys, 2019)
- ESKOM Ash Facility – Review of validity of closure liability calculation (Markus Reichardt, 2020)
- Wonderstone Mine – Water and Salt Balance (Envirogistics, 2020)
- Beeshoek Iron Ore Mine – Water and Salt Balance (Envirogistics, 2020)
- ARM Machadorp Smelter – Water and Salt Balance (Envirogistics, 2020)
- RMIPPPP 50 MW Gas Power Project Basic Assessment Report (ABS Africa, 2020)
- Beeshoek Mine – Water and Salt Balance and Water Conservation and Demand Management Plan (Envirogistics, 2020 and 2021)
- Upper Jukskei River Catchment Management Plan for the City of Johannesburg – Geohydrology component (Fourth Element, 2021)
- The Mineral Corporation – Geohydrological Opinion, Phase 2 Technical Due Diligence – Waterberg Project (TMC, 2021)
- Eskom Majuba Power Station – Geohydrological Basic Assessment (EIMS, 2022)
- Lubambe Copper Mine Zambia Geohydrological and Water Management Assessment (The Mineral Corporation, 2022)
- Karo Platinum Project Zimbabwe high-level geohydrological assessment (The Mineral Corporation, 2022)

Environmental Management:

- Management of the construction of a river diversion (Pamodzi Gold, 2006)
- Minxcon Competent Person's Report (Bema Gold, 2006)
- Management of the construction and commissioning of a 10 ML/d mine water treatment plant (Pamodzi Gold, 2008/2009)
- Standard Bank Due Diligence (Pamodzi Gold, 2009)
- Environmental Baseline Assessment: Perth Manganese Prospect (Sebilo Resources, 2010)
- Prospecting Right EMP: Aquarius Chieftans and Valhallah Prospect (SRK Consulting, 2011)
- NI43-101 Technical Report - Hydrogeology: Homeland Energy (SRK Consulting, 2011)
- Zeerust Chrome Mine EMP Amendment (Assore, 2011)
- Northam Platinum Due Diligence – Hydrogeology (SRK, 2011)
- Mogale Gold Technical Assessment – Water-related issues (MSA Geoservices, 2011)
- Rustenburg Mineral Corporation EMP Amendment (Assore, 2011)
- Mogale Gold – Lancaster Dam Baseline Assessment (Mintails SA Ltd, 2011)
- Sebilo Resources – Perth Mining Right Application EMP (2012)
- Lebalelo Water Users Association – Olifants River Project (Anglo Platinum, 2012)
- Umlabu Colliery – Due Diligence (SRK, 2012)
- Assore – PA Audits for RMDC, ZCM and Wonderstone Operations (Assore, 2013)
- Keegan Resources - Esaase Gold Project, Ghana – Gap Analysis and ESIA (Epoch Resources, 2013)
- Sebilo Resources – Quantum for Rehabilitation (Sebilo, 2014)
- Pembani Group – Evaluation of the Carolina Operations water related liabilities (Pembani, 2014)
- Obarex – Van Roois Vley Environmental Management Programme (Rock & Stock, 2014)
- Glencore & Royal Bafokeng Holdings – Boschfontein Slag Dump Groundwater Risk Assessment (EIMS, 2014)
- RK Boerdery – Baseline geohydrological study for piggery (Batho Environmental, 2015)
- Sungu Sungu Gas – Geohydrological study (EIMS, 2015)
- Gold mining industry – Groundwater component of a confidential Due Diligence (EBS, 2015)
- Sungu Sungu Gas – Groundwater specialist input – Scoping and EIA (EIMS, 2016)
- Kao Diamond Mine Lesotho – Groundwater specialist input – Scoping and EIA (EIMS, 2016)
- The Mineral Corporation – Mukulu Project Competent Persons Report Technical Review (TMC, 2016)
- HC Van Wyk Diamponds – Groundwater input to diamond prospecting (MojaTerre, 2016)
- Black Mountain Mine – Groundwater Basic Assessment Report (The MSA Group, 2016)
- Tetra4 – Virginia Gas Project Baseline Hydrogeological Study (Tetra4, 2016)
- DRD Gold – Tailings reprocessing offset evaluation (DRD Gold, 2016)
- Dwarsrivier Chrome Mine – Assessment of Quantum for Rehabilitation (Assore, 2016)
- Hlagisa – Wildfontein Section 102 application (ESS, 2017)
- African Mining Trust – Zeerust, Wonderstone and RMDC Quantum for Rehabilitation (2013 – 2017)
- Dwarsrivier Chrome Mine – Assessment of Quantum for Rehabilitation (Assore, 2018)
- AMT – Updated of Quantum for Rehabilitation for three operations (AMT, 2018)
- African Mining Trust – Wonderstone Quantum for Rehabilitation evaluation (Assore, 2020)

Appendix D4
Air Quality

Air Quality Impact Assessment for the Proposed Libanon Tailings Storage Facility Reclamation Project

GONDWANA
ENVIRONMENTAL SOLUTIONS

DOCUMENT CONTROL	
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Executive Summary

Gondwana Environmental Solutions International (Pty) Ltd was appointed by Kongiwe Environmental (Pty) Ltd to undertake an air quality impact assessment (AQIA) for the proposed reclamation of the Libanon Tailings Storage Facility (TSF). The objective of the AQIA is to evaluate the impact of the hydraulic reclamation process of the TSF on the ambient air quality of the surrounding areas.

The most significant pollutant that is generated from construction activities, clearing of vegetation and from wind erosion of a TSF is particulate matter (PM). Particulate matter with an aerodynamic diameter of less than 2.5 micrometres (µm) ($PM_{2.5}$) and particulate matter with an aerodynamic diameter of less than 10µm (PM_{10}) are criteria pollutants and maximum permissible ambient air quality concentrations of these pollutants have been prescribed in the National Ambient Air Quality Standards (NAAQSs) (Government Notice No. 1210, 2009; Government Notice No. 486, 2012).

Ambient air pollutant concentrations are of significance in terms of their potential to impact human health and the broader environment. To estimate ambient concentrations, air dispersion modelling was undertaken using AERMOD, which is recommended by the South African Modelling Regulations Code of Practice (Government Notice No. R533, 2014) for Level 2 assessments, and is the United States Environmental Protection Agency's preferred regulatory model for both simple and complex terrain. Dispersion simulations were undertaken to determine ambient concentrations of $PM_{2.5}$ and PM_{10} resulting from the proposed Libanon TSF reclamation site. Three scenarios were simulated – a status quo scenario showing the emissions from the TSF before the start of the reclamation process; a worst-case scenario showing emissions during the reclamation process; and a post-reclamation scenario where all tailings material has been removed to expose bare 'red earth'.

Low levels of organic matter and available nutrients, and unfavorable texture and structure are limitations to the revegetation of most tailings (Hossner & Hons, 1992). Aerial images show that the vegetation on the Libanon TSF ranges from a dense cover of grass and shrubs across the top to some completely bare areas along the sides. The remaining parts of the sides are sparsely vegetated.

The reclamation process starts with clearing all vegetation from a strip of land by means of graders. This increases exposure to wind and disturbs the cohesion between particles, thus increasing wind erosion. Reclamation of the tailings by means of high-pressure water monitors (hydraulic cannons) will also create areas of 'disturbed' particles. However, the increase in moisture introduced by the hydraulic reclamation process will increase the cohesion of the particles and hence reduce the erodibility of the material.

The modelling simulations indicate the following:

- Emissions from the Libanon TSF in its current, undisturbed state are expected to be causing elevated ambient concentrations of both PM_{10} and $PM_{2.5}$ in downwind areas on windy days. Exceedances of the NAAQSs are only expected immediately around the TSF.
- If reclamation of the TSFs is conducted conservatively, with the band stripped of vegetation not exceeding a width of 40 m, the area of exceedances is not likely to increase more than 180 m beyond the status quo emission situation. The highest expected concentrations at the discrete receptors included in the modelling (representing the closest residential areas and the closest school) are expected to be well below the NAAQS. Furthermore, as reclamation progresses, if all mitigation methods are adhered to, the area and extent of impact is expected to decrease progressively from the status quo emission situation.
- Once all tailings material has been removed down to 'red earth', ambient concentrations due to emissions from the cleared land are expected to be far below the NAAQSs.
- The modelling indicates that the removal of the Libanon TSF as a permanent pollution source will markedly improve the air quality of the surrounding residential areas.

The Libanon TSF project area lies in the West Rand District Municipality (WRDM). The impacts of the reclamation process will temporarily be adding to ambient concentrations which are already elevated. Therefore, the following mitigation measures must be strictly adhered to:

- Minimisation of the use of temporary storage piles for the stripped vegetation.
- Removing all tailings material down to 'red earth' as the area of work progresses, and not leaving remnants of tailings material behind which could be exposed to wind erosion.
- Control of the width of the band cleared for reclamation to a maximum width of 40 m.
- Strict speed control of all vehicles on site to 40 km/hr.

Furthermore, dust fallout must be monitored and if the increase in emissions from the reclamation activities causes the pre-operational phase dustfall levels to rise above the limits set by the National Dustfall Regulations over residential areas, the mitigation programme will have to be increased until compliance is achieved.

Possible increased mitigation measures include:

- Reducing the width or the length of the bands cleared for reclamation; and/or
- Wet suppression of the bands cleared for reclamation.

If the pre-operational phase dustfall levels already exceed the regulations over residential areas, additional care will have to be taken and mitigation should be as efficient as possible, to protect the health of the surrounding communities as far as possible.

The evaluation of the air quality impacts from mine tailings is based on a series of assumptions. Whilst care has been taken to assess the potential air pollution impact from the mine tailings, further research on tailings emission rates or continuous on-site monitoring of PM_{10} and $PM_{2.5}$ may result in different conclusions.

Table of Contents

Executive Summary *2*

Table of Contents *5*

List of Figures *7*

List of Tables *8*

List of Abbreviations *9*

1 FACILITY AND MODELLER'S INFORMATION *10*

1.1 Project Identification and Information **10**

1.2 Project Background **10**

1.2.1 Objectives of the Assessment 10

1.2.2 Overview of the Hydraulic Reclamation Process 10

1.3 Project Layout and Location **11**

1.3.1 Project Layout 11

1.3.2 Area Maps 12

1.4 Geophysical Data **17**

1.5 Elevation Data **19**

2 EMISSIONS CHARACTERISATION *19*

2.1 Emissions Inventory **20**

2.2 Operating Scenarios **21**

2.3 Source and Emission Parameters **21**

2.4 Emissions Rates **26**

2.4.1 Emission Rates from the TSFs 26

2.4.2 Emission Rates from the Stripped Bands 28

2.4.3 Emission Rates from the Post-Reclamation Surfaces 29

3 METEOROLOGICAL DATA *29*

3.1 Surface Data **30**

3.2 Upper Air Data **33**

4 AMBIENT AIR QUALITY *33*

4.1 Air Quality Legislation and Standards **33**

4.2 Ambient Air Quality / Background Concentrations **35**

5 MODELLING PROCEDURES *37*

5.1 Model Overview **37**

5.2 Emission Scenarios Modelled **39**

5.2.1 Mitigation Measures 39
5.3 Model Settings 40
5.4 Receptor Grids 40
5.5 Assumptions and Limitations 41
6 AIR QUALITY IMPACT ASSESSMENT RESULTS 43
6.1 Status Quo Ambient Impact Results 44
6.1.1 Figures Showing Isopleths of the Status Quo Concentrations 44
6.1.2 Table of the Status Quo Modelling Results 49
6.1.3 Evaluation of the Status Quo Modelling Results 49
6.2 Reclamation Scenario Ambient Impact Results 50
6.2.1 Figures Showing Isopleths of the Reclamation Scenario Concentrations 50
6.2.2 Table of the Reclamation Scenario Modelling Results 53
6.2.3 Evaluation of the Reclamation Scenario Modelling Results 53
6.3 Post-Reclamation Scenario Ambient Impact Results 54
6.3.1 Figures Showing Isopleths of the Post-Reclamation Scenario Concentrations 54
6.3.2 Table of the Post-Reclamation Scenario Modelling Results 57
6.3.3 Evaluation of the Post-Reclamation Scenario Modelling Results 57
6.4 Comparison of the Three Modelled Scenarios 58
6.5 Dust Fallout Monitoring Programme 58
6.6 Conclusions and Recommendations 59
7 AMBIENT IMPACT ASSESSMENT SUPPORTING DOCUMENTATION 61
7.1 Warning and Informational Messages in Output Files 61
7.2 Electronic files submitted with the report 61
8 REFERENCES 63
Appendix A. Methodology used in determining the significance of environmental impacts . 67
Appendix B. Health Effects of Particulate Air Pollutants 69
Appendix C. CV Summaries of the Specialists 71
Appendix D. Declarations of Independence 72
Appendix E. Particle size distribution of a Gauteng TSF 74

List of Figures

Figure 1: Project layout. 12
Figure 2: Location of the Libanon TSF. 13
Figure 3: Location of the Libanon TSF in relation to surrounding suburbs 14
Figure 4: Location of the Libanon TSF in relation to the closest schools 15
Figure 5: Sensitive receptors located within a radius of approximately 10 km from the Libanon TSF. 15
Figure 6: Large sources of airborne particulate matter in the vicinity of the Libanon TSF. 16
Figure 7: Topography of the area surrounding the Libanon TSF. 17
Figure 8: Threshold friction velocity in relation to particle diameter (Marticorena & Bergametti, Modeling the atmospheric dust cycle: 1. Design of a soil-derived dust emission scheme, 1995) 24
Figure 9: Thornthwaite's moisture index for South Africa (Leyland & Paige-Green, 2009). 26
Figure 10: Wind rose of the average winds produced by the WRF model for the Libanon TSF for the years 2021-2023. 31
Figure 11: Diurnal wind roses predicted by the WRF model for the Libanon TSF for the years 2021-2023. 31
Figure 12: Seasonal wind roses produced by the WRF model for the Libanon TSF for the years 2021-2023. 32
Figure 13: NAQI Monitoring stations near the Libanon TSF. 36
Figure 14: Daily average $PM_{2.5}$ and PM_{10} concentrations for the Jabavu-NAQI Station for the period 2017 to 2024 (SAAQIS, 2024). 37
Figure 15: Position of the discrete receptors included in the modelling 41
Figure 16: Position of the modelled reclamation strip and discrete receptors 43
Figure 17: Modelled prediction of highest 24-hour average PM_{10} concentrations resulting from the undisturbed Libanon TSF. 45
Figure 18: Modelled prediction of the annual average PM_{10} concentrations resulting from the undisturbed Libanon TSF. 46
Figure 19: Modelled prediction of the highest 24-hour average $PM_{2.5}$ concentrations resulting from the undisturbed Libanon TSF. 47
Figure 20: Modelled prediction of annual average $PM_{2.5}$ concentrations resulting from the undisturbed Libanon TSF. 48
Figure 21: Modelled prediction of the highest 24-hour average PM_{10} concentrations resulting from starting reclamation at the Libanon TSF northern area 51
Figure 22: Modelled prediction of the highest 24-hour average $PM_{2.5}$ concentrations resulting from starting reclamation at the Libanon TSF northern area 52
Figure 23: Modelled prediction of the highest 24-hour average PM_{10} concentrations resulting from the Libanon TSF project area after reclamation is completed 55
Figure 24: Modelled prediction of the highest 24-hour average $PM_{2.5}$ concentrations resulting from the Libanon TSF project area after reclamation is completed 56

List of Tables

Table 1: Identification and classification of land-use types (Auer Jr., 1978). *18*
Table 2: Parameters used for the modelling *22*
Table 3: Calculated emission factors for TSFs (with 10% erodible surface). *27*
Table 4: Emission rates *28*
Table 5: National Standards for Ambient Air Quality for PM_{10} (Government Notice No. 1210, 2009) and for $PM_{2.5}$ (Government Notice No. 486, 2012) *34*
Table 6: National Dust Control Regulations (Government Notice No. 517, 2018). *34*
Table 7: UTM coordinates and elevation of modelled receptors *44*
Table 8: Maximum modelled status quo concentrations at the discrete receptors in the vicinity of the Libanon TSF reclamation project. *49*
Table 9: Maximum modelled reclamation scenario concentrations at the discrete receptors in the vicinity of the Libanon TSF reclamation project. *53*
Table 10: Maximum modelled post-reclamation scenario concentrations at the discrete receptors in the vicinity of the proposed Libanon TSF reclamation project. *57*
Table 11: Comparison of maximum modelled concentrations at the four discrete receptors for the three modelled scenarios *58*
Table 12: Air Quality Impact Assessment Matrix for the reclamation of Libanon TSF (See Impact Assessment Methodology in Appendix A). *60*
Table 13: Significance Rating Methodology *67*
Table 14: Short-term and long-term health effects associated with exposure to PM (WHO, 2004). *70*

List of Abbreviations

AQIA	-	Air Quality Impact Assessment
AQMP	-	Air Quality Management Plan
GDARD	-	Gauteng Department of Agricultural and Rural Development
NAAQS	-	National Ambient Air Quality Standard
NAQI	-	National Air Quality Index
NEM:AQA	-	National Environmental Management: Air Quality Act (Act No. 39 of 2004)
PM_{10}	-	Particulate matter with an aerodynamic diameter of less than 10 µm
$PM_{2.5}$	-	Particulate matter with an aerodynamic diameter of less than 2.5 µm
Ppb	-	Parts per billion
Ppm	-	Parts per million
SAAQIS	-	South African Air Quality Information System
SAWS	-	South African Weather Service
Tonne	-	Metric unit of mass equivalent to 1 000 kg
TSF	-	Tailings Storage Facility
TSP	-	Total Suspended Particulates
µg/m³	-	Micrograms per cubic metre
U.S. EPA	-	United States Environmental Protection Agency
WHO	-	World Health Organisation
WRDM	-	West Rand District Municipality
WRF	-	Weather Research and Forecasting Model

1 FACILITY AND MODELLER'S INFORMATION

1.1 Project Identification and Information

Far West Gold Recoveries (Proprietary) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSF are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF).

It is FWGR's intention to reclaim and reprocess the gold residues of the Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant, and potentially at future plants. Most of the pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised. This TSF is situated approximately 2 km west of Westonaria, in the Rand West City Local Municipality (RWCLM). Kongiwe Environmental (Pty) Ltd (Kongiwe) is undertaking the Scoping and Environmental Impact Assessment process which evaluates the environmental impacts associated with the proposed project as part of an application for Environmental Authorisation. Kongiwe has appointed Gondwana Environmental Solutions International (Pty) Ltd (Gondwana) to undertake an air quality impact assessment (AQIA) in support of the applications for the required approvals. Brief CVs of the specialists working on the AQIA, and their declarations of independence are included in Appendix C and Appendix D.

1.2 Project Background

1.2.1 Objectives of the Assessment

The objective of the AQIA is to evaluate the impact of the hydraulic reclamation of the TSF on the ambient air quality of the surrounding areas.

Particulate matter is the most significant air pollutant that is generated from the construction of administrative and other support buildings. Particulate emissions will also be generated from the stripping of vegetation for the reclamation of the TSF and from entrainment of dust by vehicles on on-site roads. There will also be ongoing wind erosion of particulate matter from exposed areas of the TSF. Small particles (particles with an aerodynamic diameter smaller than 10µm (PM_{10}) and smaller than 2.5µm ($PM_{2.5}$)) are subsets of the total suspended particulates (TSP). PM_{10} and $PM_{2.5}$ are a health concern because these fine particles can be breathed into the lungs. The larger particles of TSP, on the other hand, are primarily a nuisance factor. $PM_{2.5}$ and PM_{10} are criteria pollutants. Maximum permissible ambient air concentrations of these pollutants have been prescribed in the National Ambient Air Quality Standards (NAAQS) (Government Notice No. 1210, 2009; Government Notice No. 486, 2012).

1.2.2 Overview of the Hydraulic Reclamation Process

The proposed method which will be used to remove the TSF is referred to as top-down hydraulic reclamation. First, a 15 to 40-metre-wide band of the tailings is stripped by graders in preparation for the reclamation process. Then, high-pressure water cannons with nozzles called ‘monitors’ (or mobile tracked hydraulic monitors) are used to deliver a high-pressure

water jet onto the face of the TSF. The water mixes with the tailings material and forms a slurry with a high solids content. The slurry then flows under gravity along trenches at the base of the TSF to a collection sump which is positioned at the lowest elevation of the bench being reclaimed.

At the sump, finger screens remove any debris that may impact pumping operations, and the position of the collection sump will change as the reclamation progresses. To control the volume of water reporting to the reclamation station, flapper valves are used to hold, and release, slurry contained in the collection sump. This slurry is then pumped via existing pipelines to the Driefontein 2 Plant for beneficiation. The beneficiation process involves thickening, milling, a leach section, an acid wash, elution, electro winning and regeneration. The tailings after beneficiation will be deposited through approved pipelines to the Regional TSF (Kongiwe, 2024).

1.3 Project Layout and Location

1.3.1 Project Layout

Reclamation of a TSF typically starts at the lowest side, thus facilitating the flow of the slurry towards this side as reclamation progresses. In the case of the Libanon TSF, this would mean reclamation starting along the northern side of the TSF, with the lowest point in the north-eastern corner of the TSF.

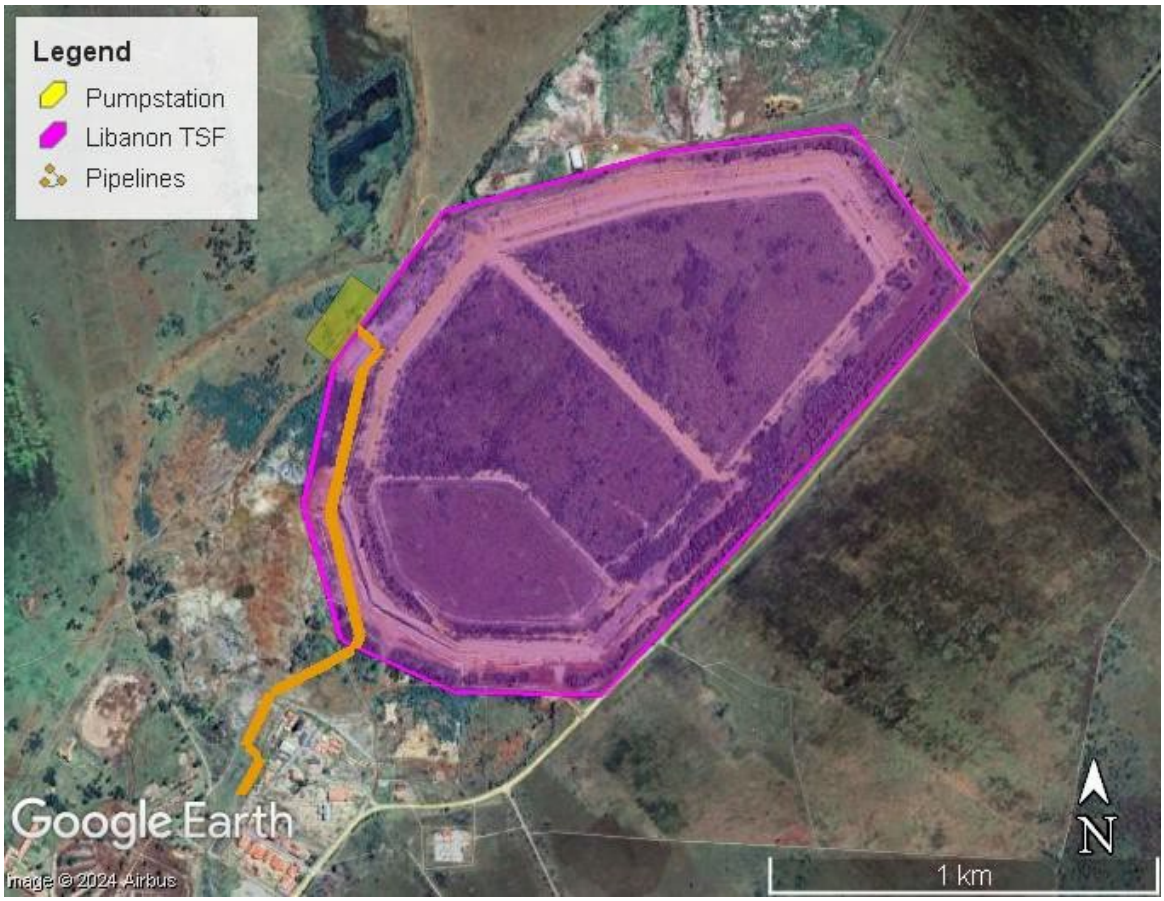

Figure 1: Project layout.

1.3.2 Area Maps

The Libanon TSF is situated approximately 2 km west of Westonaria, 20 km east of Carletonville, 20 km south-west of the Randfontein CBD and 25 km south-west of Soweto (Figure 2).

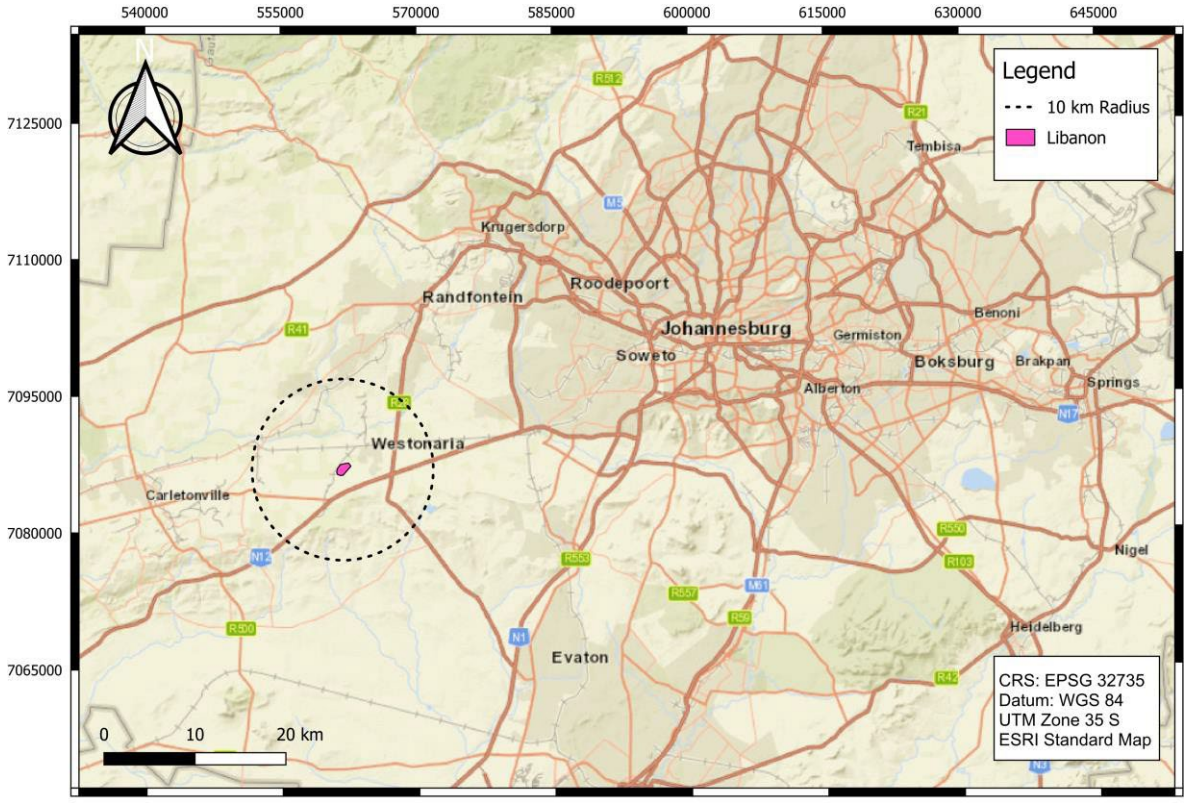

Figure 2: Location of the Libanon TSF.

The location of the Libanon TSF in relation to suburbs in the area is illustrated in Figure 3. Some residential areas of Westonaria lie immediately to the north-east of the TSF, with dwellings as close as approximately 2 km from the TSF. Residential dwellings in the Libanon Gold Mine area are situated approximately 2.2 km to the south-west of the TSF. The remainder of the land immediately surrounding the TSF is predominantly open ground with the Petrograaf Agricultural Holdings approximately 3 km north-west of the TSF. Other residential areas in close proximity include Wagterskop with the closest houses approximately 2.7 km to the south, Glenharvie with the closest houses approximately 3.9 km to the south and Hillshaven with the closest houses approximately 4.4 km to the south-east. The Wagterskop Agricultural Holdings are approximately 3.9 km south of the TSF. The Westonaria landfill site is situated along the northern boundary of the TSF.

In 2003 the Gauteng Department of Agriculture, Conservation and Environment, now the Gauteng Department of Agricultural and Rural Development, developed a set of buffer zones to demarcate safe distances for development around mine residue areas. The two buffers were devised with windblown dust as the determining factor. At a distance of 500 m from mining waste disposal facilities such as slimes dams and ash dumps, dust levels are generally acceptable, and the dust can no longer be distinguished from ambient dust pollution. Beyond a distance of 1 000 m, dust from mining areas cannot be detected (Bobbins, Trangos, Phasha, Butcher, & Munakamwe, 2018; GDARD, 2009).

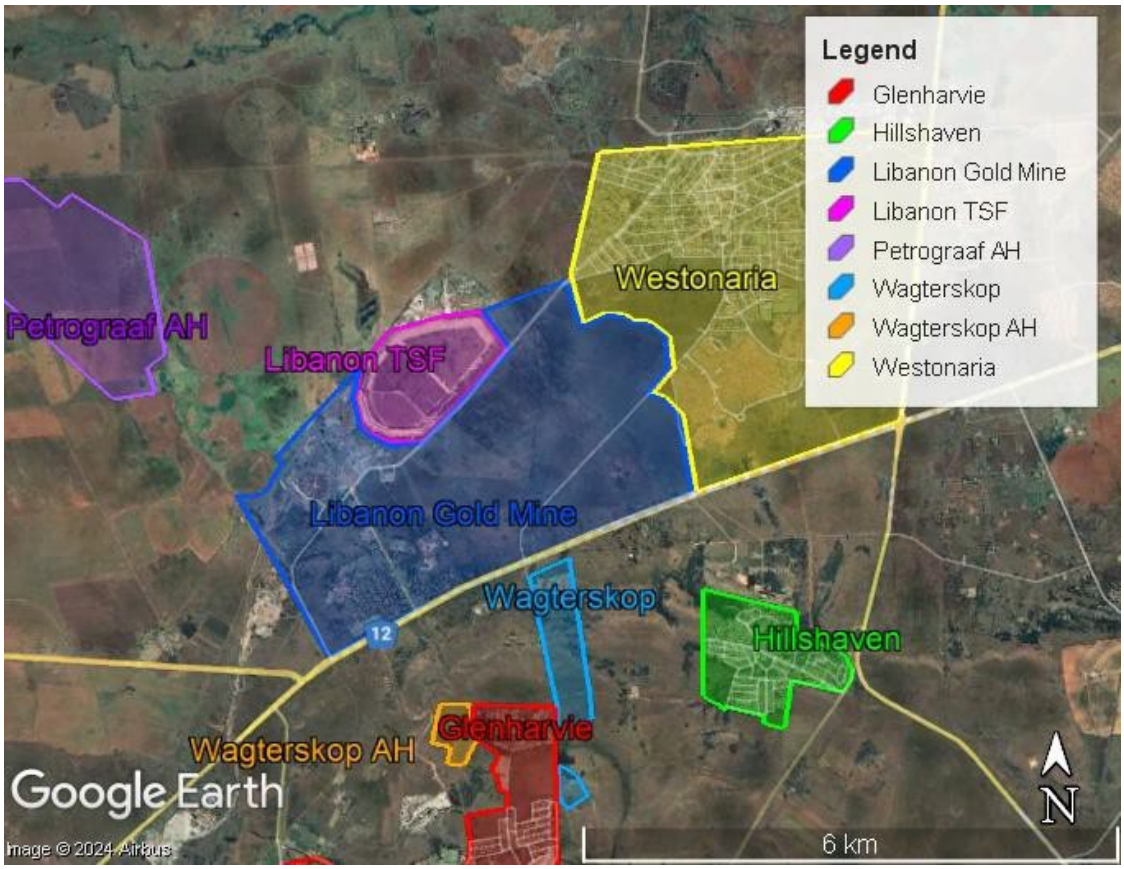

Figure 3: Location of the Libanon TSF in relation to surrounding suburbs.

Schools are considered to be sensitive receptors in terms of air pollution (Government Notice No. R533, 2014). The Tiny Tods Pre Primary CC, situated approximately 2.7 km north-east of the TSF in Westonaria, is the closest school, followed by, Itumeleng Lsen School and Little Rascals Pre-School & Creche (Figure 4). There are many more schools within a 10 km radius as well as hospitals and clinics (Figure 5).

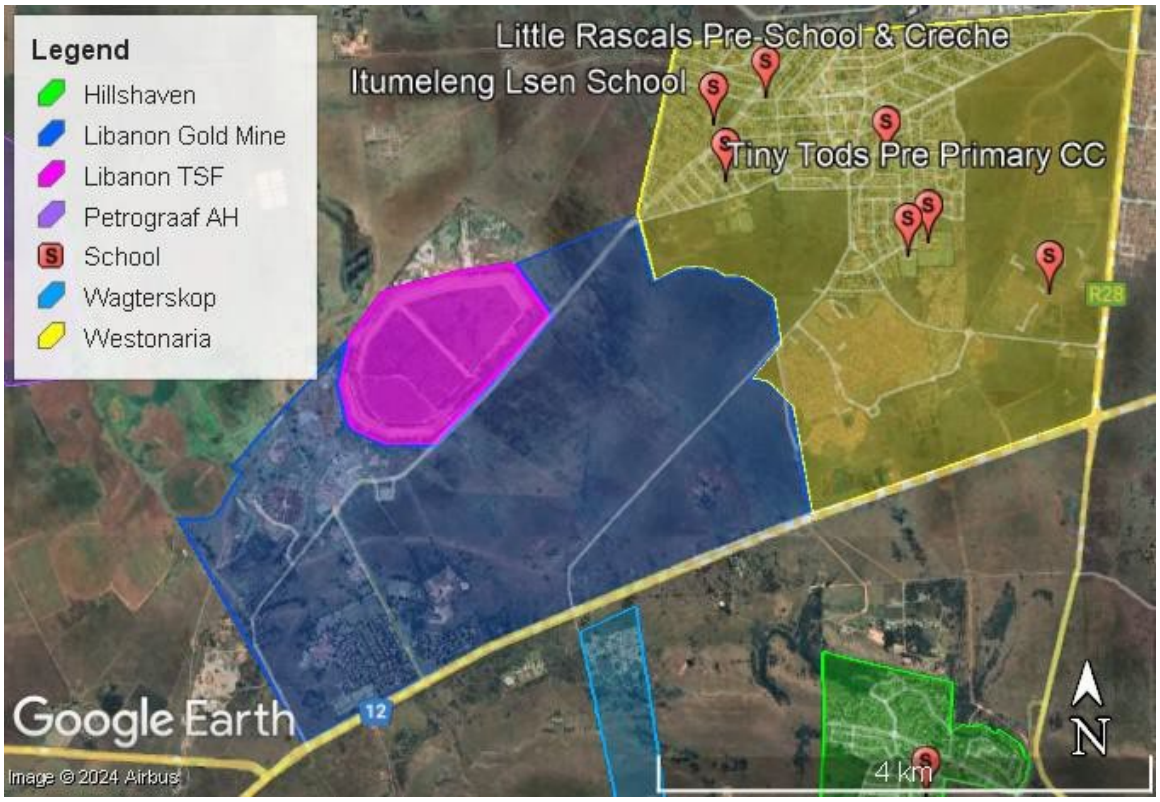

Figure 4: Location of the Libanon TSF in relation to the closest schools.

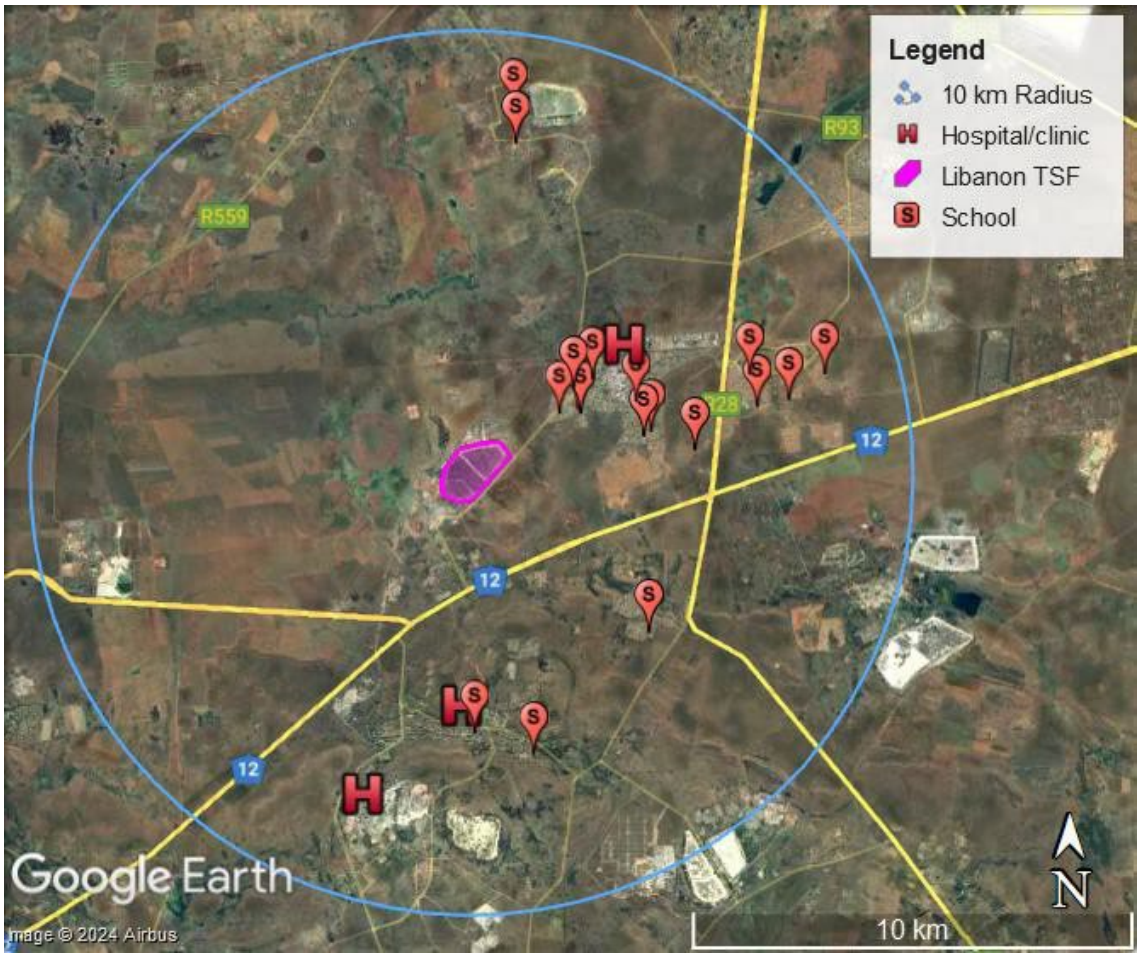

Figure 5: Sensitive receptors located within a radius of approximately 10 km from the Libanon TSF.

Other potentially large sources of particulate matter within a radius of 10 km from the project area include several TSFs, Mine dumps and Quarries as well as an industrial area, all of which contribute to the baseline levels of particulate matter in the air (Figure 6).

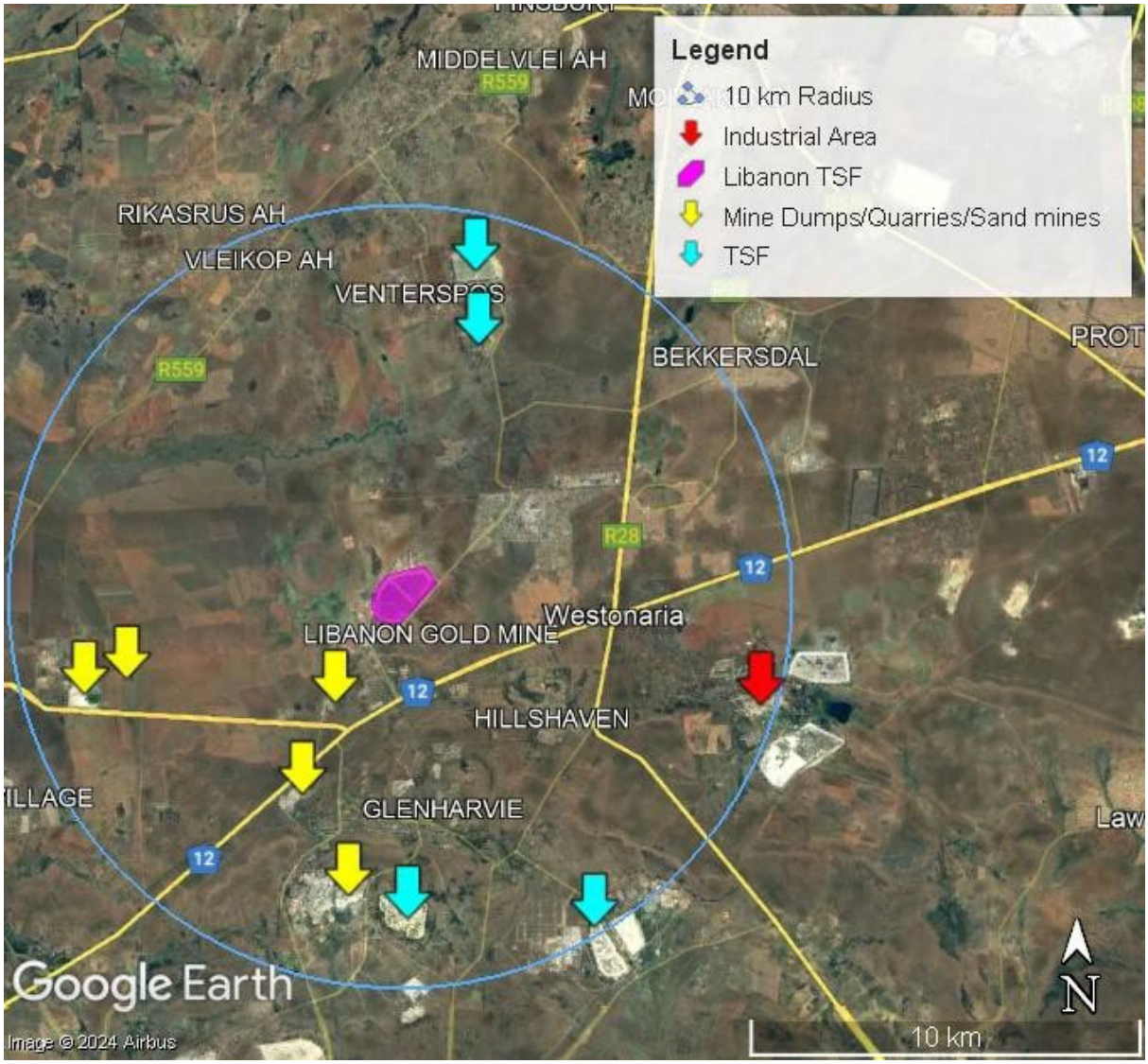

Figure 6: Large sources of airborne particulate matter in the vicinity of the Libanon TSF.

The project area is situated on the open, relatively flat area between the Wonderfonteinspruit to the north and a series of prominent ridges to the south (Figure 7). The ridges run from west to east. The Wonderfonteinspruit perennial stream flows westwards to the north of the TSF, along with two of its tributaries (Rietfonteinspruit and Middelvleispruit). The elevation of the project area is approximately 1 600 m above mean sea level.

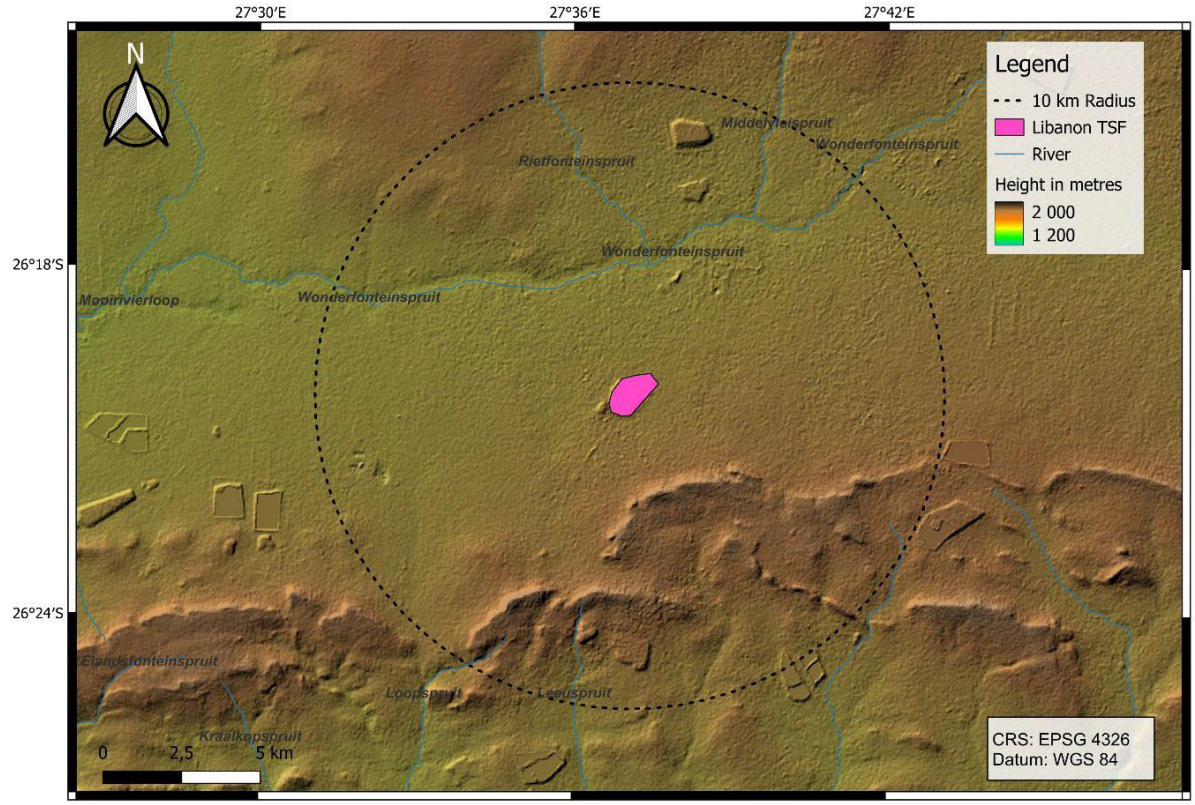

Figure 7: Topography of the area surrounding the Libanon TSF.

1.4 Geophysical Data

Urban or rural classification for the modelling domain is important because dispersion rates differ between urban and rural areas. The South African Modelling Code of Practice (Government Notice No. R533, 2014) recommends the Auer method (Auer Jr., 1978) as the preferred method for determining the urban/rural classification. The Auer land-use categories are presented in Table 1.

The modelling Code of Practice recommends that if more than 50% of an area within a 3-km radius of the facility is classified as rural, then rural dispersion coefficients (the default setting in AERMOD) are to be used in the dispersion modelling analysis. Conversely, if more than 50% of the area is urban, urban dispersion coefficients are used. This method is in line with US EPA modelling guidelines (US EPA, 2005).

Table 1: Identification and classification of land-use types (Auer Jr., 1978).

Urban Land Use			
Type	**Use and Structures**	**Vegetation**	**Percentage Vegetation Cover**
I1	Heavy Industrial Major chemical, steel, and fabrication industries.	Grass and tree growth extremely rare.	<5%
I2	Light-moderate industrial Rail yards, truck depots, warehouses, industrial parks, minor fabrications; generally, 1-3 story buildings, flat roofs.	Very limited grass, trees almost absent.	<5%
C1	Commercial Office and apartment buildings, hotels; >10 story heights, flat roofs.	Limited grass and trees.	<15%
R2	Compact Residential	Limited lawn sizes and shade trees.	<30%
R3	Compact Residential	Limited lawn sizes, old established shade trees.	<35%

Rural Land Use			
Type	**Use and Structures**	**Vegetation**	**Percentage Vegetation Cover**
R1	Common Residential Single family dwellings.	Abundant grass lawns and light-moderately wooded.	>70%
R4	Estate Residences Expansive family dwellings on multi-acre tracts.	Abundant grass lawns and lightly wooded.	>80%
A1	Metropolitan Natural Major parks, golf courses, cemeteries, campuses.	Nearly total grass and lightly wooded.	>95%
A2	Agricultural Rural	Crops.	>95%
A3	Undeveloped Uncultivated wasteland.	Mostly wild grasses and weeds, lightly wooded.	>90%
A4	Undeveloped Rural	Heavily wooded.	>95%
A5	Water surfaces		

The area surrounding the Libanon TSF, within a 3-km radius, is comprised of approximately 63% open ground and agricultural land (which equates to categories A2 and A3 -in the Auer classification, which are rural land use types). Therefore, the default setting in AERMOD is considered appropriate for this modelling application. The remainder of the land use is mostly compact residential.

1.5 Elevation Data

AERMOD requires elevation data that conveys the features of the surrounding terrain to calculate its effect on the dispersion of pollutants. Shuttle Radar Topography Mission (SRTM) 1 arc second Digital Elevation Terrain Data - Global was downloaded from the U.S. Geological Survey website for this project. The data is in GeoTIFF format with 1 arc second (approximately 30-metre) postings and 1° x 1° tiles. The NASA SRTM obtained elevation data on a near-global scale using radar interferometry. The NASA Version 3.0 SRTM Global 1 arc second product is void-filled using elevation data from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model 2 (GDEM2), the USGS Global Multi-resolution Terrain Elevation Data (GMTED) 2010, and the USGS National Elevation Dataset (NED).

2 EMISSIONS CHARACTERISATION

Wind erosion is a source of particulate matter emitted to the air from TSFs. The maximum concentrations of PM_{10} and $PM_{2.5}$, originating from any project, that can be expected to be found suspended in the air surrounding the site, are calculated by means of the following series of steps:

- First, an emissions inventory is compiled. This identifies all the potential sources of air pollutants**.**
- Secondly, a set of predictive emission factors is established to quantify the emissions from each source. These emission factors are usually expressed as the weight of pollutant emitted per unit area, weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate matter emitted per square metre of TSF). In most cases, these factors are averages of all available data of acceptable quality (from source test data, material balance studies, and engineering estimates), and are generally assumed to be representative of long-term averages for all facilities in the source category.
- Thirdly, emission rates are calculated. While the emission factor specifies the quantity of pollutant that can be expected to be emitted from a particular activity, the emission rate is calculated by multiplying the emission factor by how much of that activity is executed at the source in question. The emission rate gives the number of grams of pollutant emitted from a particular activity in one second. The emission rates from all the sources are added together to calculate the total emission rate from the facility. The general equation for emissions estimation is:

$$E = A * EF * (1 - \frac{ER}{100})$$

Where:

E = emissions

A = activity rate
EF = emission factor
ER = overall emission reduction efficiency (%)

- Finally, the dispersion of the emissions is simulated using AERMOD, to predict maximum ground level concentrations of particulate pollutants resulting from the activities and to determine the zones of influence around the emission sources.

2.1 Emissions Inventory

An emissions inventory lists all sources that would generate pollutants of concern. $PM_{2.5}$ and PM_{10} are the criteria pollutants of concern expected from the Libanon TSF project area. The activities and the associated emissions are outlined below.

a) Construction activities

Construction of infrastructure is a source of dust emissions that may have a substantial temporary impact on local air quality. Infrastructure such as roads, the pumpstation, powerlines, laydown area and a pollution control paddock will be constructed for the Libanon TSF project (Kongiwe, 2024). However, it is expected that as far as possible, access roads will be routed from existing entry points, and much of the basic infrastructure will be of a temporary nature e.g., Jojo tanks for potable water and ablution facilities.

Mainly existing pipelines will be used and only a short length of new pipeline will be laid for the project (Kongiwe, 2024). Therefore, emissions from laying of pipelines are expected to be low.

b) Vehicle emissions

Although vehicles at the reclamation site would emit gases, the impacts of these compounds were not included in this assessment. Government's cleaner fuels drive requires that the sulphur content of main grade diesel be reduced to 500 ppm or 0.05%. Therefore, the sulphur content of South African diesel is too low to cause sulphur dioxide (SO_2) levels to exceed the NAAQS.

Vehicle-entrained dust caused by vehicles moving across parts of the tailings sites is also a source of emissions. Although instantaneous emissions may be significant, it was deemed that the total amount of traffic and hence the total emissions from this source will be insignificant when averaged over 24 hours.

c) Tailings emissions

Mine tailings are made up of fine particles generated by the grinding and processing of ore. These fine, dry particles can be a source of serious dust problems on windy days, sometimes to the extent that residents living close to tailings in Gauteng take refuge in their homes

(Schwegler, 2006). Low levels of organic matter and available nutrients, as well as unfavorable texture and structure are limitations to the revegetation of most tailings (Hossner & Hons, 1992).

Aerial images show that the vegetation on the Libanon TSF ranges from a dense cover of grass and shrubs across the top to some completely bare areas along the sides. The remaining parts of the sides are sparsely vegetated.

2.2 Operating Scenarios

Conditions simulated in the modelling study:

- Status quo scenario.
- Worst-case emission scenario from reclamation operations.
- Post-reclamation scenario.

The first scenario modelled illustrates current, undisturbed emissions or the 'status quo' scenario.

The early phases of reclamation represent the time when emissions from the TSF are expected to be highest. This is the stage when all of the status quo emissions continue, with the added emissions from the 15 to 40-metre-wide band of the tailings stripped by graders in preparation for the reclamation process. As reclamation progresses, there will be progressively fewer emissions as sections of the TSF are removed as a source. Reclamation of a TSF typically starts at the lowest side, thus facilitating the flow of the slurry towards this side as reclamation progresses. In the case of Libanon TSF, this would mean reclamation starting along the northern side, with the lowest point in the north-eastern corner of the TSF. The northern side of the Libanon TSF is the closest to residential areas (Westonaria to the north- east). Therefore, to illustrate the worst-case emissions possible during the reclamation process, the second scenario modelled shows reclamation along the northern edges of the TSF.

The last scenario modelled illustrates conditions once the reclamation is complete and bare 'red earth' soil is exposed across the entire reclamation area.

2.3 Source and Emission Parameters

To determine the significance of the potential for impacts, it is necessary to quantify atmospheric emissions and predicted airborne pollutant concentrations occurring as a result of each emission source identified in the emissions inventory. Both emission factors and empirically derived predictive emission factor equations are used for this purpose. Emission

factors require activity rates to quantify the pollutant released into the atmosphere. Predictive emission factor equations require inputs of parameters that are specific to the site being evaluated as well as activity rates to quantify emissions. The parameters used for the modelling are documented in Table 2. The emission factor equations and the background to the selection of some of the site parameters are outlined below.

Table 2: Parameters used for the modelling.

Site parameters	Units	Total
Fine particle content (< 5.8 µm in diameter) of tailings[a]	%	18.79
Average particle density for tailings emissions	g/cm^3	2.86
Mass fraction of $PM_{2.5}$ used for modelling PM_{10} of tailings emissions	%	29
Average particle density for soil emissions	g/cm^3	2.63
Mass fraction of $PM_{2.5}$ used for modelling PM_{10} of soil emissions	%	33

a. Based on a Gauteng tailings particle size distribution (Appendix E).

a) Particle density

The composition of TSFs of the Witwatersrand includes: quartz (70%-80%), mica (10%), chlorite and chloritoid (9%-18%) and pyrite (1%-2%) (Kongiwe, 2018). This is supported in part by the findings of De Jesus et al. (1987) who reported quartz contents of 80-90%, pyrophyllite contents of max 16% and sericite contents of max 2% in tailings material. The average particle densities of quartz, mica, chloritoid pyrophyllite and sericite powder are 2.65, 2.80, 3.54, 2.84, and 16.00 g/cm^3 respectively. The weighted average particle density for tailings material will, therefore, be between 2.77 and 2.95 g/cm^3. An average of 2.86 g/cm^3 was used for the modelling.

b) Threshold friction velocity

Dust emissions due to the erosion of exposed areas occur when the threshold wind speed is exceeded (Cowherd, Muleski, & Kinsey, 1988; US EPA, 1995). For a particle at rest, the threshold wind speed is dependent on the size of the particle (the weight of the particle), the size of surrounding particles (interparticle cohesive forces) and the wind shear stress on the surface. The wind shear stress is controlled by roughness elements on the surface (Marticorena & Bergametti, 1995). According to Darwish (1991), threshold friction velocity varies widely for different particle sizes, shapes and moisture levels. Marticorena and Bergametti (1995) formulated a method for calculating the threshold friction velocity and emission rates from desert dust sources which is related to the size distribution of the erodible surface (See the equations below). The calculation is valid for soils with a content of less than 20% fine particles (particles < 5.8µm in diameter) (Marticorena B. , et al., 1997). The tailings particle size distribution which was obtained for a TSF in Gauteng (Appendix H) indicates a fine particle content for TSFs of approximately 18.79%.

$$U^*(D_p) = \frac{0.129\,K}{(1.928\,B^{0.092} - 1)^{0.5}}$$

Where:

U_t^* = threshold friction velocity (cm s^{-1}) – the minimal wind velocity required to mobilise a soil grain of a given size (where the wind energy transfer is assumed to be complete as no roughness elements are included in wind tunnel experiments)

D_p = particle diameter

Note: this equation is only valid for 0.03 < B < 10

$$K(D_p) = \left(\frac{P_p}{P_a}\right) \left(1 + \frac{0.006}{P_p\,g\,D_p^{2.5}}\right)^{0.5}$$

Where:

D_p = particle diameter

P_p = particle density = 2.65 g cm^{-3}

g = gravitational acceleration = 980 cm s^{-2}

P_a = air density = 0.00123 g cm^{-3}

Note: The unit of 0.006 is g $cm^{0.5}$ s^{-2}

The unit of K is cm s^{-1}

$$B = aD_p^x + b$$

Where:

B = Analytical solution of the Reynolds number

a = 1331 (To respect the dimensionless Reynolds number, a has a unit of cm^{-x})

b = 0.38 (dimensionless)

x = 1.56 (dimensionless)

D_p = particle diameter

From the above equations, threshold friction velocities for particle sizes between 0 and 11 µm were calculated (Figure 8).

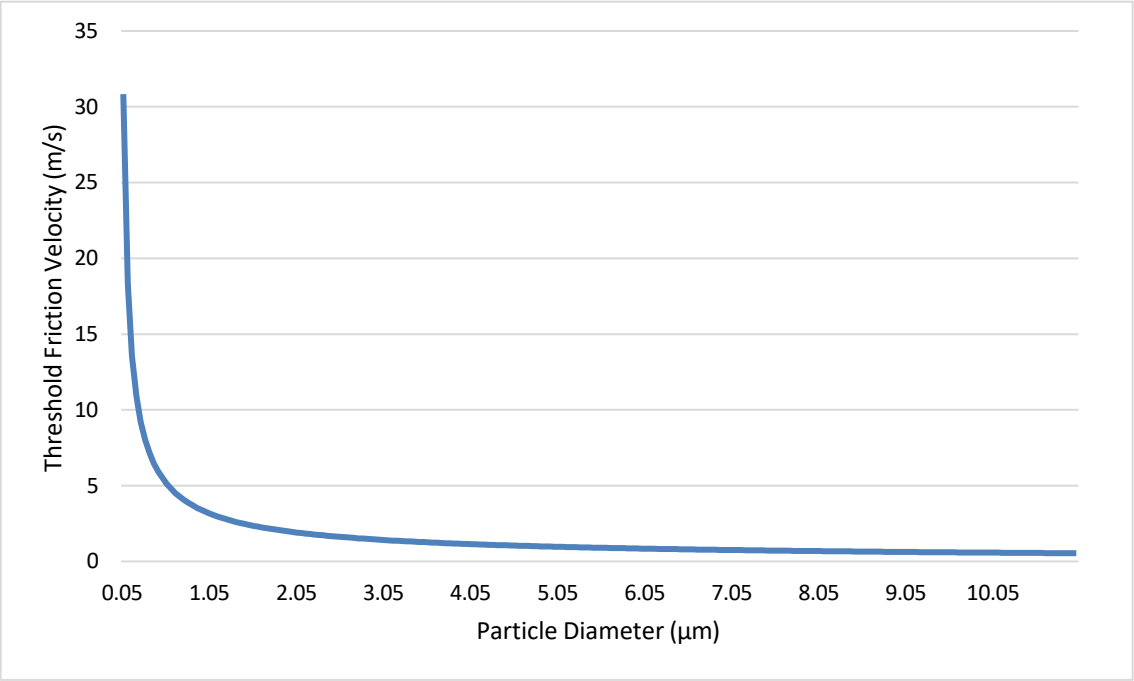

Figure 8: Threshold friction velocity in relation to particle diameter (Marticorena & Bergametti, Modeling the atmospheric dust cycle: 1. Design of a soil-derived dust emission scheme, 1995)

c) Horizontal Flux

The total amount of material set in motion by the wind includes particles which roll and 'creep' along the surface, particles in saltation (where the particles are lifted off the surface up to a height of approximately 1 m, but the drag is not sufficient to exceed the weight so the particles are only carried for a short distance downwind before being dropped to the surface again) and particles in suspension. This is the horizontal flux (G) and is described by Marticorena and Bergametti (1995) in the following equations:

$$G(D_p) = E\,C\,\frac{P_a}{g}\,U^{*3}\,(1+R)\,(1-R^2) \qquad (D_p)$$

And

$$G_{tot} = \sum_{D_p} G(D_p) \times class\,width(D_p)$$

Where:

D_p = particle diameter

$G(D_p)$ = horizontal flux of a particular diameter particle

G_{tot} = horizontal flux of the sum of all particles in a particular diameter range

E = ratio of erodible to total surface (0.1 for the partially vegetated tailings and 1.0 for the 15-metre-wide band of tailings stripped of vegetation in preparation for reclamation)

C = constant of proportionality determined from wind tunnel experiments = 2.61

P_a = air density = 0.00123 g cm^{-3}

g = gravitational acceleration = 980 cm s^{-2}

U* = wind friction velocity = 0.1 x Wind speed (cm s^{-1})

$dS_{rel}\ (D_p)$ = the percentage volume of particles in a diameter class

$$R = \frac{U_t^*(D_p)}{U^*}$$

Where:

U_t^* = threshold friction velocity (cm s^{-1})

U* = wind friction velocity = 0.1 x Wind speed (cm s^{-1})

d) Vertical Flux

$$F = G_{tot} \times 10^{(0.134 \times \%fine\ particle\ content - 6)}$$

Where:

F = emission rate (g cm^{-2} s^{-1})

U_t^* = threshold friction velocity (cm s^{-1})

fine particles = particles < 5.8 µm in diameter (Marticorena B. , et al., 1997)

e) The effect of wind gusts

When applying the above calculations to the average wind speed for the TSF project area, no PM_{10} or $PM_{2.5}$ emissions were generated. This indicates the importance of wind gusts (maximal local instantaneous wind speeds) in the erosion of mine tailings. The problem with applying this to the modelling is that gusts are not always of the same intensity nor of the same frequency. This leads to an emission rate which varies with wind speed, which is not part of the functionality of AERMOD.

f) Thornthwaite precipitation-evaporation index

One of the parameters that has the strongest influence on soil dust sensitivity to wind erosion is the soil moisture content. An indicator of the soil moisture content is given in the Thornthwaite precipitation-evaporation (PE) index. According to a revision of Thornthwaite's map for South Africa by Leyland and Paige-Green (2009), the majority of South Africa can be considered to be water deficient, with 85 per cent of the country having a water demand (loss by evapotranspiration) exceeding the water supply (by precipitation). In Figure 9, Thornthwaite's Moisture Index values of less than zero are indicative of water deficient areas with deep water tables. According to this figure, the reclamation project area has a PE of between -20 and 20.

Therefore, wet suppression will only have a short-term mitigating effect on wind erosion due to evaporation, and water will have to be reapplied regularly to be effective.

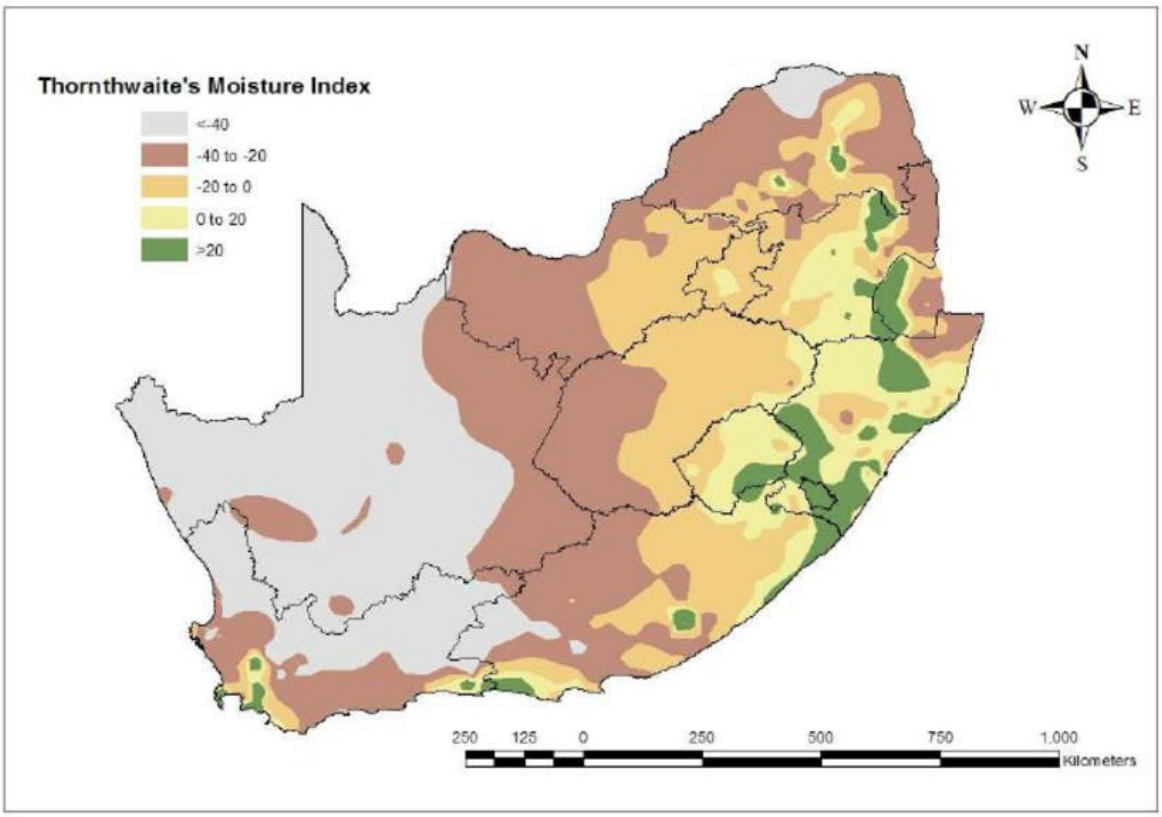

Figure 9: Thornthwaite's moisture index for South Africa (Leyland & Paige-Green, 2009).

2.4 Emissions Rates

2.4.1 Emission Rates from the TSFs

Estimating wind erosion from mine tailings is fraught with uncertainty. The Australian National Pollutant inventory (NPi, 2006) emission factor for tailings does not account for differences in stabilization by vegetation, particle size or moisture content. This makes it difficult to compare the emissions from TSFs prior to and during the reclamation process. The method formulated by Marticorena and Bergametti (1995) for calculating the threshold friction velocity and emission rates from desert dust sources is related to the size distribution of the erodible surface and vegetation cover (see the equations above). However, it is dependent on wind-gust speeds, and this does not lend itself to modelling 24-hour averages which is what is required for comparison with the NAAQS. It was, therefore, decided to establish a generic set of emission factors which is related to vegetation cover from a combination of the NPi emission factor and the results of the Marticorena and Bergametti equations. Wind data from the weather station at O.R. Tambo International Airport was used to give an indication of the validity of the resulting emission factors, as it is situated on the Highveld and provides measured wind data as opposed to modelled data.

The emission rates for 4 wind speeds – 5.9 m/s, 11.5 m/s, 16.8 m/s and 24.7 m/s were calculated using the Marticorena and Bergametti (1995) method. These wind speeds correspond to the minimum gust required to lift PM_{10}, the median of the maximum daily gusts measured at O.R. Tambo International Airport (over a three-year period from 2015 to 2017), the lowest wind speed which will result in an emission of $PM_{2.5}$, and the maximum daily gust speed measured at O.R. Tambo International Airport respectively. An assumption of an average gust length of 10 seconds at 2-minute intervals was made which would mean that the represented gust wind speed may be experienced approximately 8% of the time. The calculated emissions were therefore multiplied by 0.083 to give an emission rate that could be compared to the NPi emission rate (Table 3). Based on aerial images of Gauteng TSFs, on average, approximately 10% of the area of the dumps is not covered by vegetation. Therefore, the ratio of erodible to total surface was kept constant, at 10%, for each of the equations used, to produce emission rates for comparison with the NPi emission rate. By transposing the equation, a wind gust speed of 6.7 m/s was found for the NPi emission factor.

Table 3: Calculated emission factors for TSFs (with 10% erodible surface).

Days in the 3-yr period with average wind speeds ≥ the wind gust speed	Days in the 3-yr period with maximum gust speed ≥ the wind gust speed	Wind gust speed (m/s)	PM_{10} emission rate (g m^{-2} s^{-1})	$PM_{2.5}$ emission rate (g m^{-2} s^{-1})	Source
N/A	N/A	N/A	5.56E-06	1.59E-06	(NPi, 2006)
110	1094	5.9	2.05E-07	–	(Marticorena & Bergametti, 1995)
44	1093	6.7	5.53E-06	–	(Marticorena & Bergametti, 1995)
0	550	11.5	1.80E-04	–	(Marticorena & Bergametti, 1995)
0	79	16.8	7.50E-04	2.74E-08	(Marticorena & Bergametti, 1995)
0	2	24.7	2.64E-03	8.76E-05	(Marticorena & Bergametti, 1995)

In the period 2015 to 2017 at O.R. Tambo International Airport, 110 days recorded an average wind speed of 5.9 m/s or more; and 44 days recorded an average wind speed of 6.7 m/s or more. All except two days recorded a maximum gust speed of 6.7 m/s or more (Table 3). At these wind speeds the Marticorena and Bergametti equations predict that there will be some

emissions of PM_{10} from the tailings on almost every day of the year, with high average wind speed, gusty days producing significant amounts of emissions. Based on these findings, it was decided that the NPi emission factor could be considered to fairly represent TSFs that have been revegetated with a coverage of approximately 90%.

The ratio of erodible to total surface in the Marticorena and Bergametti equation was adjusted to calculate the different emission rates from the TSF. The resulting emission rates are presented in (Table 4). The top of the TSF is vegetated with grass and low shrubs, however, some of the sides are clearly sparsely vegetated, with the characteristic yellow-white colour of mine tailings visible. The NPi emission factor representing TSFs with a 90% vegetation cover was, therefore, used for the TSF in the modelling.

Table 4: Emission rates.

Activity	Unit	PM_{10}	$PM_{2.5}$
Wind erosion of TSFs with 90% vegetation cover (NPi emission factor).	g m^{-2} s^{-1}	5.556E-06 [a]	1.585E-06 [a]
Wind erosion of TSFs after grader removal of all vegetation for the reclamation process.	g m^{-2} s^{-1}	5.556E-05[b]	1.585E-05 [b]
'Red earth' emission factor.	g m^{-2} s^{-1}	1.348E-06 [c]	4.496E-07 [c]

Note:

a. NPi emission factor which is equivalent to using a ratio of erodible to total surface of 0.1 with the Marticorena & Bergametti equations (1995)
b. Based on the Marticorena & Bergametti equations (1995) using a ratio of erodible to total surface of 1.0.
c. Emission rate for exposed area, seeded land, stripped overburden, graded overburden (US EPA, 1995 c11s9).

2.4.2 Emission Rates from the Stripped Bands

To account for the stripping of vegetation and the 'disturbance' to the surface, the ratio of erodible to total surface in the Marticorena and Bergametti equation was changed to 1 for the 15 to 40-metre-wide band of the tailings stripped by graders in preparation for the reclamation process.

There are caveats to this emission rate. It assumes that there is an unlimited availability of erodible material, whereas studies have shown that when the threshold wind speeds are exceeded, particulate emission rates tend to decay rapidly due to the reduced availability of erodible material (Cowherd, Muleski, & Kinsey, 1988). It would have to be tested to see whether this holds true for tailings material since the particle size distribution is not 'natural'. On the other hand, the stripping of vegetation not only increases the ratio of erodible material, it also decreases surface roughness. This would increase the emission rate. There is,

therefore, a 'knowledge gap' in the choice of emission rate for the reclamation of TSFs. Nevertheless, while taking all factors into consideration, it was decided that increasing the NPi emission rate for PM_{10} and $PM_{2.5}$ by a factor of 10 for the stripped bands was a reasonable assumption (Table 4).

2.4.3 Emission Rates from the Post-Reclamation Surfaces

To evaluate emissions from the site after all tailings material has been removed, but before revegetation has been established, the emission rates recommended for exposed areas, seeded land and stripped or graded overburden in Western Coal Mines in the USA were used (US EPA, 1995 c11s9) (Table 4). This will represent the worst-case scenario in the time immediately after reclamation is completed.

3 METEOROLOGICAL DATA

Horizontal dispersion of atmospheric pollutants is a function of the prevailing wind characteristics at any site, while the vertical dispersion of pollution is largely a function of the stability of the atmosphere and the depth of the surface mixing layer. By day, vertical mixing due to incoming solar radiation is most efficient at dispersing pollutants. At night a surface temperature inversion may develop which decreases the dispersion potential. Pollutants tend to accumulate near the point of release under these conditions, particularly if they are released close to ground level.

Similarly, the dispersion potential is generally poorer on winter nights than on summer nights. In summer, solar radiation and unstable atmospheric conditions result in mixing of the atmosphere and rapid dispersion of pollutants. Summer rainfall also aids in removing pollutants through wet deposition. In contrast, winter is characterised by atmospheric stability caused by the persistent high-pressure system over South Africa. This dominant high-pressure system results in subsidence, causing clear skies and a pronounced temperature inversion over the central plateau region. This inversion layer traps the pollutants in the lower atmosphere, which results in reduced dispersion and a poorer ambient air quality. Preston-Whyte and Tyson (Preston-Whyte & Tyson, 1998) describe the atmospheric conditions in the winter months as highly unfavourable for the dispersion of atmospheric pollutants.

Mechanical turbulence is another contributor to dispersion of pollutants. Mechanical turbulence is a function of a combination of wind speed and surface roughness. Thus, higher wind speeds facilitate the vertical dilution of pollutants as well as the distance of downwind transport.

3.1 Surface Data

The preferred data for modelling would be data collected on site. This, however, is very seldom feasible given that three years of both surface and upper air meteorological data is required. To substitute for, or supplement, measured data, data from numerical models may be used. For this project AERMET pre-processed Weather Research and Forecasting Model (WRF) meteorological data has been used.

The WRF is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications which reflects recent advances in physics, numerics, and data assimilation contributed by developers from the expansive research community. WRF data is one of the datasets recommended by the Modelling Regulations Code of Practice (Government Notice No. R533, 2014). AERMET (version 23132) was used to pre-process the data for input into AERMOD (version 23132).
AERMOD contains routines that allow the model to handle missing meteorological data in the processing of short-term averages. The model treats missing meteorological data and calms by setting the concentration values to zero for that hour. It calculates the short-term averages according to EPA's calms policy, as set forth in the Guideline. Calms and missing values are tracked separately for the purpose of flagging the short-term averages. An average that includes a calm hour is flagged with a 'c', an average that includes a missing hour is flagged with an 'm', and an average that includes both calm and missing hours is flagged with a 'b'. If the number of hours of missing meteorological data exceeds 10 percent of the total number of hours for a given model run, a cautionary message is written to the main output file (US EPA, 2016).

Wind roses graphically present wind conditions over a period of time at a specific location. Wind roses for the project are presented in Figure 10 to Figure 11 below. In the wind roses, the length of each spoke represents the percentage of time that the wind blew from that direction during the period. The percentage scale is presented on the concentric grey lines (the circle scale increment is indicated on each of the wind roses). Each spoke is divided by colour into wind speed ranges.

The predominant winds at the Libanon TSF site (as given by the WRF data for the period from 2021 to 2023) are from a north-westerly direction for approximately 13 % of the time (Figure 10)The highest number of winds with speeds greater than 3 m/s are also expected from the north-westerly direction. The average hourly wind speed predicted by the WRF model is approximately 1.3 m/s. Calm conditions (wind speeds below 0.5 m/s) are predicted for approximately 2.7 % of the time.

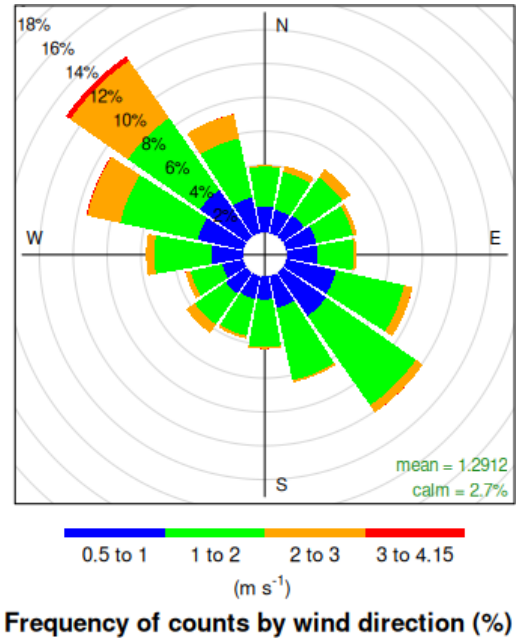

Figure 10: Wind rose of the average winds produced by the WRF model for the Libanon TSF for the years 2021-2023.

There is a clear diurnal variation in the predominant wind direction. During the day, most winds originate from a north-westerly direction, while at night most winds blow from the south-easterly direction. Most frequent winds with speeds above 3 m/s are expected from a north-westerly direction during the day. On average, wind speeds are higher during the day and there are also more incidences of calm conditions during the day than at night (Figure 11).

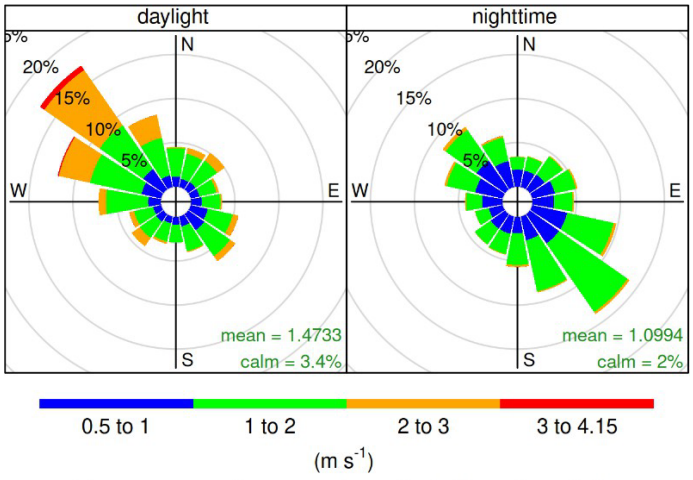

Figure 11: Diurnal wind roses predicted by the WRF model for the Libanon TSF for the years 2021-2023.

The seasonal variations in wind direction for the proposed Libanon TSF are illustrated in Figure 12. The predominant wind direction for all seasons is from the north-west. Winds with speeds over 3 m/s tend to coincide with the dominant direction from the north-west. In spring, the highest number of winds originate from the north-westerly and north-north-westerly directions. However, the highest number of winds with speeds above 3 m/s originate from the north-west, followed by the west-north-westerly direction. In summer, autumn and winter, both the predominant wind direction and the highest number of winds with speeds above 3 m/s originate from the north-westerly direction. Average wind speeds are highest in spring, and most of the calm conditions are experienced in autumn.

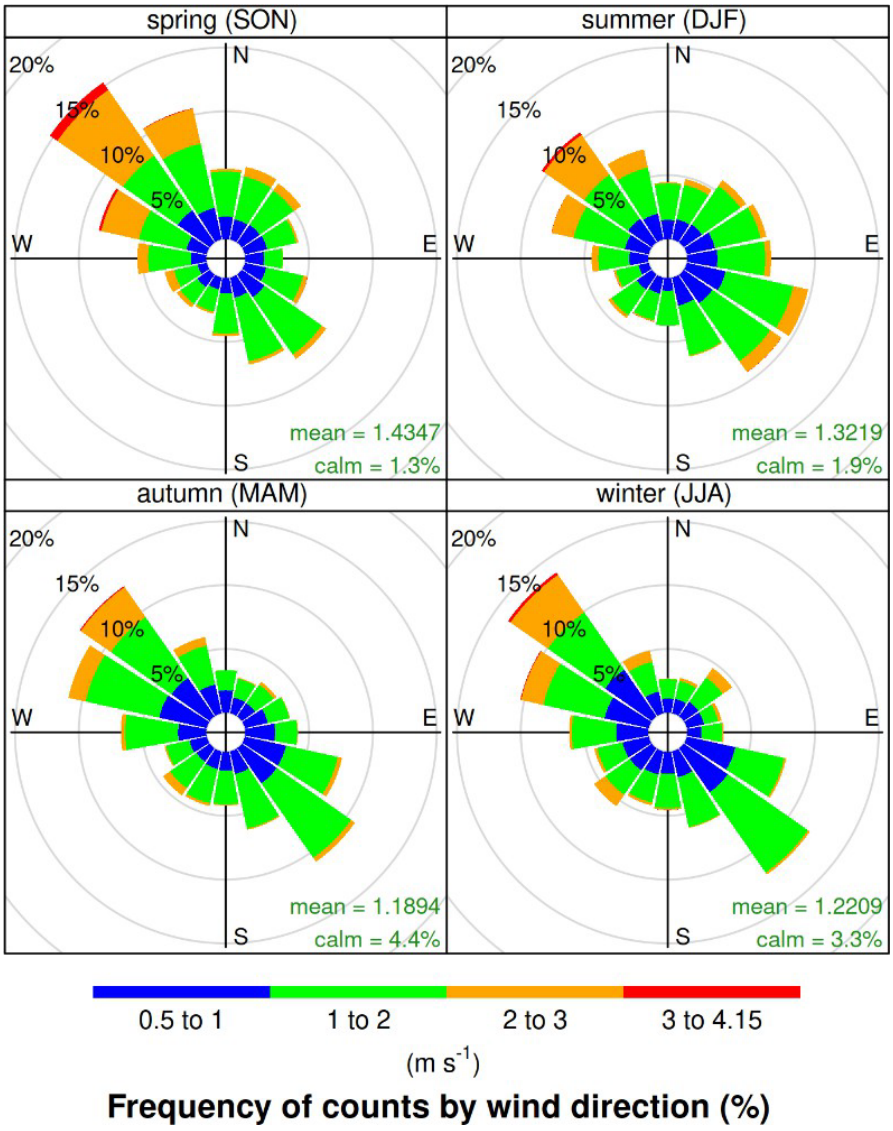

Figure 12: Seasonal wind roses produced by the WRF model for the Libanon TSF for the years 2021-2023.

3.2 Upper Air Data

The preferred data for modelling would be data collected on site. This, however, is very seldom feasible given that three years of both surface and upper air meteorological data is required. To substitute for, or supplement, measured data, the Modelling Regulations Code of Practice (Government Notice No. R533, 2014) recommends the use of data from numerical models. For this project Weather Research and Forecasting Model (WRF) meteorological data was used.

4 AMBIENT AIR QUALITY

4.1 Air Quality Legislation and Standards

Air quality in South Africa is governed under the National Environmental Management: Air Quality Act, Act 39 of 2004 (NEM:AQA) (RSA Government, Act No. 39 of 2004). The main objective of the act is to ensure the protection of the environment and human health through reasonable measures of air pollution control within the sustainable (economic, social and ecological) development framework. The NEM:AQA shifted some of the approach of air quality management from source-based control to receptor-based control. With receptor-based control the ambient air quality of receptors is the factor which is used to determine the compliance of the emission source. The measured, or expected, ambient air quality of receptors is compared to National Standards. These standards prescribe the maximum ambient concentrations of pollutants permitted (and the number of exceedances allowed) during a specified time period in a defined area. If the air quality standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest. The ambient air quality standards, therefore, provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known, or likely, to be hazardous to human health and wellbeing (WHO, 2000). The South African NAAQS for PM_{10} were published in 2009 (Government Notice No. 1210, 2009) in terms of Section 9(1) of the NEM:AQA. The NAAQS for $PM_{2.5}$ were published in 2012 (Government Notice No. 486, 2012) (Table 5).

In terms of the NEM:AQA, local government is responsible for air quality management, control and enforcement. This includes the control of all major sources, including mining, industrial, vehicle and domestic sources, in terms of ambient air concentrations. District and Metropolitan Municipalities are the licensing authorities. Provincial government is primarily responsible for ambient monitoring and ensuring municipalities fulfil their legal obligations. National government is primarily the policy maker and co-ordinator.

Table 5: National Standards for Ambient Air Quality for PM_{10} (Government Notice No. 1210, 2009) and for $PM_{2.5}$ (Government Notice No. 486, 2012).

National Ambient Air Quality Standards for Particulate Matter (PM_{10})			
Averaging Period	**Concentration ($\mu g/m^3$)**	**Frequency of Exceedance**	**Compliance Date**
24 hours	75	4	1 January 2015
1 year	40	0	1 January 2015
The reference method for the determination of the PM_{10} fraction of suspended particulate matter shall be EN 12341.			
National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$)			
Averaging Period	**Concentration ($\mu g/m^3$)**	**Frequency of Exceedance**	**Compliance Date**
24 hours	40	4	1 January 2016 – 31 December 2029
24 hours	25	4	1 January 2030
1 year	20	0	1 January 2016 – 31 December 2029
1 year	15	0	1 January 2030
The reference method for the determination of the $PM_{2.5}$ fraction of suspended particulate matter shall be EN 14907.			

The acceptable dustfall rates as set out in the National Dust Control Regulations (Government Notice No. 517, 2018) are shown in Table 6.

Table 6: National Dust Control Regulations (Government Notice No. 517, 2018).

Restriction Areas	**Dustfall Rate (D) ($mg/m^2/day$) (30-days average)**	**Permitted Frequency of Exceeding Dustfall Rate**
Residential area	D < 600	Two within a year, not sequential months.
Non-residential area	D ≤ 1 200	Two within a year, not sequential months.

The method to be used for measuring dustfall rate and the guideline for locating sampling points shall be the latest version of ASTM D1739.

In 2003 the Gauteng Department of Agriculture, Conservation and Environment, now the Gauteng Department of Agricultural and Rural Development (GDARD), developed a set of buffer zones to demarcate safe distances for development around mine residue areas. It should be noted that these buffer zones are guidelines and, as a result, cannot be enforced under South African law (GDARD, 2009). The two buffers were devised with windblown dust

as the determining factor. At a distance of 500 m from mining waste disposal facilities such as slimes dams and ash dumps, dust levels are generally acceptable, and the dust can no longer be distinguished from ambient dust pollution. Beyond a distance of 1 000 m, dust from mining areas cannot be detected (Bobbins, Trangos, Phasha, Butcher, & Munakamwe, 2018; GDARD, 2009).

Both the amount of fine dust and the chemical and mineralogical composition of the dust will dictate the potential for health impacts (Schwegler, 2006). Metalliferous mine dusts may contain potentially toxic elements such as arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, uranium and zinc. Epidemiological and toxicological studies have indicated that there are many complex factors that play a role in the associated toxic, carcinogenic or other health effects (Entwistle, Hursthouse, Marinho Reis, & Stewart, 2019). As a result, causal links between ambient air concentrations of metalliferous dust and health impacts from exposure have not yet been quantified in such a way that control can be legislated.

4.2 Ambient Air Quality / Background Concentrations

The Gauteng State of the Environment Report states that high dust fallout rates have been measured in close proximity to poorly controlled tailings impoundments, with the potential effects significantly increased where residential settlements occur in the vicinity. In addition, gold tailings contain compounds such as cyanide and heavy metals, which pose additional health risks (GDARD, 2011). However, research conducted by Phakedi (2010) indicates that the concentrations of cyanide vapour emitted from the older tailings deposits and dormant slimes dams are very low and pose little health risk to occupants of adjacent land.

According to the District Air Quality Management Plan (SEF, 2010) in the West Rand District Municipality PM is one of the major pollutants of concern, primarily from the combustion of coal, fuel oil and paraffin in industries and households. There are no ambient air quality monitoring stations within a radius of 10 km of the Libanon TSF – the Randfontein station is the closest (Figure 13). However, the Randfontein station does not monitor particulate matter. The nearest station that monitors PM_{10} and $PM_{2.5}$ is the Jabavu-National Air Quality Index (NAQI) which falls under the City of Johannesburg (Figure 13). However, since all of these stations are beyond a 10-km radius from the TSF, they can only provide a general assessment of PM_{10} and $PM_{2.5}$ conditions in the West Rand District Municipality (WRDM), not specifically for the TSF area. The South African Air Quality Information System (SAAQIS) website manages the data for these stations. Ambient air quality data collection in the West Rand District Municipality has not been consistent through the years due to a number of issues with regards to the operation and functionality of the stations. The Gauteng Province Environment Outlook Report (GDARD, 2017) reported that not all stations in the WRDM were able to provide complete and verifiable data sets. Between 2009 and 2013, the Mogale City and Randfontein stations had effectively no data, both stations had grossly incomplete data

in 2014, however, were operational for at least 9 months of the year in 2016. In 2017, there is very intermittent PM data for the Randfontein monitoring station and nothing since then.

The graph (Figure 14) of the measured PM_{10} and $PM_{2.5}$ ambient concentrations in Jabavu-NAQI (2017 to 2024) indicates frequent exceedances of the NAAQS of 75 and 40 µg/m^3 respectively in the area. The highest ambient concentrations were recorded in winter when atmospheric conditions are most unfavourable for the dispersion of air pollutants (Preston-Whyte & Tyson, 1998).

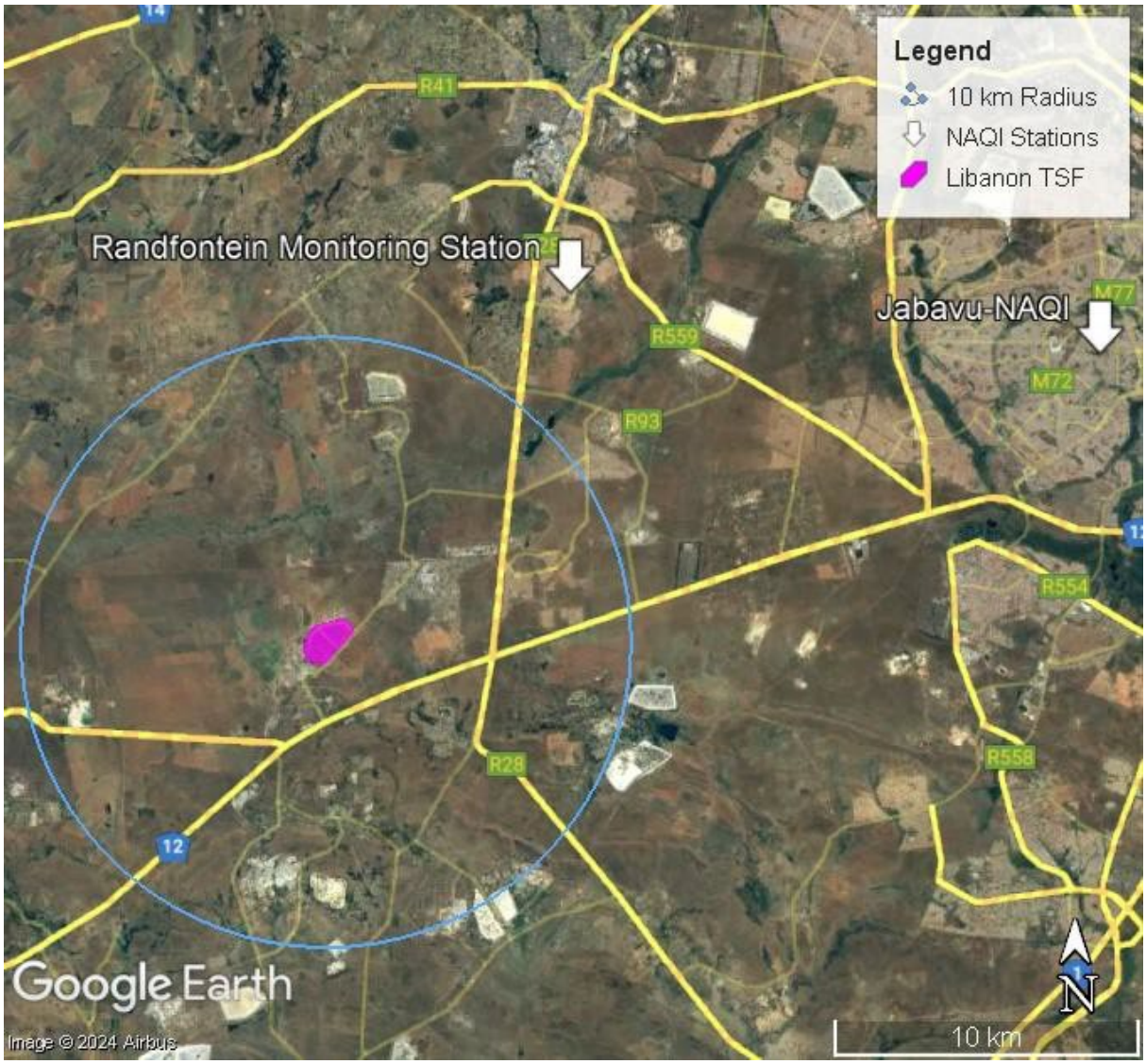

Figure 13: NAQI Monitoring stations near the Libanon TSF.

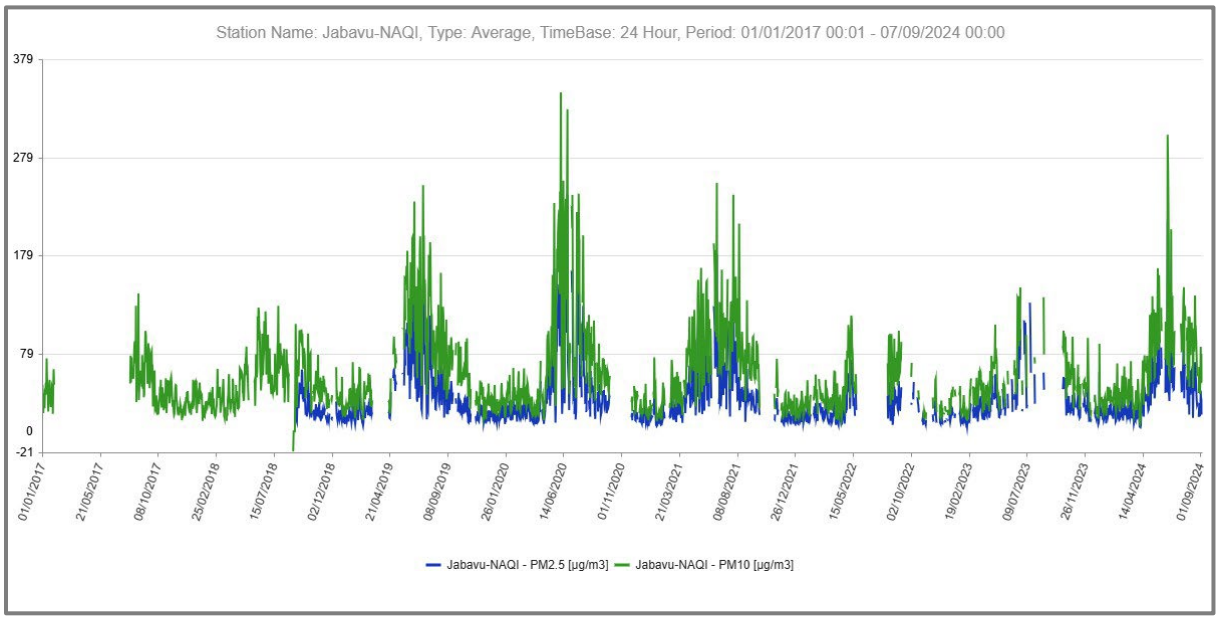

Figure 14: Daily average $PM_{2.5}$ and PM_{10} concentrations for the Jabavu-NAQI Station for the period 2017 to 2024 (SAAQIS, 2024).

5 MODELLING PROCEDURES

5.1 Model Overview

Dispersion models are used to predict the ambient-air concentrations of pollutants emitted to the atmosphere from a variety of processes. Ambient concentrations are computed as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations arising from the emissions of various sources. Increasing reliance has been placed on concentration estimates from models as the primary basis for environmental and health impact assessments, risk assessments and emission control requirements.

Three Levels of Assessment are defined in the Regulations Regarding Air Dispersion Modelling (Government Notice No. R533, 2014). The assessment of impacts resulting from emissions from this project was considered to fall within the scope of a Level 2 assessment. Level 2 assessments are used for air quality impact assessments in standard/generic licence or amendment processes where: The distribution of pollutant concentrations and depositions are required in time and space; Pollutant dispersion can be reasonably treated by a straight-line, steady-state, Gaussian plume model with first order chemical transformation; and Emissions are from sources where the greatest impacts are in less than 50 km downwind.

AERMOD is a steady-state plume dispersion model developed by The American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee (AERMIC). It has been adopted as the EPA's preferred regulatory model for both

simple and complex terrain. AERMOD incorporates air dispersion based on planetary boundary layer (PBL) turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. AERMOD is the recommended model for Level 2 assessments in the Code of Practice (Government Notice No. R533, 2014). The modelling system consists of one main program (AERMOD) and two pre-processors (AERMET and AERMAP). The versions of these programs used in this project are: AERMAP Version 18081, AERMET Version 23132 and AERMOD version 23132.

AERMOD requires elevation data that conveys the features of the surrounding terrain to calculate its effect on the dispersion of pollutants. Shuttle Radar Topography Mission (SRTM) 1 arc second Digital Elevation Terrain Data – Global was downloaded from the U.S. Geological Survey website for this project. AERMAP uses this data to establish the base elevation at each source and receptor. It then searches for the terrain height and location that has the greatest influence on dispersion for each individual receptor. This height is referred to as the hill height scale. Both the base elevation and hill height scale data are produced by AERMAP as a file or files which can be directly inserted into an AERMOD input control file. The elevation data is used by AERMOD to capture the essential physics of dispersion in complex terrain when calculating air pollutant concentrations at individual receptors (Cimorelli, et al., 2004).

AERMOD is designed to run with a minimum of observed meteorological parameters. The purpose of AERMET is to use basic meteorological measurements, representative of the modelling domain, to compute certain boundary layer parameters. Surface characteristics in the form of albedo, surface roughness and Bowen ratio, plus standard meteorological observations (wind speed, wind direction, temperature, and cloud cover), are input to AERMET. AERMET then calculates the PBL parameters: friction velocity, Monin-Obukhov length, convective velocity scale, temperature scale, mixing height, and surface heat flux. AERMET uses these parameters to generate the profiles of wind, turbulence and temperature required by AERMOD (Cimorelli, et al., 2004).

Modelled data from the Weather Research and Forecasting (WRF) Model was used to initialize the AERMET pre-processor in this project. Electronic input and output files for the modelling for AERMAP, AERMET and AERMOD have been submitted with this report. A list of these files is included in Section 6.

5.2 Emission Scenarios Modelled

Conditions simulated in the modelling study:

- Status quo scenario.
- Worst-case emission scenario from reclamation operations.
- Post-reclamation scenario.

5.2.1 Mitigation Measures

Heavy construction is a source of dust emissions that may have a substantial temporary impact on local air quality. Building and road construction are two examples of construction activities with high emissions potential. However, dust emissions often vary substantially from day to day, depending on the level of activity, the specific operations, and the prevailing meteorological conditions. Wet suppression and wind speed reduction are the two most common methods used to control open dust sources at construction sites (WRAP, 2006).

Because the Libanon TSF project area lies in the WRDM where PM is one of the major pollutants of concern (SEF, 2010), all aspects of the reclamation project should be mitigated to keep emissions to a minimum. This should include:

- Minimisation of the use of temporary storage piles for the stripped vegetation.
- Removing all tailings material down to 'red earth' as the area of work progresses, and not leaving remnants of tailings material behind which could be exposed to wind erosion.
- Control of the width of the band cleared for reclamation to a maximum width of 40 metres.
- Strict speed control of all vehicles on site to 40 km/hr. In a study by Countess Environmental (WRAP, 2006), it was found that limiting speeds on unpaved roads to 40 km/hr demonstrated a control efficiency of 44%.

Dust fallout must be monitored and if the increase in emissions from the reclamation activities cause the pre-operational phase dustfall levels to rise above the limits set by the National Dustfall Regulations, the mitigation programme will have to be increased until compliance is achieved.

Possible increased mitigation measures include:

- Reducing the width or the length of the bands cleared for reclamation; and/or
- Wet suppression of the bands cleared for reclamation.

If the pre-operational phase dustfall levels already exceed the regulations, additional care will have to be taken and mitigation should be as efficient as possible, to protect the health of the surrounding communities as far as possible.

5.3 Model Settings

The US EPA regulatory default model settings were used. These include:

- Elevated terrain algorithms requiring input of terrain height data.
- Calms processing routines.
- Missing data processing routines.

Other settings:

- Albedo by month (Generated by WRF): 0.16, 0.16, 0.16, 0.16, 0.16, 0.17, 0.17, 0.16, 0.16, 0.16, 0.16, 0.16.
- Bowen ratio by month (Generated by WRF): 8.66, 8.81, 9.04, 9.29, 9.34, 9.58, 9.67, 9.46, 9.35, 9.19, 9.58, 9.39.
- Surface roughness length by month (Generated by WRF): 0.8, 0.8, 0.8, 0.8, 0.8, 0.8, 0.8, 0.8, 0.8, 0.8, 0.8, 0.8.

5.4 Receptor Grids

A cartesian receptor grid was used for the modelling. Receptors were spaced at 50 m intervals up to 5 km from the centre point. The UTM coordinates of the centre point are: 561705.00 m E 7086933.00 m S.

Four discrete receptors were also modelled (Figure 15). Receptor 1 represents some of the closest houses to the north-east of the Libanon TSF in the Westonaria suburb, Receptor 2 represents the closest houses to the south of the TSF in the Libanon Gold Mine residential area, Receptor 3 represents the closest school (Tiny Tods Pre Primary CC) in Westonaria to the north-east of the TSF, and Receptor 4 represents the closest houses in Westonaria to the west of the TSF.

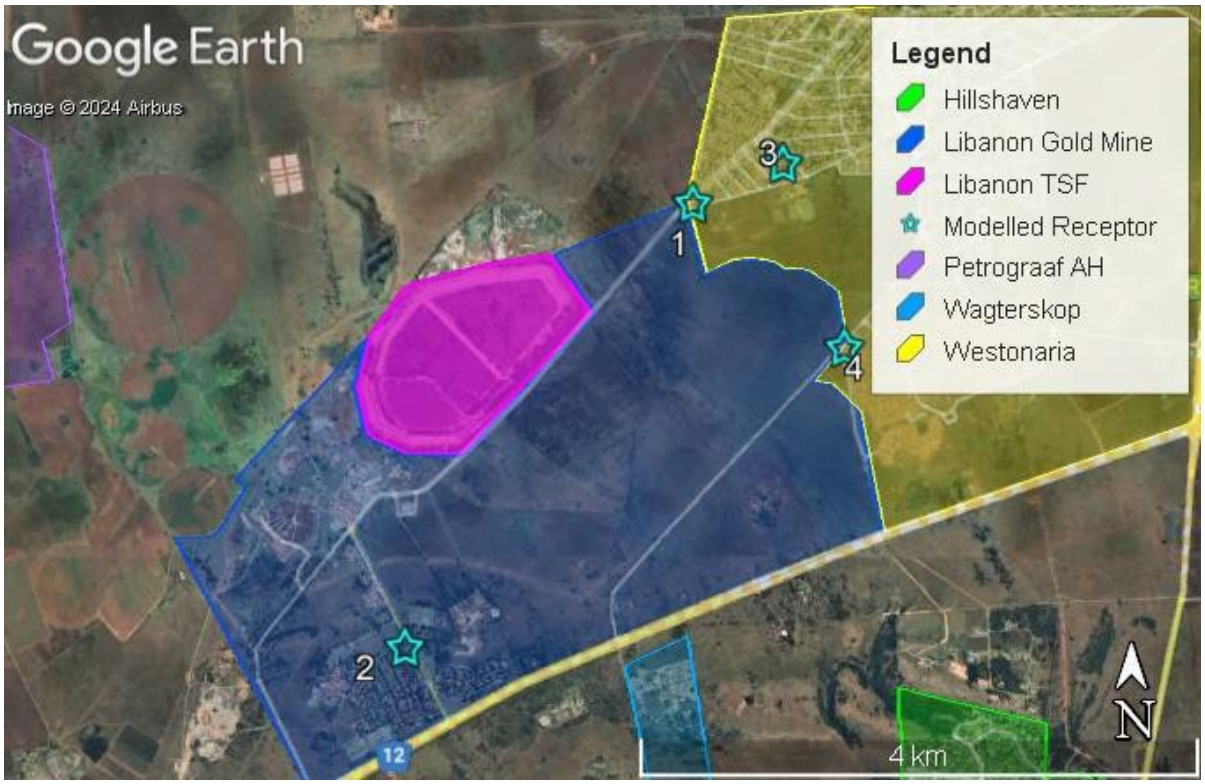

Figure 15: Position of the discrete receptors included in the modelling.

5.5 Assumptions and Limitations

- Construction of buildings and roads is a source of dust emissions that may have a substantial temporary impact on local air quality. However, there will be minimal construction activities associated with the Libanon TSF reclamation process. Access roads will be routed from existing entry points, and much of the basic infrastructure will be of a temporary nature e.g., administration buildings, mobile change houses and ablution facilities.

- Mainly existing pipelines will be used and only a short length of new pipeline will be laid for the project (Kongiwe, 2024). Therefore, emissions from laying of pipelines are expected to be low.

- Vehicles travelling across parts of the tailings could cause significant instantaneous emissions from exposed areas of tailings material. However, it was assumed that the total amount of traffic and hence the total emissions from this source would be insignificant.

- The NPi emission factor for TSFs does not account for differences in vegetation cover, moisture content, salt concentration, surface structure (structural & textural cracks & inhomogeneity), nor weathering of the tailings (NPi, 2006). For this reason, it was

assumed that in the 40-metre-wide band where all vegetation is removed for the reclamation process, the emission rates predicted by the NPi will increase by a factor of 10.

- For modelling the TSF as an area source, Zs (the height of the first vertex) was set as the highest point in the TSF instead of the actual height of the vertex. This was done because AERMOD uses the height of the first vertex as the height of the entire polygon source, but the corners of the TSFs are lower than the centre. This was done to achieve the worst-case dispersion scenario because the higher the emission source, the further the dispersion.

- The Marticorena and Bergametti equations (1995) indicate that once the threshold velocity of a particle size is exceeded, the emission rate and therefore ambient concentrations increase very rapidly. This means that large amounts of PM_{10} and $PM_{2.5}$ may be emitted from the TSF on gusty days. However, the absence of meteorological data at the level of instantaneous wind gusts means that the frequency and duration of this occurring could not be assessed.

- The Marticorena and Bergametti equations (1995) also indicate that below 6.7 m/s the emission rate and therefore ambient concentrations decrease very rapidly. In the period 2015 to 2017 at O.R. Tambo International Airport, all except two days recorded a maximum gust speed of 6.7 m/s or more, indicating that there will be some emissions of PM_{10} from the tailings on almost every day of the year. However, the average wind speed of 255 days was less than 5.9 m/s. Lower wind speeds cause the distance of dispersion to decrease. This may result in the modelling incorrectly indicating more exceedances close to the TSFs, as lower wind speeds will reduce the distance of dispersion while the model is unable to reduce emission rates on those days.

- It was assumed that reclamation would start in the areas closest to the lowest point along the north of the TSF. For the reclamation scenario it was also assumed that the areas to the south of the work face would still be emitting particulates at the same rate as for the status quo scenario.

- It was assumed that the face being removed by the jets of high-pressure water will be wet on a regular basis, therefore emissions will not be increased from this area, even though the tailings material is ‘disturbed’.

- For the ‘post-reclamation’ scenario, it was assumed that all tailings material will have been removed. If any of this fine tailings-material is left behind, the predicted emissions from these areas could be substantially different.

6 AIR QUALITY IMPACT ASSESSMENT RESULTS

Dispersion simulations were undertaken to determine ambient concentrations of $PM_{2.5}$ and PM_{10} resulting from the Libanon TSF. Three scenarios were simulated – a status quo scenario showing the emissions from the TSF before the start of the reclamation process; a worst-case scenario with reclamation starting along a 40 m wide strip along the north side of the TSF; and a post-reclamation scenario where all tailings material has been removed to expose bare 'red earth'.

The position of the 40 m strip used in the modelling is shown in Figure 16 The dispersion of particulate matter was modelled up to a distance of 5 km from a central point.

Four discrete receptors were included in the modelling to illustrate the impact of emissions from Libanon TSF on the surrounding area. The location of the modelled discrete receptors is shown in Figure 15, with their elevation and coordinates presented in Table 7.

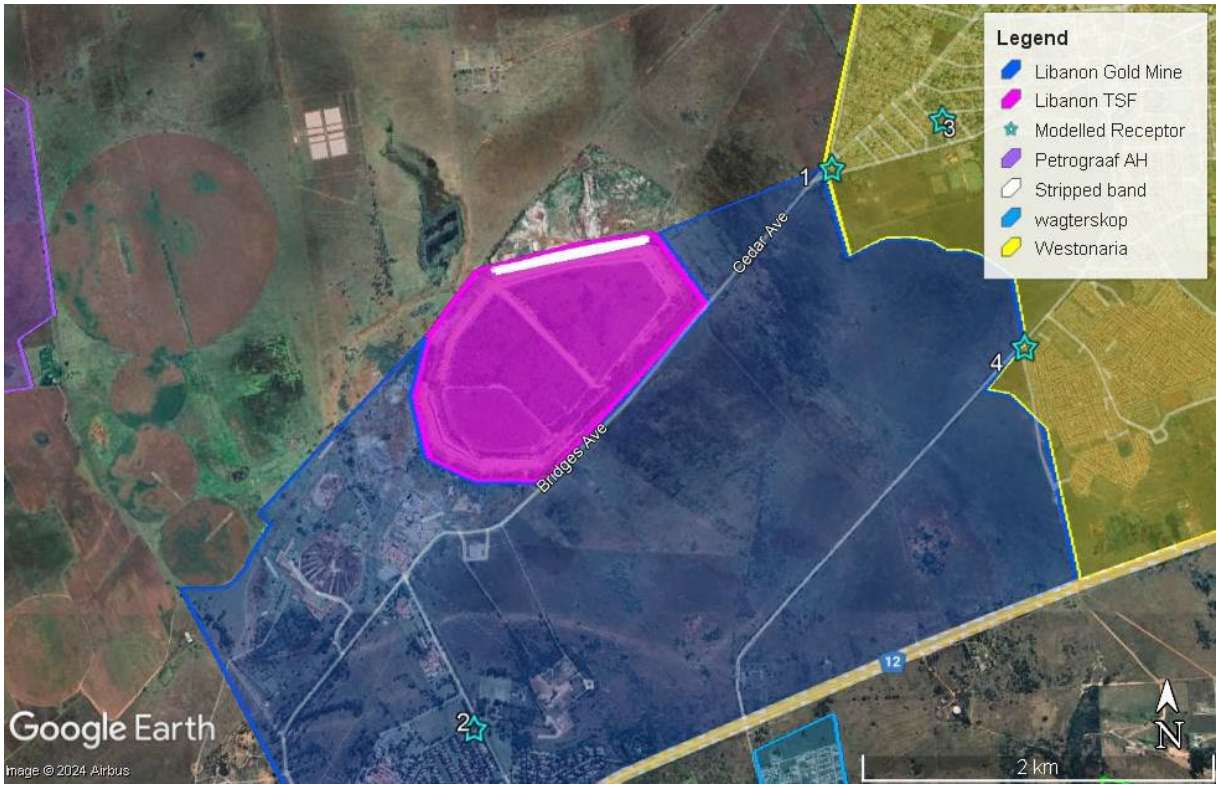

Figure 16: Position of the modelled reclamation strip and discrete receptors.

Table 7: UTM coordinates and elevation of modelled receptors.

Modelled Receptor	Description	UTM Coordinates	Elevation (m)
1	Closest Westonaria houses north-east of the Libanon TSF	563425.60 m E 7087977.76 m S	1597.13
2	Closest Libanon Gold Mine houses to the south of the Libanon TSF	561300.87 m E 7084733.21 m S	1632.83
3	Closest school north-east of the Libanon TSF	564102.00 m E 7088266.00 m S	1599.79
4	Closest Westonaria houses to the east of the Libanon TSF	564534.00 m E 7086893.00 m S	1621.02

The isopleths of the modelling results for $PM_{2.5}$ and PM_{10} are presented in Figure 17 to Figure 20 below. **The red isopleths represent the NAAQS, therefore, all areas on the map that lie within the red coloured isopleth can be expected to experience exceedances of the relevant National Standards.**

It should be noted that isopleth plots reflecting the 24-hour averaging periods contain the 99^{th} percentile or the average of the fifth-highest predicted ground level concentrations, over the three-year period for which simulations were undertaken. In other words, the model calculates the fifth-highest concentration at each receptor for each year modelled, and then averages those fifth-highest concentrations at each receptor across the three years of meteorological data for plotting. This is in line with the NAAQS which allows for four exceedances per year. Concentrations are presented in $\mu g\ m^{-3}$.

6.1 Status Quo Ambient Impact Results

6.1.1 Figures Showing Isopleths of the Status Quo Concentrations

The isopleths of the status quo modelling results are given in Figure 17 to Figure 20 below.

Status Quo Modelling Results

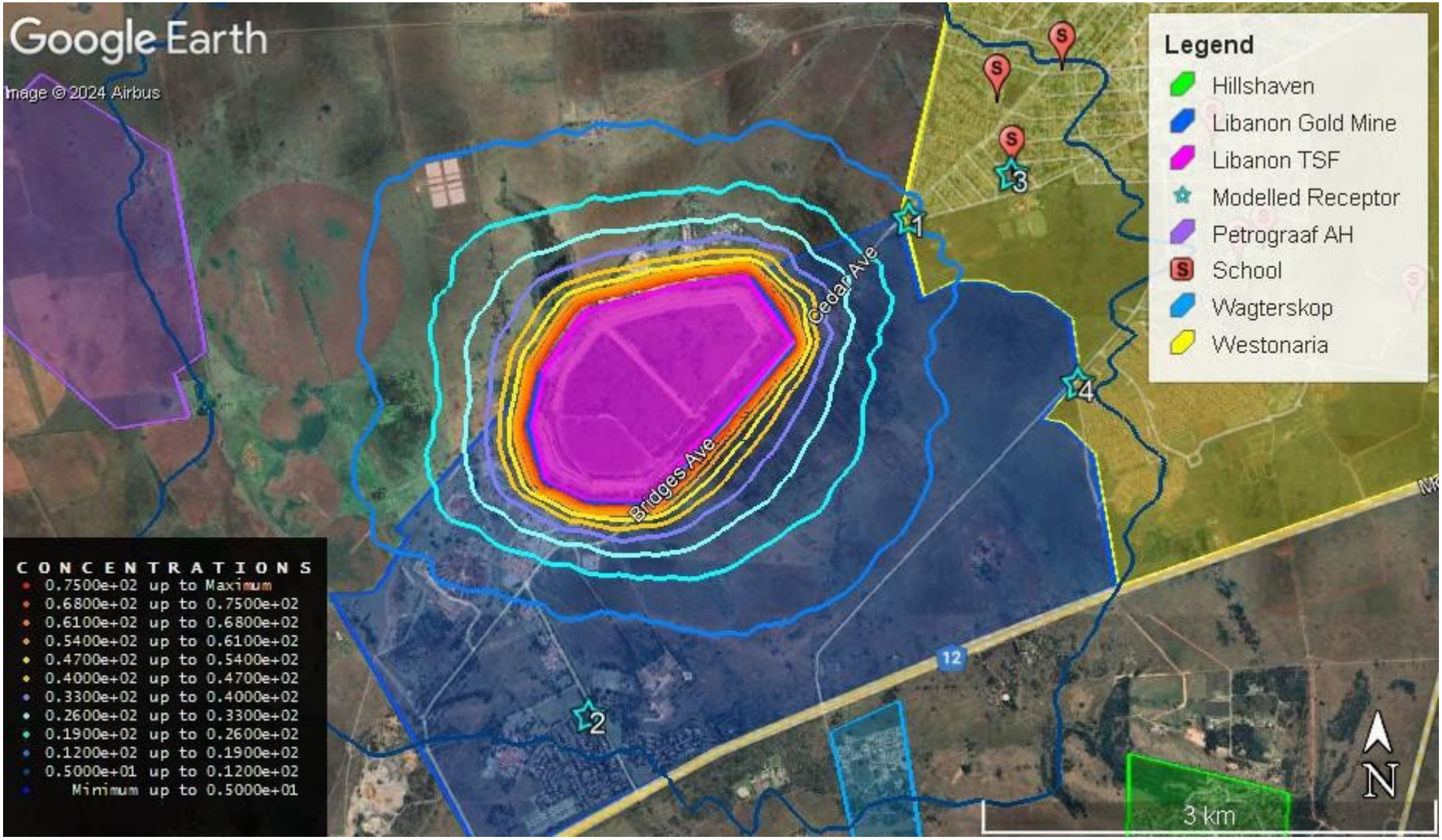

Figure 17: Modelled prediction of highest 24-hour average PM_{10} concentrations resulting from the undisturbed Libanon TSF.

Status Quo Modelling Results

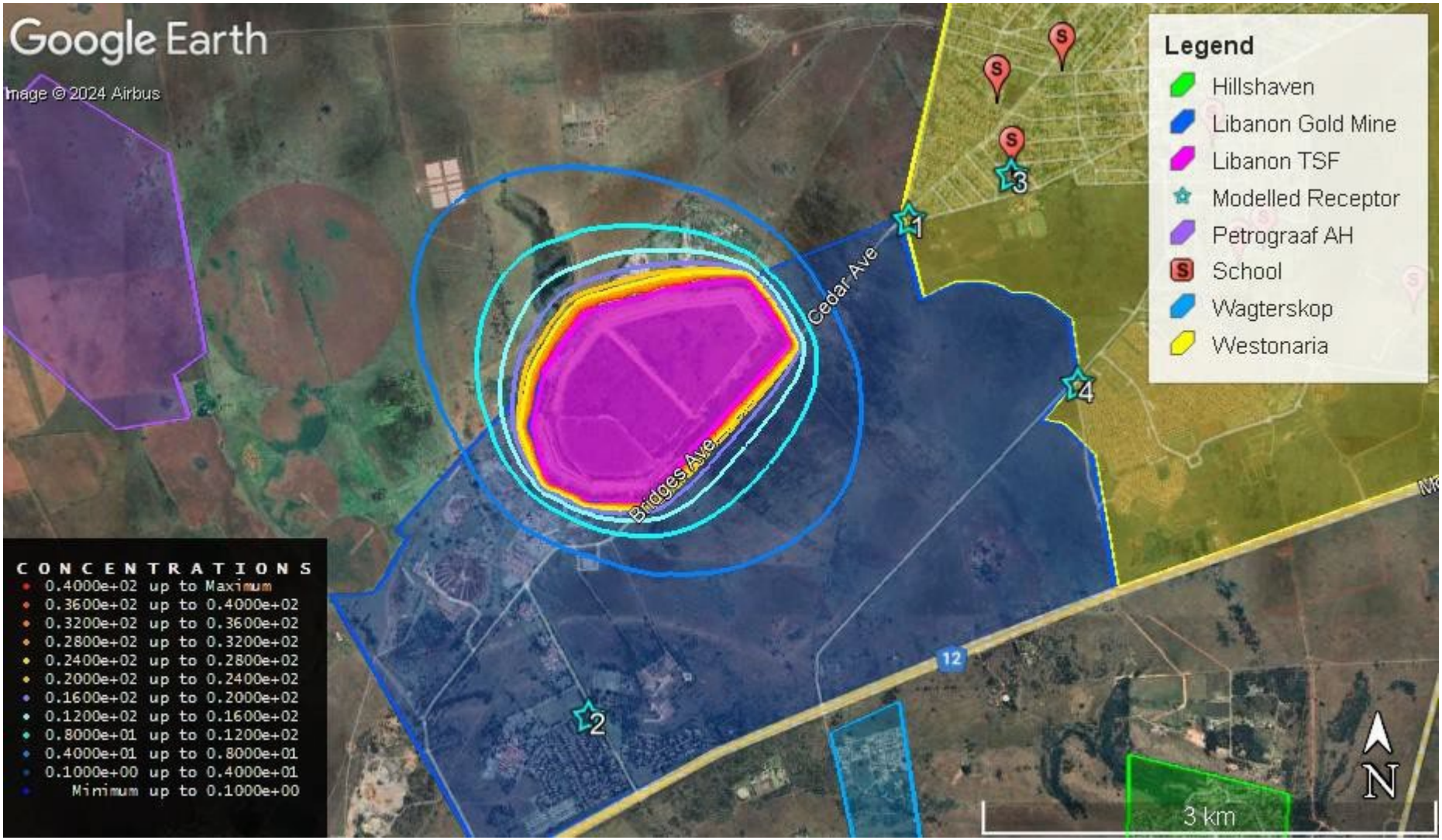

Figure 18: Modelled prediction of the annual average PM_{10} concentrations resulting from the undisturbed Libanon TSF.

Status Quo Modelling Results

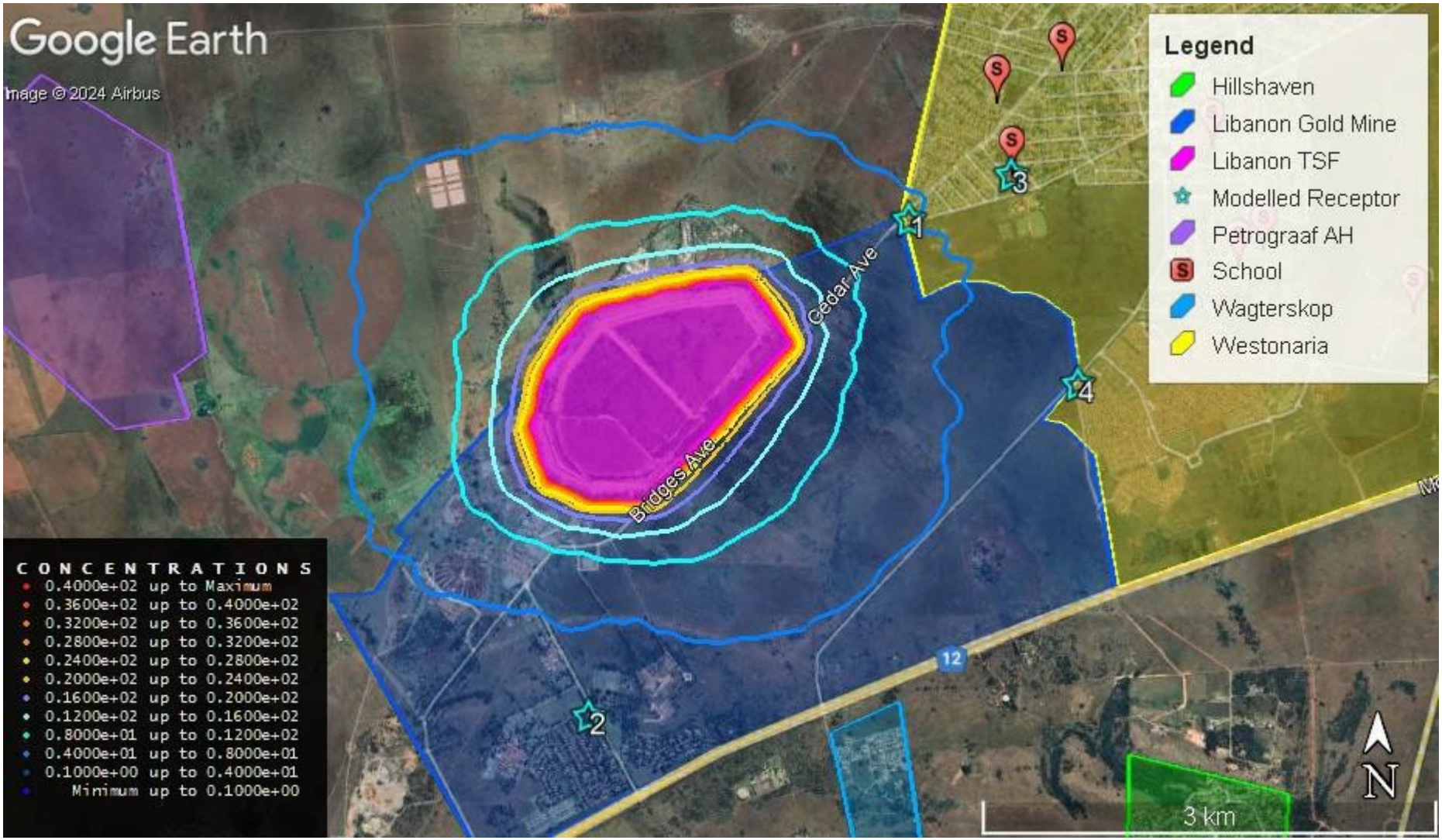

Figure 19: Modelled prediction of the highest 24-hour average $PM_{2.5}$ concentrations resulting from the undisturbed Libanon TSF.

Status Quo Modelling Results

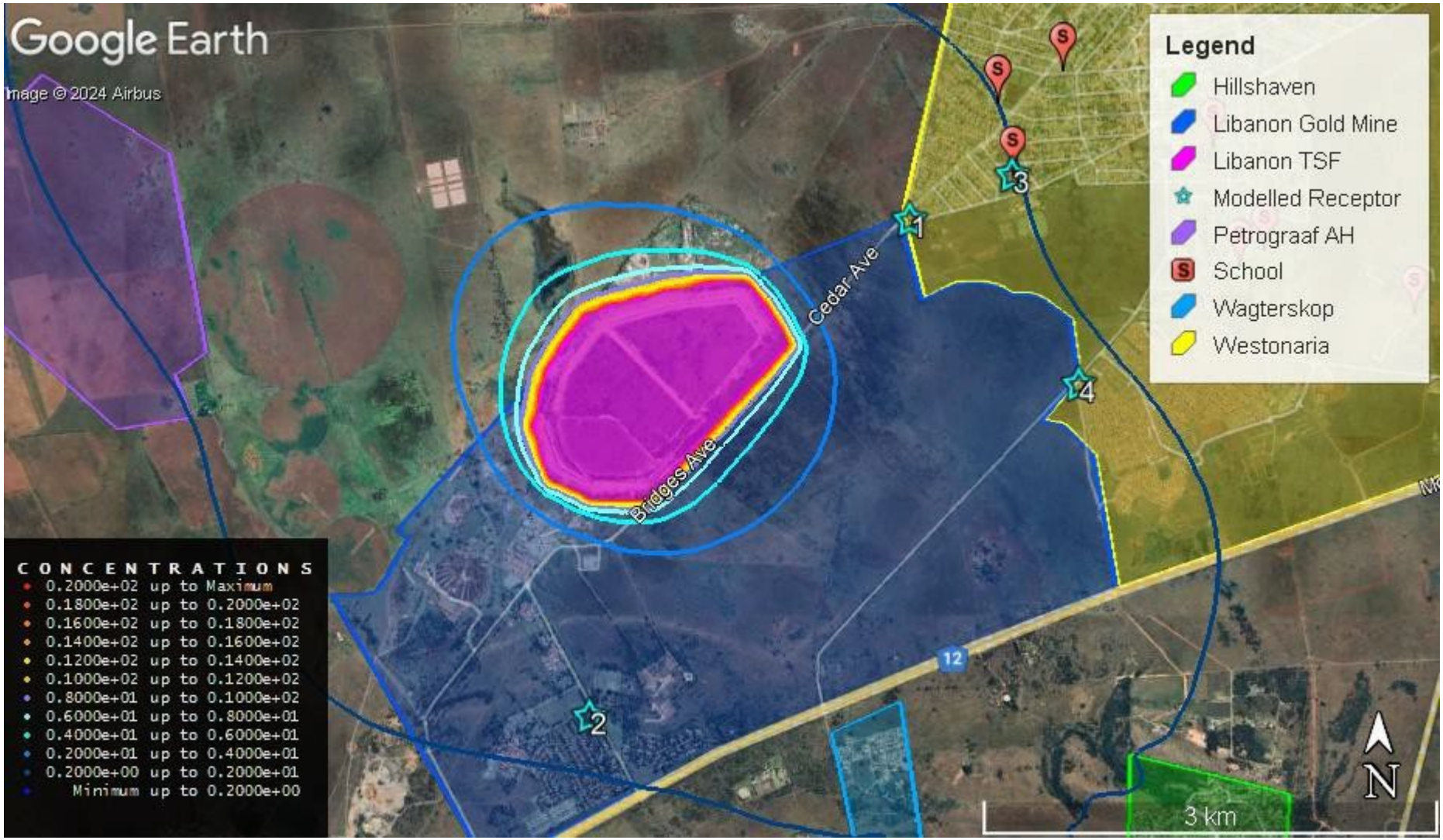

Figure 20: Modelled prediction of annual average $PM_{2.5}$ concentrations resulting from the undisturbed Libanon TSF.

6.1.2 Table of the Status Quo Modelling Results

Table 8: Maximum modelled status quo concentrations at the discrete receptors in the vicinity of the Libanon TSF reclamation project.

Averaging Time	Discrete Receptor	Date of Maximum Modelled Concentration	Maximum Modelled Concentration (µg/m³)	NAAQS (µg/m³)
PM_{10} 24 hours (99^{th} percentile)	1	17-07-2022	12.9c	75
	2	22-07-2023	6.2	
	3	07-02-2023	6.3c	
	4	26-06-2022	5.5	
PM_{10} Annual	1	Annual average	1.2	40
	2	Annual average	0.8	
	3	Annual average	0.6	
	4	Annual average	0.7	
$PM_{2.5}$ 24 hours (99^{th} percentile)	1	17-07-2022	4.4	40
	2	09-02-2021	2.2	
	3	06-08-2022	2.2	
	4	21-06-2023	1.9	
$PM_{2.5}$ Annual	1	Annual average	0.4	20
	2	Annual average	0.3	
	3	Annual average	0.2	
	4	Annual average	0.3	

Note: An average that includes a calm hour is flagged with a 'c'.

6.1.3 Evaluation of the Status Quo Modelling Results

- The modelled highest daily average concentrations of PM_{10} resulting from emissions from the Libanon TSF indicate that exceedances of the national daily standard of 75µg/m³ can be expected on windy days on the footprint of the TSF (Figure 17). The areas of exceedances are immediately around the TSF. The highest expected concentrations at the discrete receptors included in the modelling (representing the closest residential areas and the closest school) are expected to be well below the PM_{10} NAAQS (Table 8).
- The modelled highest daily average concentrations of $PM_{2.5}$ indicate that exceedances of the national daily standard of 40µg/m³ are not expected to extend beyond the TSF footprint (Figure 19). There are no residential areas in the vicinity that are expected

to experience exceedances of the $PM_{2.5}$ NAAQS from emissions from the Libanon TSF (Table 8).

- The modelling also indicates that annual average concentrations of both PM_{10} and $PM_{2.5}$ are not expected to exceed the national standards of 40µg/m^3 and 20µg/m^3 respectively beyond the TSF footprint (Figure 18 and Figure 20).

6.2 Reclamation Scenario Ambient Impact Results

6.2.1 Figures Showing Isopleths of the Reclamation Scenario Concentrations

The isopleths of the reclamation scenario modelling results are given in Figure 21 and Figure 22 below.

Reclamation Modelling Results

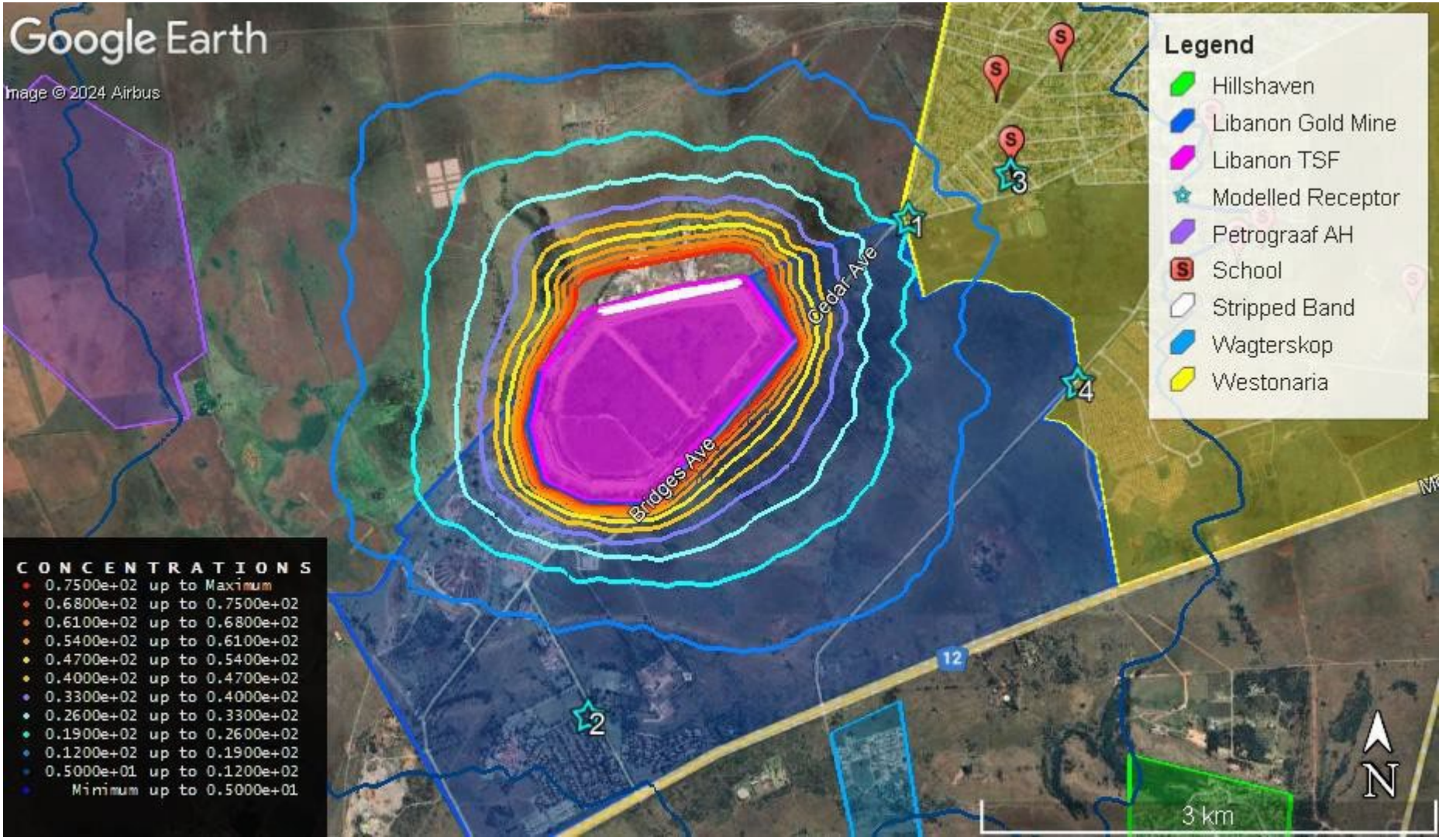

Figure 21: Modelled prediction of the highest 24-hour average PM_{10} concentrations resulting from starting reclamation at the Libanon TSF northern area.

Reclamation Modelling Results

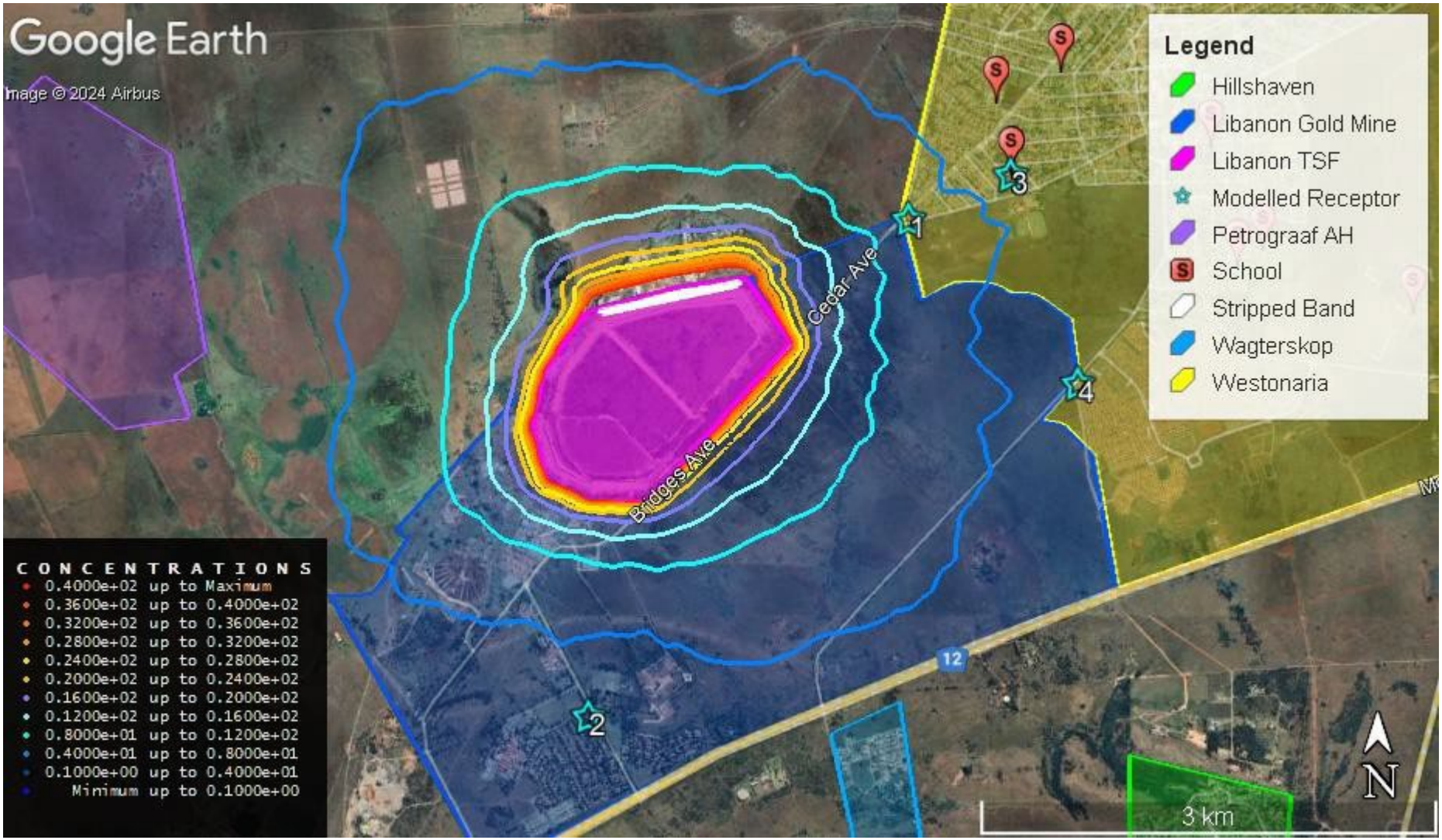

Figure 22: Modelled prediction of the highest 24-hour average $PM_{2.5}$ concentrations resulting from starting reclamation at the Libanon TSF northern area

6.2.2 Table of the Reclamation Scenario Modelling Results

Table 9: Maximum modelled reclamation scenario concentrations at the discrete receptors in the vicinity of the Libanon TSF reclamation project.

Averaging Time	Discrete Receptor	Date of Maximum Modelled Concentration	Maximum Modelled Concentration (µg/m³)	NAAQS (µg/m³)
PM_{10} 24 hours (99^{th} percentile)	1	22-07-2022	18.4	75
	2	09-02-2021	6.9	
	3	19-08-2022	9.5	
	4	26-05-2021	7.0c	
$PM_{2.5}$ 24 hours (99^{th} percentile)	1	19-08-2022	6.2	40
	2	11-07-2022	2.5	
	3	19-08-2022	3.2	
	4	07-09-2021	2.5c	

Note: An average that includes a calm hour is flagged with a 'c'.

6.2.3 Evaluation of the Reclamation Scenario Modelling Results

The initial stripping of a band for reclamation is the stage where the largest effects of the reclamation process may be expected. This is because all of the status quo emissions continue, with the added increase in emissions resulting from the stripping of vegetation in a 40-metre-wide band for reclamation. The modelling results indicate the worst-case scenario – of reclamation starting along the north side of the TSF. **The modelling results indicate that the distance from the Libanon TSF, within which exceedances of the national standards may be expected, is not expected to increase more than 180 m beyond the status quo emission scenario.**

- The difference is greatest closest to the stripped band.
- The modelled highest daily average concentrations of PM_{10} indicate that exceedances of the national daily standard of 75µg/m³ can be expected on windy days up to approximately 180 m to the north of the Libanon TSF (Figure 21). The exceedances occur in areas of bare land to the north of the TSF and therefore none of the modelled receptors are expected to experience ambient concentrations exceeding the NAAQS on worst-case days. All receptors may expect to experience ambient conditions of less than a quarter of the limit set by the NAAQS in ambient PM_{10} concentrations from at present while the TSF is not under reclamation (Table 9). It should be noted that the increase in emissions from the TSF during reclamation will be temporary and will decrease as the reclamation progresses southwards.

- The modelled highest daily average concentrations of $PM_{2.5}$ indicate that exceedances of the national daily standard of 40µg/m^3 can be expected on windy days up to approximately 70 m from the north of the Libanon TSF (Figure 22). There are no residential areas in the vicinity that are expected to experience exceedances of the NAAQS from the reclamation phase of the Libanon TSF (Table 9).

6.3 Post-Reclamation Scenario Ambient Impact Results

6.3.1 Figures Showing Isopleths of the Post-Reclamation Scenario Concentrations

The isopleths of the post-reclamation modelling results are presented in Figure 23 and Figure 24 below

Post-Reclamation Modelling Results

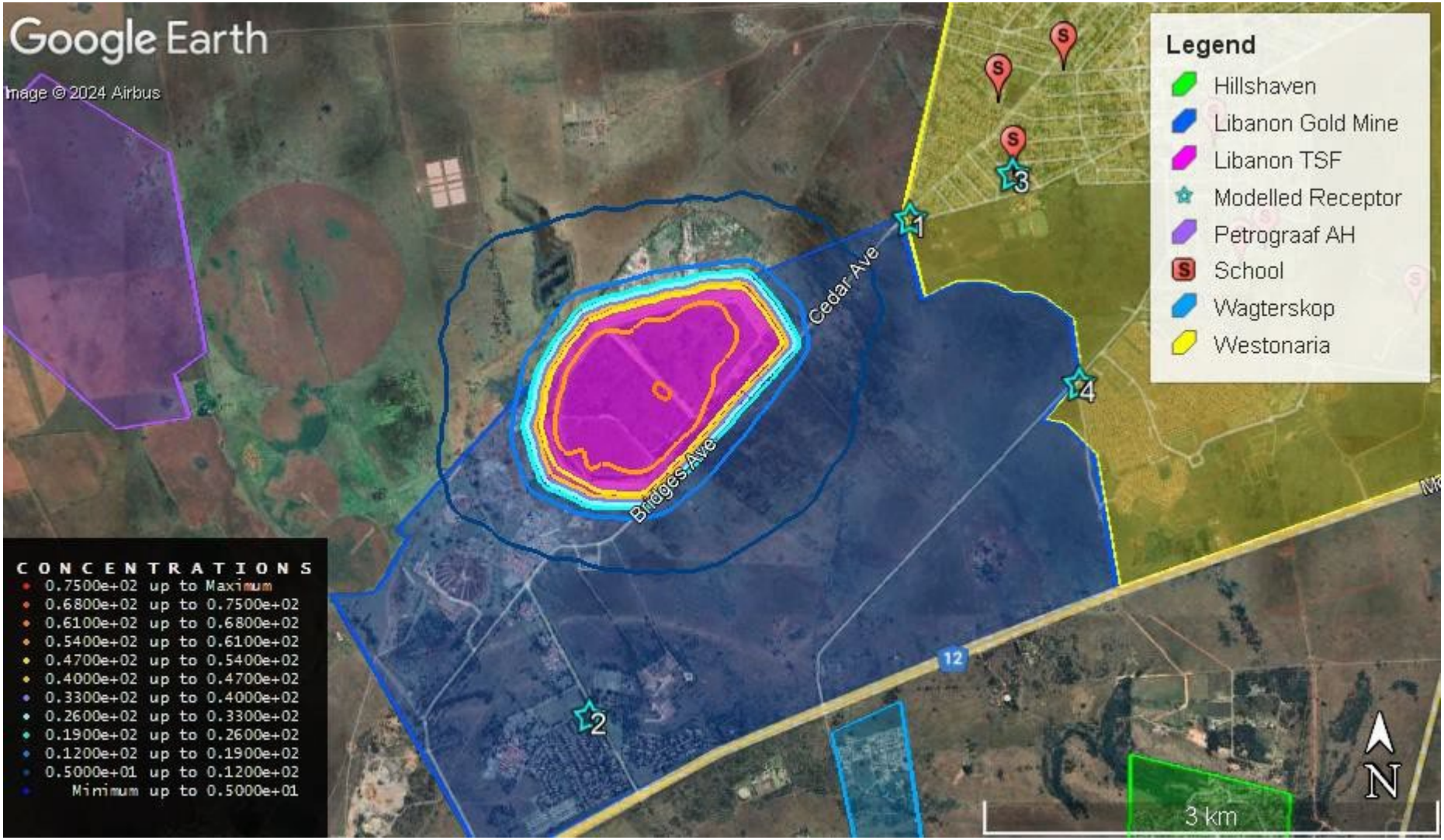

Figure 23: Modelled prediction of the highest 24-hour average PM_{10} concentrations resulting from the Libanon TSF project area after reclamation is completed.

Post-Reclamation Modelling Results

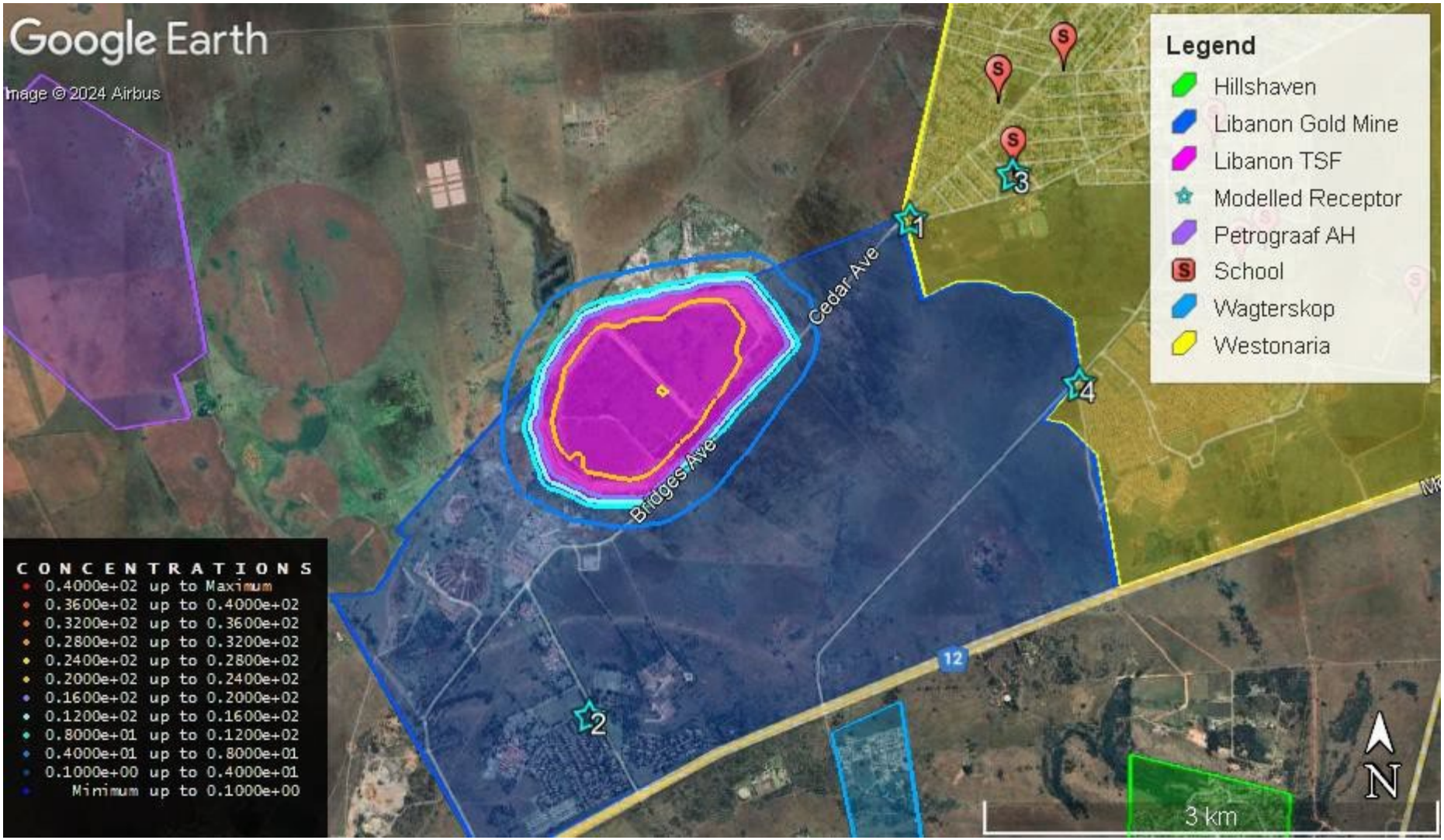

Figure 24: Modelled prediction of the highest 24-hour average $PM_{2.5}$ concentrations resulting from the Libanon TSF project area after reclamation is completed

6.3.2 Table of the Post-Reclamation Scenario Modelling Results

Table 10: Maximum modelled post-reclamation scenario concentrations at the discrete receptors in the vicinity of the proposed Libanon TSF reclamation project.

Averaging Time	Discrete Receptor	Date of Maximum Modelled Concentration	Maximum Modelled Concentration (µg/m³)	NAAQS (µg/m³)
PM_{10} 24 hours (99^{th} percentile)	1	17-07-2022	3.1c	75
	2	22-07-2023	1.5	
	3	07-02-2023	1.5c	
	4	26-06-2022	1.3	
PM_{10} Annual	1	Annual average	0.3	40
	2	Annual average	0.2	
	3	Annual average	0.1	
	4	Annual average	0.2	
$PM_{2.5}$ 24 hours (99^{th} percentile)	1	17-07-2022	1.2c	40
	2	09-02-2021	0.6	
	3	06-08-2022	0.6c	
	4	21-06-2023	0.6	
$PM_{2.5}$ Annual	1	Annual average	0.12	20
	2	Annual average	0.08	
	3	Annual average	0.06	
	4	Annual average	0.08	

Note: An average that includes a calm hour is flagged with a 'c'.

6.3.3 Evaluation of the Post-Reclamation Scenario Modelling Results

Once reclamation is complete and all tailings material has been removed, leaving bare 'red earth':

- Ambient concentrations of PM_{10} and $PM_{2.5}$ are far below the NAAQS from emissions from the cleared areas (Figure 23 and Figure 24).
- The surrounding areas should notice a marked decrease in ambient concentrations of PM_{10} and $PM_{2.5}$ on windy days (Table 10).

6.4 Comparison of the Three Modelled Scenarios

A comparison of maximum modelled concentrations at the four discrete receptors for the three modelled scenarios is presented in Table 11. The modelled concentrations show that the greatest impact of the reclamation process will be experienced to the north of the Libanon TSF. Furthermore, the improvement in ambient concentrations from the removal of this TSF is clearly evident in the modelled post-reclamation concentrations.

Table 11: Comparison of maximum modelled concentrations at the four discrete receptors for the three modelled scenarios.

Averaging Time	Discrete Receptor	Maximum Modelled Concentration (µg/m^3)		
		Status Quo Scenario	Reclamation Scenario	Post-Reclamation Scenario
PM_{10} 24 hours (99th percentile)	1	12.9c	18.4	3.1c
	2	6.2	6.9	1.5
	3	6.3c	9.5	1.5c
	4	5.5	7.0c	1.3
$PM_{2.5}$ 24 hours (99th percentile)	1	4.4	6.2	1.2c
	2	2.2	2.5	0.6
	3	2.2	3.2	0.6c
	4	1.9	2.5c	0.6

Note: An average that includes a calm hour is flagged with a 'c'.

6.5 Dust Fallout Monitoring Programme

Dustfall monitoring should be conducted to demonstrate that mitigation measures are being strictly implemented. Ongoing dustfall monitoring should be implemented as far prior to the start of the project as possible (preferably 12 months to cover all seasons), to establish a baseline against which the impacts of the reclamation activities can be assessed.

The samplers must be operated in accordance with the National Dust Control Regulations (Government Notice No. 517, 2018). As part of this monitoring programme, monthly reports must be produced. If the measured dustfall shows a marked increase from pre-operational phase levels, and particularly if the measured dustfall rates exceed the regulated dustfall rate (Table 6), urgent measures must be undertaken to further mitigate emissions.

This emphasises the importance of monitoring through all seasons prior to the commencement of reclamation activities, as the development of a baseline will make it possible to evaluate the project's actual contribution to dustfall levels more accurately and by inference to evaluate the project's contribution to ambient concentrations of PM.

6.6 Conclusions and Recommendations

An air quality impact assessment was undertaken for the reclamation of the Libanon TSF. $PM_{2.5}$ and PM_{10} represent the main criteria pollutants of concern. The following conclusions can be made from the modelling results:

- Emissions from the Libanon TSF in its current, undisturbed state are expected to be causing elevated ambient concentrations of both PM_{10} and $PM_{2.5}$ in downwind areas on windy days. Exceedances of the NAAQSs may be expected mainly around the TSF footprint. The highest expected concentrations at the discrete receptors included in the modelling (representing the closest residential areas and the closest school) are expected to be well below the PM_{10} and $PM_{2.5}$ NAAQS.
- The modelling of the TSF indicates that, if reclamation of the TSFs is conducted conservatively, with the band stripped of vegetation not exceeding a width of 40 m, the area of exceedances is not likely to increase more than 180 m beyond the status quo emission situation. If reclamation starts along the north of the TSF, this will cause increases in worst-case ambient concentrations over the bare land north of the TSF However, as reclamation progresses, if all mitigation methods are adhered to, the area of impact is expected to progressively decrease from the status quo emission situation.
- Once all tailings material has been removed down to 'red earth' ambient concentrations due to emissions from the cleared land are expected to be far below the NAAQS.
- The modelling indicates that the removal of the Libanon TSF as a permanent pollution source will improve the air quality of the surrounding residential areas.

The Libanon TSF project area is located in the WRDM where PM is one of the pollutants of concern. Therefore, all recommended mitigation measures must be strictly adhered to. Furthermore, emissions must be monitored and if the increase in emissions from the reclamation activities cause the pre-operational phase dustfall levels to rise above the limits set by the National Dustfall Regulations, the mitigation programme will have to be increased until compliance is achieved. This can include reducing the area stripped for reclamation and/or wet suppression of the area stripped for reclamation.

The evaluation of the air quality impacts from mine tailings is based on a series of assumptions. Whilst care has been taken to assess the potential air pollution impact from the mine tailings, further research on tailings emission rates or actual on-site continuous monitoring may result in different conclusions.

The impact on the environment surrounding the proposed project area is summarised in the impact assessment table below (Table 12).

Table 12: Air Quality Impact Assessment Matrix for the reclamation of Libanon TSF (See Impact Assessment Methodology in Appendix A).

Impact Assessment Matrix		
Impact Description	Stripping of vegetation from the surface of a TSF and wind erosion from exposed areas causes the emission of particulate matter into the air, thus increasing existing ambient air concentrations of criteria pollutants (both PM_{10} and $PM_{2.5}$) at receptors.	
Acceptable rating level	PM_{10} a) 24-hour Average Concentrations: National Ambient Air Quality Standard of 75µg/m^3 b) Annual Average Concentrations: National Ambient Air Quality Standard of 40µg/m^3 $PM_{2.5}$ c) 24-hour Average Concentrations: National Ambient Air Quality Standard of 40µg/m^3 d) Annual Average Concentrations: National Ambient Air Quality Standard of 20µg/m^3	
	With Mitigation	
Magnitude	**Minor negative:** Although the reclamation of the TSF is expected to increase the ambient concentrations of PM over the surrounding residential areas, this will be temporary, and will decrease as reclamation progresses. Furthermore, the undisturbed TSF is already a significant emission source and produces most of the impacts on the surrounding residential areas.	
Duration	**Long term / Medium term:** The reclamation phase of the project should take longer than 5 years and therefore will exist in the long-term. Although the duration of the whole project will be more than 5 years, the emissions will reduce as the reclamation progresses. The consequence and significance of the project will therefore decrease over the life of project as shown by the two consequence and significance assessments below.	
Spatial Scale	**Local:** Worst-case conditions lead to the NAAQS being exceeded further from the project footprint than the current status quo emissions.	
Consequence	**Medium negative**	**Low negative**
Probability	**Definite:** The undisturbed TSFs are already emitting PM**.**	
Significance of Air Quality Impact	**Medium negative**	**Low negative**
Mitigation	Restriction of the stripped band to a width of 40 metres; restriction of the use of storage piles; removing all tailings material down to 'red earth' as the area of work progresses and not leaving remnants of tailings material behind which could be exposed to wind erosion.	
Cumulative Impact	Emissions from the reclamation of Libanon TSF are predicted to only produce a limited increase in ambient concentrations of PM_{10} and $PM_{2.5}$. In the long term, removal of the dumps will reduce ambient concentrations and improve the air quality of the surrounding areas.	

7 AMBIENT IMPACT ASSESSMENT SUPPORTING DOCUMENTATION

7.1 Warning and Informational Messages in Output Files

AERMAP

RE W229	DISCAR: Too many parameters – Inputs ignored on keyword	DISCCART
OU W450	NEDCHK:Parameter not found in TIFF file. TiffTag:	274
OU W470	NEDCHK:Unexpected datum for NED file encountered:	WGS84
OU W473	NEDCHK:Default elevation units of METERS used; NED file:	1

The RE warning message is the result of numbering the discrete receptors for easier identification at a later stage.

The OU warning messages are a result of the SRTM input files not being the standard NED files for the USA.

AERMOD

CO W276 POLLID: Special proc for 1h-NO2/SO2 24hPM25 NAAQS disabled.
CO W363 COCARD: Multiyr 24h/Ann PM25 processing not applicable for SAVEFILE.
ME W182 MEOPEN: MMIF-generated meteorological inputs were used.
ME W181 MEOPEN: BULKRN Delta-T & SolarRad option for SBL was used.
ME W531 MEOPEN: CAUTION! Met Station ID Missing from SURFFILE.
ME W187 MEOPEN: ADJ*U Option for stable low winds used in AERMET.
MX W492 METEXT: SURFDATA YR .NE. 1st YR of file, adj to match file StartYR 2021.
MX W438 METQA: Convective Velocity Data Out-of-Range.

The first CO warning message indicates that the special processing for the US NAAQS has been disabled. This was done intentionally because the RSA NAAQS are different.
The second CO warning message is also a result of changing the US NAAQS requirements of a multiyear average to an average of 3 years.

The ME warning messages occur because WRF modelled data is used and South Africa does not have Met Station IDs comparable to those used in the USA.

The MX warning message indicates that the WRF run included data in 2020. This was done intentionally to prime the model to eliminate the effects of the starting boundary value conditions. This was adjusted by the program to only include a 3-year period, starting from 2021.

7.2 Electronic files submitted with the report

AERMAP input files

aermap.inp

AERMAP output files

aermap.out

aermap.rec

AERMET input files

AERMOD.AERSFC.DAT

AERMOD.DAT

AERMOD.FSL

AERMOD.IN1

AERMET output files

AERMOD.OU1

AERMOD.PFL

AERMOD.SFC

AERMOD input files

AERMOD.PFL

AERMOD.SFC

RE PM2.5.inp

SQ PM2.5.inp

WC PM2.5.inp

RE PM10.inp

SQ PM10.inp

WC PM10.inp

AERMOD output files

RE PM2.5.out

SQ PM2.5.out

WC PM2.5.out

RE PM10.out

SQ PM10.out

WC PM10.out

AERMOD plot files

PM2.5_24hrREH5H.plt

PM2.5_24hrSQH5H.plt

PM2.5_24hrWCH5H.plt

PM2.5_AnnualSQ.plt

PM10_24hrREH5H.plt

PM10_24hrSQH5H.plt

PM10_24hrWCH5H.plt

PM10_AnnualSQ.plt

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Appendix A. Methodology used in determining the significance of environmental impacts

The impact significance rating process serves two purposes: firstly, it helps to highlight the critical impacts requiring consideration in the management and approval process; secondly, it shows the primary impact characteristics, as defined below, used to evaluate impact significance.

The impact significance rating system is presented in Table 10 and involves three parts:

Part A: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale/ population and duration;

Part B: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A; and

Part C: Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from **Part B**) and the probability of occurrence.

Table 13: Significance Rating Methodology

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE ***Use these definitions to define the consequence in Part B***		
Impact characteristics	Definition	Criteria
MAGNITUDE	Major -	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded
	Moderate -	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded
	Minor -	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded
	Minor +	Minor improvement; change not measurable; or threshold never exceeded
	Moderate +	Moderate improvement; within or better than the threshold; or no observed reaction
	Major +	Substantial improvement; within or better than the threshold; or favourable publicity
SPATIAL SCALE OR POPULATION	Site or local	Site specific or confined to the immediate project area
	Regional	May be defined in various ways, e.g. cadastral, catchment, topographic

	National/ International	Nationally or beyond
DURATION	Short term	Up to 18 months.
	Medium term	18 months to 5 years
	Long term	Longer than 5 years

PART B: DETERMINING CONSEQUENCE RATING
Rate consequence based on definition of magnitude, spatial extent and duration

			SPATIAL SCALE/ POPULATION		
			Site or Local	Regional	National/ international
MAGNITUDE					
Minor	DURATION	Long term	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	DURATION	Long term	Medium	High	High
		Medium term	Medium	Medium	High
		Short term	Low	Medium	Medium
Major	DURATION	Long term	High	High	High
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High

PART C: DETERMINING SIGNIFICANCE RATING
Rate significance based on consequence and probability

		CONSEQUENCE		
		Low	Medium	High
PROBABILITY (of exposure to impacts)	Definite	Medium	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

Appendix B. Health Effects of Particulate Air Pollutants

There are an increasing number of research studies highlighting the impact of gases and other air pollutants on humans. Many of these emissions, even in small quantities, have adverse effects on workers and neighbouring residents alike.

Airborne particles can be classified by their aerodynamic properties into coarse particles, PM_{10}, and fine particles, $PM_{2.5}$ (Harrison & Van Grieken, 1998). The fine particles contain the secondarily formed aerosols such as sulphates and nitrates, combustion particles and re-condensed organic and metal vapours. The coarse particles contain earth crust materials and fugitive dust from roads and industries (Fenger, 2002). Both the amount of fine dust and the chemical and mineralogical composition of the dust will dictate the potential for health impacts (Schwegler, 2006). Metalliferous mine dusts may contain potentially toxic elements such as arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, uranium and zinc. Epidemiological and toxicological studies have indicated that there are many complex factors that play a role in the associated toxic, carcinogenic or other health effects (Entwistle, Hursthouse, Marinho Reis, & Stewart, 2019). As a result, causal links between ambient air concentrations of metalliferous dust and health impacts from exposure have not yet been quantified in such a way that control can be legislated. Furthermore, Ngole-Jeme and Fantke (2017) found that the inhalation pathway was by far the smallest pathway of exposure to the toxic effects of metalliferous mine dust when compared to ingestion and dermal exposure. On the other hand, it is known that fine particles will have a health impact regardless of their mineralogical composition. The NAAQS have been legislated to protect people from the health effects of PM_{10}, and $PM_{2.5}$.

Particulate air pollution is associated with respiratory and cardiovascular morbidity, such as aggravation of asthma, respiratory symptoms and an increase in hospital admissions. Inhalable PM also leads to increased mortality from cardiovascular and respiratory diseases and from lung cancer (WHO, 2013). Particle size is important for health because it controls where in the respiratory system a given particle is deposited. Fine particles are thought to be more damaging to human health than coarse particles, as they are able to penetrate deeper into the lungs (Manahan, 1991). Larger particles are deposited into the extrathoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2000).

In the past, daily particulate concentrations were in the range 100 to 1000µg/m^3 whereas in more recent times, daily concentrations are between 10 and 100µg/m^3. However, overall, exposure-response can be described as curvilinear, with small absolute changes in exposure at the low end of the curve having similar effects on mortality to large absolute changes at

the high end (WHO, 2000). Both short-term and long-term exposure to particulate matter in the air can have health impacts (Table 11).

Table 14: Short-term and long-term health effects associated with exposure to PM (WHO, 2004).

Pollutant	Short-term exposure	Long-term exposure
Particulate matter	• Lung inflammatory reactions • Respiratory symptoms • Adverse effects on the cardiovascular system • Increase in medication usage • Increase in hospital admissions • Increase in mortality	• Increase in lower respiratory symptoms • Reduction in lung function in children • Increase in chronic obstructive pulmonary disease • Reduction in lung function in adults • Reduction in life expectancy • Reduction in lung function development

Short-term exposure

There is good evidence that short-term exposure to particulate matter is associated with health effects (WHO, 2013). Health effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function. Susceptible groups with pre-existing lung or heart disease, as well as elderly people and children, are particularly vulnerable. For example, exposure to particulate matter affects lung development in children, including reversible deficits in lung function as well as chronically reduced lung growth rate and a deficit in long-term lung function (WHO, 2011). There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur (WHO, 2013).

Long-term exposure

Long-term exposure to low concentrations (~10µg/m^3) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000). Studies have indicated an association between lung function, chronic respiratory disease and airborne particles. Relative risk estimates suggest an 11% increase in cough and bronchitis rates for each 10µg/m^3 increase in annual average particulate concentrations (WHO, 2000). Based on studies conducted in the USA, Europe and Canada, mortality is estimated to increase by 0.2–0.6% per 10 µg/m^3 of PM_{10} (WHO, 2005; Samoli, et al., 2008). $PM_{2.5}$ is a higher risk factor than the coarse part of PM_{10} (particles in the 2.5–10 µm range), especially with long-term exposure. Long-term exposure to $PM_{2.5}$ is associated with an increase in the long-term risk of cardiopulmonary mortality by 6–13% per 10 µg/m^3 of $PM_{2.5}$ (Beelen, et al., 2008; Krewski, et al., 2009; Pope III, et al., 2002).

Appendix C. CV Summaries of the Specialists

Dr Martin van Nierop

Dr Martin van Nierop has a doctorate in Chemical Engineering from the University of the Witwatersrand, Johannesburg. While studying for his doctorate, Dr van Nierop was employed at the University as a research officer. Dr van Nierop became interested in research management, and he managed a number of large contract research projects at the University. One of these was a study of the Brown Haze air pollution problem over Cape Town. The project was conducted by the Climatology Research Group under the leadership of Dr Stuart Piketh during 2003. Dr van Nierop became the managing director of Gondwana Environmental Solutions International in 2004, and he has been involved in many atmospheric impact assessment studies since then.

Anja van Basten

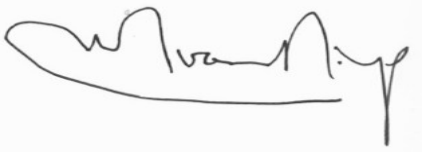
Anja van Basten completed her BA Honours degree in Physical Geography, Cum Laude, at the University of the Witwatersrand in 1988. Anja has worked for Gondwana Environmental Solutions since June 2009. In this time, she completed more than 50 Air Quality Impact Assessments with dispersion modelling using both AERMOD and CALPUFF. Emissions sources assessed include mines, tailings storage facilities, foundries, crematoria, asphalt plants, tyre pyrolysis plants, charcoal plants, landfills, organic chemicals industries, glass manufacturers, and residential, commercial, and industrial developments. Other environmental projects have included a bottom-up vehicle emissions inventory; provincial emissions inventories; a wastewater treatment works odour assessment; and air quality management plans, dust management plans and environmental management plans at facility, municipal and provincial levels

Appendix D. Declarations of Independence

I, Martin van Nierop, declare that:

- I act as the independent air quality practitioner in this application.
- I have expertise in conducting air quality impact assessments, including knowledge of the National Environmental Management Act (NEMA) (Act No. 107, 1998) and its amendments, the Environmental Impact Assessment (EIA) Regulations, as amended (Government Notice No. R982, 2014; Government Notice No. 326, 2017) and any guidelines that have relevance to the proposed activity.
- I will comply with the NEMA, and the EIA Regulations.
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that ar*e not favourable to the application*.
- I will take into account, to the extent possible, the matters listed in the National Environmental Management: Air Quality Act, 2004 (NEM:AQA) (Act No. 39, 2005); Listed Activities established in terms of the NEM:AQA (Government Notice No. 248, 2010; Government Notice No. 551, 2015); National Ambient Air Quality Standards (NAAQS) established in terms of the NEM:AQA (Government Notice No. 1210, 2009; Government Notice No. 486, 2012); Priority Areas established in terms of the NEM:AQA (Government Notice No. 365, 2006; Government Notice No. 1123, 2007; Government Notice No. 494, 2012); and Regulations Regarding Air Dispersion Modelling (Government Notice No. R533, 2014) developed in terms of the NEM:AQA, when preparing the Air Quality Impact Assessment report relating to the application.
- I undertake to disclose to the applicant, registered interested and affected parties and the competent authority all material information in my possession that reasonably has or may have the potential of influencing: any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority.
- I declare that there are no circumstances that may compromise my objectivity in performing such work.
- I have no, and will not engage in, conflicting interests in the undertaking of the activity.
- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.
- All the information submitted by me for the purposes of the application is true and correct to the best of my knowledge.
- I realise that a false declaration is an offence in terms of Regulation 48(1)(a) of the EIA Regulations, as amended, 2017 (Government Notice No. R982, 2014; Government Notice No. 326, 2017).

SIGNATURE:



I, Anja van Basten, declare that:

- I act as the independent air quality practitioner in this application.
- I have expertise in conducting air quality impact assessments, including knowledge of the National Environmental Management Act (NEMA) (Act No. 107, 1998) and its amendments, the Environmental Impact Assessment (EIA) Regulations, as amended (Government Notice No. R982, 2014; Government Notice No. 326, 2017) and any guidelines that have relevance to the proposed activity.
- I will comply with the NEMA, and the EIA Regulations.
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that ar*e not favourable to the application*.
- I will take into account, to the extent possible, the matters listed in the National Environmental Management: Air Quality Act, 2004 (NEM:AQA) (Act No. 39, 2005); Listed Activities established in terms of the NEM:AQA (Government Notice No. 248, 2010; Government Notice No. 551, 2015); National Ambient Air Quality Standards (NAAQS) established in terms of the NEM:AQA (Government Notice No. 1210, 2009; Government Notice No. 486, 2012); Priority Areas established in terms of the NEM:AQA (Government Notice No. 365, 2006; Government Notice No. 1123, 2007; Government Notice No. 494, 2012); and Regulations Regarding Air Dispersion Modelling (Government Notice No. R533, 2014) developed in terms of the NEM:AQA, when preparing the Air Quality Impact Assessment report relating to the application.
- I undertake to disclose to the applicant, registered interested and affected parties and the competent authority all material information in my possession that reasonably has or may have the potential of influencing: any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority.
- I declare that there are no circumstances that may compromise my objectivity in performing such work.
- I have no, and will not engage in, conflicting interests in the undertaking of the activity.
- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.
- All the information submitted by me for the purposes of the application is true and correct to the best of my knowledge.
- I realise that a false declaration is an offence in terms of Regulation 48(1)(a) of the EIA Regulations, as amended, 2017 (Government Notice No. R982, 2014; Government Notice No. 326, 2017).

SIGNATURE:

Appendix E. Particle size distribution of a Gauteng TSF

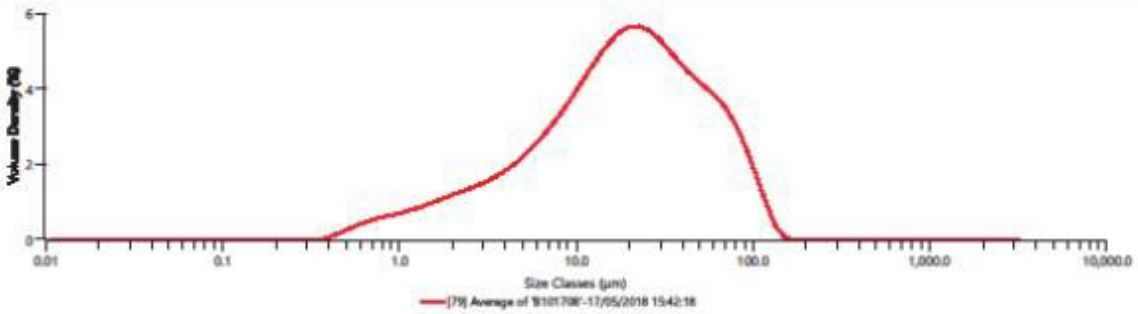
Micron Scientific

Malvern Instruments

Malvern

Measurement Details		Measurement Details	
Sample Name	Average of 'B101708'	**Measurement Date Time**	17/05/2018 15:42:18
SDS	3540	**Analysis Date Time**	17/05/2018 15:42:18
SOP File Name	Default + 60us.msop	**Original Record Number**	79
Analysis		**Analysis**	
Particle Name	Default 1.0	**Particle Refractive Index**	1,520
Dispersant Name	Water	**Dispersant Refractive Index**	1,330
Particle Absorption Index	1,000	**Laser Obscuration**	6,60 %
Weighted Residual	0,89 %	**Scattering Model**	Mie
Analysis Model	General Purpose	**Analysis Sensitivity**	Normal
Result		**Result**	
Concentration	0,0058 %	**Span**	3,376
Uniformity	1,002	**Result Units**	Volume
Specific Surface Area	812,0 m²/kg	**Dv (10)**	2,94 µm
D [3,2]	7,04 µm	**Dv (50)**	18,9 µm
D [4,3]	27,5 µm	**Dv (90)**	66,7 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0,0100	0,00	0,0895	0,00	0,991	2,44	9,86	29,36	98,1	97,51	976	100,00
0,0114	0,00	0,113	0,00	1,13	3,04	11,2	32,78	111	98,03	1110	100,00
0,0129	0,00	0,128	0,00	1,28	3,70	12,7	36,53	127	99,74	1260	100,00
0,0147	0,00	0,146	0,00	1,45	4,44	14,5	40,61	144	100,00	1430	100,00
0,0167	0,00	0,166	0,00	1,65	5,25	16,4	44,98	163	100,00	1630	100,00
0,0189	0,00	0,188	0,00	1,88	6,16	18,7	49,57	186	100,00	1850	100,00
0,0215	0,00	0,214	0,00	2,13	7,14	21,2	54,28	211	100,00	2100	100,00
0,0244	0,00	0,243	0,00	2,42	8,20	24,1	59,02	240	100,00	2390	100,00
0,0278	0,00	0,276	0,00	2,75	9,35	27,4	63,67	272	100,00	2710	100,00
0,0315	0,00	0,314	0,00	3,12	10,58	31,1	68,14	310	100,00	3080	100,00
0,0358	0,00	0,357	0,00	3,55	11,92	35,3	72,36	352	100,00	3500	100,00
0,0407	0,00	0,405	0,00	4,03	13,39	40,1	76,33	400	100,00		
0,0463	0,00	0,460	0,10	4,58	15,00	45,6	80,06	454	100,00		
0,0526	0,00	0,523	0,29	5,21	16,79	51,8	83,58	516	100,00		
0,0597	0,00	0,594	0,57	5,92	18,79	58,9	86,92	586	100,00		
0,0679	0,00	0,675	0,95	6,72	21,01	66,9	90,07	666	100,00		
0,0771	0,00	0,767	1,39	7,64	23,50	76,0	92,97	756	100,00		
0,0876	0,00	0,872	1,89	8,68	26,28	86,4	95,49	859	100,00		

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Page 1 of 1

Biograde

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Appendix D5
Socio-Economic

Socio-Economic Impact Assessment Report for the FWGR Phase 2 Expansion: Libanon Project, Gauteng Province

Photo: View on Libanon TSF from Bridges Avenue, south west

SEPTEMBER 2024

DRAFT

PREPARED BY:

Southern Economic Development (Contact: +27 (0) 82 335 4126)

FOR KONGIWE ENVIRONMENTAL PTY LTD

ON BEHALF OF ERGO MINING (PTY) LTD

TABLE OF CONTENTS

EXECUTIVE SUMMARY 5

1. PROJECT BACKGROUND 8

2. DETAILS OF SPECIALISTS 8

3. DECLARATION OF INDEPENDANCE 9

4. RELEVANT LEGISLATION AND GUIDELINES 10

5. INFORMATION REQUESTED BY THE COMPETENT AUTHORITIES 12

6. SCOPE, PURPOSE, APPROACH, AND METHODOLOGY 13

7. ASSUMPTIONS, UNCERTAINTIES, AND KNOWLEDGE GAPS 13

8. BASELINE DESCRIPTION 14

8.1 THE LOCAL AREA 14

8.2 SOCIO-ECONOMIC SENSITIVE AREAS IN THE VICINITY OF THE PROJECT SITE 15

8.3 LOCAL LAND-USES 18

8.4 DEMOGRAPHIC BASELINE 18

8.5 BASIC HOUSEHOLD SERVICES 19

8.6 EDUCATION AND SKILLS LEVELS OF THE LABOUR FORCE 19

8.7 HEALTH STATUS AND SERVICES 20

8.8 SAFETY AND SECURITY 21

8.9 THE STRUCTURE OF THE LOCAL ECONOMY 21

8.10 THE LOCAL ECONOMIC CONTRIBUTION OF ERGO RECLAMATION ACTIVITIES 22

8.11 COMPOSITION OF THE LABOUR FORCE 23

8.12 INCOME AND POVERTY LEVELS 24

8.13 ECONOMIC INFRASTRUCTURE 24

8.14 SOCIO-ECONOMIC DEVELOPMENT PRIORITIES AND INITIATIVES 24

9. SOCIO-ECONOMIC IMPACT ASSESSMENT OF THE PROPOSED PROJECT 26

9.1 RATING METHODOLOGY 26

9.2 CONSTRUCTION/OPERATIONAL PHASE IMPACTS 28

9.2.1 INTRODUCTION 28

9.2.2 IMPACT ON EMPLOYMENT AND INCOME 28

9.2.3 POSITIVE CONTRIBUTION TO SOCIAL FUNDS 29

9.2.4 IMPACT ON COMMUNITY HEALTH AND SAFETY 30

9.2.5 POTENTIAL INFLUX OF PEOPLE TO THE PROJECT AREA 31

9.2.6 INCREASE IN NUISANCE FACTORS (TRAFFIC, NOISE AND DUST) 32

9.3 POST-CLOSURE IMPACTS 33

9.3.1 INTRODUCTION 33
9.3.2 LAND RESTORATION AND UNLOCKING OF LAND OF LAND FOR FUTURE USE 33
9.3.3 DECREASE/CESSATION OF EMPLOYMENT 33
9.3.4 CESSATION OF SOCIAL CONTRIBUTIONS 34
9.3.5 DECREASE IN NUISANCE FACTORS 34
9.3.6 IMPROVED COMMUNITY HEALTH AND SAFETY 35
9.3.7 CREATION OF INFORMAL SETTLEMENTS AND LAND INVASIONS 35
10. ADDITIONAL RECOMMENDATIONS 37
11. SUMMARY AND CONCLUSION 38
12. SOURCES 39
12.1 LITERATURE 39
ANNEXURE A: CURRICULUM VITAE OF SPECIALIST: ANNA SOPHIA KRITZINGER 41

LIST OF ABBREVIATIONS

Abbreviation	Description
CHC	Community Health Care
DFFE	Department of Forestry, Fisheries and the Environment
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme Report
FWGR	Far West Gold Recoveries ()
GVA	Gross Value Added (Economic output concept)
IDP	Integrated Development Plan
LED	Local Economic Development
NEM:WA	National Environmental Management: Waste Act, 2008 (Act No 59 of 2008)
NEMA	National Environmental Management Act, 1998 (Act No 107 of 1998)
NWA	National Water Act, 1998 (Act No 36 of 1998)
PHC	Primary Health Care
RTSF	Regional Tailings Storage Facility
RWLM	Rand West Local Municipality
SAPS	South African Police Service
SEIA	Social and Economic Impact Assessment
SLP	Social Labour Plan
TSF	Tailings Storage Facility
WRTRP	West Rand Tailings Treatment Project

EXECUTIVE SUMMARY

Project background: Far West Gold Recoveries (Proprietary) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSF are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF). It is FWGR's intention to reclaim and reprocess the gold residues of the Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant, and potentially at future plants. Most of the pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised.

Project Scope: The scope and purpose of the Social and Economic Impact Assessment (SEIA) report are to provide the background of the socio-economic characteristics of the local area relevant to the project; to provide an assessment of potential impacts that are anticipated during the construction, operational, and decommissioning phases, and provide a socio-economic management plan to enhance positive impact and mitigate negative impacts.

Main Socio-Economic Baseline Characteristics of Receiving Environment: The project is situated in The West Rand District of Gauteng, in Rand West Local Municipality (RWLM). The local municipal wards that fall within the 2km influence zone of the TSF include RWLM Ward 25 and RWLM Ward 24 (Westonaria).

The main socio-economic characteristics of the local environment can be summarised as follows:

- The Libanon reclamation area is predominantly surrounded by open area, areas cleared of mining infrastructure and the closed Libanon Gold Mine. The closest residential structures to the TSF are the sections of Westonaria to the east and Libanon Mining Village to the south;
- RWLM wards close to the project area suggest high levels of historic in-migration the past decades mainly due to numerous mining activities in the municipal area;
- In RWLM the high rates of historic in-migration, the continued growth in the number of households coupled with the slow pace of the delivery of low-income housing has resulted in significant housing backlogs, land invasions and the growth in informal settlements;
- The roll-out of low-cost housing schemes resulted in a steep decline in the number of households in informal housing. Despite the improvement of the housing situation, the high increase in household growth continues placing pressure in basic service delivery in the municipal area although backlogs in 2022 are still lower than national and provincial averages;
- Apart from regular waste collection services in rural Ward 25, the wards close to Libanon TSF experienced low service delivery backlogs significantly below the municipal average in 2011;
- A relatively high percentage of the adult population in the RWLM is unskilled. This is especially the case with the local RWLM wards close to the project area; The situation could be explained by a large number of unskilled job -seekers migrating into the municipal area in search of jobs in the mining sector.
- There is an indication of a shortage in primary schools in the local area;
- The prevalence of HIV/AIDS in the local area could be higher than national average;
- The project is situated within a region that has many potential sources for air pollution including the agricultural sector industry, and mining. The close proximity to mine dumps in particular could cause higher risk of chronic respiratory symptoms;
- Per capita crime rates are slightly higher in Westonaria Police Precinct than the national average. Violent crimes are however less prevalent in the precinct than nationally. Similar to the national trend, crime rates declined since 2015, albeit at a lower rate than nationally;

- RWLM have experienced violent community protests in the past with recent protests focusing on community security issues related to the large number of illegal miners operational in the West Rand in general and in the Rand West municipal area specifically;
- Despite various mines closing and the general decline in economic production in both municipal areas, RWLM still hosts some of the largest gold mines in the country. The life of mine of most of these gold mines (apart from South Deep) will come to an end in less than 10 years.
- Employment in RWLM declined since 2011 resulting in rising unemployment (especially youth unemployment) and poverty rates;
- While unemployment rates in the RWLM Wards 24 and 25 were substantially lower than the RWLM averages in 2011, the sharp decline in employment in these wards (coupled with increased in-migration into these areas) would also have resulted in sharp increases in unemployment in both these wars since 2011;
- DRDGold through Far West Gold Recoveries Proprietary Limited (FWGR) make a large contribution towards employment and social income in the local area and larger region;
- The development priorities for the local area focus on the diversification of both economies, while still using the dominant mining sector as a basis;
- The development priorities of the local wards close to the project areas place job creation as a high priority in addition to the need for low-cost housing.

Impact assessment: As indicated in the table below, the project has a number of potential positive socio-economic impacts during the operational phase related to facilitating continued operations with associated employment creation and social funds generated through FWGC activities. A large number of positive impacts of the project are also expected to occur post-closure including the regaining of land for development, potential improvement in the safety of the local community and the reduction in nuisance factors such as dust and reduced air quality due to the current TSF.

Potential negative impacts on the local community are largely considered medium and mainly relate to social risks during the operational phase of 12 years. These risks include nuisance factors (increased noise and dust) as well as potential impacts on community safety. The communities of most at risk in terms of nuisance and health and safety impacts during operations. With the possible exception of increased informal influx due to potential job seekers seeing opportunities on the project, the social risks of the project can be effectively reduced.

Due to the project's proximity to the urban area of Westonaria there is a potential high risk for land invasions on the reclaimed area. If the recommended management measures are implemented this risk is however expected to be effective reduced to a medium social risk. In addition to the management measures related to each impact, on-going stakeholder engagement is also recommended to understand issues on the ground. To this end it is recommended that a Community Consultation Forum (Forum) be established.

Table: Summary of Socio-Economic Impacts

Impact Description	BEFORE MITIGATION SIGNIFICANCE	AFTER MITIGATION SIGNIFICANCE	Cumulative Impact

Operation (including short construction and decommissioning phases)			
Employment and Income	Medium +	Medium +	No
Social funds	Medium +	Medium +	No
Community health and safety	Medium -	Medium -	No
Informal influx	Medium-	Medium -	No
Nuisance factors	Medium -	Medium -	No
Post- Closure			
Land restoration	Medium +	Medium +	No
Cessation of employment	Medium -	Medium -	No
Cessation of public funds	Medium -	Medium-	No
Nuisance factors	Medium +	Medium +	No
Community safety	Medium +	Medium+	No
Land invasion	High -	Medium -	No

In conclusion, the proposed Project is in line with development priorities to support continued job creation in the local area. There are no fatal flaws associated with the social risks of the project and most negative impacts can be effectively managed. Based on the findings of the socio-economic impact assessment for the project it is therefore recommended that the proposed project be approved.

1. PROJECT BACKGROUND

Far West Gold Recoveries (Proprietary) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSF are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF).

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant and alternatively in the future other existing gold plants. Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised.

Required infrastructure will include:

- Pumpstation;
- Process water from Kloof Shaft 10#;
- Pollution control paddock;
- Access road
- Laydown area
- Powerlines

The proposed reclamation activity will require authorisation in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) for Section 21 water uses, the National Environmental Management Act, 1998 (Act No 107 of 1998) (NEMA) and the National Environmental Management: Waste Act, 2008 (Act No 59 of 2008), Category B Activities. An Integrated Water Use Licence Application (IWULA) will be prepared and submitted in accordance with the Water Use Licence Application and Appeals Regulations 2017 published in GNR 267 on 24 March 2017 and will be supported by a Technical Report and Integrated Water and Waste Management Plan (IWWMP).

2. DETAILS OF SPECIALISTS

2.1 EXPERTISE OF THE SPECIALIST

2.1.1 QUALIFICATIONS OF THE SPECIALIST

An Kritzinger *(Masters Economics)* is the specialist responsible for the economic baseline description and economic impact assessment of the proposed project.

2.1.2 PAST EXPERIENCE OF THE SPECIALIST

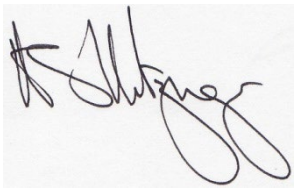
An Kritzinger has been working as a consultant in the economic development field for the past twenty years. She has extensive experience in the economic assessments of projects in various countries in Sub Saharan Africa. Her work has also focussed on applied economic modelling in South Africa, Namibia, Botswana and Mozambique including economic impact analysis, economic cost benefit analysis, social incidence studies and macroeconomic forecast modelling.

2.2 CV OF THE SPECIALIST

The detailed Curriculum Vitae (CV) of the specialist is provided in Annexure A below.

3. DECLARATION OF INDEPENDANCE

This report has been prepared as per the requirements of Appendix 6 of the Environmental Impact Assessment (EIA) Regulations, 2014 (GN R982 of 2014, as amended in June 2021. I, Anna Sophia Kritzinger declare that this report has been prepared independently of any influence or prejudice as may be specified by the Department of Forestry, Fisheries and the Environment (DFFE).



Anna Sophia Kritzinger

Signature of the specialist: `

Southern Economic Development

Name of group (trading name):

9 September 2024

4. RELEVANT LEGISLATION AND GUIDELINES

The relevant legislation and guidelines are summarised in Table 1 below.

Table 1: Policy and Legislative Context

Applicable Legislation and Guidelines used to Compile the Report	Reference where Applied during SEIA	How does this project Comply with and Respond to the Policy and Legislative Context
Constitution of the Republic of South Africa, 1996 Section 24 of the Constitution states that everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.	The SEIA has covered the identification of and proposed management measures for socio-economic impacts relevant to the Project.	A comprehensive SEIA process has been undertaken to identify the potential socio-economic impacts associated with the Project and to prescribe management measures to minimise negative impacts and enhance the Project's contribution to socio-economic development.
National Environmental Management Act (Act 107 of 1998) (NEMA), as amended. NEMA EIA Regulations, 2014 (GNR 982, as amended) **NEMA and the EIA Regulations** provide a suite of principles and tools to guide South Africa on a path to sustainable development. "Environment' is defined in holistic terms and includes biophysical, social, and economic components, as well as the connections within and between these components. While NEMA does not prescribe a specific methodology for socio-economic impact assessment, the following principles in section 2 of NEMA (that apply to all identified impacts) highlight the necessity to include socio-economic issues in EIAs: • Responsibility for the impact should apply throughout its lifecycle. • The participation of all interested and affected parties (I&AP) must be promoted. • Decisions must take into account the interests, needs, and values of all interested parties. • The costs of remedying pollution, environmental degradation, consequent adverse health effects, and of preventing, controlling, or mitigating further pollution, environmental damage, or adverse health effects must be paid for by those responsible for harming the environment, i.e., the so-called polluter-pay principle. The EIA Regulations also make provision for a cumulative effects assessment, to identify and evaluate the significance of effects from multiple actions representing potential causes of impacts. They also provide for baseline/scoping, impact assessment and management reports, including the identification of measures to monitor adherence to the Environmental Management Programme (EMP).	The SEIA has covered the identification of and proposed management measures for socio-economic impacts relevant to the Project.	A comprehensive SEIA process has been undertaken to identify the socio-economic baseline of the Project Area and potential socio-economic impacts associated with the Project; and to prescribe management measures to enhance or mitigate impacts to minimise negative impacts and enhance the Project's contribution to socio-economic development.
The National Water Act No 36 of 1998, the Water Use Licence Application and Appeals Regulations, 2017 (published under GN R267 in GG 40713 of 24 March 2017) states that in	The SEIA has covered the identification of and proposed management	A comprehensive SEIA process has been undertaken to identify the socio-economic baseline of the Project area and potential socio-economic impacts associated with

Applicable Legislation and Guidelines used to Compile the Report	Reference where Applied during SEIA	How does this project Comply with and Respond to the Policy and Legislative Context
issuing a water use license the relevant authorities must take all relevant factors into account including: • the need to redress the results of past racial and gender discrimination; • efficient and beneficial use of water in the public interest; and • the socio-economic impact related to the application.	measures for socio-economic impacts relevant to the Project	the Project; and to prescribe management measures to mitigate or minimise negative impacts and enhance the Project's contribution to socio-economic development.
National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) – NEMWA. The environmental management of residue stockpiles, including TSFs, is currently governed[1] under NEMWA and the Regulations regarding the Planning and Management of Residue Stockpiles and Residue Deposits, published under NEMWA in GN 632 of GG 39020 on 24 July 2015 (RS Regulations). The construction and expansion of residue stockpiles are current listed in the List of Waste Management Activities that have, or are likely to have, a Detrimental Effect on the Environment, published in GN 921 in GG 37083 of 29 November 2013 (Waste List). NEMWA stipulates that the effect of pollution on the environment by a waste disposal activity be considered in an application for a waste management licence. This includes impacts on socio-economic conditions. NEMWA furthermore requires that best practicable environmental options available and alternatives should be taken to protect the environment, including socio-economic conditions due to the undertaking of the waste management activity. Similar provisions are contained in NEMA.	The SEIA has covered the identification of and proposed management measures for socio-economic impacts relevant to the Project	A comprehensive SEIA process has been undertaken to identify the socio-economic baseline of the Project area and potential socio-economic impacts associated with the Project; and to prescribe management measures to mitigate and minimise negative impacts and enhance the Project's contribution to socio-economic development.
Integrated and Spatial Development Plans of provincial and local government	Planning guidelines guided the final evaluation of impacts	Planning guidelines were considered in the final evaluation of the impacts
Other guidelines and standards: • The Prevention of Illegal Eviction from and Unlawful Occupation of Land Act, 1998 (Act No. 19 of 1998) • Labour Relations Act 66 of 1995 1 • Basic Conditions of Employment Act 75 of 1997 • Restitution of Land Rights Act (Act 22 of 1994) (RLRA) • National Environmental Management: Air Quality Act (Act 39 of 2004) (NEM:AQA)	The legislation and guidelines were taken into consideration in the assessment of impacts and management measures	Legal requirements in terms of air, quality, Social and Labour Plans were considered in the assessment of the social impacts of the project and guided the recommended mitigation measures

[1] This may change in accordance certain of with the provisions of the National Environmental Management Laws Amendment Act, 2002, which are not yet in force.

5. INFORMATION REQUESTED BY THE COMPETENT AUTHORITIES

A Specialist Report Checklist Table has been compiled in accordance with the guideline as set out in Appendix 6 of the EIA Regulations. Appendix 6 relays the specific information required as per the guideline is given in the second column of the Table. Any other information requested by the Competent Authorities will be included in this chapter.

Table 2: Specialist Checklist

Specialist Report Guideline: Appendix 6 GNR 982 EIA Regulations 4 December 2014 as amended	
Details to be included in the Report	**Section in Report**
Details of	
Specialist who prepared the report	Section 2
Expertise of the specialist	Section 2
CV of the specialist	Annexure A
Declaration that the Specialist is Independent in a form as may be specified by the CA	Section 3
An indication of the Scope of and the Purpose for which the report was prepared	Section 6.1
An indication of the Quality and Age of base data used for the specialist report	Sections 6.2 and 7
A Description of existing impacts on the site, cumulative impacts of the proposed development, and levels of acceptable change	Section 8
The Duration, Date, and Season of the site investigation and the relevance of the season to the outcome of the assessment	Section 6.2
A Description of the Methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 6.2
Details of an Assessment of the specific identified Sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Section 8.2
An identification of any areas to be avoided including buffers	Section 8.2
A Map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided including buffers	Section 8.2
A Description of any Assumptions made and any Uncertainties or Gaps in Knowledge	Section 7
A Description of the Findings and Potential implications of such findings on the Impact of the proposed activity, including identified Alternatives on the environment, or activities	Section 9
Any Mitigation Measures for inclusion in the EMPr	Section 9
Any Conditions for inclusion in the Environmental Authorisation	Section 9, 10 and 11
Any Monitoring Requirements for inclusion in the EMPr or Environmental Authorisation	Section 9
As to whether the proposed activity/ activities or portions thereof should be authorised	Section 11
Regarding the acceptability of the proposed activity or activities	Section 11
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management, and mitigation measures that should be included in the EMPr and where applicable the closure plan	Section 11
A Description of any Consultation Process that was undertaken during the course of preparing the specialist report	Section 6.2
A Summary and copies of any comments received during any consultation process and where applicable all responses thereto	Not applicable
Any other information requested by the CA	Not applicable

6. SCOPE, PURPOSE, APPROACH, AND METHODOLOGY

6.1 SCOPE AND PURPOSE OF REPORT

The scope and purpose of the SEIA report are to provide the background of the socio-economic characteristics of the local area relevant to the project; to provide an assessment of potential impacts that are anticipated during the construction, operational, and decommissioning phases, and provide a socio-economic management plan to enhance positive impact and mitigate negative impacts.

6.2 APPROACH AND METHODOLOGY

The socio-economic impact assessment report was based on primary as well as secondary resources.

Primary sources include a site visit on 27 August 2024. Secondary sources include (see Section 12 for the full list of sources):

- Academic literature review
- Internet searches
- Updated policy documents relevant to the local and regional area, such as:
  - Integrated development plans, including spatial development frameworks;
  - Local economic development plans; and
- Official government data from Stats SA
- Public reports from the Municipal Demarcation Board, South African Police Service (SAPS), etc.

7. ASSUMPTIONS, UNCERTAINTIES, AND KNOWLEDGE GAPS

7.1 ASSUMPTIONS

- Where up to date site specific / ward level socio-economic data is missing, municipal and provincial trends were used as proxy for trends in the local area.
- It is assumed that the local community development priorities are expressed through public processes and public documents such as municipal integrated development plans.

7.2 UNCERTAINTIES AND LIMITATIONS

With regards to the SEIA to be undertaken, the following should be noted:

- The SEIA includes consultations with key stakeholders and potentially affected parties as part of the impact assessment phase. This does not form part of the Public Participation Process (PPP) required for the overall EIA process, except where it was specifically specified as such during the consultation session.
- Socio-economic baseline information was mainly based on official statistics from Stats SA, as well as municipal documentation. Sub-municipal data was only available for 2011. Recent trends, as well as information on a sub-municipal level, were also based on quantitative and qualitative information received from local representatives with local knowledge. The lack of more recent official socio-economic data is therefore seen as a limiting factor, although it is not anticipated to influence the outcome of the report.

8. BASELINE DESCRIPTION

8.1 THE LOCAL AREA

In terms of regional locality, the TSF is situated approximately 2 km west of the Westonaria, in the Rand West City Local Municipality (RWLM).

The project is situated in The West Rand District of Gauteng in Rand West Local Municipality (RWLM).

Figure 1: The West Rand District
Source: Municipalities of South Africa (https://municipalities.co.za/map/115/west-rand-district-municipality)

There are no fixed parameters for the social area of influence as is the case of some other physical environmental impacts. For purposes of the reports different social influence spheres are relevant:

Firstly, the social influence sphere could indicate to the immediate communities around the mine that could be affected by physical environmental impacts such as ground and surface water quality and quantity of dust, traffic and noise. For purposes of the SEIA, we have used a 2km radius around the

mine to represent communities that would possibly most affected by disamenities such as dust and noise related to the project activities (Kootbodien et. al., 2020).

As indicated in Figure 2 below, the local municipal wards that falls within the 2km influence zone of the TFS include:

- The TSF falls within rural RWLM Ward 25. The ward also includes smaller settlements such as Venterspos, Dennydale, Koksrus and West Rand Garden Estates to the north and Libanon Mine Village to the south;
- The town of Westonaria is situated to the north east of the TSF and falls under RWLM Ward 24. The north western section of Westonaria falls within the 2km radius of the project area.

Other social impacts such as supply-linked employment opportunities could impact on larger communities around a project area. In the context of this project Gauteng province could be considered to be the larger social influence zone.

8.2 SOCIO-ECONOMIC SENSITIVE AREAS IN THE VICINITY OF THE PROJECT SITE

The N12 runs 2km to the South of the TSF. The reclamation area is predominantly surrounded by open area, areas cleared of mining infrastructure and the closed Libanon Gold Mine. The extent of the TSF is approximately 170 Ha.

As indicated in Figure 2 below the closest residential structures to the TSF are the sections of Westonaria to the east and Libanon Mining Village to the south. The village is largely inhabited by some 100 Sibanye employees/families who has been handed over property rights to residential structures within the former mine village in 2013 (SANews, 2013).

Two social structures are situated to the north of the TSF, namely the Westonaria cemetery and an economic structure.

To the south east of the TSF there is open land (rehabilitated mining area) and to the west agricultural land (irrigated and rainfed), mainly maize and soya on a rotational basis.

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Figure 2: Socio-Economic Receptors Around the Project Site

Figure 3: A residential section of Westonaria east of Libanon TSF

Figure 4: Approaching Libanon TSF from the north

Figure 5: Libanon TSF viewed from the south west

8.3 LOCAL LAND-USES

While agricultural land plays a large role in the RWLM, its contribution is lower than the national average. Agricultural land is mainly used for dryland crops, followed by grazing. Natural land made a relatively larger contribution in RWLM.

Table 3 below also shows the relatively high percentage contribution of mining areas in RWLM compared to national averages with close to 23% of the RWLM land area under mining licenses.

National heritage assets made a fairly low contribution towards land-use possibly indicating to a restricting potential for tourism in the area.

Table 3: Percentage of the Municipal Land Area under Different Land Cover, 2018

Land Cover	RWLM	National
Plantations	1,0%	2,9%
Water	2,3%	2,0%
Mines	2,6%	0,2%
Agricultural land	34,7%	35,2%
irrigated field crops	1,2%	3,7%
dryland field crops	27,6%	10,4%
grazing	4,8%	13,6%
other	1,1%	3,5%
Built-up	4,1%	3,7%
Natural	53,1%	52,1%
Other	2,2%	3,9%
Total land area	**100,0%**	**100,0%**
Under mining licences	**22,6%**	**11,6%**
Natural heritage assets	**1,2%**	**7,0%**

Source: Based on Municipal Demarcation Board (2018a&b) and Stats SA (2020)

8.4 DEMOGRAPHIC BASELINE

Population growth in has been high in RWLM since 2011.The relatively low household sizes, high number of people born outside South Africa, high portion of Xhosa speaking people from the Eastern Cape and low female ratios in both municipal areas and especially in the RWLM wards close to the project area suggest high levels of historic in-migration the past decades mainly due to numerous mining activities in the municipal area. The relatively high growth in the number of households furthermore place extra pressure on municipal service delivery within the local area.

Table 4: Basic Demographics of the Area, 2011 and 2022

AREA	Population nr	Population growth %	Households nr	Household growth nr	Population density, persons/km²	Average household size	% Females	Econ active
	2022	2011-2022	2022	2011-2022	2022	2022	2022	2022
RWLM	334 773	2,3%	128 144	4,0%	300	2.6	49,6%	71%
RWLM Ward 24	6 400	2,3%	2 600	4,0%	2 931	2.4	49,4%	68%
RWLM Ward 25	11 600	2,3%	7 000	4,0%	57	2,0	35,0%	76%
Gauteng	15 099 422	1,9%	5 318 665	2,8%	830	2,8	49,5%	72%
South Africa	62 027 503	1,7%	17 828 778	1,9%	50	3,5	51,5%	67%

Source: Stats SA (2011 and2016) Note: Ward information based on population and household growth rates in MLM and RWLM since 2011

Population densities in Ward 25 where the TSF is situated is very low compared to the Gauteng average but slightly higher compared to the national average. Population densities in Ward 24 where Westonaria is situated is very high compared to Gauteng and national averages.

8.5 BASIC HOUSEHOLD SERVICES

In RWLM the high rates of historic in-migration, the continued growth in the number of households coupled with the slow pace of the delivery of low-income housing has resulted in significant housing backlogs, land invasions and the growth in informal settlements. In 2011 close to a third of households in RWLM stayed in informal houses. The roll-out of low-cost housing schemes resulted in a steep decline in the number of households in informal housing to 10.5%, i.e. slightly lower than the national average in 2022.

As indicated in Table 5 below, despite the improvement of the housing situation, the high increase in household growth continues placing pressure in basic service delivery in the municipal area with close to 20% of households still not having piped water in the house in 2022 and 10% without flush toilets. However, while high, these backlogs in 2022 are still lower than national and even provincial averages.

Table 5: Access of Households to Basic Services, 2011 and 2022

Category	RWLM	Ward 24	Ward 25	Gauteng	National
Informal houses (shacks), 2022	10.5%	n.a.	n.a.	11,5%	11,5%
Informal houses (shacks), 2011	30.1%	0.2%	2%	20,2%	20,4%
Without piped water inside the house 2022	20.4%	n.a.	n.a.	25,0%	40,3%
Without piped water inside the house 2011	47.6%	1%	2%	37,9%	53,7%
Without flushed toilets, 2022	9.7%	n.a.	n.a.	10,3%	29,2%
Without flushed toilets, 2011	25.8%	1%	8%	14,6%	39,9%
No electricity for lighting, 2022	5.0%	n.a.	n.a.	6,8%	5,3%
No electricity for lighting, 2011	25.2%	n.a.	n.a.	12,6%	15,2%
No regular waste services, 2022	14.8%	n.a.	n.a.	15,0%	33,7%
No regular waste services, 2011	25.7%	1%	40%	11,7%	38,0%

Source: Stats SA, Census 2011 and 2022

8.6 EDUCATION AND SKILLS LEVELS OF THE LABOUR FORCE

While on par with the national average, the unskilled labour force (with less than completed secondary schooling) made a higher contribution (50%) towards the RMLM labour force compared to the unskilled portion provincially (41%). Skilled labour, on the other hand made a smaller contribution towards the municipal labour force (11%) than provincially (16%) and nationally (12%). The situation could be explained by a large number of unskilled job -seekers migrating into the municipal area in search of jobs in the mining sector.

Table 6: Education levels: Percentage of the adult population above 21 years, 2022

Category	RWLM	Ward 24	Ward 25	Gauteng	National
Without schooling	4%	2%	5%	4%	7%
Some but less than secondary	46%	40%	61%	37%	43%
Completed secondary education	40%	51%	30%	43%	38%

Category	RWLM	Ward 24	Ward 25	Gauteng	National
With tertiary education	11%	8%	4%	16%	12%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Stats SA (2022) Ward information based on population and household growth rates in MLM and RWLM since 2011

The shortage in primary schools in the local wards surrounding the project is evident from the data in Table 7 below. The schools per capita ratio is much lower than national averages in all of the local wards relevant to the project area. There are no secondary schools in RWLM Ward 25 to the project area and only one high school in Ward 24 Westonaria.

Table 7: Educational facilities, 2022

Category	RWLM	Ward 24	Ward 25	National
Primary schools/10 000 people	1,5	3.4	1,1	3,8
Secondary schools/10 000 people	0,8	0.9	0,0	0,8
Pupil: educator ratio	29,8	28.5	27,9	30,1
Grade 12 pass rate (2018)	90%	n.a	n.a	78%

Source: Municipal Demarcation Board (2018a&b); Department of Basic Education, 2020 and 2022

8.7 HEALTH STATUS AND SERVICES

The RWLM has 14 PHC facilities of which two are 24-hour CHC facilities. Due to the larger population of RWLM, the per capita PCH facility ratio is lower and compared to national ratios could indicate to some shortage in PHC facilities in the area. With one district hospital in Randfontein and one private hospital, the low per capita hospital ratio could also indicate to a shortage of tertiary healthcare in area.

As indicated in Table 8 below, the ratio of the population that receive Anti- Retroviral Treatment (ART) against HIV/AIDS is higher in MLM and RWLM compared to the national average. This could indicate to the higher prevalence of HIV/AIDS in these municipalities. The high historic rates of in-migration into both municipal areas could have contributed to the higher incidence of HIV/AIDS in these areas.

Table 8: Basic Health Indicators, 2017

Indicator	RWLM	South Africa
Primary Health Care (PHC) Clinics / 100 000 persons	5	6
Community Health Care facilities as % of PHC clinics	14%	25%
Hospitals/ 100 000 persons	0,8	2,2
ART treatment (% of population)	9%	7%

Source: Health Systems Trust (2017)

The project is situated within a region that has many potential sources for air pollution including the agricultural sector industry, and mining. Local as well as international studies have shown that communities living within a one to 2 km radius from gold mine dumps could be at higher risk of chronic respiratory symptoms (chest wheezing and chronic cough) and diseases (chronic bronchitis and self-reported emphysema) due to the higher levels of inhalable particulate matter 10 µm or less (PM_{10}) in the vicinity of these gold mine waste dumps. While inhalable particulate matter may travel up to 2 km downwind of mine waste dumps, residents living within 500 m of a mine waste dump boundary, were largely found to be the high exposure group (Kootbodien et. al., 2020).

8.8 SAFETY AND SECURITY

The project area and the relevant local wards falls within the Westonaria Police Precinct. The Westonaria police station is located about 2.7 km to the east of Libanon TSF.

As indicated in Table 9 below, per capita crime rates are slightly higher in Westonaria Police Precinct than the national average in 2022. Violent crimes are however less prevalent in the precinct than nationally. Similar to the national trend, crime rates declined since 2015, albeit at a lower rate than nationally.

Table 9: Crime Statistics, 2022

Indicator	Westonaria Precinct	National average
Crime rate per 1000 people	26,7	26,4
Violent crimes [1)] per 1000 people	5,0	10,2
Increase in crimes (2015-2022)	-9,7	-22,6%

Source: SAPS (2023) [1)] Including murder, attempted murder, rape, robbery, assault

RWLM experienced violent community protests in the past. Recent protests in Mohlakeng (2022) focusing on community security issues related to the large number of illegal miners operational in the West Rand in general and in the municipal area specifically (EWN, 2022).

8.9 THE STRUCTURE OF THE LOCAL ECONOMY

Table 10 below shows the dominant contribution that the mining sector still make to the local RWLM economy, despite close to two decades of the scaling down of gold mining activities in the municipal area. The manufacturing sector also plays a relatively large role in the RWLM.

Table 10: The sectoral employment distribution, 2018

Sector	RWLM	National
Agriculture	5,9%	20,7%
Mining	32,5%	4,3%
Manufacturing	9,2%	7,4%
Utilities	0,3%	0,7%
Construction	4,8%	4,3%
Trade	11,7%	13,3%
Transport	3,1%	3,2%
Finance	6,4%	4,9%
Services	26,1%	41,2%
Total	**100,0%**	**100,0%**

Source: Municipal Demarcation Board (2018a&b)

Despite various mines closing and the general decline in economic production in both municipal areas, RWLM still hosts some of the largest gold mines in the country. The major gold producers in the local area are listed in Table 11 below. The life of mine of most of these gold mines (apart from South Deep) will come to an end in less than 10 years.

Table 11: Major gold mines in the local area

Municipality	Name of mine	Mining Company	Employment	Life of Mine
RWM	Kloof	Sibanye Stillwater	10,444	2032
RWM	Cooke	Sibanye Stillwater	966	2025
RWM	South Deep	Goldfields	3,600	2101

Sources: Goldfields (2018); Harmony Gold (2023); Sibanye Stillwater (2023)

Due to the dominance of the mining sector, the municipality experienced large fluctuations in economic output growth since 2014. The RWLM economy furthermore declined at an average annual rate of -2,3% since 2014 (Gauteng Treasury, 2022).

8.10 THE LOCAL ECONOMIC CONTRIBUTION OF ERGO RECLAMATION ACTIVITIES

Far West Gold Recoveries Proprietary Limited (FWGR) covers the activities of DRDGold in the West Rand while Ergo Mining Property Limited covers its golf tailings retreatment operations in the East Rand, extending from central Johannesburg to Ekurhuleni in the east.

As indicated in Figure 6 below, currently the FWGR operations include the Driefontein plant 2 (tailings processing plant); Driefontein 4 (tailings storage facility) and tailings reclamation from the Driefontein 5 tailings dam. The Second phase of FWCR entails reclamation of tailings from Venterspos, Kloof and Libanon as well as the construction of a central processing plant (CPP) and a Regional Tailings Storage Facility (RTSF) both situated just south of Kloof.

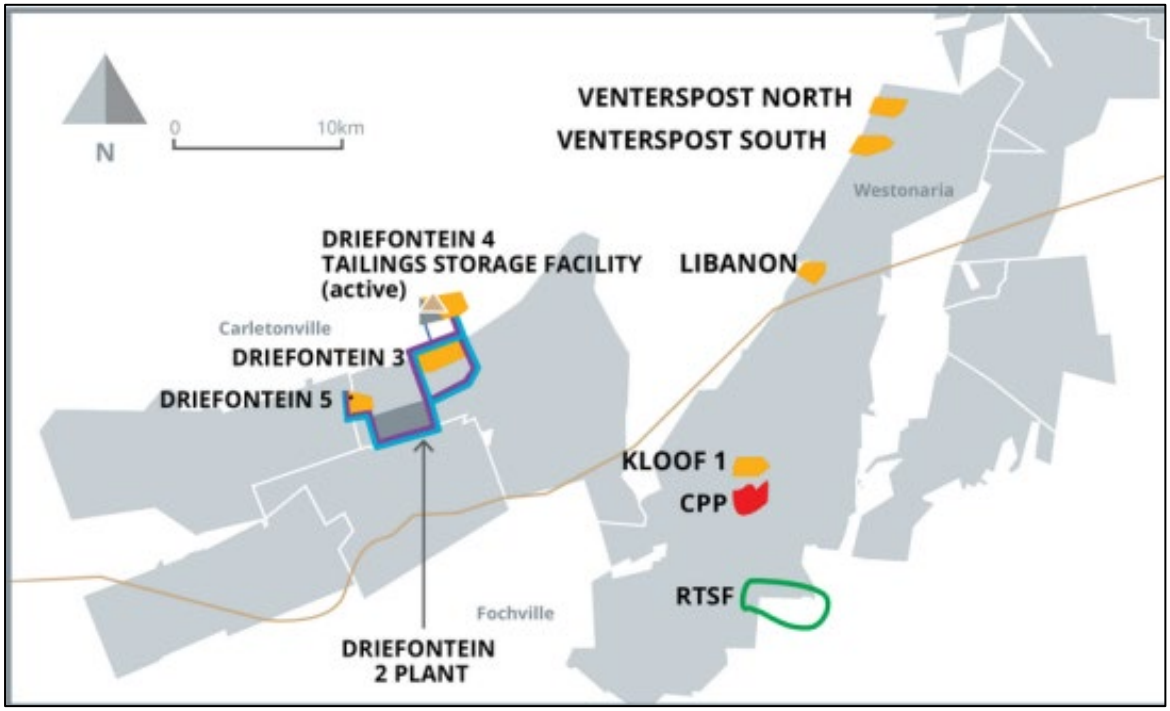

Figure 6: DRDGold Activities in the West Rand (Source: DRDGold web site)

Both FWGR and Ergo provide employment opportunities to 927 permanent employees and 2 155 specialist service providers (DRDGOLD, 2023). Apart from creating direct employment opportunities, the company also create supply-linked jobs through its spending on local suppliers.

In FY2023, R55.2 million was spent on socio-economic development, including youth education programmes, the Broad-Based Livelihoods Programme

Apart from its R 405m income tax contribution, DRDGOLD has a total corporate social investment budget of close to R53m that covers the local areas of all its projects in the East and West Rand. Local economic development projects focus on poverty alleviation, income generation and job creation (DRDGOLD, 2023).

The Broad-Based Livelihoods (BBL) Programme forms part of their local economic development focus and were designed in partnership with the University of Pretoria Enterprises Research Project. The BBL Programme has reached over 8,000 participants across Ekurhuleni, the city of Johannesburg and West Rand municipalities. The programme focuses on a wide variety of sub-programmes in response to participants' interests and ideas for increased economic activity in their local contexts, in retail and services, crop and livestock agriculture, and the health, wellness and beauty sector (DRDGOLD, 2023).

8.11 COMPOSITION OF THE LABOUR FORCE

As indicated in Table 12 below, there was a decline in employment in RWLM between 2011 and 2022 with a steep increase in unemployment from 28% in 2011 to close to 43% in 2022. Already in 2011, the youth unemployment rate (18-34 years) was substantially higher in RWLM compared to the national average.

With gold production playing a major role in Wards 24 and 25 it is possible that employment in these wards could have declined at a faster rate than the municipal average rate due to the steep decline in employment in the national gold mining industry since 2011. While unemployment rates in the RWLM Wards 24 and 25 were substantially lower than the RWLM averages in 2011, the sharp decline in employment in these wards (coupled with increased in-migration into these areas) would also have resulted in sharp increases in unemployment in both these wards since 2011.

Table 12: The local labour force, 2011 and 2022

Indicator	RWLM	Ward 24	Ward 25	National
estimated employment 2022	63 100	1 114	2 867	15.4m
estimated employment 2011	92 065	1 815	4 670	14.1m
average annual growth 2022-2011	-3,4%	-4.3%	-4.3%	0,9%
informal employment as % of employment 2011	11%	7%	5%	19%
unemployment % 2022	43%	na	na	34%
unemployment % 2011	28%	18%	13%	25%
youth unemployment rate, 2011	39%	na	na	25%

Source: Stats SA (2011and 2022); Stats SA (2024); Gauteng Treasury (2022) Note: growth in employment of the local wards were based on increase in employment in the gold industry between 2011 and 2022

8.12 INCOME AND POVERTY LEVELS

The percentage of households that earned less than R 20 000 per year in 2011 largely corresponds with the lower bound poverty rate[2] of that period. Corresponding to the lower unemployment rates in the local wards adjacent to the project area (as discussed above), the poverty rates in the local wards were also lower in 2011. With rising unemployment rates in both these wards (discussed above) poverty rates would also have shown a sharp increase since 2011.

Table 13: Percentage of households in different income, categories, 2011

Income category (per year)	RWLM	Ward 24	Ward 25	National
Less than R20 000	40%	21%	19%	45%
Between R20 000 and R 75 000	38%	33%	62%	32%
Between R 75 000 and R 150 000	10%	21%	10%	9%
More than R 150 000	12%	26%	10%	14%
Total	**100%**	**100%**	**100%**	**100%**

Source: Stats SA (2011)

While the poverty rate in Westonaria Ward 24 was higher than in Ward 25, the ward also hosted a large portion of households that earned more than R150 000 in 2011, signifying to a very unequal distribution of income within the area.

8.13 ECONOMIC INFRASTRUCTURE

National and provincial roads provide regional mobility in RWLM including the N14 which links Randfontein with Northwest and the City of Tshwane; the N12 which links Westonaria to North West and Johannesburg/East Rand, the R28 which links Randfontein, Westonaria and Sedibeng LM in Gauteng; the R41 which links Randfontein to Northwest and the R559 which links Randfontein with Southern Soweto. There is also a railway line that runs through the municipal areas that provides easy access to both areas (CoGTA, 2020).

Close to 65% of the roads in RWLM are paved. The majority of the paved roads are in a fair to very good condition while gravel roads range from fair to very poor condition. The RWLM only spent 1,5% (far below the required 8%) of its capital budget on maintenance in 2020 (Rand West City, 2020).

The local roads surrounding Libanon TSF is generally in a fair condition.

8.14 SOCIO-ECONOMIC DEVELOPMENT PRIORITIES AND INITIATIVES

The development priorities for the local area as expressed through the official planning documents include the following:

The Rand West LM IDP highlights the following relevant local development priorities for the local area (Rand West City, 2020):

[2] Statistics South Africa published 3 poverty rates for South Africa in 2011, namely the food poverty line (FPL) that allows for a minimum food intake; the lower bound poverty level (LBPL) that allows for basic food and some clothing; as well as the upper bound poverty level (UBPL) that allows for basic food clothing and some basic education.

- To ensure provision of basic services to build sustainable and safe communities
- To build a more diversified economy through the focus on the transformation of agriculture sector, building a transport logistics hub (along the N12) and establishing industrial hubs in Randfontein and Westonaria
- SMME'S and co-operatives development and township businesses support
- Job creation for unskilled, semi-skilled and skilled residents
- The implementation of a proper policy for informal economic sectors
- The formulation and implementation of a Local Economic Development Plan
- To ensure financially viable and sustainable municipality.

The development priorities of the local wards close to the project areas place job creation as a high priority in addition to the need for low-cost housing.

9. SOCIO-ECONOMIC IMPACT ASSESSMENT OF THE PROPOSED PROJECT

9.1 RATING METHODOLOGY

The impact significance rating process serves two purposes: firstly, it helps to highlight the critical impacts requiring consideration in the management and approval process; secondly, it shows the primary impact characteristics, as defined above, used to evaluate impact significance.

The impact significance rating system is presented in Table 14 -16 and involves three parts:

- **Part A**: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale/ population and duration;
- **Part B**: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A; and
- **Part C**: Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from **Part B**) and the probability of occurrence.

9.1.1 Part A: Defining Consequence in Terms of Magnitude, Duration and Spatial Scale

Use these definitions illustrated in the table below to define the consequence in Part B.

Table 14: Consequence Rating Methodology

Impact Characteristics	Definition	Criteria
Magnitude	Major -	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded
	Moderate -	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded
	Minor -	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded
	Minor +	Minor improvement; change not measurable; or threshold never exceeded
	Moderate +	Moderate improvement; within or better than the threshold; or no observed reaction
	Major +	Substantial improvement; within or better than the threshold; or favourable publicity
Duration	Short term	Up to 18 months.
	Medium term	18 months to 5 years
	Long term	Longer than 5 years
Spatial scale or population	Site or local	Site specific or confined to the immediate project area
	Regional	May be defined in various ways, e.g. cadastral, catchment, topographic
	National/ International	Nationally or beyond

9.1.2 Part B: Determining Consequence Rating

Rate consequence based on definition of magnitude, spatial extent and duration.

Table 15: Consequence Rating Methodology

			Spatial Scale/ Population		
			Site or Local	Regional	National/ international
MAGNITUDE					
Minor	**Duration**	**Long term**	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	**Duration**	**Long term**	Medium	High	High
		Medium term	Medium	Medium	High
		Short term	Low	Medium	Medium
Major	**Duration**	**Long term**	High	High	High
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High

9.1.3 Part C: Determining Significance Rating

Rate significance based on consequence and probability.

Table 16: Significance Rating Methodology

Probability (of exposure to impacts)	Consequence Negative			Consequence Positive		
	Low	Medium	High	Low	Medium	High
Definite	Medium	Medium	High	Medium	Medium	High
Possible	Low	Medium	High	Low	Medium	High
Unlikely	Low	Low	Medium	Low	Low	Medium

9.2 CONSTRUCTION/OPERATIONAL PHASE IMPACTS

9.2.1 Introduction

The following infrastructure will be utilised on site:

- Reclamation infrastructure consisting of a pump station which include:
    - Slurry sump;
    - Penstock;
    - Vibrating Screen
    - Water tank;
    - Motor control centre;
    - Pump;
- A short connecting 600mm pipeline for process water from Kloof Shaft 10#;
- A short connecting 550mm pipeline to the slurry pipeline to Driefontein 2 Plant;
- Stormwater management infrastructure including:
    - Water infrastructure and stormwater systems; and
    - Existing catchment paddocks on the TSF footprint
    - Pollution control paddock;
- An 11 kV overhead powerline capable of transmitting 3 kVA of electricity and electricity reticulation;
- Administration buildings, including change houses and ablution facilities;
- Access roads, routed from existing entry points; and
- Construction contractors' yards (temporary facilities).

The Proposed Project is expected to take approximately 12 years. An estimated amount of 600 000 tons/month of slurry is expected to be pumped from the TSF via existing pipelines to the Driefontein 2 Plant for beneficiation. The reclaimed slurry will be deposited on the approved pipelines to the Regional TSF (RTSF).

Due to the short construction period, the operational and construction period are jointly assessed.

9.2.2 Impact on employment and income

Employment opportunities created by the Project include direct employment provided on the Project itself, indirect employment through the procurement of inputs/supplies as well as induced employment generated through an overall increase in income due to higher income levels of direct employees and suppliers.

In terms of direct employment, FWGR plans to use its existing personnel on the project. This means that the project will not create additional employment for the local community but will provide job security for the current personnel. The majority of DRDGOLD's managerial and supervisory positions are Historically Disadvantaged Persons (HDP's) (74%) and female employees contributed 23% to the total workforce compared to the industry average of 14% (DRDGOLD, 2023). In terms of supply-linked employment, FWGR could also procure intermediary inputs from the local area during the operational

phase which will mainly be spent on suppliers outside the local area, within the larger Gauteng region. This could potentially create additional indirect jobs at suppliers.

Table 17: Rating of Impact on Local Employment and Income

Impact Name	**Employment and Income**	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Positive	Positive
Magnitude	Minor +	Moderate +
Duration	Long term (5 years plus)	Long term (5 years plus)
Scale	Site or local	Site or local
Consequence	Low	Medium
Probability	Possible	Possible
Environmental Risk Significance (Pre-mitigation)		Medium +
Management Measures:		
• FWGR should consider a local internship/job shadowing strategy that could benefit talented youth from the local communities in Wards 23 and 25 • *Develop a database of potential suppliers within the local area (including the wards around the project).* • FWGR to earmark a percentage of potential intermediary inputs that it could source from local suppliers, HDSAs and Small, Medium and Micro-sized Enterprises (SMMEs). • Preference should be given to capable subcontractors who based within the local municipal area. • Encourage the company's existing suppliers to enter into a Joint Venture (JV) with local SMMEs to aid with the transfer of skills. • Develop skills development and training targets for local procurement and include these in contractor management plans. • Communicate the local employment strategy clearly to the local communities adjacent to the mine (See Section 10 below for recommendations regarding stakeholder engagement).		
Environmental Risk Significance (Post-mitigation)		Medium +
Cumulative Impacts		No

9.2.3 Positive contribution to social funds

While DRDGold has a Social and Labour Plan (SLP), the reclamation of the TSFs falls outside the scope of the MPRDA and does not require a dedicated SLP. The project will however still make a larger social contribution towards national taxes. Despite not being tied to SLPs, DRDGOLD has a total corporate social investment budget of close to R53m that covers the local areas of all its projects in the East Rand (Ekurhuleni Metropolitan Municipality); West Rand (City of Johannesburg Metro Municipality) towards Carletonville in the Merafong Municipality. Local economic development projects focus on poverty alleviation, income generation and job creation (DRDGOLD, 2023).

The Broad-Based Livelihoods (BBL) Programme forms part of their local economic development focus and were designed in partnership with the University of Pretoria Enterprises Research Project. The BBL Programme has reached over 8,000 participants across Ekurhuleni, the city of Johannesburg and Merafong municipalities. The programme focuses on a wide variety of sub-programmes in response to participants' interests and ideas for increased economic activity in their local contexts, in retail and services, crop and livestock agriculture, and the health, wellness and beauty sector (DRDGOLD, 2023).

The expansion of the reclamation activities will enable DRDGold to continue its social commitment to communities in the East and West Rand in general.

Table 18: Rating of Impact on Social Funds

Impact Name	**Employment and Income**	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Positive	Positive
Magnitude	Minor +	Moderate +
Duration	Long term (5 years plus)	Long term (5 years plus)
Scale	Site or local	Site or local
Consequence	Low	Medium
Probability	Possible	Possible
Environmental Risk Significance (Pre-mitigation)		Medium +
Management Measures:		
• Develop a targeted social development strategy in Wards 93 and 21 that support the local procurement strategy through the support of local SMMEs and contractors. • Communicate the local employment strategy clearly to the local communities adjacent to the mine (See Section 10 below for recommendations regarding stakeholder engagement).		
Environmental Risk Significance (Post-mitigation)		Medium +
Cumulative Impacts		No

9.2.4 Impact on community health and safety

There is a risk for community protests if there is the perception that local communities do not receive the anticipated benefits from employment on the project. Road blockages and protest action not only pose a risk to the Project itself, but also to other businesses in close proximity to the Project.

The Project will also increase traffic flows on the adjacent flows due to employees, contractors and heavy vehicles traveling to and from the project area. The risk is especially high during the few months' construction period in the beginning of the project and the few months' decommissioning period at the end of the project. With low traffic volumes on the access roads to Libanon TSF, the risk is however considered low.

Disturbance of the gold tailings during the operational phase could furthermore increase dust fall-out from the TSF could especially pose a health risk in terms of respiratory disease to the adjacent Libanon Mining Village as well as western sections of Ward 24 in Westonaria.

Table 19: Rating of Impact on Community Health and Safety

Impact Name	**Community health and safety**	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Negative	Negative
Magnitude	Moderate-	Minor -
Duration	Long term (5 years plus)	Long term (5 years plus)

Impact Name	Community health and safety	
Scale	Site or local	Site or local
Consequence	Medium	Medium
Probability	Possible	Possible
Environmental Risk Significance (Pre-mitigation)		Medium -
Management Measures:		
• Strict security measures to apply at the Project. • The company to cooperate with the local SAPS and community safety forums. • Establish a communication strategy and network with the local community in Wards 23 and 25. The communication strategy should include protocols to lodge complaints, complaints register, speedy resolution of complaints and meetings with community leaders on a regular (quarterly) basis (also see Section 10 below). • Strict adherence to the mitigation measures of the air quality impact report.		
Environmental Risk Significance (Post-mitigation)		Medium -
Cumulative Impacts		No

9.2.5 Potential influx of people to the project area

High historic rates of job seekers might result in continued influx into the local ward areas close to the project due to perceived continuation of gold mining activities. This could place additional strain on local municipal services and potentially result in the growth of informal settlements in area around the Project sites.

Table 20: Rating of Impact on Informal Influx

Impact Name	Informal Influx Impact	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Negative	Negative
Magnitude	Moderate -	Moderate-
Duration	Long term (5 years plus)	Long term (5 years plus)
Scale	Site or local	Site or local
Consequence	Medium	Medium
Probability	Possible	Possible
Environmental Risk Significance (Pre-mitigation)		Medium -
Management Measures:		
• Engage with local representatives to communicate the recruitment strategy of the Project and to register complaints related to increase level of influx into informal settlements (See Section 10 below). • Solutions to address service delivery require interventions from the local authorities. However, the applicant can address potential issues that could lead to unrest by ensuring that an effective grievance mechanism is put in place to ensure that stakeholders are provided with a platform to raise their concerns/complaints.		
Environmental Risk Significance (Post-mitigation)		Medium -
Cumulative Impacts		No

9.2.6 Increase in nuisance factors (traffic, noise and dust)

It is anticipated that the Project will lead to an increase in traffic volumes on existing traffic network, resulting in increased congestion and delays on the local roads. The Project is also expected to increase in ambient noise levels as well as increase dust levels in the local area. As the reclamation activities will be conducted 7 days a week; 24 hours a day during the operational phase, local communities will experience the nuisance factors on a continuous basis throughout the operational period. However, due to the relative low traffic volumes on the access roads, the risk of traffic related nuisance factors is expected to be low. Dust and noise factors could however have higher impacts on adjacent Libanon Mining Village as well as western sections of Ward 24 in Westonaria.

Table 21: Rating of Impact on Nuisance factors (noise, dust and traffic)

Impact Name	**Impact of Nuisance Factors**	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Negative	Negative
Magnitude	Moderate-	Minor -
Duration	Long term (5 years plus)	Long term (5 years plus)
Scale	Site or local	Site or local
Consequence	Medium	Medium
Probability	Possible	Possible
Environmental Risk Significance (Pre-mitigation)		Medium -
Management Measures:		
• Strict adherence to the mitigation measures of the traffic and air quality impact reports. • A grievance management mechanism should be in place to receive incident related queries (See Section 10).		
Environmental Risk Significance (Post-mitigation)		Medium -
Cumulative Impacts		No

9.3 POST-CLOSURE IMPACTS

9.3.1 Introduction

Once reclamation is completed, the area will then be assessed for contamination (particularly in terms of radiation). Contaminated soils will be removed, and the land levelled to its original functioning topography levels.

9.3.2 Land restoration and unlocking of land of land for future use

Following rehabilitation, it is anticipated that the land will be returned to the landowner to use at their discretion. The project will reclaim the historic TSF and remove a pollution source from the area, aiding in the rehabilitation of the mining legacy left behind in the area.

Table 22: Rating of Land Restoration

Impact Name	**Land Restoration**	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Positive	Positive
Magnitude	Moderate +	Moderate +
Duration	Long Term > 5 years	Long Term > 5 years
Scale	Site or local	Site or local
Consequence	Medium	Medium
Probability	Definite	Definite
Environmental Risk Significance (Pre-mitigation)		Medium +
Management Measures:		
• Facilitate for Sibanye to develop a future land use plan in consultation with the local authority.		
Environmental Risk Significance (Post-mitigation)		Medium +
Cumulative Impacts		No

9.3.3 Decrease/cessation of employment

The termination of the Project will end the employment contracts with the workforce at the Project.

Table 23: Rating of Cessation of Employment and Income

Impact Name	**Cessation of employment and income**	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Negative	Negative
Magnitude	Moderate -	Minor -
Duration	Long Term > 5 years	Long Term > 5 years
Scale	Site or local	Site or local
Consequence	Medium	Medium
Probability	Possible	Possible
Environmental Risk Significance (Pre-mitigation)		Medium -
Management Measures:		

Impact Name	Cessation of employment and income
• Consider implementing a portable skills programme for the existing workforce. • Consider placement of workers in other FWGR operations.	
Environmental Risk Significance (Post-mitigation)	Medium -
Cumulative Impacts	No

9.3.4 Cessation of social contributions

The funding of any local social programmes related to Project is expected to end after the completion of the Project.

Table 24: Rating of Cessation of Social Funds

Impact Name	Cessation of social funds	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Negative	Negative
Magnitude	Moderate -	Minor -
Duration	Long Term > 5 years	Long Term > 5 years
Scale	Site or local	Site or local
Consequence	Medium	Medium
Probability	Definite	Definite
Environmental Risk Significance (Pre-mitigation)		Medium -
Management Measures:		
• Plan social programmes with clear exit strategies well ahead of the closure of the project (e.g. handing over to other entities or clearly communicate limited timeframe to communities). • Avoid social spending on infrastructure projects that would require long-term operational and maintenance funding. • Focus social programmes on local capacity building and training.		
Environmental Risk Significance (Post-mitigation)		Medium -
Cumulative Impacts		No

9.3.5 Decrease in nuisance factors

Removing all tailings material down to 'red earth' means that there will not be remnants of tailings material behind which could be exposed to wind erosion and dust fall-out that could affect the local communities. The Proposed Project will also result in the removal of a visual disturbance source.

Table 25: Rating of Impact on Nuisance Factors

Impact Name	Nuisance factors	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Positive	Positive
Magnitude	Moderate +	Moderate +
Duration	Long Term > 5 years	Long Term > 5 years
Scale	Site or local	Site or local
Consequence	Medium	Medium
Probability	Possible	Possible

Impact Name	Nuisance factors	
Environmental Risk Significance (Pre-mitigation)		Medium +-
Management Measures:		
• None		
Environmental Risk Significance (Post-mitigation)		Medium +
Cumulative Impacts		No

9.3.6 Improved community health and safety

TSFs are known to cause air and water pollution, as well as soil contamination. The dust usually contains fine particulate matter, which can be inhaled, causing damage to lung tissues. The dust of TSFs also potentially contains a number of hazardous substances that can result in chemical toxicity. The Project will remove the TSF as a source of pollution to the surrounding areas. The positive impact associated with the removal of the dumps can only materialise once the land has been successfully rehabilitated and obtain an approved radiation land clearance certificate in terms of the National Nuclear Regulator Act, 1999 (Act No. 47 of 1999) from the National Nuclear Regulator (NNR).

Once the TSF is removed the open field will also provide less shelter for criminal activity and hence contribute to increased safety in the local area. The removal of the TSF could also eliminate the attraction of illegal/informal miners who seek gold.

Table 26: Rating of Impact on Community Safety

Impact Name	Community safety	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Positive	Positive
Magnitude	Moderate +	Moderate +
Duration	Long Term > 5 years	Long Term > 5 years
Scale	Site or local	Site or local
Consequence	Medium	Medium
Probability	Possible	Possible
Environmental Risk Significance (Pre-mitigation)		Medium +-
Management Measures:		
• The applicant to apply for a land clearance certificate from the NNR-upon approval of the clearance certificate after complying with the conditions stipulated in the clearance certificate		
Environmental Risk Significance (Post-mitigation)		Medium +
Cumulative Impacts		No

9.3.7 Creation of informal settlements and land invasions

Once the TSF has been reclaimed, there is a likelihood that the area will be seen as a potential residential area by land grabbers. Although the removal of the dumps is seen as a positive impact, there is a possibility that the land (post reclamation process) may be viewed as vacant land and create an opportunity for land invasions. Being close to Westonaria the likelihood of land invasions is considered medium-high in the case Libanon.

Table 27: Rating of Potential Land Invasion Impact

Impact Name	**Potential Land Invasion**	
Environmental Risk		
Attribute	**Pre-mitigation**	**Post-mitigation**
Nature	Negative	Negative
Magnitude	High -	Medium-
Duration	Long Term > 5 years	Long Term > 5 years
Scale	Site or local	Site or local
Consequence	Medium	Medium
Probability	Possible	Possible
Environmental Risk Significance (Pre-mitigation)		High -
Management Measures:		
• Communicate upfront the proposed end land uses envisaged for the area once the reclamation process has been completed. • Mine security patrols should monitor the perimeters of the project site thereby providing an increased security presence. • FWGR to collaborate with the RWLM and implement RWLMs land use management system to prevent illegal settlements.		
Environmental Risk Significance (Post-mitigation)		Medium -
Cumulative Impacts		No

10. ADDITIONAL RECOMMENDATIONS

On-going stakeholder engagement is recommended to understand issues on the ground. To ensure effective consultation with community members during the authorisation, construction, operation and decommissioning phases of FWGR reclamation projects with RWLM, it is recommended that a Community Consultation Forum (Forum) be established. In establishing the Forum, that FWGR needs to take the following into consideration:

- Communities should democratically elect representatives to voluntarily sit on the Forum, which meets quarterly.
- Representatives would be responsible for disseminating project information to community members, and FWGR would be responsible for taking minutes and attendance registers at Forum meetings.
- The composition of the Forum might include the following Committee members:
    - Community members from the communities within the Projects area of interest (RWLM Wards 24 and 25);
    - Representatives from the Municipal Authorities; and
    - FWGR's representatives from the following divisions: Community Relations; Social Labour Plan and Environmental Management.
- Forum members would be required to hold meetings with their communities and provide FWGR with copies of the attendance registers and minutes of these meetings.
- Solutions to address service delivery require interventions from the local authorities. However, the applicant can address potential issues that could lead to unrest by ensuring that an effective grievance mechanism is put in place to ensure that stakeholders are provided with a platform to raise their concerns/complaints.
- Collaborate with the unit of the DMRE that deals with illegal mining-related issues and the SAPS to establish standard operating procedures for the control and/or removal of unauthorised individuals.

11. SUMMARY AND CONCLUSION

As indicated in Table 28 below, the project has a number of potential positive socio-economic impacts during the operational phase related to facilitating continued operations with associated employment creation and social funds generated through FWGC activities. A large number of positive impacts of the project are also expected to occur post-closure including the regaining of land for development, potential improvement in the safety of the local community and the reduction in nuisance factors such as dust and reduced air quality due to the current TSF.

Potential negative impacts on the local community are largely considered medium and mainly relate to social risks during the operational phase of 12 years. These risks include nuisance factors (increased noise and dust) as well as potential impacts on community safety. The communities of most at risk in terms of nuisance and health and safety impacts during operations. With the possible exception of increased informal influx due to potential job seekers seeing opportunities on the project, the social risks of the project can be effectively reduced.

Due to the project's proximity to the urban area of Westonaria there is a potential high risk for land invasions on the reclaimed area. If the recommended management measures are implemented this risk is however expected to be effective reduced to a medium social risk. In addition to the management measures related to each impact, on-going stakeholder engagement is also recommended to understand issues on the ground. To this end it is recommended that a Community Consultation Forum (Forum) be established.

Table 28: Summary of Socio-Economic Impacts

Impact Description	BEFORE MITIGATION SIGNIFICANCE	AFTER MITIGATION SIGNIFICANCE	Cumulative Impact
Operation (including short construction and decommissioning phases)			
Employment and Income	Medium +	Medium +	No
Social funds	Medium +	Medium +	No
Community health and safety	Medium -	Medium -	No
Informal influx	Medium-	Medium -	No
Nuisance factors	Medium -	Medium -	No
Post- Closure			
Land restoration	Medium +	Medium +	No
Cessation of employment	Medium -	Medium -	No
Cessation of public funds	Medium -	Medium-	No
Nuisance factors	Medium +	Medium +	No
Community safety	Medium +	Medium+	No
Land invasion	High -	Medium -	No

In conclusion, the proposed Project is in line with development priorities to support continued job creation in the local area. There are no fatal flaws associated with the social risks of the project and most negative impacts can be effectively managed. Based on the findings of the socio-economic impact assessment for the project it is therefore recommended that the proposed project be approved.

12. SOURCES

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ANNEXURE A: CURRICULUM VITAE OF SPECIALIST: ANNA SOPHIA KRITZINGER

1. **Family name:** Kritzinger
2. **First names:** Anna Sophia
3. **Date of birth:** 17 March 1964
4. **Nationality:** South African
5. **Contact:** +27 (0) 12 346 4855 (landline); +27 (0) 82 335 4125 (mobile)
6. **E-mail:** *anna@iafrica.com*
7. **Address:** Nr 11, 17th street, Menlopark, South Africa, 0081
8. **Education:**

Institution [Date]	Degree(s) or Diploma(s) obtained:
University of Stellenbosch, South Africa (1992)	M.Admin (Economics)
University of Pretoria, South Africa (1986)	B.Admin (Hons) (Economics)

9. **Language skills**: Indicate competence on a scale of 1 to 5 (1 - excellent; 5 - basic)

Language	Reading	Speaking	Writing
English	1	1	1
Afrikaans	1	1	1
French	2	2	3
Dutch	2	3	3
German	3	3	3

10. **Membership of professional bodies:** International Association for Impact Assessment (IAIA), Member ID: 10448490

11. **Other skills:**
    - Computer literacy –MS Office
    - Accredited Training Assessor
    - Social Accounting Matrix (SAM) (input and output modelling)

12. **Publications:**
    Kritzinger, A. S. (2011) Towards a Conceptual Framework for Local Economic Development (LED) Strategies. Skills @ Work, Volume 4: 67- 79.
    Kritzinger, A. S. and Baur P. (2012) Structuring Local Data to Determine LED Strategy Priorities: An Economic Development Perspective. Skills @ Work, Volume 5

13. **Present position:** Director of Southern Economic Development Services (SED) and freelance-associate of South African management consultancy Futurelead

14. **Years with the firm (SED):** 5 years (Director of SED); 20 years (associate of Futurelead)

15. **Areas of specialisation**
    - Socio-economic impact assessments
    - Applied economics
        - economic and social impact analysis
        - input-output modelling
        - economic cost benefit analysis
        - economic incidence analysis

- scenario planning
- Monitoring and evaluation
- Skills development in development profiling and strategies
- Economic databases & economic reviews
- Local social and economic development strategies
- Market and financial analysis

16. Professional experience:

Date from – Date to	Company (position)	Description of activities (country; year of assignment)
1998 – current	Consulting	Examples of assignments completed the included the past 8 years: **Economic and Socio-Economic impact analyses. Examples of main projects (including input-output modelling and economic cost benefit assessments):** • Economic Cost Benefit Assessment for Springfield Coal Mine, Gauteng (2022) • Economic Cost Benefit Assessment for Koppie Coal Mine, Mpumalanga (2021) • Economic Cost Benefit Assessment for Birmingham Coal Mine, Mpumalanga (2021) • Economic impact of COVID-19 on the SADC region (SADC, 2021) • Economic impact assessment of mine extension of Harmony Gold in North West (South Africa, 2021) • Economic impact assessment of Sierra Rutile Limited Mine to determine economic impacts of closure (Sierra Leone, 2021) • Comparative cost benefit analysis for different worker accommodation options for workers at Bokpoort Solar Plant, Western Cape (South Africa, 2021) • Comparative economic costs benefit assessment between an underground coal mine and existing agricultural activities in Mpumalanga (South Africa, 2021) • Socio-economic impact assessment of different bulk water augmentation measures proposed for the Richard's Bay area (South Africa, 2020) • Improved the potential impact of the national animal health technology investment programme in South Africa. The project entailed a socio-economic impact assessment with recommendations to the Animal Health Technology Innovation Programme (Technical Innovation Agency, South Africa, 2017) • Supported the evaluation of different design options as well as assessed the economic value for public money for the establishment a Health Technology Park (City of Cape Town, South Africa, 2016-2017) • Improved the programme design and facilitated the interaction between different project partners by conducting an economic cost effectiveness assessment as part of the monitoring and evaluation of a space technology (BDO-UK, South Africa, 2018-2019) • Improved the economic development impact of a national tourism investment programme by leading the sustainability assessment of the National Department of Tourism (South Africa) investment programme. The project entailed the establishment of a project management office as well as the development of guidelines specifically focussed on project sustainability including feasibility studies and operational support (GTAC, South Africa 2017-2018) • Strengthened the social investment programme of a major mining investment in the Northern Cape, South Africa. The project entailed a high-level economic impact assessment for various projects related to the mine closure programme for Sishen Mine, Northern Cape (Jones & Wagener Engineers, South Africa, 2019) • Headed a research project to reduce the social risks of project-related revenues (employment and public revenues) of a large-scale gas project (Anadarko Petroleum, Mozambique ,2012-2014)

Date from – Date to	Company (position)	Description of activities (country; year of assignment)
		• Enhanced/mitigated the socio-economic impacts on hosting communities though socio-economic impact assessments and management programmes as part of environmental authorisations for a number of projects including: ○ Socio-economic impact assessment of the Reclamation of the Delmore TSF in Gauteng (2023) ○ Olifantsfontein Land fill close to Thembisa (South Africa, 2021) ○ Proposed Kareerand Tailings Storage Facility (TSF) Reclamation Project in North West (South Africa, 2020) ○ Shondoni Colliery, Sasol Mining Pty(Ltd) (Secunda, South Africa, 2020) ○ Olifantsfontein Landfill (Thembisa, South Africa, 2020) ○ Blesboklaagte Colliery, Mpumalanga (2020) ○ Universal Coal Mine (Delmas, South Africa, 2019) ○ The planned closure of Nkomati Chrome Mine (Rainbow Minerals, Mpumalanga, South Africa, 2019) ○ Rustenburg Smelter (South Africa, 2019) ○ Four low-income housing projects that formed part of the Gauteng Province's Rapid Land Release Programme (RLRP) (South Africa, 2019) ○ Stonewall gold mines (Pilgrim's Rest, South Africa, 2019) ○ Lion Ferrocrhome Smelter, Steelpoort Mpumalanga (South Africa, 2018) **References:** • Thomas Keck (Particip, Germany); Phone: +49 761 790740, *thomas.keck@particip.de* • *Johan Naude (Futurelead, South Africa); +27 (0) 82 335 1723; johan@futurelead.co.za;* • Hendrik Prinsloo (HPM Consultants, US: California); +1 904 307 6004 (Mobile); *hendrik@teamhpm.com* • Emma Sauvanet (BDO Consultants; UK; London); + 44 (0)7870 268 715 (Mobile); *emma.sauvanet@bdo.co.uk* • Herman Marais (Exeo Capital Fund: South Africa/Nairobi/Mauritius); +27 (0)83 377 6234 (Mobile); *hermanm@agrivie.com*
1994-1997	Freelance	Freelance work in UK, travelling through Europe
1989 -1994	University of Stellenbosch (lecturer)	Tasks included: • Lecturing first to third year and marking of papers and assignments • Leading tutorial classes
1987-1988	Development Bank of Southern Africa (Researcher	Tasks included: • Profiling of selected development areas in South Africa • Analyses and database development pertaining to key economic indicators
1986	University of Pretoria	Junior lecturer: First year and third year (extra-mural)

Appendix D6
Noise

Far West Gold Recoveries (Pty) Ltd

NOISE SCREENING REPORT

for the

Libanon Tailings Storage Facility Reclamation Project, Gauteng Province

Statement done for:

KONGIWE

Prepared by:

EARES
Enviro Acoustic Research

P.O. Box 2047, Garsfontein East, 0060
Tel: 012 – 004 0362, Fax: 086 – 621 0292, E-mail: info@eares.co.za

EXECUTIVE SUMMARY

INTRODUCTION

Enviro-Acoustic Research cc was commissioned to assess the potential risk of a noise impact from the proposed reclamation of the Libanon Tailings Storage Facility (TSF) in the West Rand, Gauteng.

Because the online screening tool does not identify noise as an environmental theme that requires further investigation for the reclamation of a TSF, this report considers the requirements of SANS 10328:2008 to assess whether noise is a potential issue of concern. However, when there is a low risk of a noise impact to occur, the SANS 10328:2008 guideline also allows for the assessment of noise impacts on the environment due to a proposed activity using an administrative screening questionnaire. If the outcome of all the questions is negative, the planned development or activity is not likely to present a noise disturbance and a Screening report is deemed sufficient.

BRIEF PROJECT DESCRIPTION

It is FWGR's intention to reclaim and reprocess the gold residues of the Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant (and alternatively in the future, other existing gold plants). Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised. Required infrastructure will include:

- Pumpstation;
- Process water from Kloof Shaft 10#;
- Pollution control paddock;
- Access road
- Laydown area
- Powerlines

EXISTING AMBIENT SOUND LEVELS

Considering the land use character, as well as information gained on numerous similar projects, ambient sound levels will likely be elevated due to existing mining activities. This is based on a desktop assessment of the area as no site visit was undertaken to measure ambient sound levels. It is also not deemed necessary to measure the ambient sound levels for this project.

POTENTIAL NOISE-SENSITIVE RECEPTORS

Residential areas and potential noise-sensitive developments/receptors ("NSR") were identified using tools such as Google Earth®. No noise-sensitive receptors were identified within 500m from the project infrastructure associated with the proposed TSF reclamation project.

FINDINGS, SUMMARY AND RECOMMENDATION

Noises associated with the construction and operational phases of the reclamation project are generally limited to approximately 100m from the project activities and insignificant further than 200m from such activities. Noises associated with certain reclamation equipment (such as water pumps) may have an impact up to 200m, though such activities will be inaudible further than 500m from such equipment.

Considering the project area to be developed, the likely elevated sound character of the area as well as the distance between potential noise sources and identified NSR (more than 500 m from the proposed activity), reclamation activities associated with the Libanon TSF is unlikely to influence ambient sound levels at any NSR residing in the vicinity of the project site.

For the project development area, it is the opinion of the author that no further Scoping or other acoustical studies would be required and it is recommended that the Libanon TSF reclamation project be authorized (in terms of acoustics).

Morné de Jager
Enviro-Acoustic Research cc
2024/09/14

This report should be sited as:
De Jager, M. (2024): "*Noise Screening Report for the Proposed Libanon Tailings Storage Facility Reclamation Project, Gauteng Province*". Enviro-Acoustic Research cc, Pretoria

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Report no:
KE/SSL-LTSFR/202409-Rev 0

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Date:
September 2024

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TABLE OF CONTENTS

page

EXECUTIVE SUMMARY ..... **ii**

TABLE OF CONTENTS ..... **v**

LIST OF TABLES ..... **vi**

LIST OF FIGURES ..... **vi**

APPENDICES ..... **vi**

GLOSSARY OF ABBREVIATIONS ..... **vi**

1 THE AUTHOR **1**

2 Declaration of independence **4**

3 INTRODUCTION **5**

3.1 Introduction and Purpose 5

3.2 Brief Project Description 5

3.3 Potential Noise-generating Activities 5

3.4 Conceptual Noise Levels 6

3.5 Project Location 7

3.5.1 Topography 7

3.5.2 Roads and Railway Lines 7

3.5.3 Surrounding Land Use 8

3.5.4 Ground conditions and vegetation 8

3.5.5 Ambient Sound Levels 8

3.5.6 Potential Sensitive Receptors (NSR) 8

3.6 Terms of Reference 8

4 LEGAL CONTEXT, POLICIES AND GUIDELINES **12**

4.1 The Republic of South Africa Constitution, 1996 ("the Constitution") 12

4.2 The National Environmental Management Act (Act 107 of 1998) 12

4.3 The Environment Conservation Act (Act 73 of 1989) 13

4.3.1 National Noise Control Regulations (GN R154 of 1992) 13

4.3.2 Gauteng Noise Control Regulations: Gauteng Province (GN 5479 of 20 August 1999) 13

4.4 Noise Standards 14

4.5 International Guidelines 15

4.5.1 Night Noise Guidelines for Europe (WHO, 2009)..... 16
4.5.2 Guidelines for Community Noise (WHO, 1999)..... 16
4.5.3 IFC: General EHS Guidelines – Environmental Noise Management 16

5 METHODOLOGY: SCREENING QUESTIONNAIRE 17

6 POTENTIAL SIGNIFICANCE OF THE NOISE IMPACT 19

7 CONCLUSIONS AND RECOMMENDATIONS 20

8 REFERENCES..... 21

LIST OF TABLES

page
Table 4-1: IFC Table .7.1-Noise Level Guidelines..... 16
Table 5-1: Questions for Noise Screening (SANS 10328:2008)..... 17

LIST OF FIGURES

page
Figure 3-1: Regional Location of Libanon TSF 10
Figure 3-2: Libanon TSF reclamation project infrastrucure and closest noise-sensitive receptors 11

APPENDICES

Appendix A Glossary of Acoustic Terms, Definitions and General Information

GLOSSARY OF ABBREVIATIONS

AZSL	Acceptable Zone Sound Level (Rating Level)
dB	Decibel
DACE	Department of Agriculture, Conservation and Environment
DFFE	Department of Forestry, Fisheries and the Environment
EARES	Enviro-Acoustic Research cc

ECA	Environment Conservation Act, 1989 (Act No 78 of 1989)
EIA	Environmental Impact Assessment
ENIA	Environmental Noise Impact Assessment
ENPAT	Environmental Potential Atlas
EP	Equator Principle
EPFI	Equator Principle Financial Institutions
Etc.	etcetera / and so forth
f	fast setting, see **Appendix A**
GG	Government Gazette
GNR	Government Notice Regulation
Hz	Hertz
i	Impulse setting, see **Appendix A**
I&AP(s)	Interested and Affected Party(ies)
i.e.	that is
IFC	International Finance Corporation
In/sec	inches per second
Kg/m^2	kilogram per square metres
km/h	kilometres per hour
L_{A10}	See **Appendix A**
L_{A90}	See **Appendix A**
L_{Aeq}	See **Appendix A**
L_{Amax}	See **Appendix A**
L_{Amin}	See **Appendix A**
m	Metres
m/s	Metres per second
m^2	Square metre
m^3	Cubic metre
mamsl	Metre above mean sea level
mm	millimetre
NCR	Noise Control Regulations (under Section 25 of the ECA)
NEMA	National Environmental Management Act, 1998 (Act No 107 of 1998)
NGO	Non-government Organisation
NR	Noise Reduction
NSD	Noise-Sensitive Development
NSR	Noise-Sensitive Receptors
p/d	per day
PPE	Personal Protective Equipment
PPP	Public Participation Process

Rpm	Revolutions per minute
RSA	Republic of South Africa
SABS	South African Bureau of Standards
SANS	South African National Standards
t	Time
TOR	Terms of Reference
WHO	World Health Organisation

1 THE AUTHOR

The Author, Morné de Jager, started his career in the mining industry as a bursar Learner Official (JCI, Randfontein), working in the mining industry, doing various mining related courses (Rock Mechanics, Surveying, Sampling, Safety and Health [Ventilation, noise, illumination etc] and Metallurgy. He did work in both underground (Coal, Gold and Platinum) as well as opencast (Coal) for 4 years. He changed course from Mining Engineering to Chemical Engineering after his second year of his studies at the University of Pretoria.

After graduation he worked as a Water Pollution Control Officer at the Department of Water Affairs and Forestry for two years (first year seconded from Wates, Meiring and Barnard), where duties included the perusal (evaluation, commenting and recommendation) of various regulatory required documents (such as EMPR's, Water Licence Applications and EIA's), auditing of licence conditions as well as the compilation of Technical Documents.

Since leaving the Department of Water Affairs, Morné has been in private consulting for the last 20 years, managing various projects for the mining and industrial sector, private developers, business, other environmental consulting firms as well as the Department of Water Affairs. During that period he has been involved in various projects, either as specialist, consultant, trainer or project manager, successfully completing these projects within budget and timeframe. During that period he gradually moved towards environmental acoustics, focusing on this field exclusively since 2007.

He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. He has been doing work in this field for the past 13 years, and was involved with the following projects in the last few years:

Wind Energy Facilities	*Full Environmental Noise Impact Assessments for - Bannf (Vidigenix), iNCa Gouda (Aurecon SA), Kangnas (Aurecon), Plateau East and West (Aurecon), Wolf (Aurecon), Outeniqwa (Aurecon), Umsinde Emoyeni (ARCUS) , Komsberg (ARCUS), Karee and Kolkies Wind Farms (ARCUS), Canyon Springs (Canyon Springs), Perdekraal (ERM), Zen (Savannah Environmental – SE), Goereesoe (SE), Springfontein (SE), Garob (SE), Project Blue (SE), ESKOM Kleinzee (SE), Walker Bay (SE), Oyster Bay (SE), Hidden Valley (SE), Happy Valley (SE), Deep River (SE), Tsitsikamma (SE), AB (SE), West Coast One (SE), Hopefield II (SE), Namakwa Sands (SE), VentuSA Gouda (SE), Dorper (SE), Amakhala Emoyeni (SE), Klipheuwel (SE), Cookhouse (SE), Cookhouse II (SE), Rheboksfontein (SE), Suurplaat (SE), Karoo Renewables (SE), Koningaas (SE), Eskom Aberdene (SE), Spitskop (SE), Castle (SE), Khai Ma (SE), Poortjies (SE), Korana (SE), IE Moorreesburg (SE), Gunstfontein (SE), Vredenburg (Terramanzi), Loeriesfontein (SiVEST), Rhenosterberg (SiVEST), Noupoort (SiVEST), Prieska (SiVEST), Dwarsrug (SiVEST), Msenge Emoyeni (Windlab), Isivunguvungu Wind Farm (Aurecon), Graskoppies (SiVEST), Hartebeest Leegte (SiVEST), Ithemba (SiVEST), !Xha Boom (SiVEST), Kokerboom 1 (Aurecon), Kokerboom*

	2 (Aurecon), Teekloof (Mainstream), Sutherland (CSIR), Rietrug (CSIR), Sutherland 2 (CSIR), Spitskop West (Terramanzi)
Mining and Industry	*Full Environmental Noise Impact Assessments for – Delft Sand (AGES), BECSA – Middelburg (Golder Associates), Kromkrans Colliery (Geovicon Environmental), SASOL Borrow Pits Project (JMA Consulting), Lesego Platinum (AGES), Tweefontein Colliery (Cleanstream Environmental), Evraz Vametco Mine and Plant (JMA), Goedehoop Colliery (Geovicon), Hacra Project (Prescali Environmental), Der Brochen Platinum Project (J9 Environment), Brandbach Sand (AGES), Verkeerdepan Extension (CleanStream Environmental), Dwaalboom Limestone (AGES), Jagdlust Chrome (MENCO), WPB Coal (MENCO), Landau Expansion (CleanStream Environmental), Otjikoto Gold (AurexGold), Klipfontein Colliery (MENCO), Imbabala Coal (MENCO), ATCOM East Expansion (Jones and Wagner), IPP Waterberg Power Station (SE), Kangra Coal (ERM), Schoongesicht (CleanStream Environmental), EastPlats (CleanStream Environmental), Chapudi Coal (Jacana Environmental), Generaal Coal (JE), Mopane Coal (JE), Glencore Boshoek Chrome (JMA), Langpan Chrome (PE), Vlakpoort Chrome (PE), Sekoko Coal (SE), Frankford Power (REMIG), Strahrae Coal (Ferret Mining), Transalloys Power Station (Savannah), Pan Palladum Smelter, Iron and PGM Complex (Prescali Environmental), Fumani Gold (AGES), Leiden Coal (EIMS), Colenso Coal and Power Station (SiVEST/EcoPartners), Klippoortjie Coal (Gudani), Rietspruit Crushers (MENCO), Assen Iron (Tshikovha), Transalloys (SE), ESKOM Ankerlig (SE), Pofadder CSP (SE), Nooitgedacht Titano Project (EcoPartners), Algoa Oil Well (EIMS), Spitskop Chrome (EMAssistance), Vlakfontein South (Gudani), Leandra Coal (Jacana), Grazvalley and Zoetveld (Prescali), Tjate Chrome (Prescali), Langpan Chromite (Prescali), Vereeniging Recycling (Pro Roof), Meyerton Recycling (Pro Roof), Hammanskraal Billeting Plant 1 and 2 (Unica), Development of Altona Furnace, Limpopo Province (Prescali Environmental), Haakdoorndrift Opencast at Amandelbult Platinum (Aurecon), Landau Dragline relocation (Aurecon), Stuart Coal Opencast (CleanStream Environmental), Tetra4 Gas Field Development (EIMS), Kao Diamonds – Tiping Village Relocation (EIMS), Kao Diamonds – West Valley Tailings Deposit (EIMS), Upington Special Economic Zone (EOH), Arcellor Mittal CCGT Project near Saldanha (ERM), Malawi Sugar Mill Project (ERM), Proposed Mooifontein Colliery (Geovicon Environmental), Goedehoop North Residue Deposit Expansion (Geovicon Environmental), Mutsho 600MW Coal-Fired Power Plant (Jacana Environmentals), Tshivhaso Coal-Fired Power Plant (Savannah Environmental), Doornhoek Fluorspar Project (Exigo)*
Road and Railway	*K220 Road Extension (Urbansmart), Boskop Road (MTO), Sekoko Mining (AGES), Davel-Swaziland-Richards Bay Rail Link (Aurecon), Moloto Transport Corridor Status Quo Report and Pre-Feasibility (SiVEST), Postmasburg Housing Development (SE), Tshwane Rapid Transport Project, Phase 1 and 2 (NRM Consulting/City of Tshwane), Transnet Apies-river Bridge Upgrade (Transnet), Gautrain Due-diligence (SiVest), N2 Piet Retief (SANRAL), Atterbury Extension, CoT (Bokomoso Environmental)*
Airport	*Oudtshoorn Noise Monitoring (AGES), Sandton Heliport (Alpine Aviation), Tete Airport Scoping (Aurecon)*
Noise monitoring and Audit Reports	*Peerboom Colliery (EcoPartners), Thabametsi (Digby Wells), Doxa Deo (Doxa Deo), Harties Dredging (Rand Water), Xstrata Coal – Witbank Regional (Xstrata), Sephaku Delmas (AGES), Amakhala Emoyeni WEF (Windlab Developments), Oyster Bay WEF (Renewable Energy Systems), Tsitsikamma WEF Ambient Sound Level study (Cennergi and SE), Hopefield WEF (Umoya), Wesley WEF (Innowind), Ncora WEF (Innowind), Boschmanspoort (Jones and Wagner), Nqamakwe WEF (Innowind), Hopefield WEF Noise Analysis (Umoya), Dassiesfontein WEF Noise Analysis (BioTherm), Transnet Noise Analysis (Aurecon), Jeffries Bay Wind Farm (Globeleq), Sephaku Aganang (Exigo), Sephaku Delmas (Exigo), Beira Audit (BP/GPT), Nacala Audit (BP/GPT), NATREF (Nemai), Rappa Resources (Rayten), Measurement Report for Sephaku Delmas (Ages), Measurement Report for Sephaku Aganang (Ages), Development noise measurement protocol for Mamba Cement (Exigo), Measurement Report for Mamba Cement (Exigo), Measurement Report for Nokeng Fluorspar (Exigo), Tsitsikamma Community Wind Farm Pre-operation sound measurements (Cennergi), Waainek WEF Operational Noise Measurements (Innowind), Sedibeng Brewery Noise Measurements (MENCO), Tsitsikamma Community Wind Farm Operational noise measurements (Cennergi), Noupoort Wind Farm Operational noise measurements (Mainstream),*

Small Noise Impact Assessments	*TCTA AMD Project Baseline (AECOM), NATREF (Nemai Consulting), Christian Life Church (UrbanSmart), Kosmosdale (UrbanSmart), Louwlardia K220 (UrbanSmart), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Slag Milling Plant (AGES), Arcelor Mittal WEF (Aurecon), RVM Hydroplant (Aurecon), Grootvlei PS Oil Storage (SiVEST), Rhenosterberg WEF, (SiVEST), Concerto Estate (BPTrust), Ekuseni Youth Centre (MENCO), Kranskop Industrial Park (Cape South Developments), Pretoria Central Mosque (Noman Shaikh), Soshanguve Development (Maluleke Investments), Seshego-D Waste Disposal (Enviroxcellence), Zambesi Safari Equipment (Owner), Noise Annoyance Assessment due to the Operation of the Gautrain (Thornhill and Lakeside Residential Estate), Upington Solar (SE), Ilangalethu Solar (SE), Pofadder Solar (SE), Flagging Trees WEF (SE), Uyekraal WEF (SE), Ruuki Power Station (SE), Richards Bay Port Expansion 2 (AECOM), Babalegi Steel Recycling (AGES), Safika Ladium (AGES), Safika Cement Isando (AGES), RareCo (SE), Struisbaai WEF (SE), Perdekraal WEF (ERM), Kotula Tsatsi Energy (SE), Olievenhoutbosch Township (Nali), , HDMS Project (AECOM), Quarry extensions near Ermelo (Rietspruit Crushers), Proposed uMzimkhulu Landfill in KZN (nZingwe Consultancy), Linksfield Residential Development (Bokomoso Environmental), Rooihuiskraal Ext. Residential Development, CoT (Plandev Town Planners), Floating Power Plant and LNG Import Facility, Richards Bay (ERM), Floating Power Plant project, Saldanha (ERM), Vopak Growth 4 project (ERM), Elandspoort Ext 3 Residential Development (Gibb Engineering)*
Project reviews and amendment reports	*Loperberg (Savannah), Dorper (Savannah), Penhoek Pass (Savannah), Oyster Bay (RES), Tsitsikamma Community Wind Farm Noise Simulation project (Cennergi), Amakhala Emoyeni (Windlab), Spreeukloof (Savannah), Spinning Head (SE), Kangra Coal (ERM), West Coast One (Moyeng Energy), Rheboksfontein (Moyeng Energy), De Aar WEF (Holland), Quarterly Measurement Reports – Dangote Delmas (Exigo), Quarterly Measurement Reports – Dangote Lichtenburg (Exigo), Quarterly Measurement Reports – Mamba Cement (Exigo), Quarterly Measurement Reports – Dangote Delmas (Exigo) Quarterly Measurement Reports – Nokeng Exigo), Proton Energy Limited Nigeria (ERM), Hartebeest WEF Update (Moorreesburg) (Savannah Environmental), Modderfontein WEF Opinion (Terramanzi), IPD Vredenburg WEF (IPD Power Vredenburg)*

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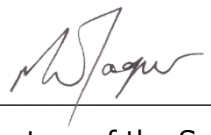
2 DECLARATION OF INDEPENDENCE

I, Morné de Jager declare that:

- I act as the independent specialist on this project;
- I will perform the work relating to this specialist study in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of the National Environmental Management Act (107 of 1998), the Environmental Impact Assessment Regulations of 2014, and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing this project;
- all the particulars furnished by me in this form are true and correct;
- will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014.



Signature of the Specialist:

Name of company:

Enviro-Acoustic Research cc

Date:

2024 – 09 – 14

3 INTRODUCTION

3.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research cc was commissioned to assess the potential risk of a noise impact associated with the reclamation of the Libanon Tailings Storage Facility (TSF) in the West Rand, Gauteng.

The online screening tool does not identify noise as an environmental theme that requires further investigation for a TSF, this report considers the requirements of SANS 10328:2008 to assess whether noise is a potential issue of concern. However, when there is a low risk of a noise impact to occur, the SANS 10328:2008 guideline also allows for the assessment of noise impacts on the environment due to a proposed activity using an administrative screening questionnaire. If the outcome of all the questions is negative, the planned development or activity is not likely to present a noise disturbance and a Screening report is deemed sufficient.

3.2 BRIEF PROJECT DESCRIPTION

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant (and alternatively in the future, other existing gold plants). The regional location of the Libanon TSF is illustrated in **Figure 3-1**. Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised. Required infrastructure will include:

- Pumpstation;
- Process water from Kloof Shaft 10#;
- Pollution control paddock;
- Access road
- Laydown area
- Powerlines

3.3 POTENTIAL NOISE-GENERATING ACTIVITIES

The proposed reclamation method that will be used to remove the TSF is referred to as top-down hydraulic reclamation. This technique uses high-pressure water monitors / cannons to deliver a high-pressure water jet to excavate unconsolidated tailings material within the TSF hydraulically. The water from the cannon mixes with the tailings and forms a slurry with a high solids content. The slurry then flows under gravity along trenches at the base of the TSF to a collection sump which is positioned at the lowest elevation of the bench being mined.

At the sump, finger screens remove any debris that may impact pumping operations and a penstock will control water flow into the sump. The position of the collection sump will change as the reclamation progresses. From the collection sump, the slurry reports to a reclamation station. To control the volume of water reporting to the reclamation station, flapper valves are used to hold, and release slurry contained in the collection sump. This slurry is then pumped via existing pipelines to the Driefontein No. 2 Plant. At the Driefontein No. 2 Plant, the slurry is prepared and treated for gold extraction and beneficiation.

The tailings after beneficiation will be pumped through approved pipelines for deposition on the Regional TSF (RTSF).

The following infrastructure will be utilised on site:

- Reclamation infrastructure consisting of a pump station which include:
    - Slurry sump;
    - Penstock;
    - Vibrating Screen
    - Water tank;
    - Motor control centre;
    - Pump;
- A short connecting 600mm pipeline for process water from Kloof Shaft 10#;
- A short connecting 550mm pipeline to the slurry pipeline to Driefontein 2 Plant;
- Stormwater management infrastructure including:
    - Water infrastructure and stormwater systems; and
    - Existing catchment paddocks on the TSF footprint
    - Pollution control paddock;
- An 11 kV overhead powerline capable of transmitting 3 kVA of electricity and electricity reticulation;
- Administration buildings, including change houses and ablution facilities;
- Access roads, routed from existing entry points; and
- Construction contractors' yards (temporary facilities).

3.4 CONCEPTUAL NOISE LEVELS

Noise associated with the reclamation project mainly originates from construction activities of required infrastructure as well as noises from motors and pumps during the operational phase.

Noises relating to the development of the pipeline and pump station system would be:

- Limited to within 100m from construction activities, could be high at times but would be of a temporary nature;
- Insignificant further than 200m from the activities.

Noises associated with the operational phases would be:

- Limited to within 100m from hydraulic reclamation activities and motors (of the slurry pumps). Noises from the vibrating screening could be high at times;
- Could be clearly audible up to 200m during quiet periods (from the vibrating screens as well as night-time pumping activities);
- Would be insignificant further than 500m from such activities.

Noises associated with rehabilitation activities would generally be limited to a distance less than 200m from the rehabilitation activities.

Therefore, three areas might be considered, namely:

- An area where noise levels may be elevated, enclosed within the orange line on **Figure 3-2**;
- An area where noises from the activities may be audible (between the orange and light-green line on **Figure 3-2**); and
- An area where noises would be insignificant (outside the light-green line on **Figure 3-2**)

3.5 PROJECT LOCATION

The TSF is located south-west of Westonaria within the Rand West City Local Municipality, Province. The regional location of the proposed project is illustrated in **Figure 3-1**.

The area is further described in terms of environmental components that may contribute to or change the sound character in the area.

3.5.1 Topography

The project is located in an area described as plains. The surrounding area is heavily modified due to anthropogenic activities (mining and agriculture).

3.5.2 Roads and Railway Lines

The N12 national highway passes the project area to the south, but this road is too far from the project area to influence the local soundscape. Other smaller gravel roads with insignificant traffic are located in the surrounding area.

3.5.3 Surrounding Land Use

The area in the direct vicinity of the project is mainly used for mining activities.

3.5.4 Ground conditions and vegetation

The natural veldt has been significantly impacted by anthropogenic activities with little natural vegetation remaining in the area.

3.5.5 Ambient Sound Levels

Ambient sound levels were not measured for this project, it is also not deemed necessary to measure the ambient sound levels for a screening level report.

3.5.6 Potential Sensitive Receptors (NSR)

Residential areas and potential noise-sensitive developments/receptors ("NSR") were identified using tools such as Google Earth®. No noise-sensitive receptors were identified within 500m from the project infrastructure associated with the proposed TSF reclamation project. The closest NSR are illustrated on **Figure 3-2**.

3.6 TERMS OF REFERENCE

Construction and operational noises could affect environmental noise, with the extent of the noise impact depending upon:

- the existing environmental noise level (or the ambient sound level);
- the noise levels associated with the noise sources;
- the time that the noise generating activities may take place; and
- the number of, and potential sensitivities of NSR in the area.

The online screening tool does not identify noise as a theme that needs to be investigated for a TSF, therefore the screening requirements as per SANS 10328:2008 will be applicable to this study.

SANS 10328:2008 (Edition 3) specifies the methodology to assess the noise impacts on the environment due to a proposed activity that might impact on the environment. The standard also stipulates the minimum requirements to be investigated for screening purposes. These minimum requirements are:

a) Identification and description of the noise sources and noise-sensitive developments associated with the development that has to be investigated;

b) Identification and description of the noise sources and noise-sensitive developments in the target area that could affect the development (or that could be affected by the development) that has to be investigated;
c) Identification, with the assistance of all interested or affected parties, and description of all the noise sources and noise-sensitive developments associated with the development, or located within the target area, that are to be excluded from the investigation. The reason(s) for the exclusion shall be stated; and
d) A reference to this standard regarding the method of investigation.

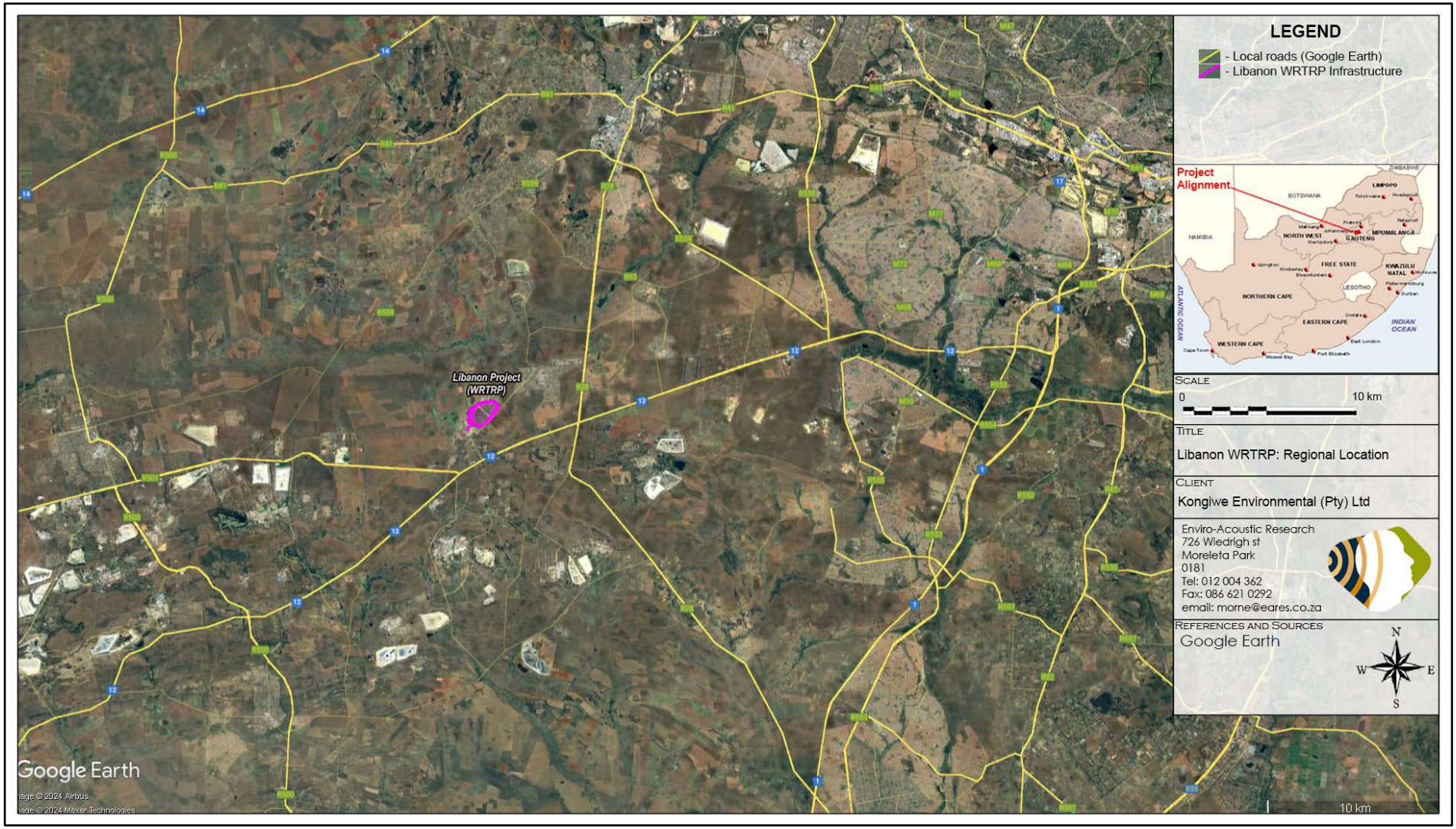


Figure 3-1: Regional Location of Libanon TSF

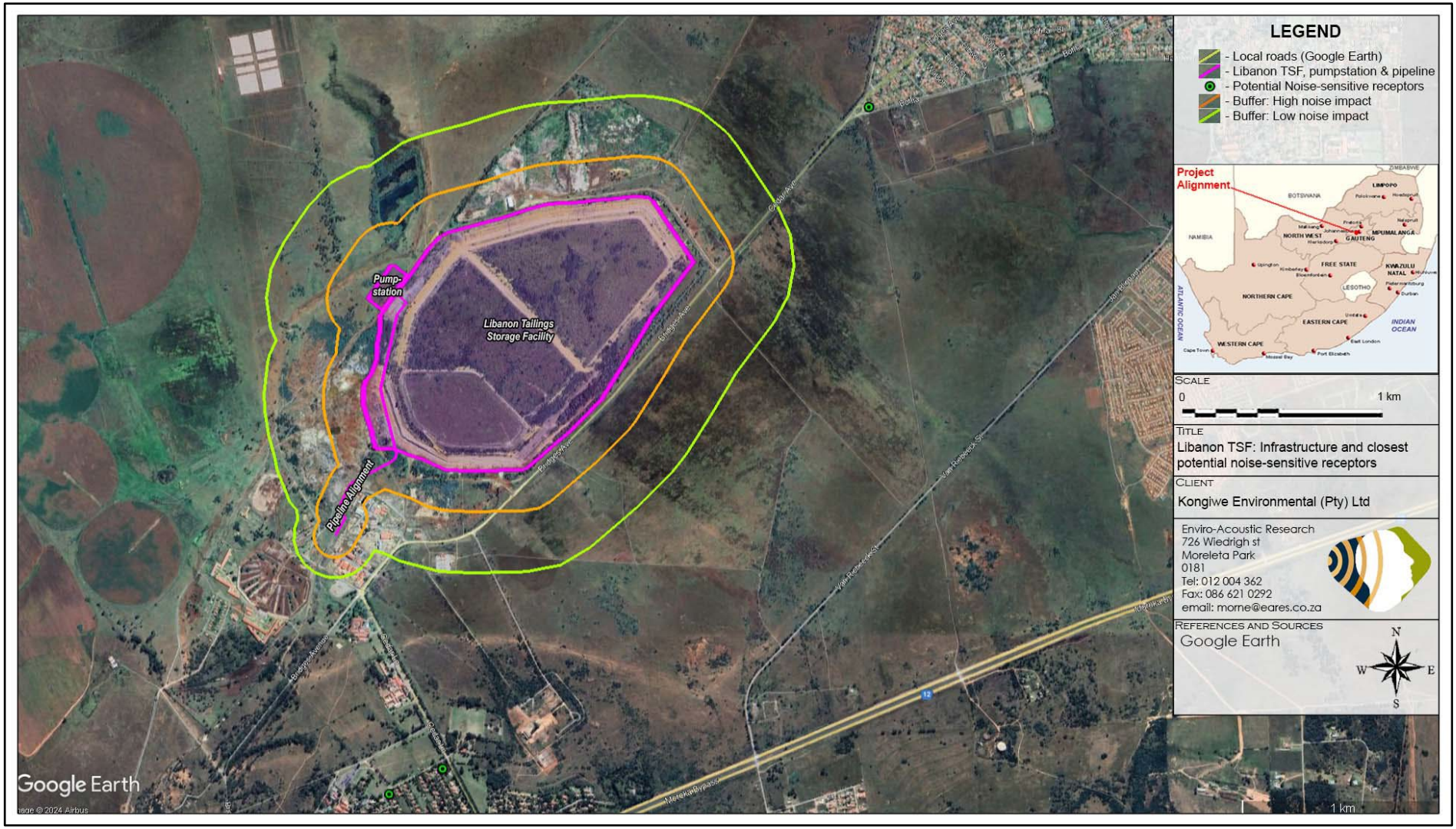


Figure 3-2: Libanon TSF reclamation project infrastrucure and closest noise-sensitive receptors

4 LEGAL CONTEXT, POLICIES AND GUIDELINES

Legal policies, guidelines (National and International) are provided in this section for reference purpose.

4.1 THE REPUBLIC OF SOUTH AFRICA CONSTITUTION, 1996 ("THE CONSTITUTION")

The environmental rights contained in section 24 of the Constitution provide that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate in the particular circumstances. The subjectivity of this approach can be problematic which has led to the development of noise standards (see **Section 4.4**).

"Noise pollution" is specifically included in Part B of Schedule 5 of the Constitution, which means that noise pollution control is a local authority competence, provided that the local authority concerned has the capacity to carry out this function.

4.2 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT 107 OF 1998)

The National Environmental Management Act ("NEMA") defines "pollution" to include any change in the environment, including noise. A duty therefore arises under section 28 of NEMA to take reasonable measures while establishing and operating any facility to prevent noise pollution occurring. NEMA sets out measures which may be regarded as reasonable. They include the following measures:

1. to investigate, assess and evaluate the impact on the environment;
2. to inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;
3. to cease, modify or control any act, activity or process causing the pollution or degradation;
4. to contain or prevent the movement of the pollution or degradation;
5. to eliminate any source of the pollution or degradation; and
6. to remedy the effects of the pollution or degradation.

In addition, a number of regulations have been promulgated as the Environmental Impact Assessment Regulations (GNR982 of December 2014 as gazetted in Government Notice

38282, subsequently amended in 2017 and 2021) in terms of this Act. It defines minimum information requirements for specialist reports, with Government Notice 43110 (20 March 2020) updating the minimum requirements for reporting.

4.3 THE ENVIRONMENT CONSERVATION ACT (ACT 73 OF 1989)

The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Water and Environmental Affairs") to make regulations regarding noise, among other concerns. See also section **4.3.1**. While most sections of this Acts has been repealed with the promulgation of the NEMA, Section 25 of this Act is still in effect.

4.3.1 National Noise Control Regulations (GN R154 of 1992)

The National Noise Control Regulations (GN R154 in *Government Gazette* No. 13717 dated 10 January 1992) were promulgated in terms of section 25 of the ECA. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations exists in the Free State, Gauteng and Gauteng provinces.

4.3.2 Gauteng Noise Control Regulations: Gauteng Province (GN 5479 of 20 August 1999)

The Gauteng Noise Control Regulations is based on the National Noise Control Regulations and most of the regulations are the same. It prohibits the generation of a disturbing noise in any manner (Regulation 8) and defines and prohibits activities that can result in a noise nuisance (Regulation 9). Regulation 11(1) allows a local authority to designate a controlled area as well as zone sound levels for specific areas and during specific times.

The difference between the National Noise Control Regulations and the Gauteng Province is the criteria set out for a controlled area, namely:

"controlled area" means a piece of land designed by a local authority where, in the case of-

(c) industrial noise in the vicinity of an industry -

i. the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter was in operation, exceeds 60 dBA; or

ii. the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 metres, but not more than 1,4 metres, above the ground for a period of 24 hours, exceeds 60 dBA

"disturbing noise" as the noise level that causes the ambient noise level to rise above the designated zone level, or if no zone level has been designated, the typical rating levels for ambient noise in districts, indicated in table 2 of SABS 10103.

"measuring point" relating to -

(a) a piece of land from which an alleged disturbing noise emanates, means a point outside the property projection plane where an alleged disturbing noise shall be measured in accordance with the provisions of regulation 16;

"noise level" means the reading on an integrating impulse sound level meter taken at a measuring point in the presence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation, and, if the alleged disturbing noise has a discernible pitch, for example, a whistle, buzz, drone or music, to which 5 dBA has been added;

Section 8 of the Gauteng Noise Control Regulations prohibits the making, producing or causing of a disturbing noise.

4.4 NOISE STANDARDS

There are a few South African scientific standards (SABS) relevant to noise from developments, industry and roads. They are:

- SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.
- SANS 10210:2004. 'Calculating and predicting road traffic noise'.
- SANS 10328:2008. 'Methods for environmental noise impact assessments'.
- SANS 10357:2004. 'The calculation of sound propagation by the Concave method'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account, but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. With regards to SANS 10103:2008, the recommendations are likely to inform

decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful *per se.*

It must be noted that SANS 10103:2008 does stipulate *"for industries legitimately operating in an industrial district during the entire 24 h day/night cycle,* $L_{Req,d} = L_{Req,n} = 70$ *dBA can be considered as typical and normal".*

With regards to SANS 10103:2008:

- the recommended noise rating levels are likely to inform decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful *per se*; and
- does stipulate *"for industries legitimately operating in an industrial district during the entire 24 h day/night cycle,* $L_{Req,d} = L_{Req,n} = 70$ *dBA can be considered as typical and normal".*

The SANS 10328:2008 guideline covers various issues with regards to noise studies, including, amongst others:

- identifying issues that could have acoustics implications in section 5;
- a screening process to investigate potential acoustical implications in section 6;
- a process to assess a potential noise impact on a scoping level in section 7; and
- procedures to investigate and assess the environmental noise impact from a future project in section 8.

The SANS 10328:2008 recommends that the procedures provided in clause 6 to clause 8 in this guideline be followed if:

a) An application, in respect of any if the activities identified in terms of the current relevant national legislation and noise sources (defined in clauses 3.17 and 3.18), or the issues listed in clause 5, is made to the relevant authority;
b) An application for a noise-sensitive development (in terms of clause 3.16) is made to the relevant authority;
c) An application for a change in land use is made to the relevant authority; or
d) An environmental noise impact investigation is requested by an applicant or any interested or affected party.

4.5 INTERNATIONAL GUIDELINES

While a number of international guidelines and standards exists, those selected below are used by numerous countries for environmental noise management. **It should be noted that these guidelines remain in this report only for reference purpose.**

4.5.1 Night Noise Guidelines for Europe (WHO, 2009)

Refining previous Community Noise Guidelines issued in 1999, and incorporating more recent research, the World Health Organization has released a comprehensive report on the health effects of night time noise, along with new (non-mandatory) guidelines for use in Europe. Rather than a maximum of 30 dB inside at night (which equals 45-50 dB max outside), the WHO now recommends a maximum year-round outside night-time noise average of 40 dB to avoid sleep disturbance and its related health effects.

4.5.2 Guidelines for Community Noise (WHO, 1999)

The World Health Organization's (WHO) document on the *Guidelines for Community Noise* is the outcome of the WHO expert task force meeting held in London, United Kingdom, in April 1999. It is based on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute. The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments

4.5.3 IFC: General EHS Guidelines – Environmental Noise Management

These guidelines are applicable to noise created beyond the property boundaries of a development that conforms to the Equator Principles. The environmental standards of the World Bank have been integrated into the social policies of the IFC since April 2007 as the International Finance Corporation Environmental, Health and Safety (EHS) Guidelines.

It sets noise level guidelines (see **Table 4-1**) and highlights the certain monitoring requirements pre- and post-development. It adds another criterion in that the existing background ambient noise level should not rise by more than 3 dBA. This criterion will effectively sterilize large areas of any development. Therefore, it is EARES's opinion that this criterion was introduced to address cases where the existing ambient noise level is already at, or in excess of the recommended limits.

Table 4-1: IFC Table .7.1-Noise Level Guidelines

Receptor type	One hour L_{Aeq} (dBA)	
	Daytime 07:00 - 22:00	Night-time 22:00 – 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

5 METHODOLOGY: SCREENING QUESTIONNAIRE

As the exact noise emission of the proposed facility is unknown, the potential noise impact would be evaluated as defined by SANS 10328:2008. Clause 5.4 of SANS 10103 provide potential examples of situations that could have acoustical implications. Relating to this project, an activity that may result in a noise impact, are illustrated in clause 5.4(a) which states: "*if a proposed plant is to be developed on a site that is situated within 200 m of a noise-sensitive development*".

The proposed noise sources would mainly be:

- Noises associated with the construction of the proposed pump station and associated infrastructure;
- Noises associated with motors and pumps; and
- Noises associated with the vibrating screens.

Because there are no NSR located within 200m, risks from noise are expected to be low. The need for a full noise assessment will be evaluated using Clause 6 of SANS 10328:2008 as summarized in **Table 5-1**. This evaluation would be relevant for both the construction and operational phases.

Table 5-1: Questions for Noise Screening (SANS 10328:2008)

Question	Answer	Comment
Does the planned linear source (arterial road, planned arterial road reserve, or a main line railway line) at any position along the route pass within 1 000 m from an area which is developed or zoned for residential purposes?	*No*	***Not relevant***
Does the planned linear source (suburban road, planned suburban road reserve where only two lanes of traffic will be present at an average speed limit not exceeding 60 km/h, or a suburban electric traction railway line) at any position along the route pass within 500 m from an area which is developed or zoned for residential purposes?	*No*	***Not relevant***
Does the planned development of a residential area or a piece of land zoned for residential purposes fall within 1 000 m from a planned linear source (arterial road, planned arterial road reserve, or a main line railway line)?	*No*	***Not relevant***
Does the planned development of a residential area or a piece of land zoned for residential purposes fall within 500 m from a planned linear source (suburban road, planned suburban road reserve where only two lanes of traffic will be present at an average speed limit not exceeding 60 km/h, or a suburban electric traction railway line)?	*No*	***Not relevant***

Question	Answer	Comment
Does a planned industrial development or a building housing a plant fall within a distance of 1 000 m from an already developed residential area or land zoned for residential purposes?	*No*	***Not relevant***
Does a piece of land to be developed for residential purposes or land to be zoned for residential purposes fall within 1 000 m from an already developed industrial area or a building housing plant?	*No*	***Not relevant***
Does planned light industrial development or a building(s) housing workshops fall within a distance of 500 m from an already developed residential area or land zoned for residential purposes?	*No*	***Not relevant***
Does a piece of land to be developed for residential purposes or land to be zoned for residential purposes fall within 500 m from an already developed light industrial development or a building(s) housing workshops?	*No*	***Not relevant***
Does a piece of land to be developed for residential purposes or land to be zoned for residential purposes fall within 2 000 m from an existing wind generator farm?	*No*	***Not relevant***
Does a piece of land to be developed as a wind generator farm fall within 2 000 m from a piece of land to be developed for residential purposes or land to be zoned for residential purposes?	No	***Not relevant***
Does a piece of land to be developed for residential purposes or land to be zoned for residential purposes fall within 2 000 m from a low frequency source (e.g. low speed ventilation fans or low speed diesel engines)?	No	***Not relevant***
Does an activity containing a low frequency source (e.g. low speed ventilation fans or low speed diesel engines) to be developed fall within 2 000 m from a piece of land to be developed for residential purposes or land use to be zoned for residential purposes?	No	***Not relevant***
Will the planned repaving of a suburban street be provided with normal, non-sound absorptive bitumen or cement concrete paving?	*No*	***Not relevant***
Where an aircraft landing strip, heliport, hoverport or airport is planned, or is to be altered, will this planned activity be such that the calculated appropriate limit noise contour for the full planned use of the activity fall inside the boundaries of any residential area or any piece of land zoned for residential purposes?	*No*	***Not relevant***
Where a residential area is planned or a piece of land is to be zoned for residential purposes, will the evaluated appropriate limit noise contour for the full planned use of an aircraft landing strip, heliport, hoverport or airport fall inside the boundaries of the residential area or the piece of land zoned for residential purposes?	*No*	***Not relevant***

6 POTENTIAL SIGNIFICANCE OF THE NOISE IMPACT

Noise associated with the reclamation project mainly originates from construction activities of required infrastructure as well as noises from motors and pumps during the operational phase.

Noises associated with the construction and operational phases are generally limited to approximately 100m from the project activities and noises will be insignificant further than 200m from such activities. Noises associated with certain reclamation equipment (such as water pumps and the vibrating screens) may have an impact up to 200m, though such activities will be inaudible further than 500m from such equipment.

The closest NSR is further than 500 m from the project area, or locations where noise-generating activities may take place. Noise levels from the project will be low at the closest NSR and of no acoustic concern. There is a very low potential for a noise impact occurring and the significance will be low.

7 CONCLUSIONS AND RECOMMENDATIONS

This Screening report assesses the potential noise impact due to the proposed reclamation activities associated with the Libanon TSF west of Westonaria, Gauteng Province.

Noises associated with the construction and operational phases of the reclamation project are generally limited to approximately 100m from the project activities and insignificant further than 200m from such activities. Noises associated with certain reclamation equipment (such as water pumps) may have an impact up to 200m, though such activities will be inaudible further than 500m from such equipment.

Considering the project area to be developed, the likely elevated sound character of the area as well as the distance between potential noise sources and identified NSR (more than 500 m from the proposed activity), reclamation activities associated with the Libanon TSF is unlikely to influence ambient sound levels at any NSR residing in the vicinity of the project site.

For the project development area, it is the opinion of the author that no further Scoping or other acoustical studies would be required and it is recommended that the Libanon TSF reclamation project be authorized (in terms of acoustics).

8 REFERENCES

In this report reference was made to the following documentation:

1. Audiology Today, 2010: *Wind-Turbine Noise – What Audiologists should know*
2. Hassall, 2021: *Environmental Noise Report – Proposed PV Power Plant, Mogalakwena Mine – Draft Report.* JH Consulting, Northriding
3. Minnesota Department of Health, 2009: *Public Health Impacts of Wind Farms*
4. Renewable Energy Research Laboratory, 2006: *Wind Turbine Acoustic Noise*
5. SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.
6. SANS 10210:2004. 'Calculating and predicting road traffic noise'.
7. SANS 10328:2008. 'Methods for environmental noise impact assessments'.
8. SANS 10357:2004 The calculation of sound propagation by the Concave method'.

APPENDIX A

Glossary of Acoustic Terms, Definitions and General Information

1/3-Octave Band	A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the centre frequency of the band. See also definition of octave band.
A – Weighting	An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.
Air Absorption	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
Alternatives	A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are not limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called "no go" alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.
Ambient	The conditions surrounding an organism or area.
Ambient Noise	The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.
Ambient Sound	The all-encompassing sound at a point being composite of sounds from near and far.
Ambient Sound Level	Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used.
Amplitude Modulated Sound	A sound that noticeably fluctuates in loudness over time.
Anthropogenic	Human impact on the environment or anthropogenic impact on the environment includes impacts on biophysical environments, biodiversity and other resources
Applicant	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
Assessment	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
Attenuation	Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels.
Audible frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
Ambient Sound Level	The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.
Best Practices	A best practice is a method or technique that has consistently shown results superior to those achieved with other means, and that is used as a benchmark. In addition, a "best" practice can evolve to become better as improvements are discovered.
Broadband Noise	Spectrum consisting of a large number of frequency components, none of which is individually dominant.
C-Weighting	This is an international standard filter, which can be applied to a pressure signal or to a *SPL* or *PWL* spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.
dB(A)	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.

Decibel (db)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 μ Pa.
Diffraction	The process whereby an acoustic wave is disturbed and its energy redistributed in space as a result of an obstacle in its path, Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing noise	Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level at the same measuring point by 7 dBA or more.
Echolocation	Echo locating animals emit calls out to the environment and listen to the echoes of those calls that return from various objects near them. They use these echoes to locate and identify the objects. Echolocation is used for navigation and for foraging (or hunting) in various environments.
Environment	The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.
Environmental Control Officer	Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.
Environmental impact	A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.
Environmental Impact Assessment	An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.
Environmental issue	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)	The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.
Equivalent continuous A-weighted rating level ($L_{Req,T}$)	The Equivalent continuous A-weighted sound exposure level *($L_{Aeq,T}$)* to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value.
F (fast) time weighting	(1) Averaging detection time used in sound level metre. (2) Fast setting has a time constant of 125 milliseconds and provides a fast reacting display response allowing the user to follow and measure not too rapidly fluctuating sound.
Footprint area	Area to be used for the construction of the proposed development, which does not include the total study area.
Free Field Condition	An environment where there is no reflective surfaces.
Frequency	The rate of oscillation of a sound, measured in units of Hertz (Hz) or kiloHertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate.

Green field	A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Greenfield is Brownfield, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brownfield suggests that an investigation should be made to determine if environmental damage exists.
G-Weighting	An International Standard filter used to represent the infrasonic components of a sound spectrum.
Harmonics	Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.
I (impulse) time weighting	(1) Averaging detection time used in sound level metre as per South African standards and Regulations. (2) Impulse setting has a time constant of 35 milliseconds when the signal is increasing (sound pressure level rising) and a time constant of 1,500 milliseconds while the signal is decreasing.
Impulsive sound	A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level.
Infrasound	Sound with a frequency content below the threshold of hearing, generally held to be about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind.
Integrated Development Plan	A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000).
Integrated Environmental Management	IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable approach.
Interested and affected parties	Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public.
Key issue	An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.
Listed activities	Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act.
L_{AMin} *and* L_{AMax}	Is the RMS (root mean squared) minimum or maximum level of a noise source.
Loudness	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
Magnitude of impact	Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.
Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.
Mitigation	To cause to become less harsh or hostile.
Natural Sounds	Are sounds produced by natural sources in their normal baseline.
Negative impact	A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance).
Noise	a. Sound that a listener does not wish to hear (unwanted sounds). b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record. c. A class of sound of an erratic, intermittent or statistically random nature.
Noise Level	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.

Noise-sensitive development	developments that could be influenced by noise such as: a) districts (see table 2 of SANS 10103:2008) 1. rural districts, 2. suburban districts with little road traffic, 3. urban districts, 4. urban districts with some workshops, with business premises, and with main roads, 5. central business districts, and 6. industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas; and f) nature reserves. In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
Positive impact	A change that improves the quality of life of affected people or the quality of the environment.
Property	Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development
Reflection	Redirection of sound waves.
Refraction	Change in direction of sound waves caused by changes in the sound wave velocity, typically when sound wave propagates in a medium of different density.
Reverberant Sound	The sound in an enclosure which results from repeated reflections from the boundaries.
Reverberation	The persistence, after emission of a sound has stopped, of a sound field within an enclosure.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
S (slow) time weighting	(1) Averaging times used in sound level metre. (2) Time constant of one [1] second that gives a slower response which helps average out the display fluctuations.
Sound Level	The level of the frequency and time weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level.
Sound Power	Of a source, the total sound energy radiated per unit time.
Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as L_p in dB (not weighted) or in various other weightings.
Study area	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the

	world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
Tone	Noise can be described as tonal if it contains a noticeable or discrete, continuous note. This includes noises such as hums, hisses, screeches, drones, etc. and any such subjective description is open to discussion and contradiction when reported.
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS 10103:2008.

End of Report

Appendix D7
Closure and Rehabilitation

THE RECLAMATION OF THE LIBANON TAILINGS STORAGE FACILITY IN THE WEST RAND, GAUTENG PROVINCE

DRAFT CLOSURE AND REHABILITATION REPORT

DMRE REFERENCE NUMBER: GP30/5/1/1/2/000073 BP/BAR

Report Information

Project:	The Reclamation of the Libanon Tailings Storage Facility in the Rand West City Local Municipality, Gauteng Province
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Executive Summary

Introduction and Project Background

Far West Gold Recoveries (Proprietary) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSFs are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF).

It is FWGR's intention to reclaim and reprocess the gold residues of the Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant, and potentially at future plants. Most of the pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised.

Required infrastructure will include:

- Pumpstation;
- Connecting pipelines for process water from Kloof Shaft 10#;
- Connecting slurry pipelines to existing pipelines;
- Pollution control paddock;
- Access roads;
- Laydown area; and
- Powerlines,

Reprocessed tailings will be deposited on the RTSF.

Project Rehabilitation and Future Land use

The primary aim of rehabilitation, in the context of this document, is to:

- Reduce the actual or potential environmental threat.
- Reduce the potential risks so that unacceptable risks identified in the EIA are reduced to acceptable levels.
- Protect the future liability of the land by re-establishing a sustainable land use as close to, or similar to, its pre-mining condition.

Once the TSF has been reclaimed, rehabilitated and cleared of radiation, the land will be shaped and revegetated to match the surrounding environment. The land will then be made available to the landowner (Sibanye) to use at its discretion. The end land uses for the areas associated with the TSF footprints will most likely be to rehabilitate the disturbed areas to align with the surrounding mix of land uses (predominantly agriculture), and establish vegetation types congruent with the surrounding vegetation communities.

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Purpose of the Report

The Libanon TSF is historic mineral storage deposit and as such, the Mineral and Petroleum Resources Development Act, 2002 Act No 12 of 2002) (MPRDA) is not strictly applicable to the reclamation of the TSF. FWGR has nonetheless chosen to comply with the provisions of the MPRDA, the National Environmental Management Act, 1998 (Act No 107 of 1998) (NEMA), the Environmental Impact Assessment Regulations, as amended in 2017 and 2021 (EIA 2014 Regulations) and in particular, with the Regulations Pertaining to the Financial Provision for Prospecting, Exploration, Mining or Production Operations (GNR. 1147 of 2015, as amended) (the Financial Provision Regulations), published in accordance with NEMA. This report serves accordingly to meet the Financial Provision Regulations, which requires that a final rehabilitation, decommissioning and mine closure plan is developed which includes the determination of financial provision to guarantee the availability of sufficient funds to undertake rehabilitation and remediation of the adverse environmental impacts of mining. This Report presents the conceptual rehabilitation, decommissioning and mine closure plan for the proposed Libanon TSF Reclamation.

The rehabilitation, decommissioning and mine closure plan must be updated and amended annually to comply with legislation. During this process, changes in baseline information, legislation amendments, spatial developments and any other changes which may impact the closure of the mine must be incorporated to ensure that the plan remains current and implementable.

The focus of this report is on areas associated with surface infrastructure and laydown areas for the reclamation of the Libanon TSF. It is anticipated that the Project will be active for a total life of mine (LoM) of 12 years, including rehabilitation and closure periods.

The closure calculation has been based as follows:

- Closure cost after Year 1 of operation;
- Closure cost at end of life of operation.

Table A details the closure costs (excl. VAT)

Table A: Closure Costs

	Unplanned closure (year 1)	Planned Closure (year 12)
Libanon TSF	R31 355 706.61	R21 460 578.14

FWGR will provide for the closure liability for premature closure associated with the Project through the procurement of suitable guarantees as allowed by the Financial Provision Regulations, with such guarantees provided to the DMR following authorisation of the Project.

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Table of Contents

1 INTRODUCTION 1
2 REHABILITATION, DECOMMISSIONING AND CLOSURE PLAN 2
2.1 Purpose of the Report 2
2.2 Terms of Reference 2
2.3 Objectives 3
2.4 Statutory Requirements 3
3 LIMITATIONS 9
4 PROJECT DESCRIPTION 10
4.1 Project Location 10
4.2 Activity Description 12
4.2.1 Infrastructure intended for the Project 12
4.2.2 Method of Reclamation 14
4.2.3 Pipelines 15
4.2.4 Access 15
4.2.5 Power Supply and Potable Water 15
4.2.6 Process Water 16
4.2.7 Rehabilitation 16
4.2.8 Works Schedule and Life-cycle of the Project 16
5 ENVIRONMENTAL CONTEXT 19
5.1 Climate 19
5.1.1 Rainfall 19
5.1.2 Evaporation 20
5.1.3 Temperature 21
5.1.4 Wind Direction 22
5.2 Topography 22
5.3 Geology 23
5.4 Soils, Land Capability and Land Use 24
5.4.1 Soils 24
5.4.2 Land Capability 24
5.4.3 Land Use 24

5.5 Biodiversity 26
5.5.1 Habitat Assessment 26
5.5.2 Screening Tool Comparison 28
5.6 Wetlands 29
5.6.1 Survey Results 29
5.6.2 Ecological Sensitivity 31
5.7 Surface Water 32
5.7.1 Surface Water Runoff 32
5.7.2 Surface Water Quality 32
5.8 Groundwater 34
5.8.1 Groundwater Quality 34
5.8.2 Contamination Modelling 35
5.9 Air Quality 39
5.10 Heritage 43
5.11 Social 43
5.11.1 Socio-economic sensitive areas in the vicinity of the project site. 43
5.11.2 Demographic 43
5.11.3 Basic Household Services 44
5.11.4 Education and Skills Level of the Labour Force 45
5.11.5 Health Status and Services 45
5.11.6 Safety and Security 46
5.11.7 Structure of the Local Economy 47
5.11.8 Local Economy Contribution of FWGR Reclamation Activities 48
5.11.9 Composition of the Labour Force 49
5.11.10 Income and Poverty Levels 49
5.11.11 Economic Infrastructure 50
5.11.12 Socio-economic Development Priorities and Initiatives 50
5.12 Noise 51
5.12.1 Conceptual Noise Levels 51
6 STAKEHOLDER PARTICIPATION 53
7 DESIGN PRINCIPLES 54
7.1 Closure Vision and Objectives 54
7.2 Closure and Post-Closure Options 54

7.3 Closure and Post Closure Period 55
7.4 Closure Options Research 55
7.5 Closure Assumptions 56
8 RISK ASSESSMENT FINDINGS 57
8.1 Methodology 57
8.2 Results of Risk Assessment 60
9 PROPOSED POST-MINING LAND USE 67
10 REHABILITATION PLAN 68
10.1 Rehabilitation Activities 68
10.1.1 Building Infrastructure 69
10.1.2 Pipelines 69
10.1.3 Access and Service Roads 69
10.1.4 Secondary Containment Dam and Pump Station 70
10.1.5 Groundwater 70
10.1.6 Stormwater (Surface Water) 70
10.1.7 NNR Certificate 71
10.2 General Rehabilitation Principles 71
10.2.1 Vegetation Establishment 71
10.3 General Monitoring and Maintenance Guidelines 72
10.3.1 Final Topography 73
10.3.2 Erosion Monitoring 73
10.3.3 Surface Water 73
10.3.4 Groundwater 73
10.3.5 Vegetation Species 74
10.3.6 Alien Invasive Control 74
11 ACTION SCHEDULE 75
12 ORGANISATIONAL CAPACITY 76
13 GAPS 77
14 RELINQUISHMENT CRITERIA 78
15 CLOSURE COST METHODOLOGY 80
15.1 Annual Rehabilitation Costs 82
15.2 Summary of Closure Costs 82
16 MONITORING, AUDITING AND REPORTING REQUIREMENTS 83

17 ENVIRONMENTAL RISK ASSESSMENT: LATENT AND RESIDUAL ENVIRONMENTAL IMPACTS.....85
17.1 Assessment Process to Describe Latent Environmental Risks..... 85
17.2 Management Activities, Costing and Monitoring Requirements..... 85
18 AMENDMENT MOTIVATIONS.....86
19 CONCLUSION.....87
20 REFERENCES.....88

Figures

Figure 4-1: Locality Map illustrating the location of the proposed project..... 11
Figure 4-2: Project Infrastructure Map..... 13
Figure 4-3: Mobile tracked hydraulic monitor on a tailings facility in South Africa..... 14
Figure 4-4: Typical bench widths proposed for a gold reclamation project..... 15
Figure 4-5: Stages of the mining method..... 16
Figure 5-1: Mean monthly rainfall for the area..... 19
Figure 5-2: Average min and max temperature in Westonaria. 21
Figure 5-3: Wind rose of the average winds produced by the WRF model for the Libanon TSF for the years 2021-2023. 22
Figure 5-4: Project area topography..... 23
Figure 5-5: Regional geology. 24
Figure 5-6: Soil map of the project area..... 25
Figure 5-7: Land uses of the Proposed Project site and surrounding area..... 25
Figure 5-8: Habitats identified within the PAOI..... 26
Figure 5-9: Map illustrating the site ecological importance for the PAOI..... 29
Figure 5-10: Photographical examples of the different water resources found within the 500 m regulated area, A & B) Artificial wetland, C) Artificial Canal, D & E) Artificial Channel, F) Artificial Attenuation Pond and G) Artificial Seep. 30
Figure 5-11: The delineated systems of the FWGR Libanon Project..... 31
Figure 5-12: Surface Water Map of the Proposed Project site and surrounding area..... 33
Figure 8-30: Simulated sulphate and iron plumes at the end of reclamation..... 37
Figure 8-31: Anticipated long-term sulphate and iron plumes..... 38
Figure 5-13: Modelled prediction of highest 24-hour average PM10 concentrations resulting from the undisturbed Libanon TSF. 41
Figure 5-14: Modelled prediction of the annual average PM10 concentrations resulting from the undisturbed Libanon TSF. 41
Figure 5-15: Modelled prediction of the highest 24-hour average PM2.5 concentrations resulting from the undisturbed Libanon TSF. 41
Figure 5-16: Modelled prediction of annual average PM2.5 concentrations resulting from the undisturbed Libanon TSF. 41
Figure 5-17: Modelled prediction of the highest 24-hour average PM10 concentrations resulting from starting reclamation at the Libanon TSF northern area. 42

Figure 5-18: Modelled prediction of the highest 24-hour average PM2.5 concentrations resulting from starting reclamation at the Libanon TSF northern area. 42
Figure 5-19: Modelled prediction of the highest 24-hour average PM10 concentrations resulting from the Libanon TSF project area after reclamation is completed. 42
Figure 5-20: Modelled prediction of the highest 24-hour average PM2.5 concentrations resulting from the Libanon TSF project area after reclamation is completed. 42
Figure 5-21: DRDGOLD Activities in the West Rand (Source: DRDGOLD web site) 48
Figure 5-22: Libanon TSF reclamation project infrastructure and closest noise-sensitive receptors 52

Tables

Table 2-1: Legislation Summary 5
Table 4-1: Project perspective and technical details 16
Table 4-2: Estimated timeframes and deadlines of the different phases associated with the Libanon Project 17
Table 4-3: Summary table of the Activities associated with the different phases of the Proposed Project 17
Table 5-1: Storm rainfall depths for the project 19
Table 5-2: Evaporation for the area 20
Table 5-4: Table providing descriptions of the habitat types delineated for the PAOI 27
Table 5-5: Summary of the screening tool vs specialist assigned sensitivities 28
Table 5-6: Summary of the Screening Tool Sensitivity versus the Specialist assigned Site Ecological Importance (SEI) for the Field Survey Area of the Project Area 31
Table 5-7: UTM coordinates and elevation of modelled receptors 39
Table 5-8: Comparison of maximum modelled concentrations at the four discrete receptors for the three modelled scenarios. 40
Table 5-9: Basic Demographics of the Area, 2011 and 2022 44
Table 5-10: Access of Households to Basic Services, 2011 and 2022 44
Table 5-11: Education levels: Percentage of the adult population above 21 years, 2022 45
Table 5-12: Educational facilities, 2022 45
Table 5-13: Basic Health Indicators, 2017 46
Table 5-14: Crime Statistics, 2022 46
Table 5-15: The sectoral employment distribution, 2018 47
Table 5-16: Major gold mines in the local area 47
Table 5-17: The local labour force, 2011 and 2022 49
Table 5-18: Income and Poverty levels 49
Table 8-1: Consequence Rating Definitions 57
Table 8-2: Probability Rating Definitions 59
Table 8-3: Significance Rating Methodology 59
Table 8-4: Risk Assessment 60
Table 14-1: Relinquishment Criteria 78
Table 15-1: Closure Cost Assumptions 81

Appendices

Appendix A: Curriculum Vitae

Appendix B: Closure Costing

Abbreviations

Abbreviation	Description
ARPs	Annual Rehabilitation Plans
CBAs	Critical Biodiversity Areas
CPP	Central Processing Plant
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme Report
ERA	Environmental Risk Assessment
ESA	Ecological Support Area
FWGR	Far West Gold Recoveries (Pty) Ltd
Kongiwe	Kongiwe Environmental (Pty) Ltd
MHSA	Mine Health and Safety Act (No. 29 of 1996)
MPRDA	Mineral and Petroleum Resources Development Act (No. 28 of 2002)
NAAQS	National Ambient Air Quality Standards
NEMA	National Environmental Management Act (No. 107 of 1998)
NEM:AQA	National Environmental Management Air Quality Act (No. 39 of 2004)
NEM:BA	National Environmental Management Biodiversity Act (No. 10 of 2004)
NEM:LAA	National Environmental Management Laws Amendment Act (No. 25 of 2014)
NEM:WA	National Environmental Management Waste Act (No. 59 of 2008)
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act (Act No. 36 of 1998)
PAOI	Project Area of Influence
PM	Particulate matter
RWLM	Rand West Local Municipality
RTSF	Regional Tailings Storage Facility
SANBI	South African National Biodiversity Institute
SCC	Species of Conservation Concern
SEI	Site Ecological Importance
SAIIAE	South African Inventory of Inland Aquatic Ecosystems
TSF	Tailings Storage Facility
VCR	Ventersdorp Contact Reef
WRTRP	West Rand Tailings Retreatment Project

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1 INTRODUCTION

Far West Gold Recoveries (Pty) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSFs are being reprocessed at present at the Driefontein 2 Plant , with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF).

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- Connecting slurry pipelines to existing pipelines;
- Pollution control paddock;
- Access roads;
- Laydown area; and
- Powerlines,
- Reprocessed tailings will be deposited on the RTSF.

The Department of Environmental Affairs (DEA), in consultation with the Department of Mineral Resources (DMR) identified the need for the alignment of EAs and promulgated a single environmental system under the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) whereby the DMR has become the competent authority for the authorisation of mining-related projects under the Environmental Impact Assessment Regulations, 2014, as amended in 2017 and 2021 (the EIA 2014 Regulations). This has resulted in simultaneous decisions in terms of NEMA, the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM:WA) and other specific environmental management Acts.

The NEMA Regulations Pertaining to the Financial Provision for Prospecting, Exploration, Mining or Production Operations (GNR.1147 of 2015) (the Financial Provision Regulations) require that a final rehabilitation, decommission and mine closure plan is developed which includes the determination of financial provision to guarantee the availability of sufficient funds to undertake rehabilitation and remediation of the adverse environmental impacts of mining. This report presents the final rehabilitation, decommission and mine closure plan for the proposed mine.

The focus of this report is based on areas associated with surface infrastructure and the reclamation of the Libanon TSF.

This plan covers the proposed activities associated with the Libanon TSF Reclamation Project. The perimeter for this plan is the outer extent of the areas associated with the infrastructure and activities relating to the Project.

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2 REHABILITATION, DECOMMISSIONING AND CLOSURE PLAN

2.1 Purpose of the Report

The purpose of this document is to provide a plan that is measurable and auditable to the DMR that takes into consideration the proposed post-mining end land use of the affected area. It must be stated from the outset that to comply with current legislation, this rehabilitation, decommissioning and mine closure plan must be reviewed, updated and revised annually. During this process, changes in baseline information, legislative amendments, spatial developments and any other changes which may impact the closure of the mine must be incorporated to ensure the plan remains current and implementable.

This report encompasses information as per the guideline document pertaining to the Financial Provision Regulations, and therefore includes the definition of the closure vision, objectives and design and relinquishment criteria, indicating infrastructure and activities which will ultimately be decommissioned, closed, removed and remediated.

The risk drivers determine actions, which specify how the closure activities will be implemented to achieve the closure relinquishment criteria as required by the DMR as well as indicating monitoring, auditing and reporting requirements.

2.2 Terms of Reference

Section 41 (1) of Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) has been repealed and replaced by the provisions of Section 24PA in the NEMA, as amended, which provides that the holder of a Mining Right must make financial provision for rehabilitation of negative environmental impacts. The financial provision must guarantee the availability of sufficient funds to undertake the-

- Rehabilitation of the adverse environmental impacts of the listed or specified activities;
- Rehabilitation of the impacts of the prospecting, exploration, mining or production activities, including the pumping and treatment of polluted or extraneous water;
- Decommissioning and closure of the operations;
- Remediation of latent or residual environmental impacts which become known in the future;
- Removal of building structures and other objects; and/ or
- Remediation of any other negative environmental impacts.

In addition to Section 24PA, as mentioned above, the Financial Provision Regulations apply to the Libanon TSF Reclamation Project. Various Draft Regulations dealing with financial provisioning for mines have been published for comment, most recently in 2022, but it is not clear when these will be promulgated. In light of this uncertainty, this report is prepared under the current regulatory regime at date of finalisation.[1]

[1] Although the Financial Provision Regulations were amended in 2016 to provide for an extension of the transitional period for compliance, this was only applicable to certain holders or holders of a right or permit, as deined in Regulation 1. Although FWGR is not such a holder, it has elected to comply with the Regulations and accordingly, Chapter 2 of the Financial Provision Regulations will be applicable to the Libanon TSF Reclamation Project.

Regulation 6 of the Financial Provision Regulations requires a holder of a Mining Right to determine the quantum of the financial provision through detailed itemisation of all activities and costs, calculated based on the actual costs of implementation of the measures required for:

- Annual rehabilitation, as reflected in Annual Rehabilitation Plans (ARPs);
- Final rehabilitation, decommissioning and closure of the mining operations which includes the findings of the Environmental Risk Assessment (ERA); and
- Remediation of latent or residual environmental impacts as identified in the ERA.

It must be noted that exemption from compiling an ARP is being requested as it is expected that no annual rehabilitation will be undertaken in the initial construction and operational phases as the mine project consists of reprocessing slimes dams. The need for an Annual Rehabilitation Plan will be reassessed annually as part of the financial provision update.

2.3 Objectives

The objective of the rehabilitation, decommissioning and mine closure plan, which must be measurable and auditable, is to identify a post-mining land use that is feasible through:

- Providing the vision, objectives, targets and criteria for final rehabilitation, decommissioning and closure of the Project;
- Outlining the design principles for closure;
- Explaining the risk assessment approach and outcomes and link closure activities to risk rehabilitation;
- Detailing the closure actions that clearly indicate the measures that will be taken to mitigate and/ or manage identified risks and describes the nature of residual risks that will need to be monitored and managed post closure;
- Committing to a schedule, budget, roles and responsibilities for final rehabilitation, decommissioning and closure of each relevant activity or item of infrastructure;
- Identifying knowledge gaps and how these will be addressed and filled;
- Detailing the full closure costs for the life of project at increasing levels of accuracy as the project develops and approaches closure in line with the final land use proposed; and
- Outlining monitoring, auditing and reporting requirements.

2.4 Statutory Requirements

There are a number of legal and regulatory frameworks with which the project must comply, which could materially affect rehabilitation and closure:

- Constitution of the Republic of South Africa, 1996;
- NEMA;
- National Environmental Management Laws Amendment Act (Act No. 25 of 2014) (NEM:LAA);
- The Financial Provision Regulations, which replaces the equivalent provisions in the MPRDA – closure and financial provision elements repealed;

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- MPRDA as it pertains to the Mining Work Programme and the Social and Labour Plan;
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) and supporting regulations (NEM:WA);
- National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEM:AQA);
- National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA);
- National Water Act, 1998 (Act No. 36 of 1998) (NWA); and
- Mine Health and Safety Act, 1996 (Act No. 29 of 1996) (MHSA).

Although legislation influencing closure is varied, all statutes require that the impacts of the operation on the environment need to be mitigated and the solutions implemented are required to be sustainable. Table 2-1 details required legislation and its impact on closure.

Table 2-1: Legislation Summary

Applicable Section of the Legislation	Impact on Closure
The Constitution, 1996 In terms of Section 24 of the Constitution "Everyone has the right to an environment that is not harmful to their health or well-being; and To have the environment protected, for the benefit of present and future generations."	Constitutional requirement to ensure that the Plan includes measures that protect the rights of people to an environment that is not harmful to health or well-being post closure.
National Environment Management Act, 1998 Sections 28 (1) and (3) of NEMA set out the duty of care principle, which is applicable to all types of pollution and must be taken into account in considering any aspects of potential environmental degradation. Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment. Section 24PA provides that the holder of an environmental authorisation for a mining activity must maintain and retain a financial provision until a closure certificate is issued and review and adjust the environmental liability from time to time. That holder must also annually undertake the prescribed mitigation and rehabilitation measures.	The measures required in terms of subsection (1) may include measures to - Investigate, assess and evaluate the impact on the environment; Inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed to avoid causing significant pollution or degradation of the environment; Cease, modify or control any act, activity or process causing the pollution or degradation; Contain or prevent the movement of pollutants or the causes of degradation; Eliminate any source of the pollution or degradation; or Remedy the effects of the pollution or degradation. The financial provision must be calculated by an independent party and be subject to audit. These provisions are amplified in the Financial Provision Regulations.
Environmental Impact Assessment Regulations, 2014, as amended in 2017 and 2021 These regulations were developed for the preparation, evaluation, submission, processing and consideration of, and decision on, applications for environmental authorisations.	Any new EIAs or Basic Assessments (BAs) for the mine will be required to consider closure during planning and to include a closure plan and closure estimate to support an authorisation application.
National Environment Management: Waste Act , 2008 Part 8 of Chapter 4 of the Act indicates the requirement to identify the status and risk of contaminated sites and provides a legal mechanism for remediation activities to be instigated and controlled	Contamination resulting from operational activities will require remediation, with the final soil quality meeting requirements as specified in the Acts and Regulations.
Waste Classification and Management Regulations The Waste Classification and Management Regulations require that (Chapter 2, 4(2)) all waste generators must ensure that the waste they generate is classified in accordance	The Waste Classification and Management Regulations and the supporting Norms and Standards as well as Regulations regarding the Planning and Management of Residue

Applicable Section of the Legislation	Impact on Closure
with SANS 10234 within 180 days of generation and if the waste is to be disposed of to landfill that the waste is assessed in accordance with the Norms and Standards for Assessment of Waste for Landfill Disposal (Chapter 2 (8)1) (a)).	Deposits and Residue Stockpile do not contain specifications around closure, other than the requirements in Regulations regarding the Planning and Management of Residue Deposits and Residue Stockpile that stockpiles and deposits be closed according to the relevant provisions in the environmental authorisations, an EMPr and any other applicable legislation.
Regulations Regarding the Planning and Management of Residue Stockpiles and Residue Deposits The regulations specify design approach and considerations for Residue Stockpiles and Residue Deposit (RSRD), but more importantly specify that these facilities must comply with the Norms and Standards.	
Regulations pertaining to the Financial Provision for Prospecting, Exploration, Mining or Production Operations The purpose of these Regulations is to regulate the determine and making of financial provision as contemplated in the Act for the costs associated with the undertaking of management, rehabilitation and remediation of environmental impacts from prospecting, exploration, mining or production operations through the lifespan of such operations and latent or residual environmental impacts that may become known in the future. The Regulations also include detailed descriptions of the wording required in the documentation to support the provisioning for liability using Bank Guarantees and Trust Funds. Finally, the legislation also provides detail on the information to be contained in the following plans: Annual rehabilitation plan Final rehabilitation, decommissioning and mine closure plan Environmental risk assessment report Care and maintenance plan.	Closure planning process will need to be expanded to include Annual rehabilitation plan, Final rehabilitation, decommissioning and mine closure plan, Environmental risk assessment report and Care and Maintenance Plan.
The National Environment Management: Air Quality Act, 2004 This Act regulates atmospheric pollution and repealed the Atmospheric Pollution Prevention Act. The Act came into full effect on 1 April 2010 and entrusts the Department of Environmental Affairs with the task of preventing pollution and ecological degradation, while at the same time promoting justifiable economic and social development. Metropolitan and District Municipalities are charged with issuing atmospheric emission licenses for certain listed activities. It must be shown that the best practical means are being employed to limit air pollution before these certificates	Other aspects of the NEM:AQA such as monitoring and application of management/ mitigation measures may apply during closure.

Applicable Section of the Legislation	Impact on Closure
will be issued. Penalties and criminal sanctions are imposed for noncompliance with the National Management: Air Quality Act. On 1 April 2010, the Department of Environmental Affairs established a list of activities which require atmospheric emission licenses. The Department has published the minimum emission standards resulting from these listed activities. These include the permissible amount, volume, emission rate or concentration of that substance or mixture of substances that may be emitted into the atmosphere and the manner in which measurements of such emissions must be carried out. The consequences of the listing of these activities is that no person may, without a provisional atmospheric emission licence or an atmospheric emission license, conduct an activity listed on the list anywhere in the Republic or listed on the list applicable in a province anywhere in that province.	
The National Environmental Management: Biodiversity Act, 2004 The Act seeks amongst other things, to manage and conserve biological diversity, to protect certain species and ecosystems, to ensure the sustainable use of biological resources and to promote the fair and equitable sharing of benefits arising from bio-prospecting involving those resources. The NEMBA includes a Regulation related to the management of threatened and protected species. A similar Regulation is applied to Threatened Ecosystems. NEMBA has a set of norms and standards for the development of management plans for both species (e.g. Threatened or Migratory Species) and ecosystems (Endangered or Critically Endangered). The National Environmental Management: Protected Areas Act, 2003: Protected areas such as nature reserves and special nature reserves are declared and managed in terms of this Act. Depending on the nature of the protected area, certain activities (such as mining) may require Ministerial consent or be prohibited outright. The Act also aims to promote the sustainable use of protected areas and the participation of local communities in such areas. In addition, it provides for the continued existence of the South African National Parks.	If relevant species or threatened ecosystems are presence on the mine concession, a management plan must be developed in alignment with these norms and standards.
Mineral and Petroleum Resources Development Act , 2002	

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Applicable Section of the Legislation	Impact on Closure
The MPRDA makes provision for equitable access to and sustainable development of South Africa's mineral resources. The MPRDA requires that the environmental management principles set out in NEMA shall apply to all mining operations and serves as a guideline for the interpretation, administration and implementation of the environmental requirements of NEMA.	Historically requirements relating to closure planning and provisioning were included in the MPRDA. These have now been replaced by those in the Financial Provision Regulations under NEMA.
National Water Act, 1998 Section 19 of the NWA sets out the principles for "an owner of land, a person in control of land or a person who occupies or uses land" to: • Cease, modify or control any act or process causing pollution; • Comply with any prescribed waste standard or management practice; Contain or prevent the movement of pollutants; • Eliminate any source of pollution; • Remedy the effects of the pollution; and • Remedy the effects of any disturbance to the bed and banks of a watercourse. It also describes the actions that can be taken by the catchment management agency to enforce the requirements of the NWA.	This places the obligation to mitigate any aspects that cause or have caused pollution as well as to remediate any residual contaminated water at closure.
Mine Health and Safety Act, 1996 This Act deals with the protection of the health and safety of persons in the mining industry but has some implications for environmental issues due to the need for environmental monitoring within mine operations and maintenance of mine residue deposits.	All closure activities will have to be undertaken in a safe manner where the Health and Safety of all workers involved in closure activities is protected.

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3 LIMITATIONS

This document was compiled based on the following assumptions and limitations:

- Current information available to Kongiwe was used in developing the rehabilitation, decommissioning and mine closure plan;
- The information contained within this report is based on current layout plans provided;
- Information, mitigation measures and recommendations given are based on the specialist studies that have been conducted in support of the application process;
- The report has been compiled utilising current legislation pertaining to mine closure and rehabilitation. Amended regulations ,at the time of compiling this document, have not yet been promulgated; and
- This report must be considered as a living document and will be updated as additional information becomes available, new legislation and regulatations are promulgated and as monitoring and rehabilitation progresses.

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4 PROJECT DESCRIPTION

4.1 Project Location

The locality of the Libanon TSF Reclamation Project is presented in Figure 4-1. Land uses over the area are mining, stock farming and limited cropping (maize and vegetables). Due to shallow rocky soil, stock farming is the favoured agricultural practice.

The area is predominantly surrounded by mining infrastructure, disturbed land and open land. The following infrastructure is encountered in the area:

- Roads
- Power lines
- Mine worker hostel;
- Sibanye Libanon Gold Mine infrastructure;
- Celamanzi Shaft;
- Sibanye Settling Dams; and
- Libanon Landfill Site.

This is a “Brownfield Project" as it is the reclamation of a historical mineral storage deposit with partly existing infrastructure. The potential negative and positive impacts of the Proposed Project on the environmental and social aspects were objectively considered though studies undertaken by specialist professionals during the EIA phase.

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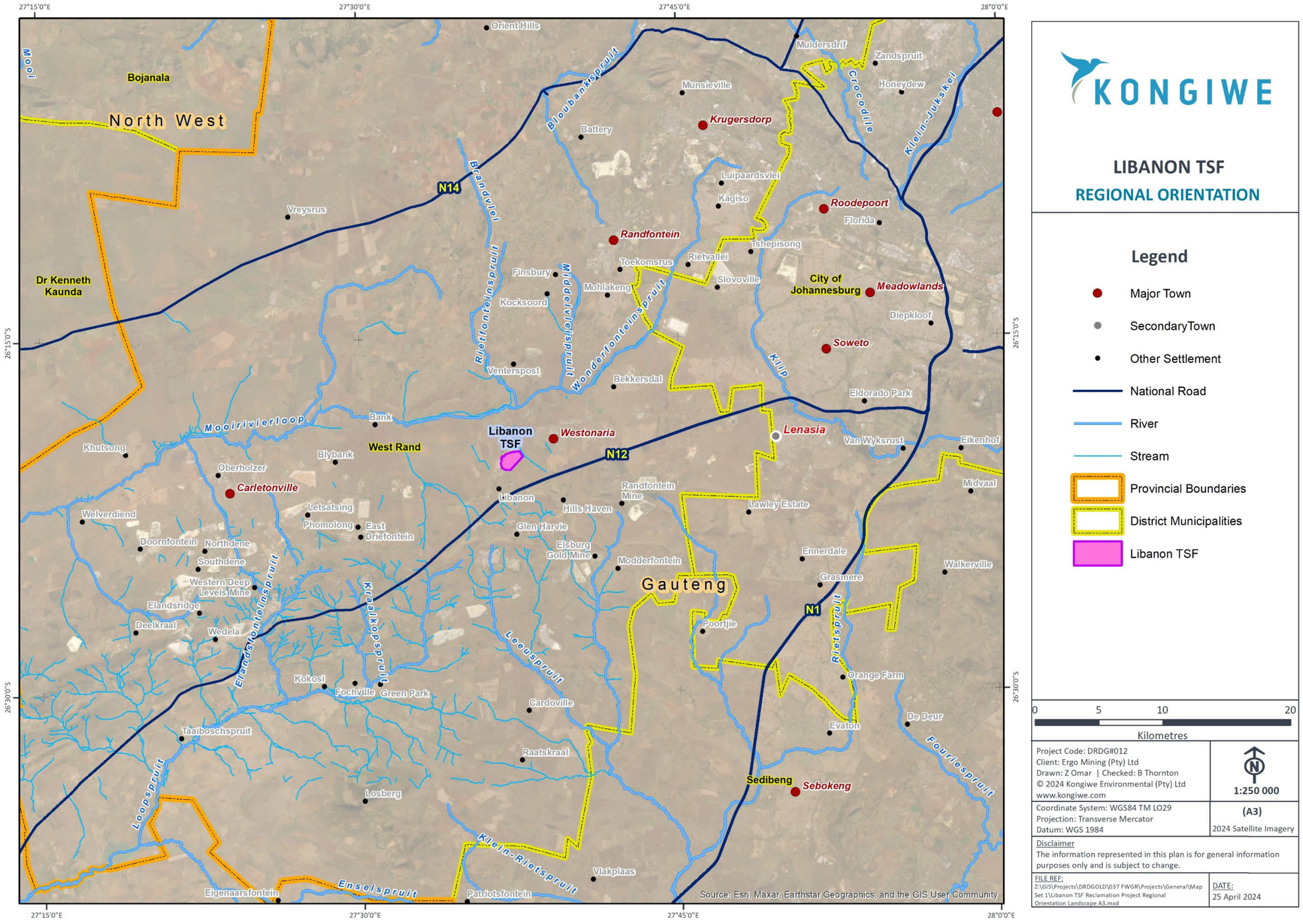

KONGIWE

LIBANON TSF
REGIONAL ORIENTATION

Legend

- Major Town
- SecondaryTown
- Other Settlement
- National Road
- River
- Stream
- Provincial Boundaries
- District Municipalities
- Libanon TSF

0 5 10 20
Kilometres

Project Code: DRDG#012 Client: Ergo Mining (Pty) Ltd Drawn: Z Omar | Checked: B Thornton © 2024 Kongiwe Environmental (Pty) Ltd www.kongiwe.com	1:250 000
Coordinate System: WGS84 TM LO29 Projection: Transverse Mercator Datum: WGS 1984	(A3) 2024 Satellite Imagery
Disclaimer The information represented in this plan is for general information purposes only and is subject to change.	
FILE REF: Z:\GIS\Projects\DRDGOLD\037 FWGR\Projects\General\Map Set 1\Libanon TSF Reclamation Project Regional Orientation Landscape A3.mxd	DATE: 25 April 2024

Figure 4-1: Locality Map illustrating the location of the proposed project

4.2 Activity Description

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant and alternatively in the future other existing gold plants (Figure 4-2). Final deposition will be on the licenced RTSF. The life of mine for the Proposed Project is expected to be 12 years. An estimated amount of 600 000 tons/month of slurry is expected to be pumped from the TSF to the Plants for beneficiation.

4.2.1 Infrastructure intended for the Project

The following infrastructure will be utilised on site:

- Reclamation infrastructure consisting of a pump station which includes:
  - Slurry sump;
  - Penstock;
  - Vibrating Screen
  - Water tank;
  - Motor control centre;
  - Pump;
- A connecting 600mm pipeline for process water from Kloof Shaft 10#;
- A connecting 550mm pipeline to the slurry pipeline to Driefontein 2 Plant;
- Stormwater management infrastructure including:
  - Water infrastructure and stormwater systems;
  - Existing catchment paddocks on the TSF footprint; and
  - Pollution paddock (Lined Catchment Paddock);
- An 11 kV overhead powerline capable of transmitting 3 kVA of electricity and electricity reticulation;
- Administration buildings, including change houses and ablution facilities;
- Access roads, routed from existing entry points; and
- Construction contractors' yards (temporary facilities which include offices, vehicle service area, hydrocarbon storage, diesel storage, chemical toilets/septic tanks).

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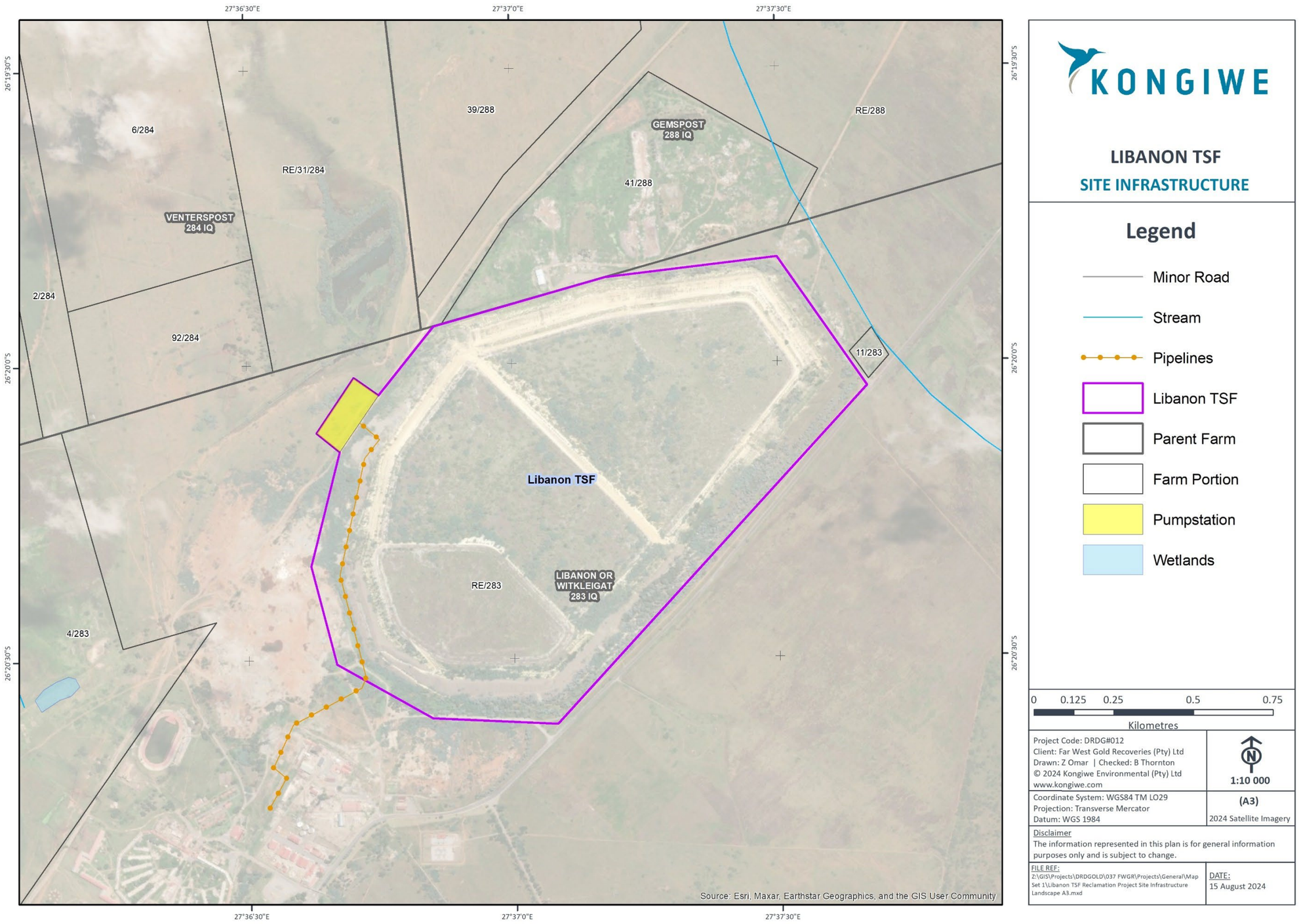

Figure 4-2: Project Infrastructure Map

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4.2.2 Method of Reclamation

The proposed method which will be used to remove the TSF is referred to as top-down hydraulic reclamation. This technique uses high-pressure water monitors (or mobile tracked hydraulic monitors) to deliver a high-pressure water jet to excavate unconsolidated tailings material within the TSF hydraulically. The water from the cannon mixes with the tailings and forms a slurry with a high solids content. The slurry then flows under gravity along trenches at the base of the TSF to a collection sump which is positioned at the lowest elevation of the bench being reclaimed.

At the sump, finger screens remove any debris that may impact pumping operations, and a penstock will control water flow into the sump. The position of the collection sump will change as the reclamation progresses. From the collection sump, the slurry reports to a reclamation station. To control the volume of water reporting to the reclamation station, flapper valves are used to hold and release slurry contained in the collection sump. This slurry will then be pumped via pipelines to the Driefontein No. 2 Plant (or another authorised plant). At the Plant, the slurry is prepared and treated for gold extraction and beneficiation.

Figure 4-3: Mobile tracked hydraulic monitor on a tailings facility in South Africa

Reclamation will take place in predetermined benches (or ‘cuts’) and will move unidirectionally until the entire TSF has been reclaimed. Generally, 30 m cuts are made for reclamation as per Figure 4-4 below.

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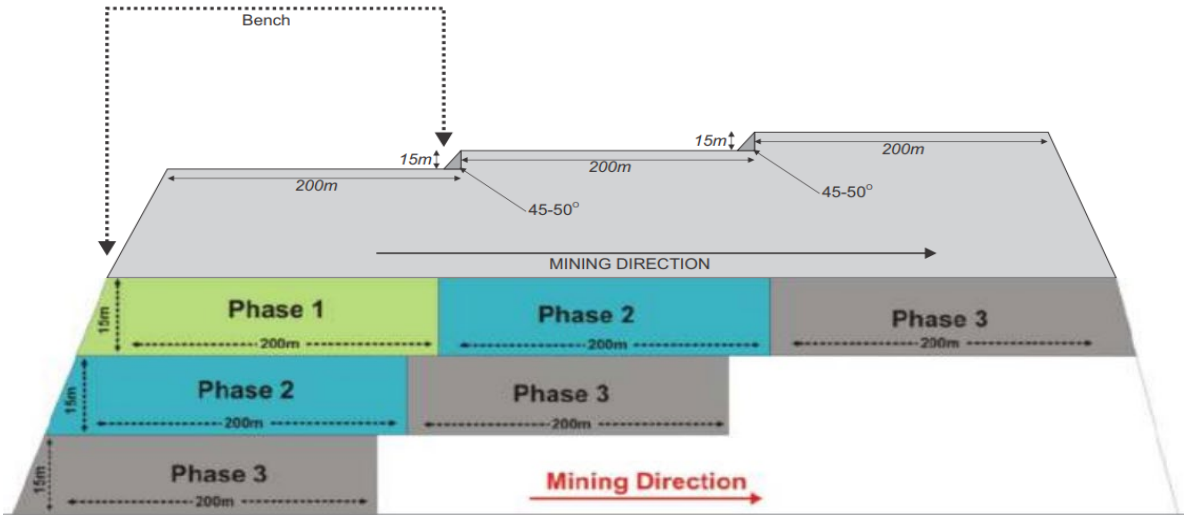

Figure 4-4: Typical bench widths proposed for a gold reclamation project

(Source: www.drdgold.com/investors-and-media/circulars/cpr-samrec-wrtrp-26022018.pdf)

4.2.3 Pipelines

There are pipelines linking the Libanon TSF with the Driefontein No. 2 Plant already in existence and authorised although there will also be new short connecting pipelines for process water and slimes. The connecting slimes pipeline will run from the Pumpstation located Northwest of the TSF, to existing pipelines running to the Driefontein No.2 Plant.

4.2.4 Access

Major routes around the mine dump are the N12 which runs 2km to the South of the TSF and Bridges Avenue which runs parallel to the TSF. As far as possible, existing access roads will be utilised, and where this is not possible, these will be constructed as a two-by-two roadway, operating in both directions. Where access roads are to be constructed, these will be 4 m wide gravel road with stormwater earth channels and mitre drains to protect the road structure from flood damage. Intersections will be properly designed to provide safe entry and exit in and out of the project area. Approvals from the provincial roads' authorities will be obtained where necessary.

4.2.5 Power Supply and Potable Water

The proposed reclamation activity will require the construction of a new 11 kV powerline. Power will be supplied by Eskom and potable water will be purchased from the municipality or existing sources, with a contingency for portable JoJo tanks or connection to existing water pipeline infrastructure.

4.2.6 Process Water

In terms of process water, the water cycle operates as a closed circuit, meaning that limited make-up water will be required for the reclamation of the TSF. Water required for the reclamation activity will be sourced from the return water from the RTSF and make up water from the Kloof Shaft 10#, this will be conveyed through an existing process water pipeline to the project site for reuse in a closed-circuit system.

4.2.7 Rehabilitation

The property on which the Libanon TSF is situated currently belongs to Sibanye-Stillwater (Sibanye). As such, the rehabilitation will need to be in line with Sibanye's closure plans. At present Sibanye's closure plan indicates that the end land uses for the areas associated with the TSF footprints will most likely be to rehabilitate the disturbed areas to align with the surrounding mix of land uses (predominantly agriculture), and establish vegetation types congruent with the surrounding vegetation communities.

Once the TSF has been reclaimed, rehabilitated and cleared of radiation, the land will be shaped and revegetated to match the surrounding environment. The land will then be made available to Sibanye to use at its discretion.

4.2.8 Works Schedule and Life-cycle of the Project

The anticipated life span of the project is approximately 12 years. It is expected that there would be a 1 year construction and ramp-up period which would include the placement of infrastructure and site preparation, a 6 year Life of Operation (LoO) where active hydraulic reclamation and mechanical removal would take place, a 2 year ramp-down period and 3 years to rehabilitate the reclaimed site.

The mining method is divided into five stages, as shown in Figure 4-5 below.

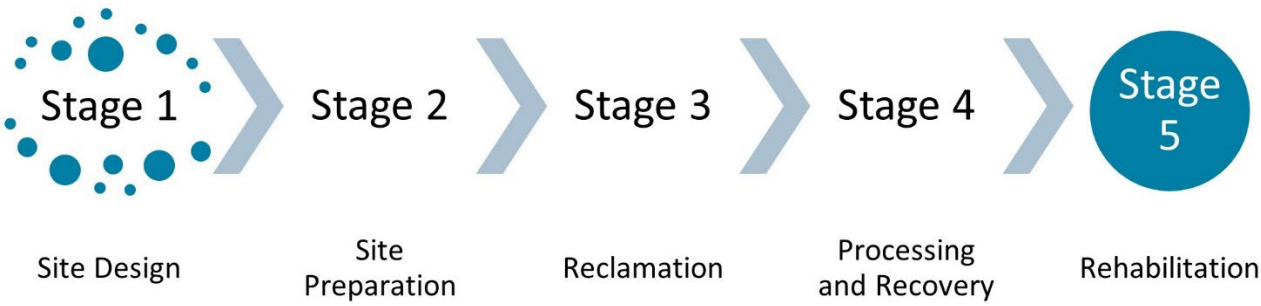

Figure 4-5: Stages of the mining method

Information that provides perspective on the scale of the Proposed Project is presented in Table 4-1 below.

Table 4-1: Project perspective and technical details.

Group	Specific	Details
Reclamation	Target Mineral	Gold, nickel, silver, pyrites and all associated minerals in mine tailings.
	Reclaimed Area	The Proposed Project site covers a combined total area of **170 Ha**.
	Depth of minerals	Only surface reclamation will be taking place.
	Extent of area for infrastructure	0.5 Ha
	Product	Gold will be the primary product during the reclamation of the TSF, although nickel, silver and associated metals are present in the tailings.
Resource use	Water demand	Process water in a closed circuit for hydraulic reclamation and reclamation activities.
	Power demand	Eskom
Employment	Staff allocation: construction	Continual Development
	Operating Times	7 days a week - 24 hours a day

4.2.8.1 Estimated Project Timeframes

Table 4-2 gives an indication of the estimated timeframes in relation to the implementation of the actions, activities or processes of the mining phases (construction, operation and decommissioning) for the Proposed Project.

Table 4-2: Estimated timeframes and deadlines of the different phases associated with the Libanon Project

Phase	Timeframe	Year Start Date
Pre-Construction and Construction for the site	1 year	2027- 2028
Operations starting at Libanon TSF	6 years	2028 – 2034
Decommissioning and rehabilitation of Libanon TSF	5 years	2034 – 2039

4.2.8.2 Life-Cycle Phases of the Project

The following table is summary of the activities that will occur at the different phases of this project.

Table 4-3: Summary table of the Activities associated with the different phases of the Proposed Project

Activity	Description
Pre-Construction	
1	Conduct a further pre-construction baseline radiation walk-over survey
2	Removal of vegetation and site clearance
3	Preparation of access roads should this be required
4	Initiation of a community forum for engagement throughout the project life cycle
5	Start implementing monitoring plans, Authorisation, Licensing and EMPr condition.
6	Employment of workers should this be required (minimal)

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Activity	Description
Construction phase	
7	Operation of construction machinery and vehicles
8	Install reclamation station and its associated infrastructure
9	Construction of pipelines and electricity reticulation and power line
10	Instatement of waste management and dust control measures on site
11	Desilting of existing facilities
12	Instatement of traffic signage, access, parking bays
Operational Phase	
13	Reclamation Activities (including concurrent rehabilitation)
14	Operation of pipes
15	Operation of pump station and the associated infrastructure
16	Continued community engagement
Decommissioning	
17	Decommissioning and rehabilitation activities: Demolition of temporary infrastructure such as: screens, the pumpstation and pipelines, and Rehabilitation of the project area.
18	Closure forum to be established with key stakeholders.
Post-Closure	
19	Post- Closure Monitoring.

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5 ENVIRONMENTAL CONTEXT

Baseline biophysical and socio-economic information was obtained from Kongiwe's EIA Report as well as from a number of specialist studies that were conducted as a result of the Project.

5.1 Climate

5.1.1 Rainfall

Rainfall data for the area was obtained from the DWS weather station C2E007 located at the Zuurbekom pump station, 19 km east of the project. This station is the closest available weather station to the project with a recent rainfall record and a similar altitude. Rainfall data was extracted for the period between October 2002 – September 2020, which was the most recent and complete record available. The mean monthly rainfall is depicted in Figure 5-1. The area has a Mean Annual Precipitation (MAP) of 685 mm. Rainfall is highest over the summer months of October to April, with January generally being the wettest month. The remaining winter months receive much less rain, with July being the driest month.

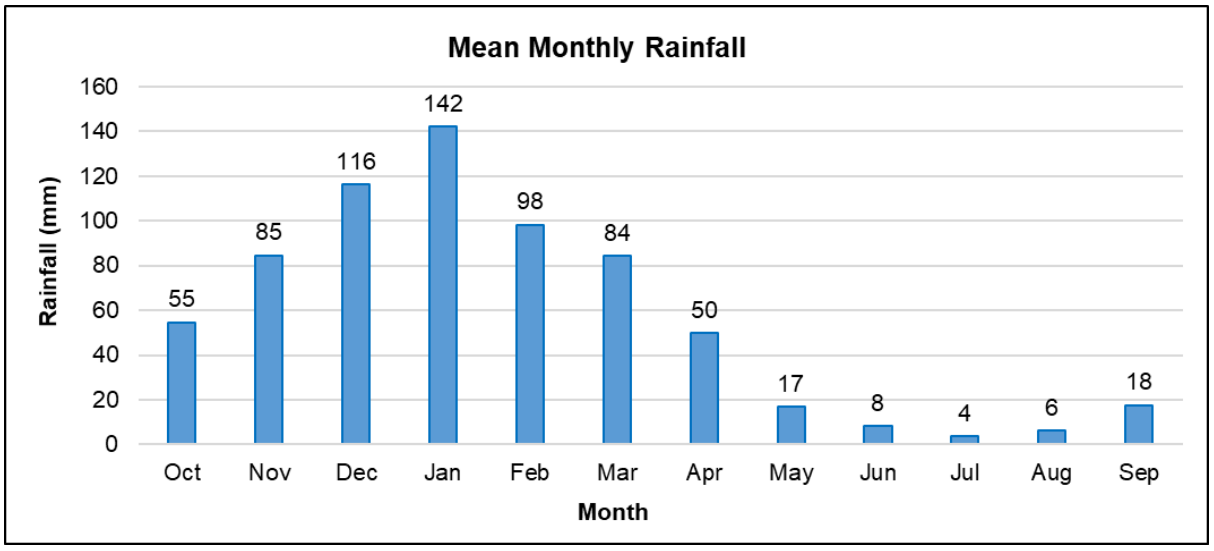

Figure 5-1: Mean monthly rainfall for the area

The storm rainfall depths for the centre position of the Libanon TSF were extracted from the Design Rainfall Estimation in South Africa software programme (Smithers and Schulze, 2002). The programme uses the six closest rainfall stations to a user specified position, to calculate the storm rainfall depths. The extracted storm rainfall depths for various storm durations and recurrence intervals for the project are provided in Table 5-1.

Table 5-1: Storm rainfall depths for the project

Storm Duration	Storm Rainfall Depth (mm)						
	1:2 yr	1:5 yr	1:10 yr	1:20 yr	1:50 yr	1:100 yr	1:200 yr
5 min	9	12	14	16	18	20	22
10 min	13	17	20	23	26	29	32

Storm Duration	Storm Rainfall Depth (mm)						
	1:2 yr	1:5 yr	1:10 yr	1:20 yr	1:50 yr	1:100 yr	1:200 yr
15 min	16	21	25	28	33	36	40
30 min	20	27	32	36	42	46	51
45 min	23	31	37	42	48	53	58
1 hr	26	35	40	46	53	59	65
1.5 hr	30	40	47	53	62	68	75
2 hr	33	44	52	59	68	75	83
4 hr	39	53	61	70	81	90	98
6 hr	44	58	68	77	90	99	108
8 hr	47	62	73	83	96	106	116
10 hr	49	66	77	88	102	112	123
12 hr	52	69	81	92	106	118	129
16 hr	56	74	86	99	114	126	138
20 hr	59	78	91	104	121	133	146
24 hr	61	82	96	109	126	140	153
1 day	53	71	83	94	110	121	132
2 day	65	87	102	116	135	149	163
3 day	74	99	115	131	152	168	184
4 day	80	107	125	142	165	182	200
5 day	86	114	133	152	176	194	213
6 day	90	120	140	160	185	205	224
7 day	94	126	147	167	194	214	234

5.1.2 Evaporation

As with the rainfall, Symons Pan (S-Pan) evaporation data for the area was obtained from the DWS weather station C2E007, which is located at a similar altitude as the project. S-Pan evaporation measurements are not a true reflection of evaporation from natural open water bodies, as the water temperatures in the S-Pan are higher, resulting in higher evaporation rates. To convert S-Pan measurements to open water evaporation, monthly open water evaporation conversion factors were used, which were obtained from the WR2012 study. The adopted monthly evaporation for the project is indicated in Table 5-2. The open water Mean Annual Evaporation (MAE) is 1 267 mm, with evaporation being highest over the warmer months of September to March, and lowest over the cooler months of April to August.

Table 5-2: Evaporation for the area

Month	S-Pan Evaporation (mm)	Evaporation Factor	Open Water Evaporation (mm)
Oct	162	0.81	132
Nov	166	0.82	136
Dec	168	0.83	139
Jan	168	0.84	141
Feb	139	0.88	122
Mar	128	0.88	113
Apr	101	0.88	89

Month	S-Pan Evaporation (mm)	Evaporation Factor	Open Water Evaporation (mm)
May	84	0.87	73
Jun	67	0.85	57
Jul	75	0.83	62
Aug	106	0.81	85
Sep	144	0.81	117
Total	**1 508**	**N/A**	**1 267**

5.1.3 Temperature

The project area has a mean monthly minimum temperature of around 10,67 C° and a mean monthly maximum temperature of around 23,08 C°, with the hottest months of the year being January, October, November and December (summer), dropping to daily minimum temperature of around 3◦C in July (winter). The area is characterised by warm to hot days and cool evenings. See Figure 4 1, this illustrates the average min and max temperature in Westonaria.

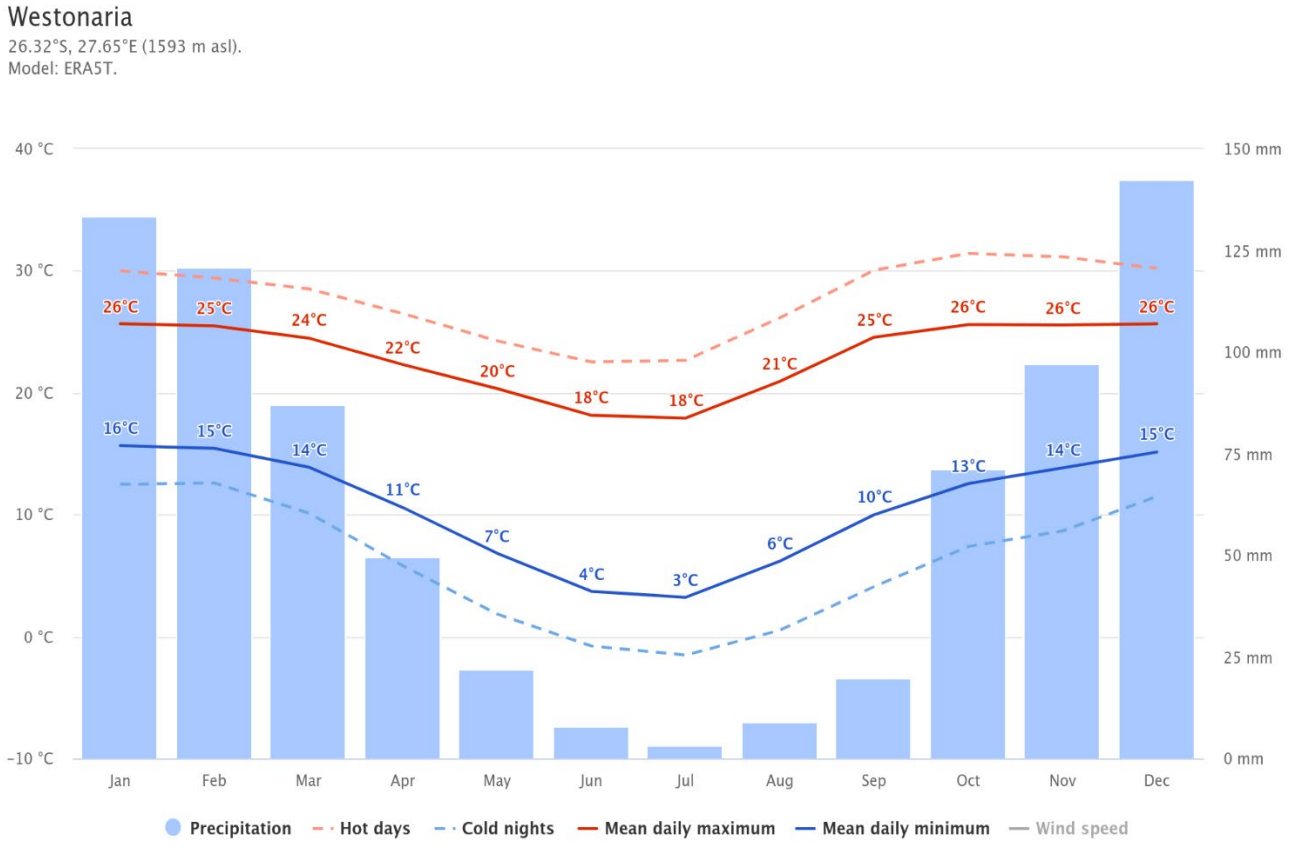

Figure 5-2: Average min and max temperature in Westonaria.

Source: https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/westonaria_south-africa_940316

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5.1.4 Wind Direction

The predominant winds at Libanon TSF site (as given by the Weather Research and Forecasting Model (WRF) data for the period from 2021 to 2023) are from a north-westerly direction for approximately 13 % of the time (Figure 5-3). The highest number of winds with speeds greater than 3 m/s are also expected from the north-westerly direction. The average hourly wind speed predicted by the WRF model is approximately 1.3 m/s. Calm conditions (wind speeds below 0.5 m/s) are predicted for approximately 2.7 % of the time.

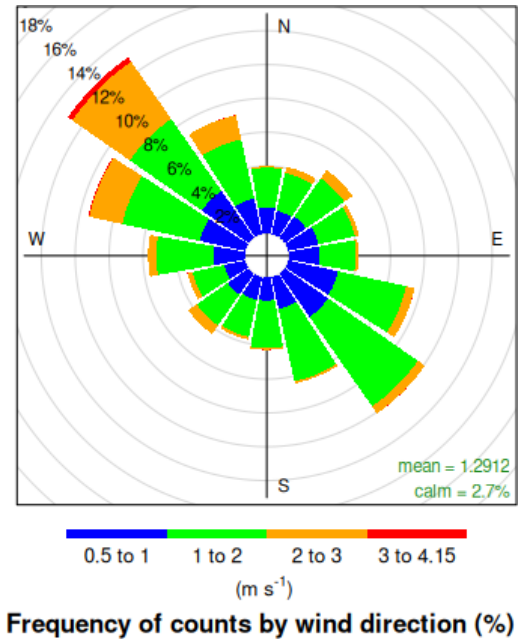

Figure 5-3: Wind rose of the average winds produced by the WRF model for the Libanon TSF for the years 2021-2023.

5.2 Topography

The project area is situated on the open, relatively flat area between the Wonderfonteinspruit to the north and a series of prominent ridges to the south. The ridges run from west to east. The Wonderfonteinspruit perennial stream flows westwards to the north of the TSF, along with two of its tributaries (Rietfonteinspruit and Middelvleispruit). The elevation of the project area is approximately 1 600 m above mean sea level. The local terrain morphology consists of gently undulating grassland which is dissected by the Wonderfonteinspruit.

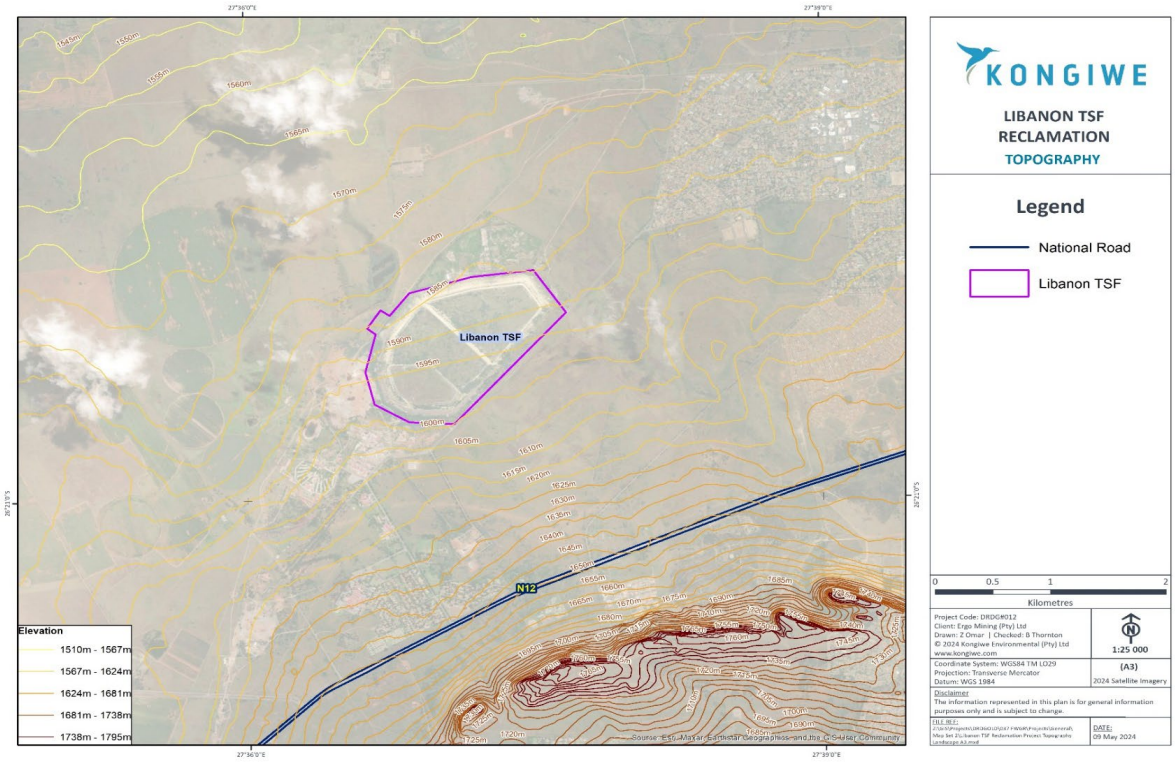

Figure 5-4: Project area topography

5.3 Geology

Five major geological successions are found on the mines of the Libanon Division (the Libanon TSF is situated in the southern section):

- Karoo Sequence;
- Pretoria Group, Transvaal Sequence;
- Malmani Subgroup, Transvaal Sequence (dolomite);
- Ventersdorp Supergroup; and
- Venterspost Conglomerate Formation.

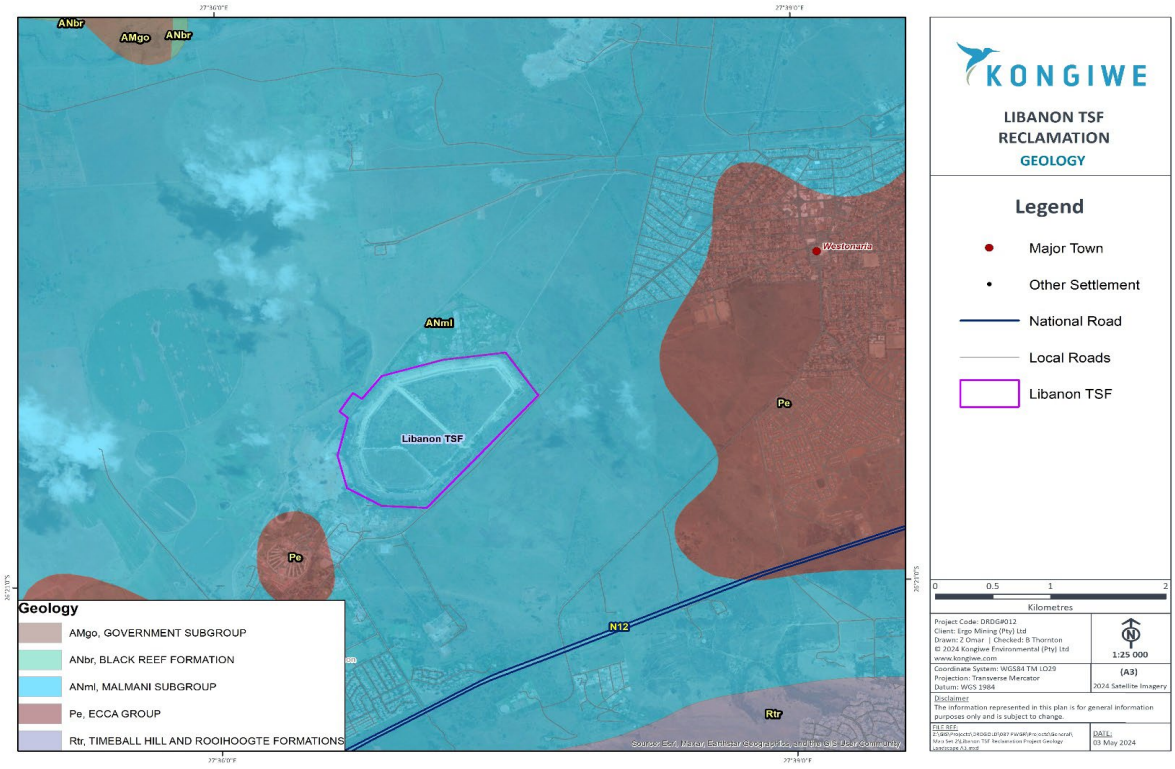

Figure 5-5: Regional geology.

5.4 Soils, Land Capability and Land Use

5.4.1 Soils

There is only one land type occurring in the study area, namely Ab7. Ab land types are freely drained, with red and yellow, dystrophic/mesotrophic soils occupying more than 40% of the area (yellow soils <10%).

5.4.2 Land Capability

The area on which the Libanon TSF is situated is a disturbed area, where previously the Libanon Plant was situated, but has since been demolished. Land on which mine surface infrastructure was established, generally has low agricultural potential.

5.4.3 Land Use

Land uses over the area are mining, stock farming and limited cropping (maize and vegetables). Due to shallow rocky soil, stock farming is the favoured agricultural practice. See Figure 5-7 below.

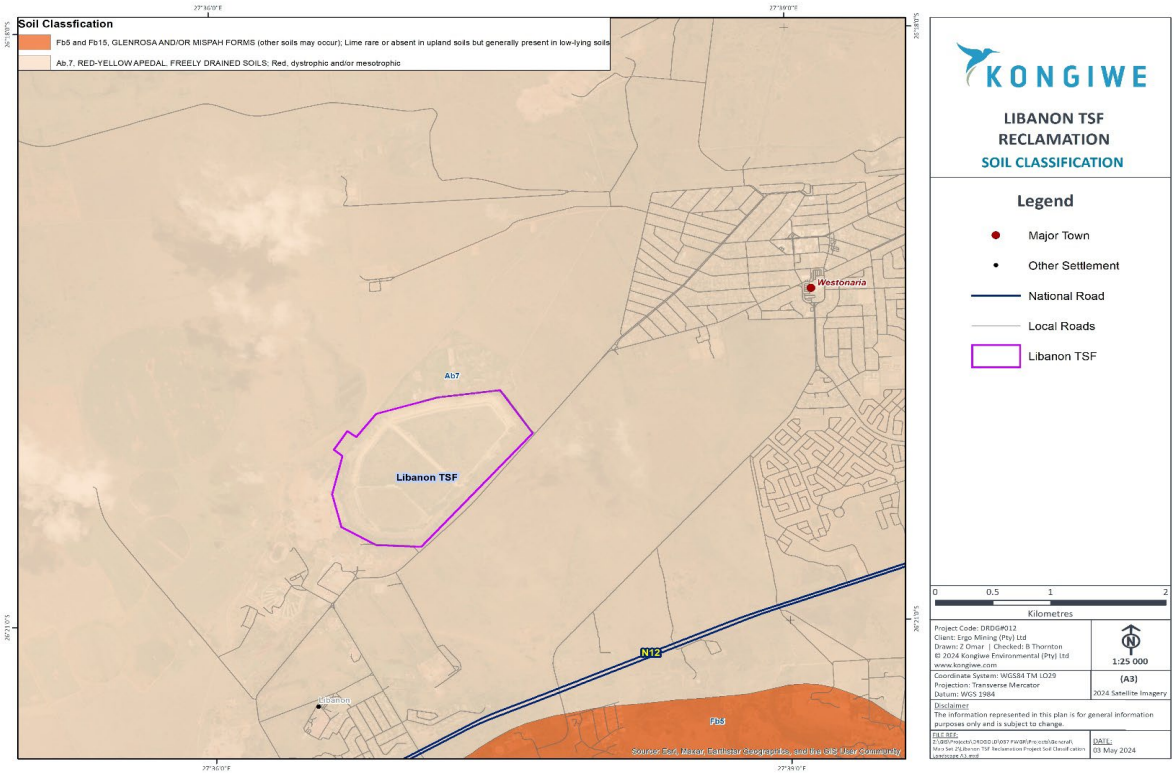

Figure 5-6: Soil map of the project area

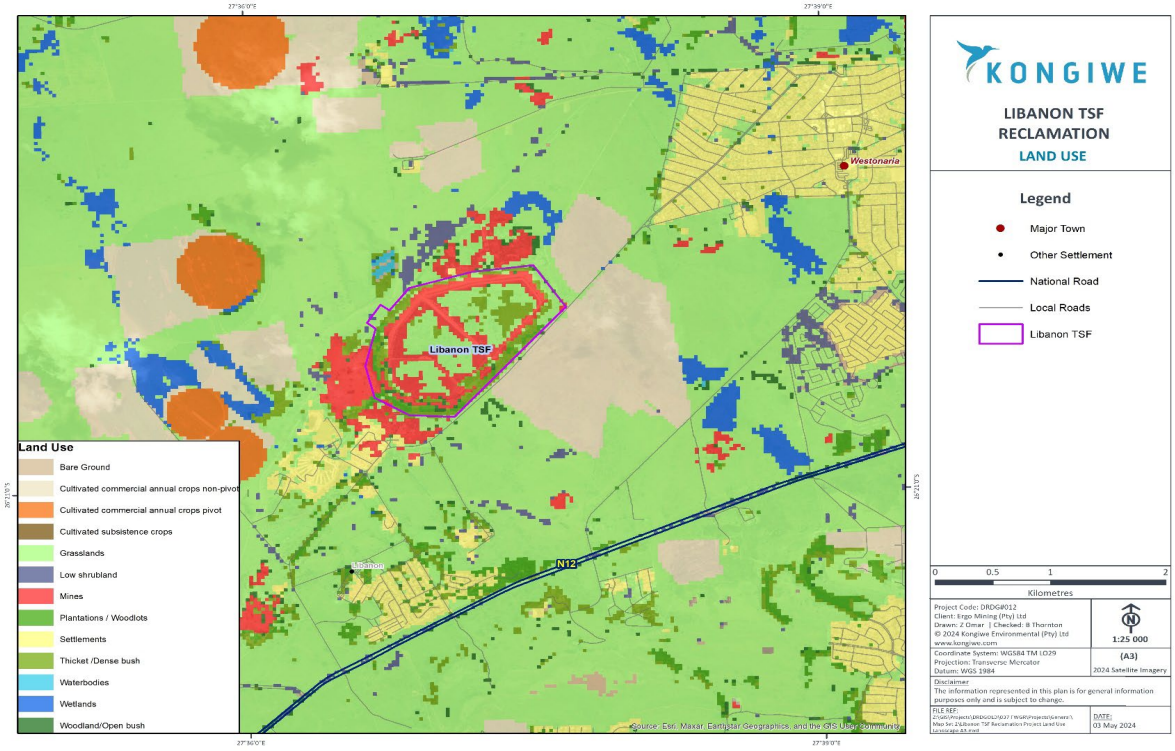

Figure 5-7: Land uses of the Proposed Project site and surrounding area

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5.5 Biodiversity

5.5.1 Habitat Assessment

Four main habitat types were identified across the Project Area of Influence (PAOI) and include:

- Degraded Grassland;
- Secondary Grassland;
- Artificial Water Resources; and
- Alien Stands.

The habitat units for the PAOI can be seen delineated in Figure 5-8 and descriptions of the habitat units can be found in Table 5-3.

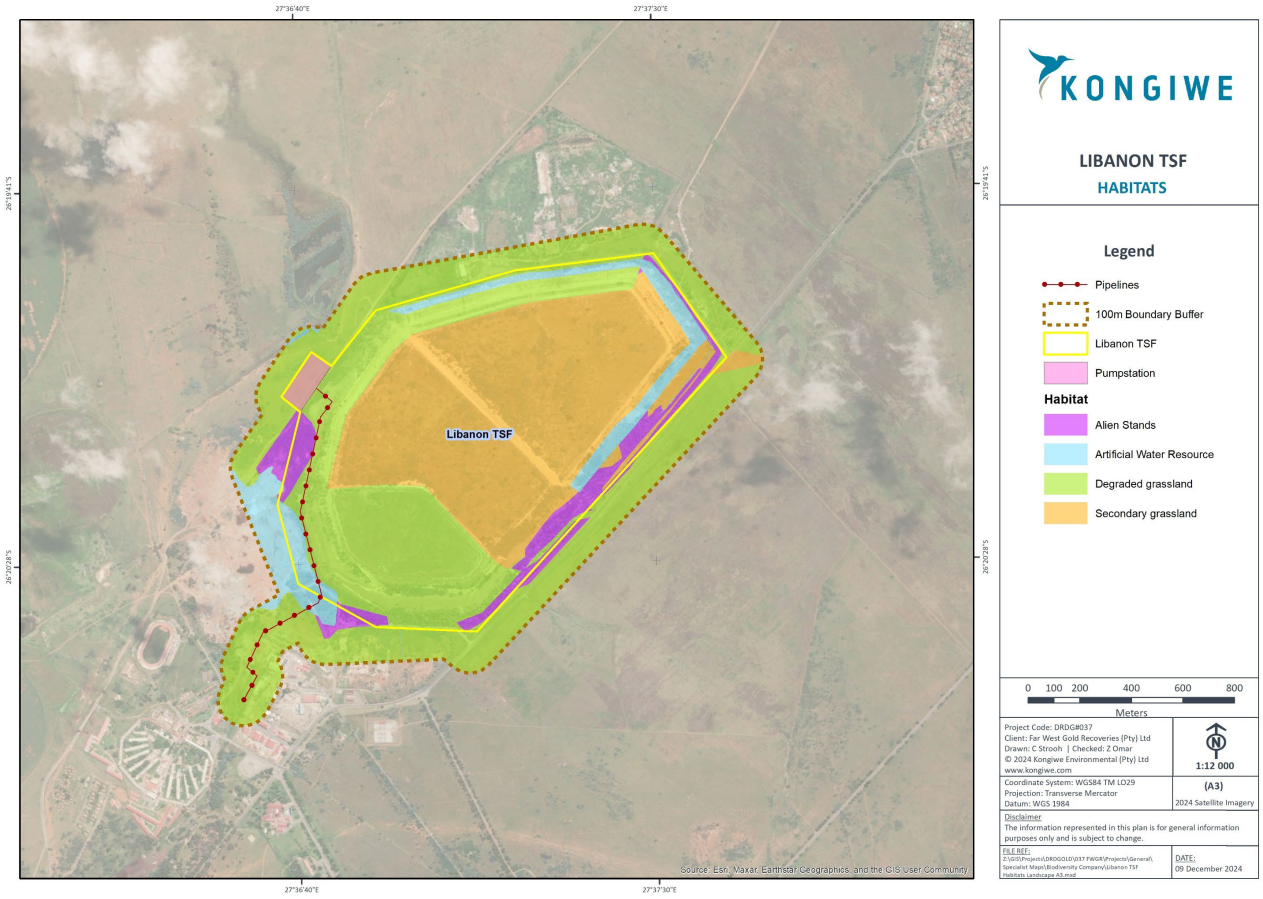

Figure 5-8: Habitats identified within the PAOI

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Table 5-3: Table providing descriptions of the habitat types delineated for the PAOI

Habitat	Description and Condition
Secondary Grassland	This habitat unit is characterised by secondary growth grassland habitat that has naturalized from historical clearing as the PAOI has not been cleared in more than 10 years. Due to the high levels of disturbance, this habitat never regained full ecological function and is associated with high numbers of alien and invasive plants, such as, *Datura stramonium, Verbena bonariensis, V. brasiliensis, Bidens Pilosa, Acacia mearnsii* and *Eucalyptus camaldulensis*. Anthropogenic disturbances were present evidenced by litter amongst the grassland as well as building materials such as concrete blocks and barbed wire. Some sections of this habitat unit are in better condition than others, particularly those bordering on the artificial water resource habitat, with good potential for rehabilitation back to an ecologically stable state. The areas of the site that overlap with the Ecological Support Area (ESA) and Critical Biodiversity Areas (CBA) are not representative of such. Future active rehabilitation would be required to create a potential functional habitat. Dominant indigenous species include, *Themeda triandra, Eragrostis rigidor, Cymbopogon caesius, Hyparrhenia hirta* and *Cynodon dactylon.* Additional common grassland species associated with disturbance and secondary growth are expected. No fauna or flora Species of Conservation Concern (SCC) were observed, and none are expected to be resident in the PAOI. Some fauna SCC may make use of the PAOI for foraging and as a movement corridor.
Degraded Grassland	This habitat unit is characterised by the presence of native grassland species in areas with high anthropogenic disturbances such as livestock grazing, dumping and a well-used road network. This grassland has been cleared within the last 10 years and has not fully recovered. The habitat has a low ecological functionality due to high disturbance levels and the presence of numerous alien plant species such as *Datura stramonium, Verbena bonariensis, V. brasiliensis, Bidens Pilosa, Erigeron bonariensis, Acacia mearnsii* and *Acacia dealbata* as well as areas of bare ground associated with tailings material. Anthropogenic activity has substantially modified this area's primary ecological functions and species composition. Dominant indigenous species include, *Cymbopogon pospischilii, Hyparrhenia hirta, Themeda triandra*, *Cynodon dactylon, Asparagus africanus* and *Gomphocarpus fruticosus.* Additional common grassland species associated with disturbance and secondary growth are expected, as well as some provincially protected species, particularly geophytes. No fauna or flora SCC were observed, and none are expected to be resident in the PAOI. Some fauna SCC may make use of the PAOI for foraging and as a movement corridor however, due to current anthropogenic activity this is unlikely.
Alien Stands	The alien stands habitats, characterized by the presence of fully grown *Eucalyptus camaldulensis, Acacia dealbata* and *Melia azedarach species*, have established themselves within degraded and modified grasslands, as well as open patches. These

Habitat	Description and Condition
	non-native species dominate the landscape, significantly altering the ecological balance. The habitat often occurs near roads and heavily anthropogenically modified areas, where human activities have facilitated the spread of these invasive trees. The ecological characteristics of this habitat are marked by low rehabilitation potential and low ecological functionality. The dominance of alien species, coupled with extensive habitat degradation, makes ecological restoration challenging. The alien stands represent a heavily altered habitat with low ecological value, resulting in a challenging environment for native species and low potential for natural rehabilitation. No fauna or flora SCC were observed, and none are expected to be resident in the PAOI. Some fauna SCC may make use of the PAOI for foraging and as a movement corridor.
Artificial Water Resources	This is a non-terrestrial habitat made up of artificial wetlands and dams within the PAOI. This habitat unit is associated with hydrophytes, such as *Phragmites australis*, as well as high numbers of alien plant species, such as, *Arundo donax* and *Verbena brasiliensis.* No fauna or flora SCC were observed, and none are expected to be resident in the PAOI. Some fauna SCC may make use of the PAOI for foraging and as a movement corridor. Additional information regarding this habitat unit may be found in the accompanying freshwater assessment (TBC, 2024).

5.5.2 Screening Tool Comparison

The allocated sensitivities for each of the relevant themes are either disputed or validated for the overall PAOI in Table 5-4 below. A summative explanation for each result is provided as relevant. The specialist-assigned sensitivity ratings are based largely on the Site Ecological Importance (SEI) process, and consideration is given to any observed or likely presence of SCC species. A map illustrating the overall SEI allocations for the PAOI can be seen in Figure 5-9.

Table 5-4: Summary of the screening tool vs specialist assigned sensitivities

Screening Tool Theme	Screening Tool	Specialist	Tool Validated or Disputed by Specialist - Reasoning
Animal Theme	Medium	Low	**Disputed** – Habitat exists in a largely degraded or modified state with high levels of anthropogenic disturbance, particularly those associated with the TSF on site, as well as historical land clearing. No SCC observed and unlikely to be resident, although some may use the habitats on site for foraging and as a movement corridor.
Plant Theme	Medium	Low	**Disputed** – Habitat exists in a largely degraded or modified state with high levels of anthropogenic disturbance, particularly those associated with the TSF on site. High numbers of alien and invasive plants. No SCC observed and unlikely to occur.
Terrestrial Theme	Very High	Low	**Disputed** – Habitat exists in a largely degraded or modified state with high levels of anthropogenic disturbance, particularly those associated

Screening Tool Theme	Screening Tool	Specialist	Tool Validated or Disputed by Specialist - Reasoning
			with the TSF on site, and has therefore lost much of its ecosystem functionality. Habitat will not recover without human intervention and will continue to degrade over time without rehabilitation. Rehabilitation efforts thus far have been inadequate to return the ecosystem to a functional state. The habitat is no longer representative of an ESA or CBA.

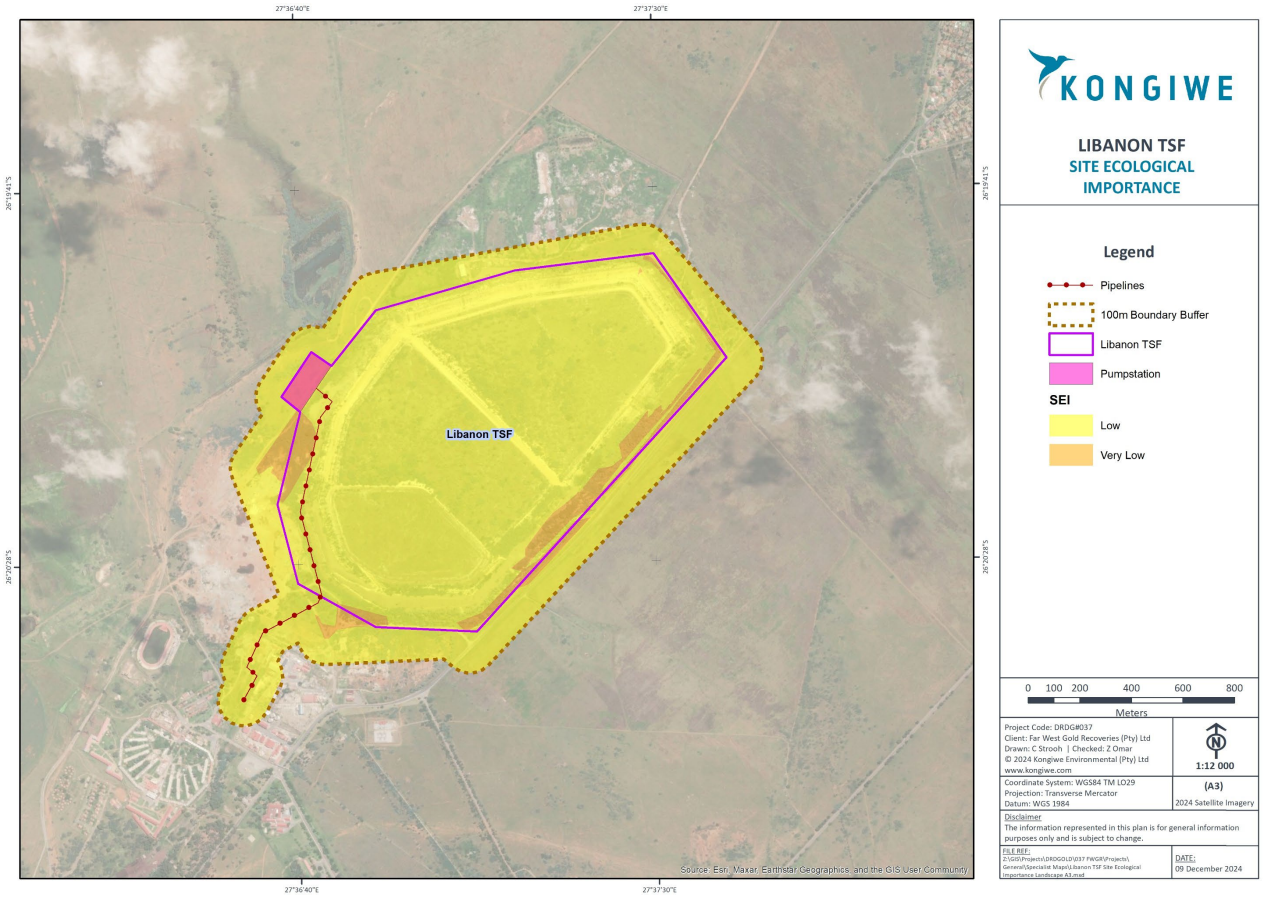

Figure 5-9: Map illustrating the site ecological importance for the PAOI

5.6 Wetlands

5.6.1 Survey Results

During the site visit numerous artificial watercourses were identified within the project area of influence. These include artificial seep wetlands, artificial wetlands, artificial channels, an artificial canal and an artificial attenuation pond (Figure 5-10 & Figure 5-11). Furthermore, no natural wetland or rivers were identified within the 500 m PAOI. Importantly, the project components (TSF, pipeline and pumpstation) do not traverse any natural watercourses, ensuring minimal disruption to the natural hydrological environment. Due to the artificial characteristics of these systems, no further assessment has been undertaken.

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Since no natural watercourses were identified during the site visit and all watercourses were found to be artificial, no foreseeable impacts from the proposed project were identified.

Figure 5-10: Photographical examples of the different water resources found within the 500 m regulated area, A & B) Artificial wetland, C) Artificial Canal, D & E) Artificial Channel, F) Artificial Attenuation Pond and G) Artificial Seep.

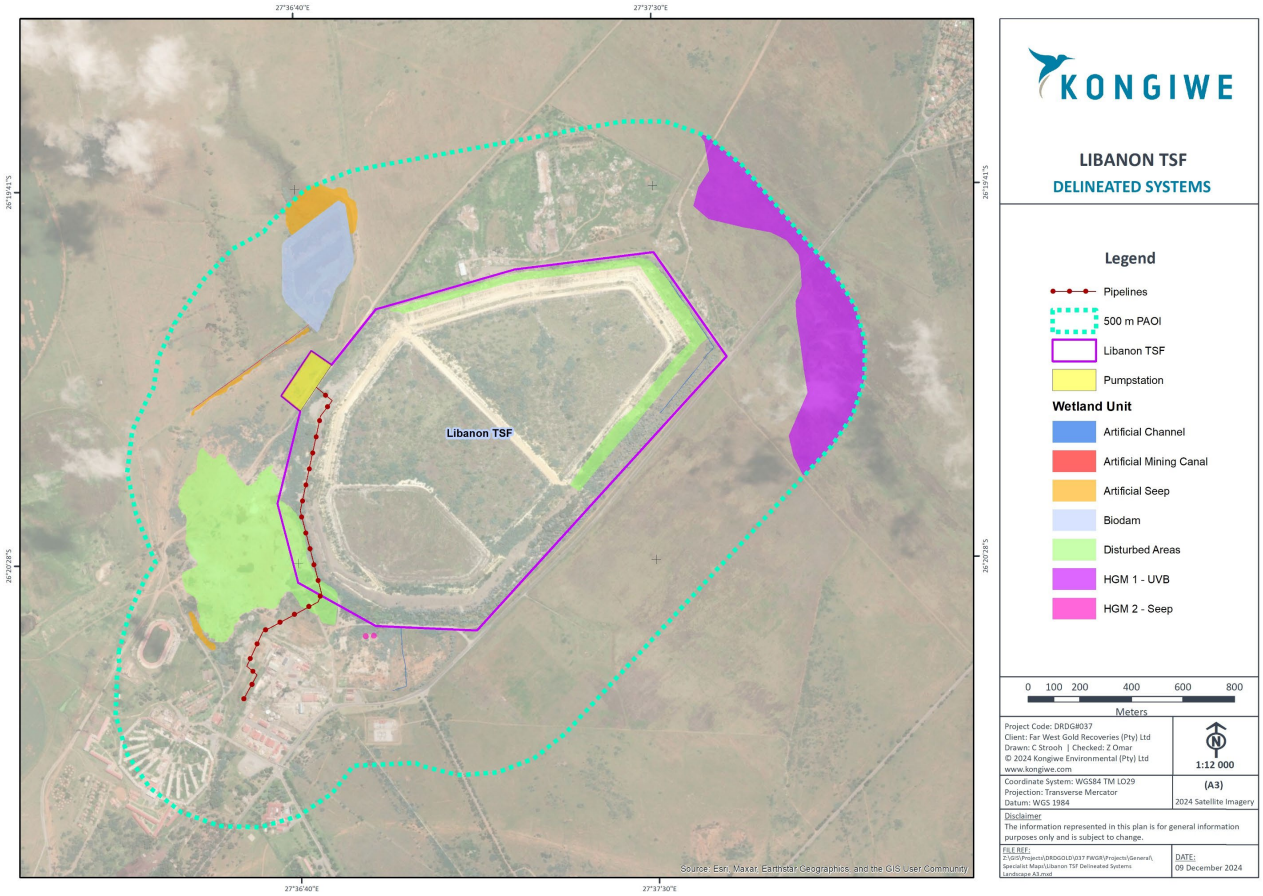

Figure 5-11: The delineated systems of the FWGR Libanon Project

5.6.2 Ecological Sensitivity

Table 5-5 provides a comparison between the Environmental Screening Tool and the specialist determined SEI of the project. The specialist-assigned sensitivity ratings are based largely on the SEI process.

Table 5-5: Summary of the Screening Tool Sensitivity versus the Specialist assigned Site Ecological Importance (SEI) for the Field Survey Area of the Project Area

Screening Tool Theme	Screening Tool	System	Specialist	Tool Validated or Disputed by Specialist - Reasoning
Aquatic Biodiversity Theme	Very High	Wetland	Low	Disputed – Much of the area within the wetland has been historically modified through agricultural fields and road developments. Importantly, this was not identified as a wetland during the site visit due to the absence of wetland vegetation and soil mottling. The proposed activities are not anticipated to significantly modify the hydrological characteristics of the entire area; therefore a “Low” sensitivity has been assigned for these areas in relation to freshwater biodiversity.

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Screening Tool Theme	Screening Tool	System	Specialist	Tool Validated or Disputed by Specialist - Reasoning
	Low	Artificial watercourses	Low	Validated - Due to being artificially created, this area is regarded as degraded due to removal of vegetation and excavations. Furthermore, the artificial watercourses provide no ecological function. Therefore, these watercourses were assigned a "Low" sensitivity
	Low	Remaining area	Low	Validated – No natural surface water features were identified within the rest of the project area of influence.

5.7 Surface Water

The DWS has divided South Africa into primary, secondary, tertiary and quaternary catchments. Primary catchments are the largest defined catchments for South Africa, of which there are 22, and are assigned a letter ranging from A – X (excluding O). Secondary catchments are subdivisions of the primary catchments, and are the second largest catchments in South Africa, and are assigned the primary catchment letter within which they are located, and a number e.g. A5 (secondary catchment 5 located within primary catchment A). Similarly, tertiary catchments are subdivisions of secondary catchments, and are represented for example by A53 (tertiary catchment 3 located within secondary catchment A5). Lastly, quaternary catchments are the smallest defined catchments and are assigned the tertiary catchment number, along with a quaternary catchment letter e.g. A53D (quaternary catchment D located within tertiary catchment A53). Further divisions into sub-quaternary reaches have also been implemented.

Further to the above, the DWS have divided South Africa into 9 Water Management Areas (WMAs). The 9 WMAs include the Limpopo, Olifants, Inkomati-Usuthu, Pongola-Mtamvuna, Vaal, Orange, Mzimvubu-Tsitsikamma, Breede-Gouritz and Berg-Olifants. Not all of the WMAs have been formalised.

The project is located in quaternary catchment C23D which forms part of the Vaal WMA (Figure 5-12).

5.7.1 Surface Water Runoff

Due to the large number of sinkholes that have formed along non-perennial drainage lines and the Wonderfonteinspruit, surface water runoff within quaternary catchment C23D is limited, as it is almost entirely lost to the underlying dolomite via sinkholes. For this reason, as well as the 1 m pipeline that conveys the flow of the Wonderfonteinspruit between the Donaldson Dam and Carletonville, the Wonderfonteinspruit to the north of the project is dry.

5.7.2 Surface Water Quality

The following provides a summary of the water quality:

- pH exceeded the DWS irrigation limit at SW1, SW4, WS001 and WS006. The high pH values that have been recorded are most likely due to agricultural, livestock and mining activities in the area;
- Electrical Conductivity (EC) and Total Dissolved Solids (TDS), which provide an indication of the dissolved salts in water, exceeded the irrigation limit at SW4, as well as regularly at WS001 and WS006. Sodium, which contributes to elevated EC and TDS levels, followed a similar trend. The exceedances are likely due to agricultural and mining activities;
- Orthophosphate was elevated at SW4 and SW5, as well as regularly at WS001 and WS006. Nitrate was elevated at SW4. These exceedances are most likely due to sewage runoff from the upstream settlements and Wastewater Treatment Works (WWTW);
- Aluminium exceeded the stringent DWS limit for aquatic ecosystems at SW4, but was regularly within the RQO limit at all sampling points;
- Copper exceeded the RQO limit at SW1, SW4 and SW5, as well as occasionally at WS001 and WS006;
- Zinc exceeded the DWS aquatic ecosystem limit at SW1, but was within the Kloof WUL limit at this sampling point. Zinc also exceeded the DWS aquatic ecosystem limit at WS001 and WS006 on a number of occasions;
- Manganese exceeded the DWS aquatic ecosystem limit at WS001 and WS006 on a number of occasions; and
- Uranium was within limits at all of the points sampled during the site visit, however, uranium regularly exceeded the RQO limit at WS001 and WS006.

From the above, it is apparent that the water quality of the area is impacted by mining, sewage and agricultural and urban runoff.

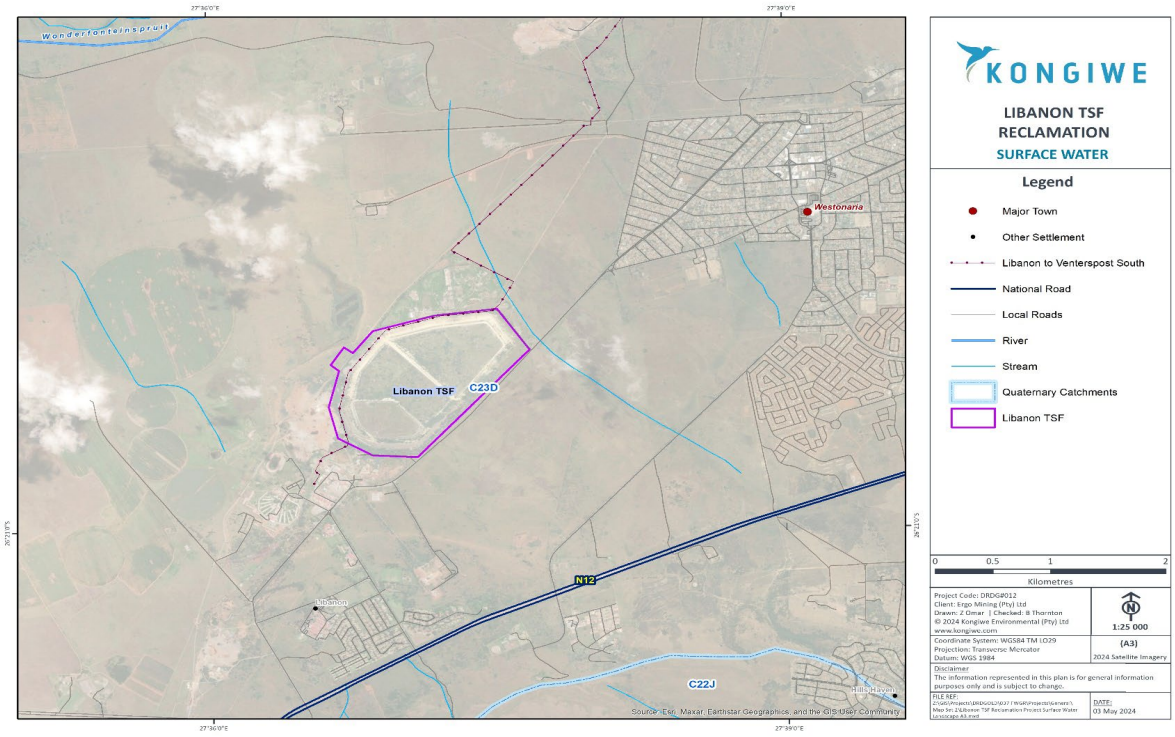

Figure 5-12: Surface Water Map of the Proposed Project site and surrounding area

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5.8 Groundwater

5.8.1 Groundwater Quality

During the August 2024 hydrocensus only one borehole was identified, and a groundwater sample was collected (borehole Lib 1). Another two groundwater samples were collected during the aquifer test program. The water samples were submitted to Aquatico Laboratories for analysis. Aquatico is a SANAS accredited laboratory.

Based on the water quality results the following conclusions were drawn (SANS 241:2015 comparison):

- Chronic Health effects:
  - Total Iron – An elevated iron concentration (exceeding the chronic health limits) was recorded for borehole Lib-BH3s (7.62 mg/L), with the SANS limit set at 2 mg/L. The concentration of dissolved iron in water is also dependent on the occurrence of other heavy metals or could be related to the local Karoo and dolomite geology or leaching from the TSF.
  - Borehole Lib-BH3s is on the downstream side (west) from Libanon TSF. The total iron concentrations were below the detection limit for the other two sampled sites.
  - Manganese – Borehole Lib-BH3s measured a manganese concentration that could result in chronic health effects (22.2 mg/L). The health impact limit is set at 0.4 mg/L.
  - The manganese concentration could be related to the local Karoo and dolomite geology or leaching from the TSF. The manganese concentrations were below detection limit or the SANS aesthetic limit for the other two sampled sites.
  - Sulphate – Borehole Lib-BH3s exceeds the health guideline limits for sulphate with a measured concentration of 1623 mg/L. The health limit set at 500 mg/L).
  - The sulphate concentrations were below detection limit or the SANS aesthetic limit for the other two sampled sites.
  - Nickel – An elevated nickel concentration was recorded for Lib-BH3s (0.136 mg/L). The maximum SANS guideline health limit is 0.07 mg/L. The nickel concentrations were below the detection limit for the other two sampled sites.
- Aesthetic / Operational effects:
  - Ammonium – The ammonium concentration for borehole Lib-BH3s exceeds the aesthetic limits for drinking water (13.0 mg/L) with the aesthetic limit set at 1.5 mg/L.
  - Total hardness – Very hard total hardness values were measured at the two downstream boreholes at Libanon TSF – Lib-BH3s and Lib-BH3d.

In terms of major cations and anions, sulphate is by far the most significant element of concern, with a concentration of above 1500 mg/l for Lib-BH3s. Elevated sulphate concentrations are typical of the impact of gold tailings on groundwater quality, as it is a product of sulphide oxidation.

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In terms of metals, manganese and iron concentrations are significantly elevated. Manganese concentrations exceeding 20 mg/L are probably more reflective of the geochemical character of the residual dolomite (wad) than the impact of the Libanon TSF on groundwater quality. Manganese is one of the byproducts of dolomite dissolution, as discussed earlier. Iron is also to some extent a byproduct of dolomite dissolution, but it is also a characteristic element of the oxidation of sulphide minerals. For this reason, sulphate and iron will be used as the two indicator elements for this impact assessment.

5.8.2 Contamination Modelling

The outcome of the simulations is presented as sulphate and iron concentration contour maps that delineate the anticipated plumes for the three scenarios tested. These are based on the source term discussed earlier. The three operational scenarios tested are:

- **Best case scenario**: comparatively good quality seepage during reclamation and low seepage infiltration, equivalent to dry conditions, to the underlying aquifers.
- **Likely scenario**: measured quality seepage during reclamation and moderate seepage infiltration rates, equivalent to average conditions, to the underlying aquifers.
- **Worst case scenario**: comparatively poor quality leachate during reclamation with higher seepage infiltration, equivalent to wet conditions, to the underlying aquifers. This scenario is also presented as an indication of long-term impacts if the Libanon TSF is not removed, i.e. the No Project option.

The impact assessment was completed for the residual and weathered dolomitic aquifers. Since vertical flow will be prominent underneath the TSF and in the absence of attenuation in the unsaturated zone, potential contamination from surface is likely to affect both aquifers over time.

The overall outcome of the simulations is summarised as follows:

- Simulations suggest that the private borehole south of the Libanon TSF fall outside the anticipated groundwater impact zones delineated for the project. This borehole will therefore not be affected by the tailings reclamation project.
- The plumes are expected to migrate regionally in a north-westerly direction towards the Wonderfonteinspruit in the residual and weathered dolomitic aquifers. It is highly unlikely that plumes associated with the Libanon TSF could reach this stream, even in the long-term. This is because aquifer permeabilities are low and the plumes are anticipated to move less than 50 m per year. In addition, vertical groundwater flow to the level of dewatering in the compartment will prevail until underground dewatering ceases and groundwater levels have regionally rebounded. Previous studies completed on the Kloof underground workings estimate that groundwater levels could recover within 20 years after pumping ceases to an elevation of 1560 mamsl. This is the elevation of the Venterspost Eye from which the compartment is expected to decant into the Wonderfonteinspruit once groundwater levels reach this elevation. Under these conditions the residual dolomitic aquifer underneath the Libanon TSF is expected to remain dewatered, as the current groundwater level in Lib-BH3s is at 1581 mamsl. The deeper weathered aquifer may however recover to 1560 mamsl, thus rewatering Lib-BH3d by approximately 40 m.

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- On a local scale, groundwater flow will be towards the two non-perennial streams northeast and southwest of the Libanon TSF. It is likely that groundwater impacted by the TSF has already reached the stream 200 m northeast of the TSF.
- Flow in the residual and weathered dolomitic aquifers will be controlled by the presence and extent of dolomitic grykes and pinnacles, which was delineated based on a gravity survey completed for the aquifer. Preferential flow is expected in the dolomitic pinnacles. The grykes are expected to be significantly more clay-rich and therefore have lower permeabilities and groundwater flow conditions.
- A small northwestern portion of the Libanon TSF is located within the adjacent Bank Dolomitic Compartment. The boundary between the Venterspost and Bank Compartments is formed by the Venterspost Dyke that transects the northwestern edge of the Libanon TSF. Groundwater levels on the eastern edge of this compartment are not lowered significantly, based on the available dataset (**Error! Reference source not found.**). Preferential flow is therefore likely to take place in this area, as the dolomitic aquifer is not as significantly dewatered compared to the Venterspost Compartment.
- The shape of the plumes is affected by the aquifer parameters as well as the calculated dispersion in the formations. Of most significance is the presence and extent of dolomitic grykes as well as regional post-Transvaal age dykes and faults. Dispersion especially plays a role in the extent to which lower concentrations of sulphate and iron would spread from the TSF. Dispersion can account for the spread of contamination that is not necessarily driven by groundwater flow.
- The zones of significant risk to groundwater quality delineated by the 1000 mg/L sulphate and the 1 mg/L iron concentration contours are expected to be restricted mainly to the footprint of the Libanon TSF. The extent of the zones of significant risk to groundwater reduces for Scenarios 2 and 3. This highlights the importance of implementing a sound water balance during operations and controlling the quality of leachate associated with the TSF. It is noted that FWGR has already committed to measures to control the factors and for this reason, long-term impacts are expected to approximate the likely scenario.
- The historical impact of tailings deposition is expected to continue to affect groundwater quality associated with the project areas in the long-term, even if FWGR removes the tailings as part of the proposed project. This is because the contamination already present in the aquifers will continue to move slowly down gradient, away from the TSF along groundwater flow patterns. For this reason, the shape of the plumes remains similar for the three scenarios tested. The difference is the concentration of contaminants within the plumes and a reduction in the extent of the zone of unacceptable impact after tailings reclamation, as mentioned.
- The extent of the iron plume is larger compared to that of sulphate. This is because lower water quality objectives are imposed on manganese compared to sulphate.

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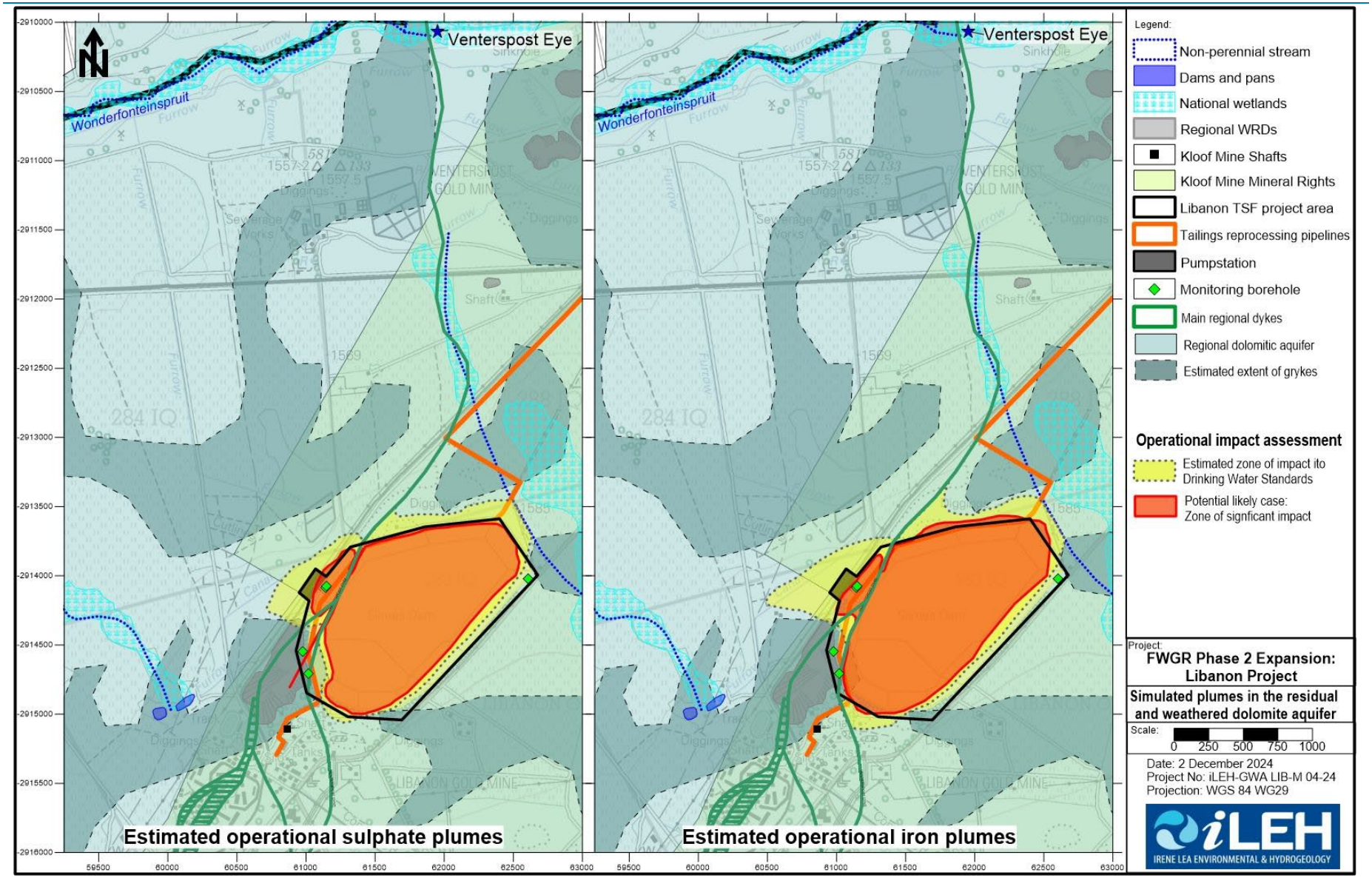

Figure 5-13: Simulated sulphate and iron plumes at the end of reclamation

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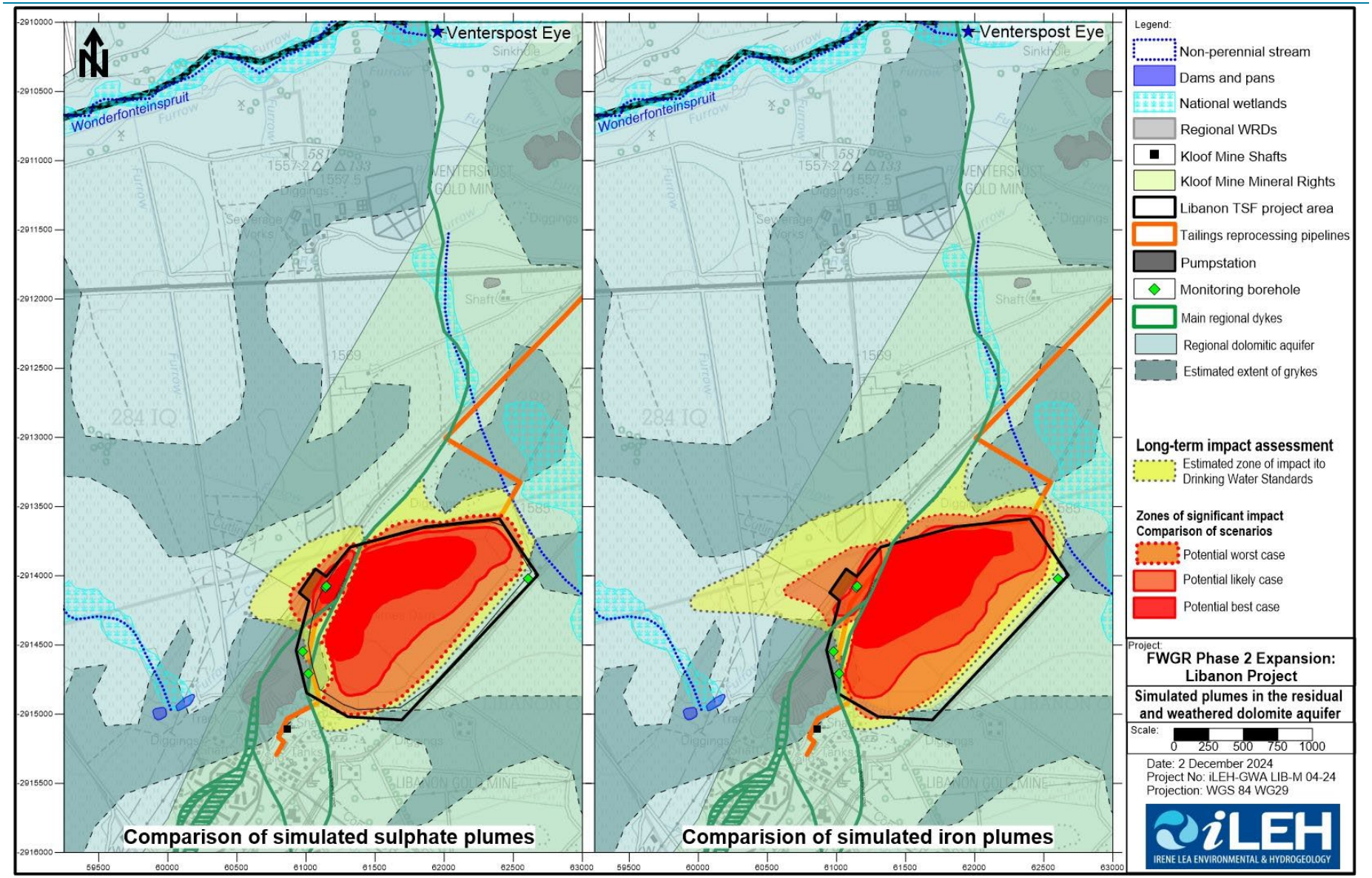

Figure 5-14: Anticipated long-term sulphate and iron plumes

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5.9 Air Quality

Numerous studies have found that air pollution in cities have a major negative impact on the health of both the environment and the surrounding communities. Repeated exposure to air pollutants over long periods of time may potentially cause several respiratory, cardiovascular, reproductive and gastrointestinal health problems.

Particulate Matter (PM) exists in the atmosphere as either solid or liquid particles varying in chemical composition and size, these particles can be considered as either primary or secondary pollutants. Particles can be classified by their aerodynamic properties into coarse particles, PM_{10} and fine particles, $PM_{2.5}$ (Harrison and Van Grieken, 1998). The fine particles contain the secondarily formed aerosols such as sulphates and nitrates, combustion particles and re-condensed organic and metal vapours. The coarse particles contain earth crust materials and fugitive dust from roads and industries (Fenger, 2002). It is the amount of fine dust and the chemical and mineralogical composition of the dust which will dictate the potential for health impacts (Schwegler, 2006).

Dispersion simulations were undertaken for the Proposed Project to determine ambient concentrations of $PM_{2.5}$ and PM_{10} resulting from the Libanon TSF. Three scenarios were simulated – a status quo scenario showing the emissions from the TSF before the start of the reclamation process; a worst-case scenario with reclamation starting along a 40m wide strip along the north side of the TSF; and a post-reclamation scenario where all tailings material has been removed to expose bare 'red earth'.

Four discrete receptors were included in the modelling to illustrate the impact of emissions from Libanon TSF on the surrounding area. The location of the modelled discrete receptors is shown with their elevation and coordinates in.

Table 5-6: UTM coordinates and elevation of modelled receptors

Modelled Receptor	Description	UTM Coordinates	Elevation (m)
1	Closest Westonaria houses north-east of the Libanon TSF	563425.60 m E 7087977.76 m S	1597.13
2	Closest Libanon Gold Mine houses to the south of the Libanon TSF	561300.87 m E 7084733.21 m S	1632.83
3	Closest school north-east of the Libanon TSF	564102.00 m E 7088266.00 m S	1599.79
4	Closest Westonaria houses to the east of the Libanon TSF	564534.00 m E 7086893.00 m S	1621.02

The isopleths of the modelling results for $PM_{2.5}$ and PM_{10} are presented in Figure 5-15 to Figure 5-22. The red isopleths represent the National Ambient Air Quality Standards (NAAQS), therefore, all areas on the map that

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lie within the red coloured isopleth can be expected to experience exceedances of the relevant National Standards.

A comparison of maximum modelled concentrations at the four discrete receptors for the three modelled scenarios is presented in Table 5-7. The modelled concentrations show that the greatest impact of the reclamation process will be experienced to the north of the Libanon TSF. **Furthermore, the improvement in ambient concentrations from the removal of this TSF is clearly evident in the modelled post-reclamation concentrations.**

Table 5-7: Comparison of maximum modelled concentrations at the four discrete receptors for the three modelled scenarios.

Averaging Time	Discrete Receptor	Maximum Modelled Concentration (µg/m^3)		
		Status Quo Scenario	Reclamation Scenario	Post-Reclamation Scenario
PM_{10} 24 hours (99^{th} percentile)	1	12.9c	18.4	3.1c
	2	6.2	6.9	1.5
	3	6.3c	9.5	1.5c
	4	5.5	7.0c	1.3
$PM_{2.5}$ 24 hours (99^{th} percentile)	1	4.4	6.2	1.2c
	2	2.2	2.5	0.6
	3	2.2	3.2	0.6c
	4	1.9	2.5c	0.6

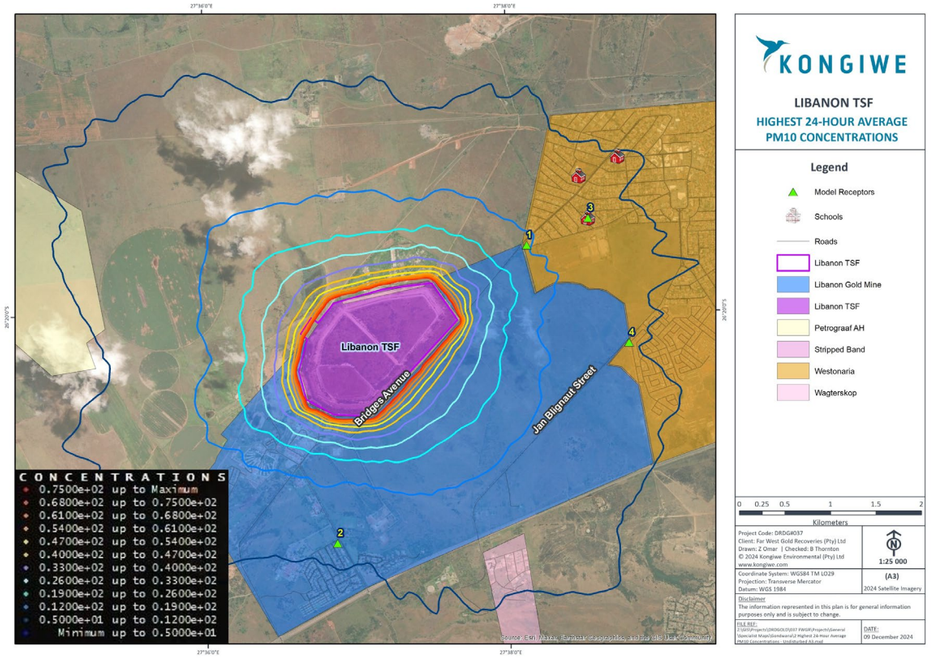

Figure 5-15: Modelled prediction of highest 24-hour average PM10 concentrations resulting from the undisturbed Libanon TSF.

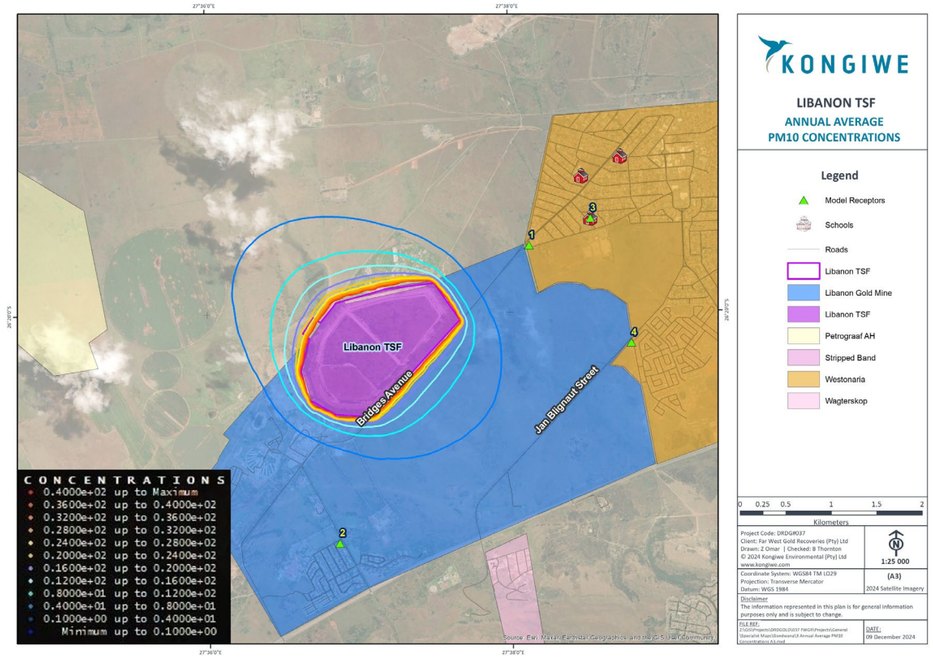

Figure 5-16: Modelled prediction of the annual average PM10 concentrations resulting from the undisturbed Libanon TSF.

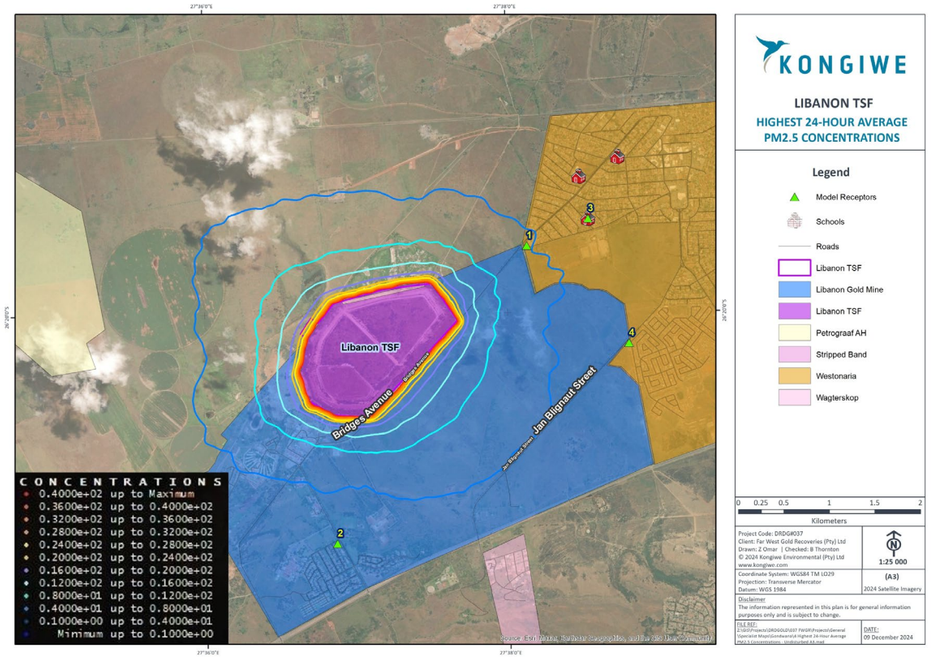

Figure 5-17: Modelled prediction of the highest 24-hour average PM2.5 concentrations resulting from the undisturbed Libanon TSF.

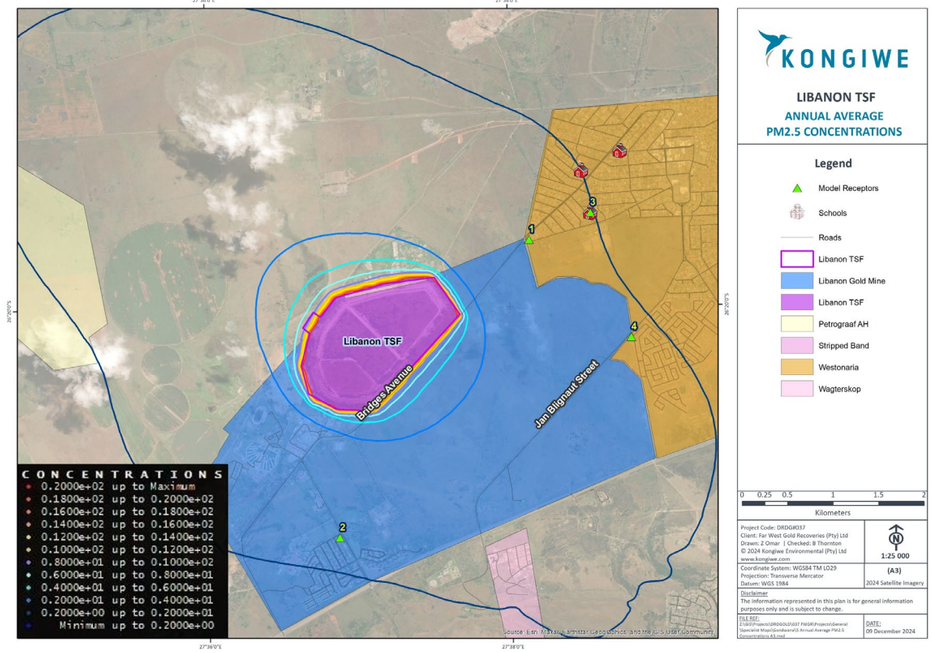

Figure 5-18: Modelled prediction of annual average PM2.5 concentrations resulting from the undisturbed Libanon TSF.

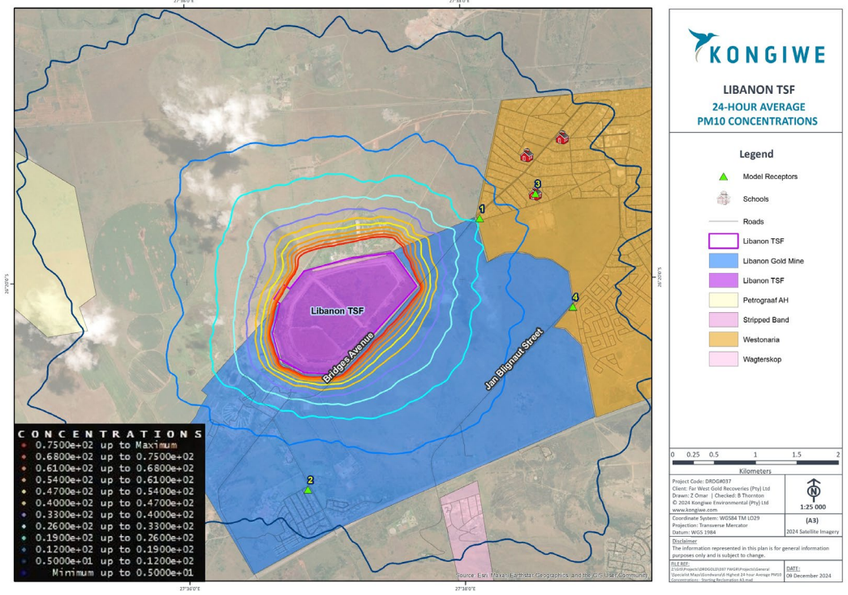

Figure 5-19: Modelled prediction of the highest 24-hour average PM_{10} concentrations resulting from starting reclamation at the Libanon TSF northern area.

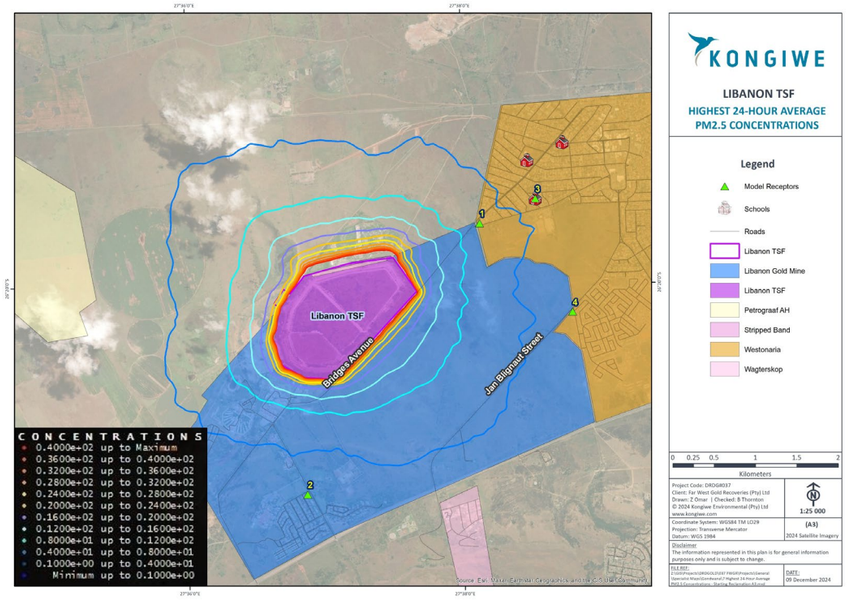

Figure 5-20: Modelled prediction of the highest 24-hour average $PM_{2.5}$ concentrations resulting from starting reclamation at the Libanon TSF northern area.

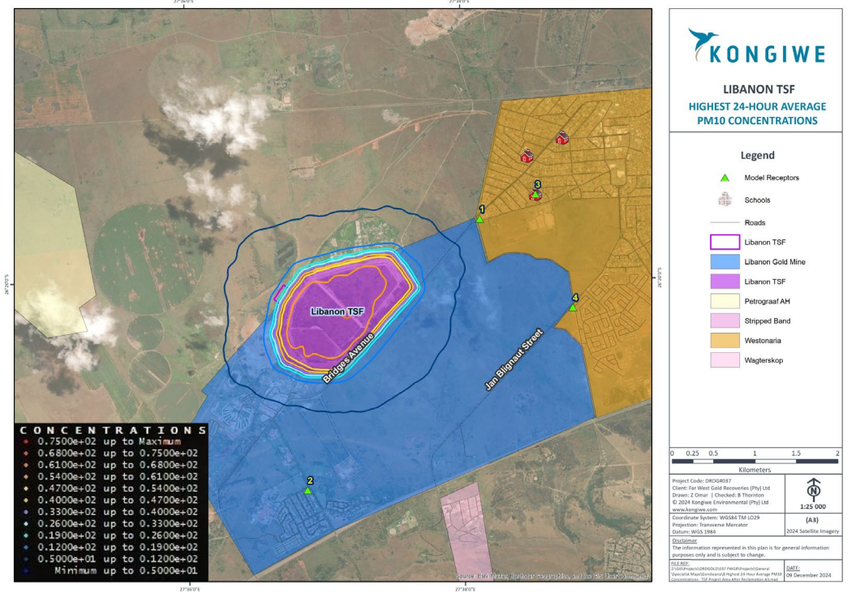

Figure 5-21: Modelled prediction of the highest 24-hour average PM_{10} concentrations resulting from the Libanon TSF project area after reclamation is completed.

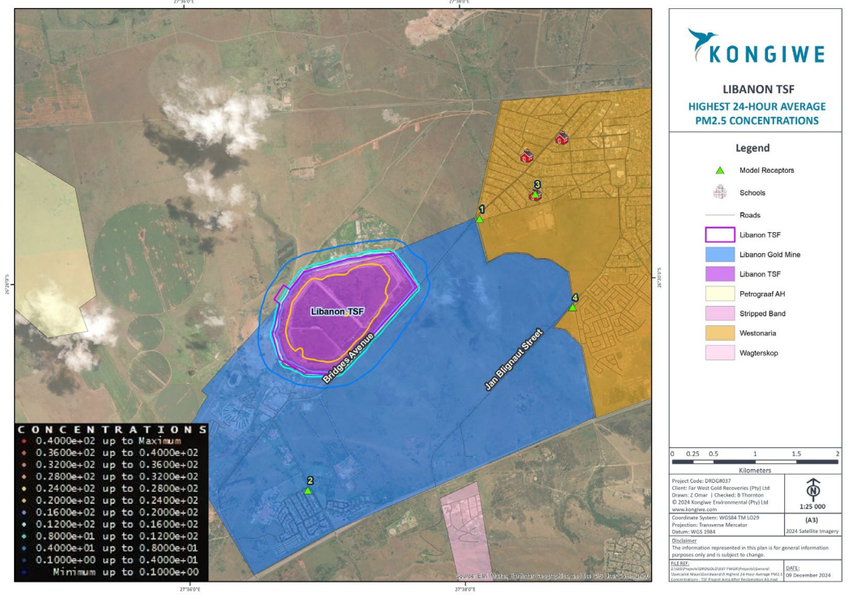

Figure 5-22: Modelled prediction of the highest 24-hour average PM2.5 concentrations resulting from the Libanon TSF project area after reclamation is completed.

5.10 Heritage

The background research revealed that the greater landscape within which the project area is located has a rich and diverse history and contains heritage resources that range from archaeological sites (Iron Age and Anglo-Boer War), through historical farmsteads and mining resources (including graves).

The Libanon TSF landscape is heavily degraded from previous mining land use. This limits the chances of encountering significant in situ archaeological sites to be preserved in situ. The chances of recovering significant archaeological materials were seriously compromised and limited due to historic mining activities.

In accordance with the Environmental Impact Assessment (EIA) conducted for Sibanye Gold Limited's West Rand Tailings Retreatment Project, specifically the Heritage Impact Assessment by Digby Wells (2016), no heritage infrastructure were identified at the Libanon TSF.

5.11 Social

In terms of regional locality, the TSF is situated approximately 2 km west of the Westonaria, in the RWLM.

- The TSF falls within rural RWLM Ward 25. The ward also includes smaller settlements such as Venterspos, Dennydale, Koksrus and West Rand Garden Estates to the north and Libanon Mine Village to the south;
- The town of Westonaria is situated to the north east of the TSF and falls under RWLM Ward 24. The north western section of Westonaria falls within the 2km radius of the project area.

5.11.1 Socio-economic sensitive areas in the vicinity of the project site.

The N12 runs 2km to the South of the TSF. The reclamation area is predominantly surrounded by open area, areas cleared of mining infrastructure and the closed Libanon Gold Mine. The extent of the TSF is approximately 170 Ha.

The closest residential structures to the TSF are the sections of Westonaria to the east and Libanon Mining Village to the south. The village is largely inhabited by some 100 Sibanye employees/families who were handed over property rights to residential structures within the former mine village in 2013 (SANews, 2013). Two social structures are situated to the north of the TSF, namely the Westonaria cemetery and an economic structure.

To the south east of the TSF there is open land (rehabilitated mining area) and to the west agricultural land (irrigated and rainfed), mainly maize and soya on a rotational basis.

5.11.2 Demographic

Population growth in has been high in RWLM since 2011. The relatively low household sizes, high number of people born outside South Africa, high portion of Xhosa speaking people from the Eastern Cape and

low female ratios in both municipal areas and especially in the RWLM wards close to the project area suggest high levels of historic in-migration the past decades mainly due to numerous mining activities in the municipal area. The relatively high growth in the number of households furthermore places extra pressure on municipal service delivery within the local area.

Table 5-8: Basic Demographics of the Area, 2011 and 2022

Area	Population nr	Population growth %	Households nr	Household growth nr	Population density, persons/km2	Average household size	% Females	Econ active
	2022	2011-2022	2022	2011-2022	2022	2022	2022	2022
RWLM	334 773	2,3%	128 145	4,0%	300	2.6	49,6%	71%
RWLM Ward 24	6 400	2,3%	2 600	4,0%	2 931	2.4	49,4%	68%
RWLM Ward 25	11 600	2,3%	7 000	4,0%	57	2,0	35,0%	76%
Gauteng	15 099 422	1,9%	5 318 665	2,8%	830	2,8	49,5%	72%
South Africa	62 027 503	1,7%	17 828 778	1,9%	50	3,5	51,5%	67%

Source: Stats SA (2011 and 2022) Note: Ward information based on population and household growth rates in MLM and RWLM since 2011.

Population densities in Ward 25 where the TSF is situated is very low compared to the Gauteng average but slightly higher compared to the national average. Population densities in Ward 24 where Westonaria is situated is very high compared to Gauteng and national averages.

5.11.3 Basic Household Services

In RWLM the high rates of historic in-migration, the continued growth in the number of households coupled with the slow pace of the delivery of low-income housing has resulted in significant housing backlogs, land invasions and the growth in informal settlements. In 2011 close to a third of households in RWLM stayed in informal houses. The roll-out of low-cost housing schemes resulted in a steep decline in the number of households in informal housing to 10.5%, i.e. slightly lower than the national average in 2022.

As indicated in Table 5-9 below, despite the improvement of the housing situation, the high increase in household growth continues to place pressure in basic service delivery in the municipal area with close to 20% of households still not having piped water in the house in 2022 and 10% without flush toilets. However, while high, these backlogs in 2022 are still lower than national and even provincial averages.

Table 5-9: Access of Households to Basic Services, 2011 and 2022

Category	RWLM	Ward 24	Ward 25	Gauteng	National
Informal houses (shacks), 2022	10.5%	n.a.	n.a.	11,5%	11,5%
Informal houses (shacks), 2011	30.1%	0.2%	2%	20,2%	20,4%
Without piped water inside the house 2022	20.4%	n.a.	n.a.	25,0%	40,3%
Without piped water inside the house 2011	47.6%	1%	2%	37,9%	53,7%
Without flushed toilets, 2022	9.7%	n.a.	n.a.	10,3%	29,2%

Category	RWLM	Ward 24	Ward 25	Gauteng	National
Without flushed toilets, 2011	25.8%	1%	8%	14,6%	39,9%
No electricity for lighting, 2022	5.0%	n.a.	n.a.	6,8%	5,3%
No electricity for lighting, 2011	25.2%	n.a.	n.a.	12,6%	15,2%
No regular waste services, 2022	14.8%	n.a.	n.a.	15,0%	33,7%
No regular waste services, 2011	25.7%	1%	40%	11,7%	38,0%

Source: Stats SA, Census 2011 and 2022.

5.11.4 Education and Skills Level of the Labour Force

While on par with the national average, the unskilled labour force (with less than completed secondary schooling) made a higher contribution (50%) towards the RMLM labour force compared to the unskilled portion provincially (41%). Skilled labour, on the other hand made a smaller contribution towards the municipal labour force (11%) than provincially (16%) and nationally (12%). The situation could be explained by a large number of unskilled job-seekers migrating into the municipal area in search of jobs in the mining sector.

Table 5-10: Education levels: Percentage of the adult population above 21 years, 2022

Category	RWLM	Ward 24	Ward 25	Gauteng	National
Without schooling	4%	2%	5%	4%	7%
Some but less than secondary	46%	40%	61%	37%	43%
Completed secondary education	40%	51%	30%	43%	38%
With tertiary education	11%	8%	4%	16%	12%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

The shortage in primary schools in the local wards surrounding the project is evident from the data in Table 5-11 below. The schools per capita ratio is much lower than national averages in all of the local wards relevant to the project area. There are no secondary schools in RWLM Ward 25 to the project area and only one high school in Ward 24 Westonaria.

Table 5-11: Educational facilities, 2022

Category	RWLM	Ward 24	Ward 25	National
Primary schools/10 000 people	1,5	3.4	1,1	3,8
Secondary schools/10 000 people	0,8	0.9	0,0	0,8
Pupil: educator ratio	29,8	28.5	27,9	30,1
Grade 12 pass rate (2018)	90%	n.a	n.a	78%

Source: Municipal Demarcation Board (2018a&b); Department of Basic Education, 2020 and 2022.

5.11.5 Health Status and Services

The RWLM has 14 PHC facilities of which two are 24-hour CHC facilities. Due to the larger population of RWLM, the per capita PCH facility ratio is lower and compared to national ratios could indicate to some

shortage in PHC facilities in the area. With one district hospital in Randfontein and one private hospital, the low per capita hospital ratio could also indicate to a shortage of tertiary healthcare in area.

As indicated in Table 5-12 below, the ratio of the population that receive Anti- Retroviral Treatment (ART) against HIV/AIDS is higher in MLM and RWLM compared to the national average. This could indicate to the higher prevalence of HIV/AIDS in these municipalities. The high historic rates of in-migration into both municipal areas could have contributed to the higher incidence of HIV/AIDS in these areas.

Table 5-12: Basic Health Indicators, 2017

Indicator	RWLM	South Africa
Primary Health Care (PHC) Clinics / 100 000 persons	5	6
Community Health Care facilities as % of PHC clinics	14%	25%
Hospitals/ 100 000 persons	0,8	2,2
ART treatment (% of population)	9%	7%

Source: Health Systems Trust (2017).

The project is situated within a region that has many potential sources for air pollution including the agricultural sector industry and mining. Local as well as international studies have shown that communities living within a one to two km radius from gold mine dumps could be at higher risk of chronic respiratory symptoms (chest wheezing and chronic cough) and diseases (chronic bronchitis and self-reported emphysema) due to the higher levels of inhalable particulate matter 10 µm or less (PM_{10}) in the vicinity of these gold mine waste dumps. While inhalable particulate matter may travel up to 2 km downwind of mine waste dumps, residents living within 500 m of a mine waste dump boundary, were largely found to be the high exposure group (Kootbodien et. al., 2020).

5.11.6 Safety and Security

The project area and the relevant local wards falls within the Westonaria Police Precinct. The Westonaria police station is located about 2.7 km to the east of Libanon TSF.

As indicated in Table 5-13 below, per capita crime rates are slightly higher in Westonaria Police Precinct than the national average in 2022. Violent crimes are however less prevalent in the precinct than nationally. Similar to the national trend, crime rates declined since 2015, albeit at a lower rate than nationally.

Table 5-13: Crime Statistics, 2022

Indicator	Westonaria Precinct	National average
Crime rate per 1000 people	26,7	26,4
Violent crimes[1)] per 1000 people	5,0	10,2
Increase in crimes (2015-2022)	-9,7	-22,6%

Source: SAPS (2023) [1)] *Including murder, attempted murder, rape, robbery, assault.*

RWLM experienced violent community protests in the past. Recent protests in Mohlakeng (2022) focusing on community security issues related to the large number of illegal miners operational in the West Rand in general and in the municipal area specifically (EWN, 2022).

5.11.7 Structure of the Local Economy

Table 5-14 below shows the dominant contribution that the mining sector still makes to the local RWLM economy, despite close to two decades of the scaling down of gold mining activities in the municipal area. The manufacturing sector also plays a relatively large role in the RWLM.

Table 5-14: The sectoral employment distribution, 2018

Sector	RWLM	National
Agriculture	5,9%	20,7%
Mining	32,5%	4,3%
Manufacturing	9,2%	7,4%
Utilities	0,3%	0,7%
Construction	4,8%	4,3%
Trade	11,7%	13,3%
Transport	3,1%	3,2%
Finance	6,4%	4,9%
Services	26,1%	41,2%
Total	**100,0%**	**100,0%**

Source: Municipal Demarcation Board (2018a & b).

Despite various mines closing and the general decline in economic production in both municipal areas, RWLM still hosts some of the largest gold mines in the country. The major gold producers in the local area are listed in Table 5-15 below. The life of mine of most of these gold mines (apart from South Deep) will come to an end in less than 10 years.

Table 5-15: Major gold mines in the local area

Municipality	Name of mine	Mining Company	Employment	Life of Mine
RWM	Kloof	Sibanye Stillwater	10,444	2032
RWM	Cooke	Sibanye Stillwater	966	2025
RWM	South Deep	Goldfields	3,600	2101

Sources: Goldfields (2018); Harmony Gold (2023); Sibanye Stillwater (2023).

Due to the dominance of the mining sector, the municipality experienced large fluctuations in economic output growth since 2014. The RWLM economy furthermore declined at an average annual rate of -2,3% since 2014 (Gauteng Treasury, 2022).

5.11.8 Local Economy Contribution of FWGR Reclamation Activities

As indicated in Figure 5-23 below, currently the FWGR operations include the Driefontein plant 2 (tailings processing plant); Driefontein 4 (tailings storage facility) and tailings reclamation from the Driefontein 5 tailings dam. The Second phase of FWGR entails reclamation of tailings from Venterspos, Kloof and Libanon as well as the construction of a Regional Tailings Storage Facility (RTSF) situated just south of Kloof.

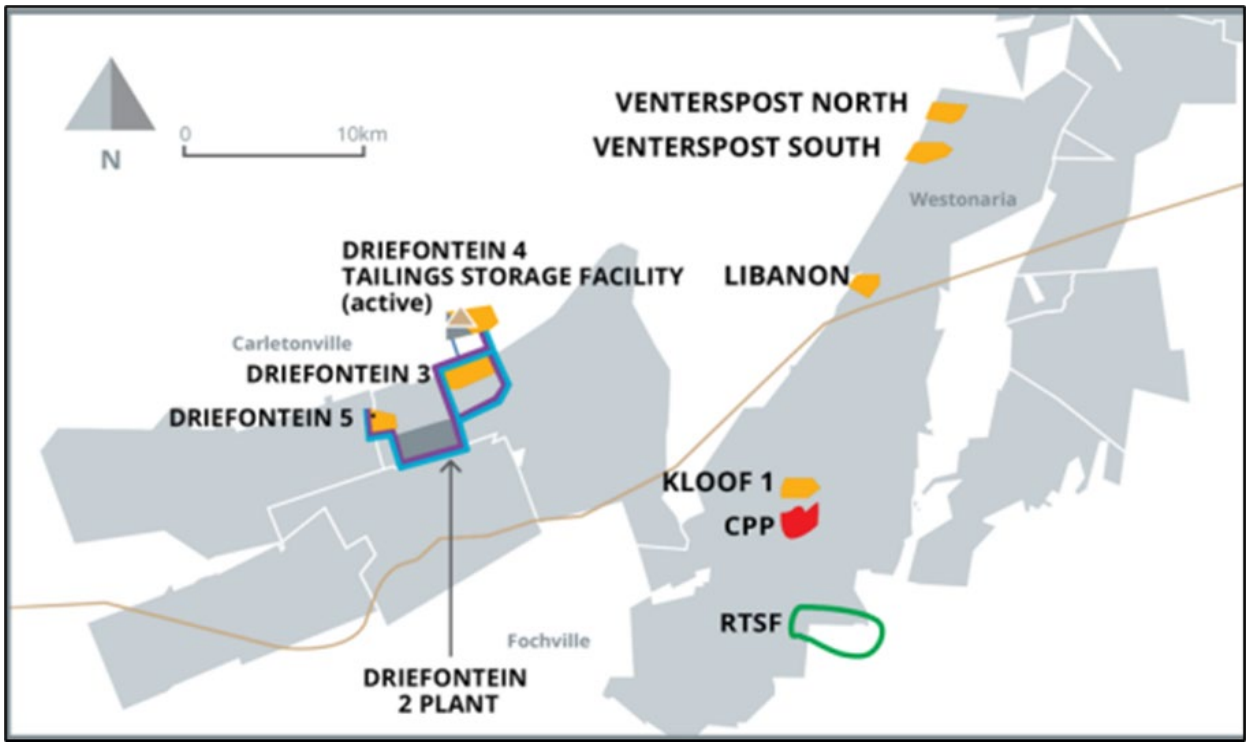

Figure 5-23: DRDGOLD Activities in the West Rand (Source: DRDGOLD web site)

Both FWGR and Ergo provide employment opportunities to 927 permanent employees and 2 155 specialist service providers (DRDGOLD, 2023). Apart from creating direct employment opportunities, the company also create supply-linked jobs through its spending on local suppliers.

In FY2023, R55.2 million was spent on socio-economic development, including youth education programmes, the Broad-Based Livelihoods Programme.

Apart from its R 405m income tax contribution, DRDGOLD has a total corporate social investment budget of close to R53m that covers the local areas of all its projects in the East and West Rand. Local economic development projects focus on poverty alleviation, income generation and job creation (DRDGOLD, 2023).

The Broad-Based Livelihoods (BBL) Programme forms part of their local economic development focus and were designed in partnership with the University of Pretoria Enterprises Research Project. The BBL Programme has reached over 8,000 participants across Ekurhuleni, the city of Johannesburg and West Rand municipalities. The programme focuses on a wide variety of sub-programmes in response to participants' interests and ideas for increased economic activity in their local contexts, in retail and services, crop and livestock agriculture, and the health, wellness and beauty sector (DRDGOLD, 2023).

5.11.9 Composition of the Labour Force

As indicated in Table 5-16 below, there was a decline in employment in RWLM between 2011 and 2022 with a steep increase in unemployment from 28% in 2011 to close to 43% in 2022. Already in 2011, the youth unemployment rate (18-34 years) was substantially higher in RWLM compared to the national average.

With gold production playing a major role in Wards 24 and 25 it is possible that employment in these wards could have declined at a faster rate than the municipal average rate due to the steep decline in employment in the national gold mining industry since 2011. While unemployment rates in the RWLM Wards 24 and 25 were substantially lower than the RWLM averages in 2011, the sharp decline in employment in these wards (coupled with increased in-migration into these areas) would also have resulted in sharp increases in unemployment in both these wards since 2011.

Table 5-16: The local labour force, 2011 and 2022

Indicator	RWLM	Ward 24	Ward 25	National
estimated employment 2022	63 100	1 114	2 867	15.4m
estimated employment 2011	92 065	1 815	4 670	14.1m
average annual growth 2022-2011	-3,4%	-4.3%	-4.3%	0,9%
informal employment as % of employment 2011	11%	7%	5%	19%
unemployment % 2022	43%	na	na	34%
unemployment % 2011	28%	18%	13%	25%
youth unemployment rate, 2011	39%	na	na	25%

Source: Stats SA (2011and 2022); Stats SA (2024); Gauteng Treasury (2022) Note: growth in employment of the local wards were based on increase in employment in the gold industry between 2011 and 2022.

5.11.10 Income and Poverty Levels

The percentage of households that earned less than R 20 000 per year in 2011 largely corresponds with the lower bound poverty rate[2] of that period. Corresponding to the lower unemployment rates in the local wards adjacent to the project area (as discussed above), the poverty rates in the local wards were also lower in 2011. With rising unemployment rates in both these wards (discussed above) poverty rates would also have shown a sharp increase since 2011.

Table 5-17: Income and Poverty levels

Income category (per year)	RWLM	Ward 24	Ward 25	National
Less than R20 000	40%	21%	19%	45%
Between R20 000 and R 75 000	38%	33%	62%	32%
Between R 75 000 and R 150 000	10%	21%	10%	9%
More than R 150 000	12%	26%	10%	14%

[2] Statistics South Africa published 3 poverty rates for South Africa in 2011, namely the food poverty line (FPL) that allows for a minimum food intake; the lower bound poverty level (LBPL) that allows for basic food and some clothing; as well as the upper bound poverty level (UBPL) that allows for basic food clothing and some basic education.

Income category (per year)	RWLM	Ward 24	Ward 25	National
Total	**100%**	**100%**	**100%**	**100%**

Source: Stats SA (2011).

While the poverty rate in Westonaria Ward 24 was higher than in Ward 25, the ward also hosted a large portion of households that earned more than R150 000 in 2011, signifying to a very unequal distribution of income within the area.

5.11.11 Economic Infrastructure

National and provincial roads provide regional mobility in RWLM including the N14 which links Randfontein with Northwest and the City of Tshwane; the N12 which links Westonaria to North West and Johannesburg/East Rand, the R28 which links Randfontein, Westonaria and Sedibeng LM in Gauteng; the R41 which links Randfontein to Northwest and the R559 which links Randfontein with Southern Soweto. There is also a railway line that runs through the municipal areas that provides easy access to both areas (CoGTA, 2020).

Close to 65% of the roads in RWLM are paved. The majority of the paved roads are in a fair to very good condition while gravel roads range from fair to very poor condition. The RWLM only spent 1,5% (far below the required 8%) of its capital budget on maintenance in 2020 (Rand West City, 2020).

The local roads surrounding Libanon TSF is generally in a fair condition.

5.11.12 Socio-economic Development Priorities and Initiatives

The development priorities for the local area as expressed through the official planning documents include the following:

The Rand West LM IDP highlights the following relevant local development priorities for the local area (Rand West City, 2020):

- To ensure provision of basic services to build sustainable and safe communities;
- To build a more diversified economy through the focus on the transformation of agriculture sector, building a transport logistics hub (along the N12) and establishing industrial hubs in Randfontein and Westonaria;
- SMME'S and co-operatives development and township businesses support;
- Job creation for unskilled, semi-skilled and skilled residents;
- The implementation of a proper policy for informal economic sectors;
- The formulation and implementation of a Local Economic Development Plan; and
- To ensure financially viable and sustainable municipality.

The development priorities of the local wards close to the project areas place job creation as a high priority in addition to the need for low-cost housing.

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5.12 Noise

Natural sounds are a part of the environmental noise surrounding humans. Ambient sound levels are significantly affected by the area where the sound measurement location is situated. When the sound measurement location is situated within an urban area, close to industrial plants or areas with a constant sound source (ocean, rivers, etc.), seasons and even increased wind speeds have an insignificant to massive impact on ambient sound levels.

The Proposed Project site is in an area with a mixed-use development character. The major noise sources in the area include vehicular traffic on the national and provincial roads in the areas, noises from the local communities; and mining related noises.

5.12.1 Conceptual Noise Levels

Noise associated with the reclamation project mainly originates from construction activities of required infrastructure as well as noises from motors and pumps during the operational phase. Noises relating to the development of the pipeline and pump station system would be:

- Limited to within 100m from construction activities, could be high at times but would be of a temporary nature; and
- Insignificant further than 200m from the activities.

Noises associated with the operational phases would be:

- Limited to within 100m from hydraulic reclamation activities and motors (of the slurry pumps). Noises from the vibrating screening could be high at times;
- Could be clearly audible up to 200m during quiet periods (from the vibrating screens as well as night-time pumping activities); and
- Would be insignificant further than 500m from such activities.

Noises associated with rehabilitation activities would generally be limited to a distance less than 200m from the rehabilitation activities. Therefore, three areas might be considered, namely:

- An area where noise levels may be elevated, enclosed within the orange line on Figure 5-24;
- An area where noises from the activities may be audible (between the orange and light-green line on Figure 5-24; and
- An area where noises would be insignificant (outside the light-green line on Figure 5-24).

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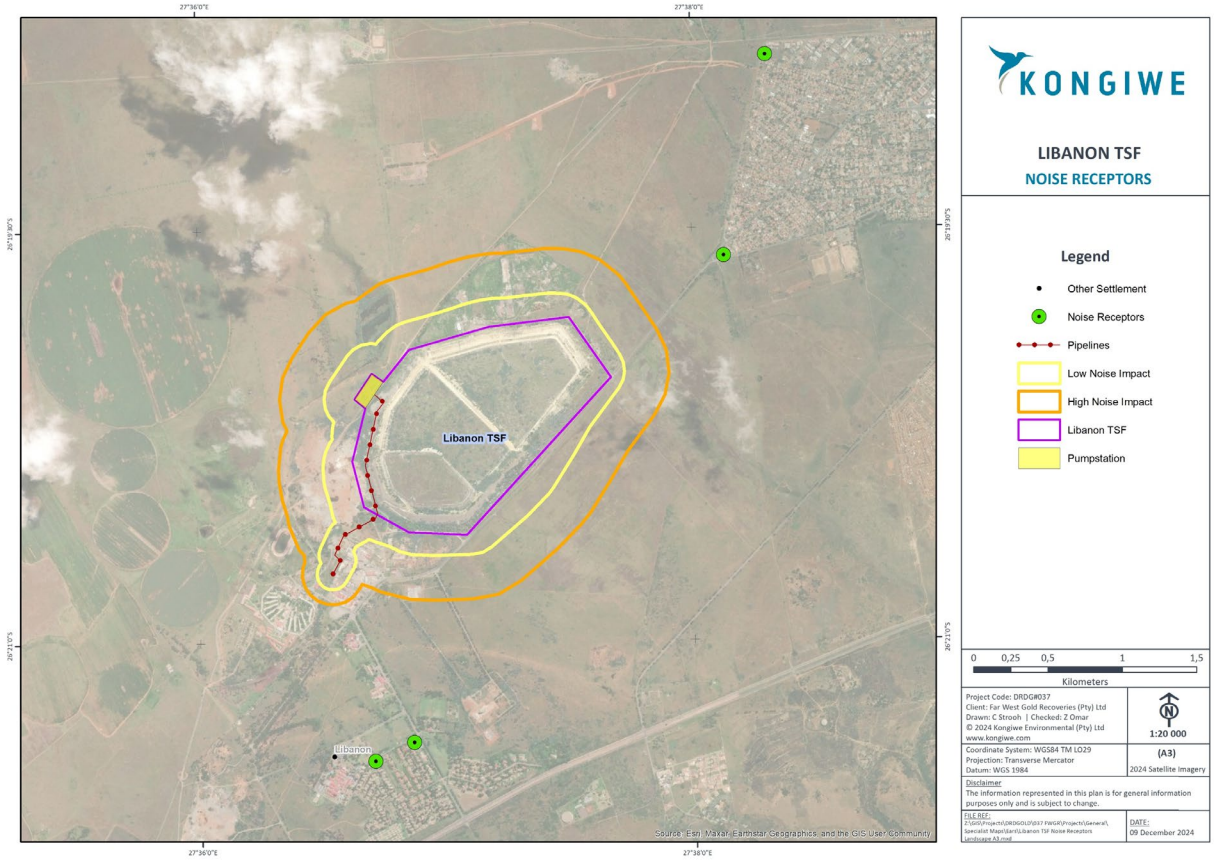

Figure 5-24: Libanon TSF reclamation project infrastructure and closest noise-sensitive receptors

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6 STAKEHOLDER PARTICIPATION

No stakeholder issues or comments have informed this Rehabilitation, Decommissioning and Mine Closure Plan at this stage and this will be undertaken during the public participation component of the proposed project. Results from the draft EIA comment period will be incorporated into the finalised report, once comments have been received.

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7 DESIGN PRINCIPLES

7.1 Closure Vision and Objectives

The closure vision for the Project is intended to inform the closure objectives. The closure objectives set as part of the mine closure planning process aims to ensure that the final land use is achieved and that the area is sustainable in the long-term from an environmental and social point of view. The objective is to

Restore areas that have been impacted by mining through rehabilitation

Closure and rehabilitation is a continuous series of activities that begin with planning prior to the Project's design and construction, and end with achievement of long-term site stability and the establishment of a self-sustaining ecosystem. Not only will the implementation of this concept result in a more satisfactory environmental conclusion, but it will also reduce the financial burden of closure and rehabilitation The vision is underpinned by the objectives listed below:

- Adhere to all statutory and other legal requirements (National, Provincial and Local);
- Implement progressive rehabilitation measures where possible to ensure protection of the local environment;
- Create a safe, physically stable rehabilitated landscape that limits long-term erosion potential and environmental degradation;
- Focus on establishing a functional post-mining landscape;
- Utilise closure strategies that promote a self-sustaining condition with little or no need for ongoing care and maintenance; and
- Create opportunities for alternative post-mining livelihoods by aligning to Integrated Development Plans, Spatial Development Frameworks and other developmental initiatives.

Rehabilitation and closure objectives have been tailored to the project at hand. This Rehabilitation, Decommissioning and Mine Closure Plan aims to assist FWGR in carrying out successful rehabilitation for the Project.

7.2 Closure and Post-Closure Options

The main vision of closure is to prevent or minimise adverse long-term socio-economic and environmental impacts, and to create a self- sustaining natural ecosystem or alternative land use based on an agreed set of objectives. Thus noting that set objectives need to be agreed upon it is important that all role players involved are engaged regarding closure and rehabilitation objectives, specifically related to long term impacts and end land use.

The objectives that should be considered are the following:

- To encourage the development of a comprehensive closure plan that returns the site to a viable, and wherever practicable, self-sustaining ecosystem, and that this plan is adequately financed, implemented and monitored within all jurisdictions;
- To manage closure in an integrated and sustainable manner;
- To encourage FWGR and Sibanye to work together to achieve the goal of leaving behind a self-sustaining ecosystem after closure;
- To ensure that the project does not impact negatively on the livelihood of adjacent/interconnected mines in a demarcated area;
- To promote a strategic approach to managing water at mining and mineral processing sites so that water in more efficiently managed and valued;
- Set out the strategic issues that mining and mineral processing operations needs to consider for sustainable mine closure in an area in order to manage risks and identify opportunities for continuous improvement; and
- Provide high-level guidance on issues that should be addressed in developing a post- closure mine water strategy for an area.

Thus it is important that closure and rehabilitation for this proposed project considers the above objectives where practical and possible.

7.3 Closure and Post Closure Period

The post-mining landscape will have a restored area with a lowered topography and the TSF will be gone. The area will have a flat and disturbed topography that will need to be addressed. Given the seepage from the TSF, the soil might be contaminated and polluted. This pollution might pose a risk to the restoration process planned for the area. The surrounding groundwater and surface water might also have received polluted water due to runoff or seepage from the reclamation process. This drainage might also lead to a negative impact on the wetlands.

Once closure activities have been implemented, FWGR will commence with its closure monitoring period. During this time, erosion repair, vegetation establishment and groundwater and surface water remediation activities will be undertaken and monitoring activities will be conducted. At this stage, biological processes should have become established, leading to stable vegetation cover and heathier functioning ecosystems. Data would be collected to demonstrate that the closure is sustainable and that there is no unmitigated impacts to the receiving environment. Overall the relinquishment criteria and other statutory requirements would be achieved.

7.4 Closure Options Research

During the operational phase, it is advised that continual monitoring of both surface and groundwater is conducted. This information needs to be collected and used to update specific water models to monitor and evaluate the impact of the operation. Additionally, it would be advisable to conduct monthly dust fall monitoring to evaluate the ongoing and probable air pollution. This will allow FWGR to establish the best practicable option to ensure that the minimal impact on both water sources and wetlands occur.

The final rehabilitation, decommissioning and mine closure plan is a living document and will be reviewed and amended through the life of the project, any changes due to new research will be incorporated into these amendments.

Ongoing research and investigations for closure options and current best practice will be focussed on during the LoM. The final rehabilitation, decommissioning and mine closure plan is a living document and will be reviewed and amended through the life of the project, any changes due to new research will be incorporated into these amendments.

7.5 Closure Assumptions

Information currently available may need to be supplemented during the operational phase of the Project. As additional information will be collected during operations and these assumptions will need to be reviewed and revised.

The assumptions used to prepare this report are the following:

- The Libanon TSF site is a brownfields site;
- The closure period will commence once the last tailings have been removed;
- The life of the operations is estimated at 10 years, including the ramp-up period and decommissioning period at mine closure;
- At closure, the area will be levelled and prepared to be used for wilderness as per Sibanye's closure requirements;
- The mine plan, design and layout have been adhered to;
- There are limited opportunities for post-closure infrastructure for community uses. Therefore all buildings will be demolished;
- All demolition rubble is considered General Waste as per the definition of Demolition waste in Category B of Schedule 3 of the NEM:WA and, based on the classification as 'General Waste', can therefore be incorporated into the backfill;
- All hazardous and domestic waste will be transported offsite for disposal in licenced landfills; and
- Access roads to the site required for the new land use will not be closed as part of normal closure actions.

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8 RISK ASSESSMENT FINDINGS

The objective of the risk assessment is outlined in the Financial Provisioning Regulations. The objective is to:

- Ensure timeous risk reduction through appropriate interventions;
- Identify and quantify the potential latent environmental risks related to post closure;
- Detail the approach to managing the risks;
- Quantify the potential liabilities associated with the management of the risks; and
- Outline monitoring, auditing and reporting requirements.

8.1 Methodology

A desktop risk assessment for the project was undertaken utilising a risk assessment process. During this desktop assessment, the risks associated with the Project were described and a determination was taken to assess the nature of the risk. Subject to the nature of the risk, it is ranked according to predetermined criteria for probability and consequence. Five categories are considered to describe the nature of the risk, these categories include:

- Health and Safety;
- Environment;
- Financial;
- Legal and Regulatory Obligations; and
- Reputational, Social or Community.

Once the risks had been captured, the probability of the risk occurring as well as the consequence of the risk transpiring were rated according to the criteria presented below.

Table 8-1: Consequence Rating Definitions

	Consequence Category				
	1 - Insignificant	2 - Minor	3 - Moderate	4 - Major	5 - Catastrophic
Safety and Health	**First Aid Case**	**Minor Injury,** Medical Treatment Case with/or Restricted Work Case.	**Serious Injury** or Lost Work Case	**Major or Multiple Injuries** - permanent injury or disability	**Single or Multiple Fatalities**
Environment	**No impact** on baseline environment. Localized to point source.	**Localized** within site boundaries. Recovery measurable within 1 month of impact	**Moderate** harm with possible wider effect. Recovery in 1 year	**Significant** harm with local effect. Recovery longer than 1 year.	**Significant** harm with widespread effect. Recovery longer than 1

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	Consequence Category				
	1 - Insignificant	2 - Minor	3 - Moderate	4 - Major	5 - Catastrophic
	No recovery required				year. Limited prospect of full recovery
Financial	< R100k	R100k - R500k	R500k - R5M	R5M - R10M	>R10M
Reputational, Social or Community	**Minor impact**; awareness/ concern from specific individuals/ Minor disturbance of culture/ social structures	**Limited impact**; concern/ complaints from certain groups/ organizations (e.g. NGOs) / Some impacts on local population, mostly repairable. Single stakeholder complaint in reporting period	**Local impact**; public concern/ adverse publicity localised within neighbouring communities / On-going social issues. Isolated complaints from community members/ stakeholders	**Suspected reputational damage**; local/ regional public concern and reactions / Significant social impacts. Organized community protests threatening continuity of operations	**Noticeable reputational damage**; national/ international public attention and repercussions/ Major widespread social impacts. Community reaction affecting business continuity. "License to operate" under jeopardy
Legal & Regulatory Obligations	Technical non-compliance. No warning received; no regulatory reporting required	Breach of regulatory requirements; report/involvement of authority. Attracts administrative fine	Minor breach of law; report/investigation by authority. Attracts compensation/ penalties/ enforcement action	Breach of the law; may attract criminal prosecution, penalties/ enforcement action. Individual licence temporarily revoked	Significant breach of the law. Individual or company law suits; permit to operate substantially modified or withdrawn

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Table 8-2: Probability Rating Definitions

Probability Category				
1 - Rare	**2 - Unlikely**	**3 - Moderate**	**4 - Likely**	**5 - Almost Certain**
Highly unlikely to occur on this project	Given current practices and procedures, this incident is unlikely to occur on this project	Incident has occurred on a similar project	Incident is likely to occur on this project	Incident is very likely to occur on this project, possibly several times

FWGR considers that the Health, Safety and Environmental risks typically represent external risks to the biophysical and socio-economic environment that may exist at closure, and the financial, legal and reputational risks are internal risks and present how risks at closure influence the Project.

A matrix listing the probability and consequence is then used numerically to rank the risk and determine whether the risk level is:

- **High** (H);
- **Significant** (S);
- **Medium** (M); or
- **Low** (L).

Table 8-3: Significance Rating Methodology

Probability (of exposure to impacts)	Consequence				
	1 - Insignificant	**2 - Minor**	**3 - Moderate**	**4 - Major**	**5 - Catastrophic**
5 - Definite	6	7	8	9	10
4 - Likely	5	6	7	8	9
3 - Moderate	4	5	6	7	8
2 - Unlikely	3	4	5	6	7
1 -Rare	2	3	4	5	6

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8.2 Results of Risk Assessment

The risk assessment is detailed inTable 8-4.

Table 8-4: Risk Assessment

Risk Log		Risk at Closure															Closure Strategy	Risk after Implementation of Closure Strategy														
		Health and Safety			Environment			Financial			Legal			Reputational & Social				Health and Safety			Environment			Financial			Legal			Reputational & Social		
		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank
Health and Safety	Unauthorised access gained to site may lead to health and safety risk	2	1	L													The Group's security service provider and in-house security managers increase staff complements as required. Surveillance equipment allows for continuous monitoring of properties by security personnel. The areas shall also be fenced off during the closure and rehabilitation phases.	1	1	L													
	If not rehabilitated correctly dust may cause health risk	1	3	L													FWGR has the required rehabilitation and mitigation measures set in place to mitigate these issues.	1	2	L												
	Seepage of metals and other pollutants into the environment may lead to potential health and safety hazard	4	2	S													Hydrocarbon spillages should be contained and cleaned up immediately. Other pollution/waste potential activities will occur in bunded areas. FWGR has the required rehabilitation and mitigation measures set in	1	1	L												

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Risk Log		Risk at Closure															Closure Strategy	Risk after Implementation of Closure Strategy														
		Health and Safety			Environment			Financial			Legal			Reputational & Social				Health and Safety			Environment			Financial			Legal			Reputational & Social		
		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank
																	place to mitigate these issues.															
	Inadequate removal of contaminated materials and infrastructure may pose a potential risk to individual health and safety	4	2	S													Following of the mine closure and rehabilitation plan will ensure that all buildings and other forms of infrastructure are adequately removed. FWGR has the required rehabilitation and mitigation measures set in place to mitigate these issues.	1	1	L												
	Inappropriately demolished infrastructure may result in a health and safety risk	2	1	L													Following of the mine closure and rehabilitation plan will ensure that all buildings and other forms of infrastructure are adequately removed. FWGR has the required rehabilitation and mitigation measures set in place to mitigate these issues.	1	1	L												
	Dust generated on site may be a health and safety risk	1	3	L													FWGR has the required rehabilitation and mitigation measures set in place to mitigate these issues.	1	2	L												
Environment	Exposure of tailings to oxygen during the reclamation process may lead to acid and metalliferous drainage which				4	4	H										Ensure that hazardous waste is disposed of in the appropriate manner. Hydrocarbon spillages should be contained and				1	3	L									

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Risk Log		Risk at Closure															Closure Strategy	Risk after Implementation of Closure Strategy												
		Health and Safety			Environment			Financial			Legal			Reputational & Social				Health and Safety			Environment			Financial			Legal			Reputational & Social		
		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank
	may find its way into the groundwater leading to contamination.																remediated immediately. Continual monitoring should occur to ensure for compliance, until the surrounding water sources has recovered to specific objectives.													
	Contaminated soil may be washed down slope into the surrounding surface water, impacting ground water quality.				4	4	H										Ensure that hazardous waste is disposed of in the appropriate manner. Hydrocarbon spillages should be contained and remediated immediately. Continual monitoring should occur to ensure for compliance, until the surrounding water sources has recovered to specific objectives.				1	3	L									
	Encroachment of alien invasive plant species.				5	2	S										Ensure that the site is monitored during the duration of the closure period and ensure that the continual removal of alien vegetation occurs.				3	1	L									
	Dust dispersal and soil erosion				3	3	M										Ensure that the revegetation and rehabilitation plan occurs as it is suggested. The re-established vegetation shall prevent soil				1	3	L									

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Risk Log		Risk at Closure															Closure Strategy	Risk after Implementation of Closure Strategy												
		Health and Safety			Environment			Financial			Legal			Reputational & Social				Health and Safety			Environment			Financial			Legal			Reputational & Social		
		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank
																	erosion and dust dispersal.															
	Sedimentation of watercourses				3	3	M										The trench around the tailings dam should be maintained, this will ensure that the run-off from the tailings area does not enter the environment.				1	3	L									
	A failure to rehabilitate the site fully may lead to an impact of recolonization by significant species				3	3	M										Ensure that revegetation occurs and that the re-seeding is done successfully. This will create new habitat for fauna and thus they species shall move back.				1	3	L									
	Possible radioactivity presence on site may pose a risk				3	3	M										Ensure that the correct monitoring and mitigation plans are set in place and followed.				2	4	L									
	Unidentified impacts that occur that are not mitigated that occur during the closure phase				2	2	L										Ensure that mitigation plans are up to date and continually reviewed to ensure that any issues that may arise are compensated for.				2	2	L									
Financial	Possible environmental legislation, regulatory authorities and changes.							4	2	M							The Group has funds invested and financial guarantees in place to adequately fund our rehabilitation obligations.							4	1	L						
	Volatile commodity prices and foreign							4	3	S							Key gold price trends and market indicators are constantly monitored to							4	2	M						

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Risk Log		Risk at Closure															Closure Strategy	Risk after Implementation of Closure Strategy												
		Health and Safety			Environment			Financial			Legal			Reputational & Social				Health and Safety			Environment			Financial			Legal			Reputational & Social		
		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank
	exchange fluctuations.																ensure an effective response to commodity price and exchange rate fluctuations.														
	Financial constraints or operational cost increases due to labour and other socio economic issues.							3	4	S							The Group has funds invested and financial guarantees in place to adequately fund our rehabilitation obligations.							3	3	M						
	Reliance on Eskom for power supply.							4	4	H							Generators have been installed to prevent the challenges experienced during power outages such as long delays in restarting operations after an interruption in power supply							2	3	M						
Legal and Regulatory Obligations	Mine will not be able to demonstrate that all of the relinquishment criteria have been achieved, resulting in closure not being granted.										3	4	S				The closure actions have been developed to achieve the relinquishment criteria and appropriate monitoring activities have been identified to assist with demonstrating that relinquishment criteria have been achieved. Plans will be adapted to meet changing legislative and environmental pressures.							2	3	M						

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Risk Log		Risk at Closure															Closure Strategy	Risk after Implementation of Closure Strategy													
		Health and Safety			Environment			Financial			Legal			Reputational & Social				Health and Safety			Environment			Financial			Legal			Reputational & Social		
		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank
	Social licence to operate.										3	4	S				FWGR has an ongoing commitment to improving engagement with its employees and surrounding communities. Its strategic objective to support the neighbouring communities by improving quality of life, poverty alleviation and youth education helps mitigate the risk.							2	3	M						
	Unforeseen changes to mining legislation and regulatory authorities.										4	4	8				FWGR monitors changes and engages with government and regulators to ensure compliance. The Group also maintains close relationships with authorities at regional and national level so that any issues can be addressed speedily										3	3	M			
	Undetermined land owner issues.										2	4	S				Ensure that all of the attempts to find any and all land owners have been documented and archived.										1	2	L			
Reputational, Social or	Increased levels of crime and gold theft.													4	4	H	FWGR maintains close relationships with leaders in the communities surrounding our operations. The Group's security service provider													3	3	M

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Risk Log		Risk at Closure															Closure Strategy	Risk after Implementation of Closure Strategy														
		Health and Safety			Environment			Financial			Legal			Reputational & Social				Health and Safety			Environment			Financial			Legal			Reputational & Social		
		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank		Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank	Prob	Cons	Rank
																	and in-house security managers increase staff complements as required. Surveillance equipment allows for continuous monitoring of properties by security personnel														
	Degradation of relationship with the surrounding I&AP's (dust, traffic or other forms of disrupting activities)													4	3	S	FWGR has an ongoing commitment to improving engagement with its employees and surrounding communities. Its strategic objective to support the neighbouring communities by improving quality of life, poverty alleviation and youth education helps mitigate the risk.												2	2	L

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9 PROPOSED POST-MINING LAND USE

It is proposed that before the decommissioning phase of the Project starts , FWGR should establish a Closure Forum. This Closure forum will encompass the following:

- Discuss and develop joint action plans and strategies with key stakeholders to achieve sustainable closure;
- Identification and analysis of problems and challenges impacting the operations during the closure phase of the Project;
- Accountability for the implementation of action plans and strategies;
- Review of current economic trends and programmes within the province to ensure that the strategies in place are best suited;
- Generating awareness around the decommissioning and closure of the project; and
- Alignment with the SLP.

Post-closure land-use is determined in consultation with stakeholders so that the use meets the requirements of all the participants.

The end land uses for the areas associated with the TSF footprints will most likely be to rehabilitate the disturbed areas to align with the surrounding mix of land uses (predominantly agriculture), and establish vegetation types congruent with the surrounding vegetation communities.

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10 REHABILITATION PLAN

The main aim in developing the Rehabilitation, Decommissioning and Mine Closure Plan is to minimise and mitigate the impacts caused by mining and industrial activities and to restore land back to a satisfactory standard. It is best practice to develop the Plan as early as possible so as to ensure the optimal management of rehabilitation and closure issues that may arise. It is critical that a mine's Rehabilitation, Decommissioning and Mine Closure Plan is defined and understood from before mining progresses and is complimentary to the objectives and goals set. Rehabilitation and closure objectives need to be tailored to the project at hand and be aligned with the Environmental Management Plan Report (EMPr).

The Rehabilitation, Decommissioning and Mine Closure Plan aims to inform on the actions required to rehabilitate the project to ensure that the area is socially and environmentally safely and sustainably closed. Importantly, the Rehabilitation Plan consists of direct activities associated with rehabilitation of various infrastructure components.

This Plan should inform how the infrastructure is removed from site. During the operational phase, it is recommended that an assessment be undertaken of the infrastructure to determine if some of the infrastructure can be utilised post closure.

The rehabilitation and closure actions for the particular infrastructure are detailed below and separated into phases.

10.1 Rehabilitation Activities

Limited surface infrastructure will be established to support the mining activities for the Project and this infrastructure footprint will need to be rehabilitated. The primary structures proposed for the project include:

- Building infrastructure which includes:
  - Temporary administration buildings and contractor's construction yards;
  - Reclamation pump station; and
  - Secondary Containment Dam.
- Stormwater system; and
- Pipelines (process water and slimes).

The rehabilitation plan is comprised of these stages:

1. Removal of existing infrastructure;
2. Re-shaping of the landforms;
3. Re-vegetation of the landscape; and
4. Monitoring and maintenance.

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10.1.1 Building Infrastructure

Infrastructure, including foundation should be removed. The following steps should be followed:

- The re-usable items should be removed from the site;
- Remaining structures should be demolished to 1 m below surface and the demolition rubble removed;
- Soil should be tested for contamination. If contamination is discovered, this soil should be removed and disposed of in the appropriate waste disposal facility;
- Once the site has been cleared of all infrastructure and rubble and no contamination is present, the exposed underlying materials should be reshaped to create a gently sloping, free-draining topography. Re-instate natural drainage lines to limit erosion and sediment build up within local river courses;
- Remove alien invasive plants;
- Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land; and
- Ensure that robust care and maintenance plans are in place.

10.1.2 Pipelines

- Remove supporting plinths for pipeline as well as foundations and other associated infrastructure:
- The re-usable items should be removed from the site;
- Remaining structures should be demolished to 1000 mm below surface and the demolition rubble removed; and
- Soil should be tested for contamination. If contamination is discovered, this soil should be removed and disposed of in the appropriate waste disposal facility.
- Once the site has been cleared of all infrastructure and rubble and no contamination is present, the exposed underlying materials should be reshaped to create a gently sloping, free-draining topography. Re-instate natural drainage lines to limit erosion and sediment build up within local river courses;
- Remove alien invasive plants;
- Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land to reduce erosion; and
- Ensure that robust care and maintenance plans are in place.

10.1.3 Access and Service Roads

Roads that can and will be used for rehabilitation/ monitoring or by other users post-closure should be left *in situ* provided this is agreed upon by all parties concerned. If there is no future use for roads onsite, they will require the following actions:

- Soil should be tested for contamination. If contamination is discovered, this soil should be removed and disposed of at the appropriate waste disposal facility;
- Remove alien invasive plants; and
- Ensure that robust care and maintenance plans are in place.

10.1.4 Secondary Containment Dam and Pump Station

The secondary containment dam will be retained during the majority of the closure period to provide water for closure activities as well as to capture any flows of contaminated water which may be generated on the site. The expectation is that as rehabilitation continues, the contaminated water catchment area will reduce until there is no further need for containment. All structures and infrastructure associated with the secondary containment dam will need to be removed. The following actions will be required:

- Desilt the secondary containment dam;
- Dismantle dam infrastructure - these should be disposed of at the correct hazardous waste disposal facility;
- Remove associated infrastructure:
  - The reusable items should be removed from the site;
  - Remaining structures should be demolished to 1m below surface and the demolition rubble removed; and
  - Soil should be tested for contamination. If contamination is discovered, this soil should be removed and disposed of in the appropriate waste disposal facility.
- Once the site has been cleared of all infrastructure and rubble and no contamination is present, the exposed underlying materials should be reshaped to create a gently sloping, free-draining topography. Re-instate natural drainage lines to limit erosion and sediment build up within local river courses;
- Remove alien invasive plants; and
- Ensure that robust care and maintenance plans are in place.

10.1.5 Groundwater

To restrict the impacts post-closure on the groundwater environment (level, yield and quality) and mitigate the loss of groundwater from the catchment, the following is recommended:

- Use the results of the monitoring programme to validate the predicted impacts on groundwater availability after closure every five years;
- Update existing predictive tools to verify long-term impacts on groundwater;
- Present the results to Government on an annual basis to determine compliance with the closure objectives set during the Decommissioning Phase;
- Continue the groundwater quality and groundwater level monitoring for a period of at least five years after mining ceases to establish post-closure groundwater level and quality trends. If required, the monitoring information will be used to update, verify and recalibrate the predictive tools used during the study.

10.1.6 Stormwater (Surface Water)

Prior to closure a final stormwater management plan will be prepared to identify at closure where water can be designed to flow freely from the site and away from potential areas of contamination. All berms,

trenches and paddocks will be flattened by backfilling the excavations or dozing the structures to a functioning topography, except where they have been positioned prevent additional water flowing onto rehabilitated areas. Structures which may potentially remain onsite will have a stormwater management plan which will ensure that any potential impact to surface water is managed.

10.1.7 NNR Certificate

Once reclamation of the TSF has been undertaken and depending on the desired end land use, it is highly recommended to assess the potential of residual radiation remaining and to identify possible latent environmental impacts remaining. This is important to ensure that once the land is handed over that there is no potential further risk to the land owners.

The National Nuclear Regulator (NNR) has set the level for gamma radiation, for which regulation is not required, below 500 Bq (Becquerel) per kg. Direct radiation originates from uranium, which is a common mineral associated in the reefs that contain gold and is contained within the slimes material. The Radiation Assessment should measure the gamma radiation emanating from the decaying of the uranium atoms.

In terms of release of radioactively contaminated land, the Safety Standards and Regulatory Practices, under section 5.4, specifies that a site used in the conduct of an authorised action may be released for unrestricted use provided that it is demonstrated that the radioactive contamination and radioactive materials which can reasonably be attributed to the authorised action have been removed from the site, or in the case of naturally occurring radioactive nuclides, have activity concentrations below the levels of exclusion. The end land use will be dependent on the findings of such an assessment and will determine if these sites could be utilised or released for unrestricted use.

10.2 General Rehabilitation Principles

10.2.1 Vegetation Establishment

The objectives for the re-vegetation of reshaped and top-soiled land are to:

- Prevent erosion;
- Restore the land to the agreed land capability;
- Re-establish eco-system processes to ensure that a sustainable land use can be established without requiring fertilizer additions; and
- Restore the biodiversity of the area as far as possible.

10.2.1.1 Re-vegetation Steps

The following steps should be taken during the re-vegetation of disturbed areas:

- All soils are to be ripped to full potential rooting depth to correct compaction;
- Analyse the topsoil to determine the lime and fertilizer requirements;
- Prepare the soil by adding lime and fertilizer and ploughing the area;

- Plant a grass seed mixture consisting of a range of indigenous species;
- Inspect the area after a good rainfall event;
- Eradicate weeds where necessary;
- Repeat the procedure for the next growing season;
- Define and establish the long-term land management system;
- Allow natural grasses to become re-established; and
- Conduct annual monitoring (repeatable demarcated transect surveys).

10.2.1.2 Species Selection

Some of the criteria that should be considered during the selection of the appropriate species for rehabilitation include:

- Use species which are perennial and well adapted to the area;
- The species should be tolerant of adverse soil conditions;
- Species should have a large biomass and prolific root system; and
- As areas of rehabilitation expand, maintenance costs increase, so species selected should be those with minimal maintenance cost, or with production and financial returns that exceed the cost.

10.2.1.3 Climatic Conditions

Planting will be most successful when it is done after the first rains and into freshly prepared seedbeds (provided the soil material is not prone to crusting). Water retention in the seed zone will stimulate germination and can be supported by the application of light vegetation mulches.

10.2.1.4 Vegetation Conservation

If rare and protected flora species are found on the project area during construction or operational activities, they should be conserved by removing and relocating them to another section of the project area which is suitable. The rare/protected plants can be kept in a nursery; the plants can then be replanted during rehabilitation of the disturbed areas.

Control and management of alien vegetation will contribute to the conservation of the natural vegetation. The alien species should, therefore, be removed from site and control measures must be implemented to ensure spreading of these species does not occur to other parts of the project area or the surrounding lands.

10.3 General Monitoring and Maintenance Guidelines

The purpose of monitoring is to ensure that the objectives of rehabilitation are met and that the rehabilitation process is followed. The physical aspects of rehabilitation should be carefully monitored during the operational phase as well as during the progress of establishment of desired final ecosystems.

The following items should be monitored continuously:

- Alignment of actual final topography to agreed planned landform;
- Erosion status;
- Surface drainage systems and surface water quality;
- Groundwater quality at agreed locations;
- Vegetation basal cover;
- Vegetation species diversity; and
- Proportion of land that has been fully rehabilitated.

10.3.1 Final Topography

The topography that is achieved during rehabilitation should be monitored and compared to the planned topography. The final profile achieved should be acceptable in terms of the surface water drainage requirements and the end land use objectives. The survey department should do an assessment of the reshaping carried out on the site and signoff should be obtained from the rehabilitation specialist before the topsoil is replaced.

10.3.2 Erosion Monitoring

Continuous erosion monitoring of rehabilitated areas should be undertaken and zones with excessive erosion should be identified. Erosion can either be quantified or the occurrence there-of simply recorded for the particular location.

10.3.3 Surface Water

10.3.3.1 Drainage Systems

The functionality of the surface water drainage systems should be assessed on an annual basis. This should preferably be done after the first major rains of the season and then after any major storm. An assessment of these structures will ensure that the drainage on the recreated profile matches the rehabilitation plan as well as to detect early on when any drainage structures are not functioning efficiently. These structures can then be repaired or replaced before significant erosion damage is caused.

10.3.3.2 Water Quality

The quality of all water leaving the property should be monitored on a regular basis to ensure compliance of the various constituents with the standards approved by the government. Samples should be analysed for particulate and soluble contaminants as well as biological.

10.3.4 Groundwater

The groundwater levels and quality should be measured and monitored in a similar way to the surface water to determine the impact of the reclamation and other project activities on the groundwater

resources. A hydrogeologist, together with the relevant authorities, should determine the locations of the monitoring boreholes. The monitoring frequency will be determined by the regulator.

10.3.5 Vegetation Species

Biodiversity assessments and surveys should be undertaken by external experts to establish the full range of plants that have become established. The assessments should be undertaken during summer and winter months.

10.3.6 Alien Invasive Control

Invasive alien plant species are difficult to control. Methods should be used that are appropriate for the species concerned, as well as to the ecosystem in which they occur.

The satisfactory control of weeds and other invasive species is usually only achieved when several complementary methods, including biological control, improved land management practices, herbicides and mechanical methods, are carefully integrated. Such a strategy is termed an Integrated Control Strategy (ICS).

Follow-up control of alien plant seedlings, saplings and coppice regrowth is essential to maintain the progress made with initial control work, and to prevent suppression of planted or colonizing grasses. Before starting new control operations on new infestations, all required follow-up control and rehabilitation work must be completed in areas that are originally prioritized for clearing and rehabilitation.

The following additional measures are recommended in order to prevent the future introduction or spread of alien species, and to ensure the rehabilitation of transformed areas:

- There must be no planting of alien plants anywhere within the project area;
- Annual surveys, aimed at updating the alien plant list and establishing and updating the invasive status of each of the alien species, should be carried; and
- The transportation of soils or other substrates infested with alien species should be strictly controlled.

Benefits to local communities as a result of the alien plant control programme should be maximised by not only ensuring that local labour is employed, but by also ensuring that cleared alien trees are treated as a valuable wood resource that can be utilised.

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11 ACTION SCHEDULE

The closure schedule needs to be linked to the financial provision estimate and forecast that is undertaken for each year of reclamation. The schedule should take into account areas that become available for rehabilitation and costs should be provided to undertake such rehabilitation.

The closure schedule addresses the timing of rehabilitation and closure activities performed during the decommissioning and post-closure phases for a particular operation. As a result of the type of mining that is undertaken (reclammation),concurrent rehabilitation will be undertaken s soon as red soil is reached and it is feasible to rehabilitate.

Areas may be available during the construction phase that may require rehabilitation, such as construction laydown areas and these could be rehabilitated after the construction phase.

Presented below is a high-level schedule of closure related aspects that should be undertaken either during the LoM and/ or during the decommissioning phase:

- Annual review and update of the Rehabilitation, Decommissioning and Mine Closure Plan;
- One year prior to closure start with the closure engagement process with stakeholders and employees;
- Decommissioning phases are expected to take three years, including a one year ramp down period and a two year rehabilitation which will restore the site to red earth; and
- Post-closure vegetation monitoring and maintenance for three years and groundwater and surface water monitoring for five years.

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12 ORGANISATIONAL CAPACITY

During final rehabilitation and closure phase of the mine, suitably skilled technical persons would need to be employed to ensure that rehabilitation works are completed correctly and successfully. These positions would include an Environmental Manager, a Rehabilitation Officer and a Rehabilitation Superintendent, who will ensure that all work involving reshaping are done according to specification.

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13 GAPS

This is the first draft of the mine rehabilitation, decommissioning and closure plan, it is envisaged that through the operational phase of this project many further specialist studies and improvements in technology will take place and as such it is recommended the this plan be revisited and updated with these findings as an annual requirement of the Financial Provision Regulations (replaced by GN R1147 if applicable in the future).

Further update and review of the rehabilitation, decommissioning and closure plan based on new information may highlight further gaps in this plan, however, this plan includes information available at present.

The following has been identified, with respect to threats, opportunities and uncertainties with respect to the compilation of this plan to define any additional work that is needed in order to reduce the level of uncertainty:

- Ongoing surface water and groundwater quality monitoring during the operational LoM to determine trends overtime and to monitor changes in water quality overtime to determine if the mine is impacting on water quality resources;
- Ongoing dust monitoring during the operational LoM to determine trend overtime and to monitor changes in air quality overtime and to determine if the mine is impacting the air quality
- The sampling results should be utilised to update the Numerical Model, initially undertaken, in order to refine the model and more accurately predict post closure impacts based on actual data obtained during the operational phase;
- Ongoing engagement with communities surrounding the area, with respect to the closure vision and tacking these issues into account when closure is being considered;
- Skill development training for employees and engagement with employees to ensure that when closure is reached and downscaling and retrenchment of staff occurs that all are aware of the process and that people have the required skills in order to find alternative employment; and
- Adopting closure recommendations as identified in the respective specialist reports, with particular emphasis on social, water and biodiversity related aspects.

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14 RELINQUISHMENT CRITERIA

Relinquishment requires formal acceptance from the regulatory authority to ensure that all obligations associated with closure are achieved, prior to a closure certificate being issued. To achieve relinquishment, criteria need to be set, measured and met for all parties to understand what needs to be done to obtain a closure certificate. This provides all parties involved in the process a target that needs to be achieved and sets the standards that closure and rehabilitation are measured against. Table 14-1provides the respective environmental relinquishment criteria.

Table 14-1: Relinquishment Criteria

Aspect	Closure Requirement	Indicator	Evidence
Biodiversity	Establishment of vegetation that has a basal cover of 15% and that is self-sustaining and can be measured over a 3 - 5 year period, indicating that natural succession has occurred.	Vegetation monitoring and rehabilitation monitoring.	Monitoring Reports.
Soil	Soil quality as assessed against the Norms and Standards to support Chapter 8 of NEMWA.	Soil quality located on footprints of infrastructures.	Soil sample analysis which results indicate a sustaining soil.
Soil, Land Use and Land Capability	Erosion	No visible signs of erosion (sheet erosion, rill or gully formation, or bank collapse).	Post-rehabilitation slope analysis mapping must be conducted immediately after re-grading (re-sloping) [before 'top soiling'] utilising an aerial photograph and generated contours. Over steep slopes must be corrected before 'top soiling'. Photographic record.
Soil, Land Use and Land Capability	Post land use mining assessment to determine status of rehabilitated areas with respect to soil quality and that rehabilitated areas have been rehabilitated to an agreed upon land use. In addition to the above, inspections should be undertaken to identify areas of erosion and that erosion	Soil chemistry, depth (300 mm) and physical properties analysis to determine soil quality.	Post-rehabilitation slope analysis mapping must be conducted immediately after re-grading (re-sloping) [before 'top soiling'] utilising an aerial photograph and generated contours. Over steep slopes must be corrected before 'top

Aspect	Closure Requirement	Indicator	Evidence
	measures have been constructed.		soiling'. Photographic record
Land Use	Levelled and undisturbed site, cleared down to red earth that will be used for development purposes.	Stable, flat and cleared site, with locale and original topography. Cleared down to red earth ready to support and promote new development.	Regular post-closure monitoring using visual observations. Photographic record.
Surface Water	Surface water qualities need to comply with the qualities as stipulated in the WUL, GNR.704 and the appropriate DWS and SANS Standards	Up and down stream water quality monitoring.	Monitoring reports indicating a decrease in impact from the site.
Groundwater	Surface water qualities need to comply with the qualities as stipulated in the WUL, GNR.704 and the appropriate DWS and SANS Standards	Borehole water quality monitoring.	Monitoring reports indicating a decrease in impact from the site. Detailed understanding of any pollution plumes.
Air Quality	Dust, PM_{10} and $PM_{2.5}$ must comply with the minimum standards and limits as set by the NEMAQA and applicable regulations and guidelines.	Monthly and Quarterly Reports.	Monitoring reports indicating a decrease in impact from the site.
Social Environment	Compliance to the companies SLP.	Successful implementation of LED projects, development of SMMEs etc. as per SLP commitments.	Sustaining local economy excluding the mines contribution.
Community Health and Safety	The site is safe for use by humans and animals. No latent environmental impacts remain which can endanger surrounding communities.	Successful rehabilitation. Water and air quality monitoring results.	Evidence in final closure and rehabilitation report that appropriate risk assessment has been undertaken and control measures are in place.
Stakeholder Engagement	Aspects raised during public participation are addressed.	Grievance mechanism are in place. Minutes of forums established.	A full public participation process will be undertaken during closure.

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15 CLOSURE COST METHODOLOGY

Digby Wells Environmental (DWE) was appointed to undertake the Far West Gold Recoveries Closure Cost Assessment for 2024. The closure costing for the Libanon Reclamation Project is based on the costing methodology used by DWE.

The closure cost assessment was developed in line with the requirements of the NEMA as amended. These Regulations provide that the holder of a mining right must make financial provision for rehabilitation of negative environmental impacts.

The financial provision must guarantee the availability of sufficient funds to undertake the following:

- Rehabilitation of the adverse environmental impacts of the listed or specified activities;
- Rehabilitation of the impacts of the prospecting or mining activities, including the pumping and treatment of polluted or extraneous water;
- Decommissioning and closure of the operations;
- Remediation of latent or residual environmental impacts which become known in the future;
- Removal of building structures and other objects; and/or
- Remediation of any other negative environmental impacts.

The Financial Provisioning Regulations, 2015 (GN R1147) for the determination of financial provision for mine rehabilitation and closure were promulgated on 20 November 2015 under the NEMA, as amended.

On 1 February 2024, the Minister of Forestry, Fisheries and the Environment (Minister) again amended the transitional period contained in regulation 17B of the Financial Provision Regulations, 2015. The transitional arrangements in regulation 17B of the Financial Provision Regulations allows the holder of a right or permit granted or issued, as the case may be, in accordance with the Mineral and Petroleum Resources Development Act, 2002 (MPRDA), who applied for such right or permit before 20 November 2015, to continue making financial provision in accordance with regulations 53 and 54 of the regulations published under the MPRDA. Stated differently, a person who applied for a right or permit prior to 20 November 2015, is not yet required to comply with the Financial Provision Regulations.

In the previous amendments to the regulation 17B of the Financial Provision Regulations, the Minister always specified a date by when the transitional period would expire and when all holders would be required to comply with the Financial Provision Regulations. However, this time the Minister has amended regulation 17B to provide that the transitional period will continue to apply until the Minister published a date by when all holders are required to comply with the Financial Provision Regulations.

It should also be noted that on 11 July 2022, the Minister of Forestry, Fisheries and the Environment published the latest draft version of the Proposed Regulations Pertaining to Financial Provisioning for the Mitigation and Rehabilitation of Environmental Damage Caused by Reconnaissance, Prospecting, Exploration, Mining or Production Operations NEMA FP Regulation. The draft regulations are intended to repeal and replace the current Financial Provisioning Regulations, 2015.

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The closure model calculates the cost of demolishing, removing and rehabilitating each infrastructure component which may include (but is not limited to):

- Rehabilitation of the pump station and pipeline footprints;
- Generalised rehabilitation and vegetation management strategies;
- Ensuring the reclaimed footprints are free draining;
- Vegetation on the TSFs that will remain post-closure;
- Radiation clearance for each rehabilitated footprint; and
- Post-closure maintenance and monitoring costs.

The following assumptions were made by DWA.

Table 15-1: Closure Cost Assumptions

Assumptions	Consequences
The calculations do not account for any value recovered from sale of plant, steel or other material.	Value recovered from sale of the mine`s operational infrastructure can be used for any other purpose.
Where contractor rates were not received, the current rates database was used and escalated with an average annual inflation of 5.9%.	Impact on overall closure cost estimate.
Water tariffs updated as per the quotations received in 2024.	Impact on overall closure cost estimate should the actual rate be different.
FWGR will: • Demolish concrete up to one (1) m below natural ground level; • Dispose all inert waste (i.e. building rubble) on site burying it 1 m underground during decommissioning; • Remove all powerlines at closure; • Remove all fences at closure; • Demolish the diesel tank infrastructure subsequent to the owner removing the tanks; • Demolish all prefabricated buildings at the end of LoM; and • Remove all temporary structures from site prior to closure.	Listed components removed prior to closure have not been considered in the Financial Provision calculations.
General surface rehabilitation must involve the shaping of the surface topography to match the surrounding landscape. During the process of shaping the landscape and drainage lines must be properly reinstated into the topography; • The footprint areas occupied by permanent surface infrastructure will require ripping, followed by vegetation; and • Any heaps of excess material also need to be removed to ensure effective revegetation.	Ability to effectively implement the final land use.

Assumptions	Consequences
.	
The financial provision estimate does not include VAT	VAT must be included separately
a contingency of 10% on the financial provision has been provided for.	Price fluctuations with regard to plant hire, fuel prices and possible omissions from the assessment have been accounted for.
A 6% allowance has been made where the cost is more than R100,000,000, and 12% allowance where the cost is less than R100,000,000 for preliminary and general (P&Gs).	Changes to this assumption will impact the closure cost.
It is assumed that the machine hire rates and rehabilitation quotations received are independent and accurate.	Any changes to the prices quoted will impact the closure cost.

To ensure that the site is up to standards for the proposed land use, the following activities need to take place:

- All surface plants, buildings and equipment needs to be removed from site, foundations will also need to be removed to a metre below the surface. After all of the infrastructure has been removed the surface will need to be levelled and revegetated and, all haul and other activity roads will need to be ripped and vegetated. The secondary containment dam will also need to be removed along with powerlines and other electrical infrastructure.

15.1 Annual Rehabilitation Costs

Annual rehabilitation costs will be included into the operating budget of the mine. The operation has not been initiated and a Zero (R 0.00) rand annual rehabilitation cost is reported for the Libanon site.

15.2 Summary of Closure Costs

A summary of the closure cost estimate (excl. VAT) is presented in Table 15-2.

Table 15-2: Closure costs

	Unplanned closure (year 1)	Planned Closure (year 12)
Libanon TSF	R31 355 706.61	R21 460 578.14

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16 MONITORING, AUDITING AND REPORTING REQUIREMENTS

Monitoring, Auditing and Reporting will be undertaken for future revisions to this plan, which are required annually. Final monitoring and reporting on the monitoring required in achieving the relinquishment criteria will be undertaken.

The following will be undertaken during the operational phases of the project, to ensure compliance with necessary legislations:

- Annual internal monitoring, auditing and reporting to account for changes in the environment, risk profile and progression of concurrent rehabilitation to ensure that the annual liability assessment reflects the true liability at that point in time.
- An external review will be undertaken by a specialist and then by the financial auditors as part of the annual financial/ accounting audit to determine that the liability assessment is appropriate and that the quantum of the liability is included in the operations provisions.
- Appointment of an external consultant to review and update the rehabilitation, decommissioning and mine closure plan annually.
- Other statutory audits required, such as EMP Environmental Audits, Water Use Licence Audits, GN704 audits and Social and Labour Plan Audits, which will be undertaken as stipulated in accordance with their conditions.

According to the Chamber of Mines/ Coaltech, 2007. Final monitoring and reporting should encompass the following items:

- Alignment of actual final topography to agreed planned landform.
- Depth of topsoil stripped and replaced.
- Chemical, physical and biological status of soils replaced due to erosion.
- Surface water drainage systems and surface water quality.
- Groundwater quality at agreed locations.
- Vegetation basal cover.
- Vegetation species diversity.
- Faunal re-colonisation.
- Proportion of mined land that has been fully rehabilitated.

To achieve the above an operational monitoring programme as well as a post closure monitoring programme will be developed to track the recovery of the site towards the long-term post-closure land capability goals, in accordance with the overall closure objectives.

The monitoring programme is designed to collect information to prove that the relinquishment criteria have been accomplished. The monitoring programme will include:

- Groundwater: Quality monitoring of both the shallow and deep aquifers against the parameters required by the WUL. Sampled quarterly for a five-year post-closure period;

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- Surface water monitoring: Quality monitoring of the surrounding surface water against the requirements of the WUL. Sampled quarterly for a five-year post-closure period;
- Dust fall monitoring: Quality monitoring of the air quality surrounding the project area against the legislative requirements. Sampled monthly for a year post-closure period;
- Photographic records should be maintained together with findings, follow up actions and close out records as part of the Environmental Management System.

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17 ENVIRONMENTAL RISK ASSESSMENT: LATENT AND RESIDUAL ENVIRONMENTAL IMPACTS

According to the Financial Provisioning Regulations, the objective of the environmental risk assessment report that relates to latent and residual impacts is to:

- Ensure timeous risk reduction through appropriate interventions;
- Identify and quantify the potential latent environmental risks related to post closure;
- Detail the approach to managing the risks;
- Quantify the potential liabilities associated with the management of the risks; and
- Outline monitoring, auditing and reporting requirements.

This Report aims to address these objectives separately in cases where they have not been considered in previous sections.

17.1 Assessment Process to Describe Latent Environmental Risks

The Environmental Impact Assessment (EIA) Report provides a detailed description of the environmental impact/ risk identification and assessment (including the methodology and findings) undertaken for the Project. Further details of the risk assessment methodology are detailed in Section 8 of this report. The EIA Report and EMPr have identified mitigation measures which, once implemented successfully, will result in the avoidance or acceptable reduction of associated biophysical, socio-economic and cultural heritage impacts.

The drivers that could result in latent environmental risks are largely defined by the historical nature of the activity and the site, as well as the proximity to water sources and wetlands. Further investigations must be conducted during annual revisions of the rehabilitation plan to provide more clarity. These investigations must include regular revision of the environmental risk assessment and consequently inform the responsible management of latent and residual impacts.

17.2 Management Activities, Costing and Monitoring Requirements

New international best practice guidelines that may be developed in the future will be considered in all annual updates of the financial provisions and changes to the risk assessment will be reported on. In addition, monitoring results and auditing reports as described above for one year after closure will inform the revised risk assessment.

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18 AMENDMENT MOTIVATIONS

The plan will be updated annually where any amendments required will be incorporated into the plan to ensure it is relevant and up to date with all available specialist information, concurrent rehabilitation undertaken, changes or progress in terms of mining activities and finally the audited financial provision assessment.

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19 CONCLUSION

The report serves to meet the NEMA Regulations pertaining to the Financial Provision for Prospecting, Exploration, Mining or Production Operations (GNR. 1147 of 2015, as amended) which require that a final rehabilitation, decommission and mine closure plan is developed which includes the determination of financial provision to guarantee the availability of sufficient funds to undertake rehabilitation and remediation of the adverse environmental impacts of mining. This document presented the conceptual rehabilitation, decommissioning and mine closure plan for the Project. The rehabilitation, decommissioning and mine closure plan will be updated and amended annually to comply with current legislation. During this process, changes in baseline information, legislation amendments, spatial developments and any other changes which may impact the closure of the mine will be incorporated to ensure that the plan remains current and implementable.

FWGR will provide for the closure liability for premature closure associated with the project through the procurement of suitable guarantees as allowed by the Financial Provision Regulations, with such guarantees provided to the DMRE following authorisation of the Project.

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APPENDIX A:
Curriculum Vitae

Curriculum Vitae – Gerlinde Wilreker

Technical Director

Professional Registration
- South African Council for Natural Science Professionals (SACNASP) – 2009
- Environmental Assessment Practitioners Association of South Africa (EAPASA) – 2019
- International Association of Impact Assessment South Africa

Qualifications
- Management Development Programme, University of Stellenbosch Business School, 2021
- Diploma Environmental Law, University of Johannesburg, 2005
- M.Sc. Environmental Management, RAU, 2004
- B.SC. Hons Environmental Management, RAU, 2002
- B.Sc. Earth Sciences, RAU, 2001

Languages
- English – Fluent
- French – Fluent
- German – Fluent
- Afrikaans – Average

Countries Worked in
- South Africa
- Democratic Republic of Congo
- Mauritania
- Mali
- Senegal
- Zambia

Gerlinde has over eighteen years' work experience, predominantly in the mining industry. Her practical experience in the mining and construction industry has given her a depth of knowledge regarding project processes from pre-feasibility phases through to implementation. She is adept at working in different contexts, and problem-solving with her team to meet the required outcomes. She has expertise in relation to Environmental Authorisation Processes in terms of the South African legal regime and has extensive environmental auditing experience, particularly in the mining sector. She has a M.Sc. Environmental Management from the former RAU (now UJ) and is also a registered Environmental Assessment Practitioner (EAP) with the Environmental Assessment Partitioners Association of South Africa (EAPASA) and a Natural Scientist with the South African Council for Natural Science Professionals (SACNASP).

Her skills include:

- Project Management;
- Environmental Authorisations;
- Environmental Auditing;
- Environmental Control Officer; and
- Gap analyses and Due Diligences.

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PROJECT EXPERIENCE

Project	Dates	Location	Client	Project Description	Position Held	Activities Performed
Environmental Authorisations / Water Use Licences						
Henrietta Wind Project	2023-2024	Mauritius	Akuo Energy	Provision of strategic E&S advisory services as well as conduct IFC compliant specialist studies.	Technical Director	Project Management
Genesis Steyn Solar PV Facility	2023-2024	Free State Province, South Africa	Genesis Eco-Energy Developments (Pty) Ltd.	Environmental Authorisations and IWULA	Technical Director	Project Management, Technical review
Ergo Mining: Valley Silts Expansion	2024	Gauteng, South Africa	DRDGOLD (Pty) Ltd	Environmental Authorisations and IWULA	Technical Director	Project Management, Technical review
Ergo Mining: Daggafontein Reinstatement	2024	Gauteng, South Africa	DRDGOLD (Pty) Ltd	Environmental Authorisations and IWULA	Technical Director	Project Management, Technical review
Ergo Mining: Withok TSF Recomissioning	2024	Gauteng, South Africa	DRDGOLD (Pty) Ltd	Environmental Authorisations and IWULA	Technical Director	Project Management, Technical review
Umsimbithi eMakhazeni Mining Project	2023- 2024	Mpumalanga Province, South Africa	Umsimbithi Mining (Pty) Ltd	IWULA	Technical Director	Project Management Technical review
Harmony Free State Operations IWULA	2022-2023	Free State Province, South Africa	Harmony Gold	IWULA	Technical Director	Technical review IWWP
Ergo Mining: Reclamation and Reprocessing of the 4L39 Dump	2022	Gauteng, South Africa	DRDGOLD (Pty) Ltd	Environmental Authorisations and IWULA	Technical Director	Project Management, Technical review Scoping Report
Ergo Mining: Reclamation and	2022	Gauteng, South Africa	DRDGOLD (Pty) Ltd	Environmental Authorisations and IWULA	Technical Director	Project Management, Technical review IWWMP

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Project	Dates	Location	Client	Project Description	Position Held	Activities Performed
Reprocessing of the 5L23 Dump						
Ubuntu Colliery 2022 RSIP Update	2022	Mpumalanga Province, South Africa	Universal Coal	Updating of the Ubuntu Colliery RSIP	Technical Director	Project Management, Technical review
Wonderfontein Colliery	2020 - 2022	Mpumalanga Province, South Africa	Wonderfontein Cilliery	Assisting with improvements of the Wonderfontein water management systems and IWULA	Technical Director	Project Management, Technical review
Umsimbithi eMakhazeni Mining Project	2019-2023	Mpumalanga Province, South Africa	Umsimbithi Mining (Pty) Ltd	Amendment of Environmental authorisation process for a coal mining project near Belfast	Technical Director	Project Management, Technical review
Sibanye Kloof EMP and IWUL Amendments	2019-2024	Gauteng Province South Africa	Sibanye-Stillwater (Pty) Ltd	Amendment of the existing EMP and IWUL	Technical Director	Project Management, Technical review
Sibanye Driefontein EMP and IWUL Amendments	2019-2024	Gauteng Province South Africa	Sibanye-Stillwater (Pty) Ltd	Amendment of the existing EMP and IWUL	Technical Director	Project Management, Technical review
Ergo Mining: Reclamation and Reprocessing of the Marievale Dumps	2019-2024	Gauteng, South Africa	DRDGOLD (Pty) Ltd	Environmental Authorisations and IWULA	Technical Director	Project Management, Technical review
Ergo Mining: Reclamation and Reprocessing of the City Deep Dumps	2018-2020	Gauteng, South Africa	DRDGOLD (Pty) Ltd	Environmental Authorisations and IWULA	Principal Environmental Consultant	Project Management Technical review EAP, IWULA
Ergo Mining: Reclamation and Reprocessing of the Rooikraal Tailings Storage Facility	2018-2020	Gauteng, South Africa	DRDGOLD (Pty) Ltd	Environmental Authorisations and IWULA	Principal Environmental Consultant	Project Management Technical review EAP, IWULA

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Project	Dates	Location	Client	Project Description	Position Held	Activities Performed
Leslie 1 Project	2017-2022	Mpumalanga Province, South Africa	Glencore Operation (Pty) Ltd	Environmental authorisation process for a coal mining project near Leandra	Principal Environmental Consultant	EAP, Project Manager. Managing specialists undertaking the specialist studies for the Environmental Impact Assessment
Umsimbithi eMakhazeni Mining Project	2017-2023	Mpumalanga Province, South Africa	Umsimbithi Mining (Pty) Ltd	Environmental authorisation process for a coal mining project near Belfast	Principal Environmental Consultant	EAP, Project Manager. Managing specialists undertaking the specialist studies for the Environmental Impact Assessment
Lephalale Coal and Power Project	2017-2020	Limpopo Province, South Africa	Dedicoal (Pty) Ltd	Environmental authorisation process for the Lephalale Coal and Power Project	Principal Environmental Consultant	EAP, Project Manager. Managing specialists undertaking the specialist studies for the Environmental Impact Assessment
Exxaro Coal Underground Coal Gasification Project	October 2015 – May 2016	Limpopo Province, South Africa	Exxaro Coal	Environmental Impact Assessment process for an underground coal gasification project	Environmental Consultant	Project Manager. Managing specialists undertaking the specialist studies for the Environmental Impact Assessment
Fumani Gold Mine	2013 -2015	Limpopo Province, South Africa	Corridor Mining Resources	Environmental Impact Assessment process for the proposed Fumani gold mine	Environmental Consultant	Managing consultants undertaking the EIA for the proposed Fumani gold mine
Kambove Copper Processing Plant	2013	Democratic Republic of Congo	Gécamines	Environmental, Social and Health Impact study (ESHIA) for the processing plant and tailings facilities	Environmental Consultant	Managing consultants undertaking the Environmental, Social and Health Impact study (ESHIA)

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Project	Dates	Location	Client	Project Description	Position Held	Activities Performed
PV Pant Authorisation	2012	KwaZulu Natal Province, South Africa	GX Energie	Basic assessment process for a PV plant.	Environmental Consulting	Assisting with BA compilation and public participation
Pering Mine	2009 - 2011	Northern Cape Province, South Africa	Minéro	Environmental Impact Assessment process for the proposed Reivilo lead and Zinc mine	Environmental Consultant	Compiling Scoping and EIA reports, public participation
Exxaro Coal Belfast Project	2008 -2011	Mpumalanga Province, South Africa	Exxaro Coal	Environmental authorisation process for the proposed Belfast Coal Mine	Environmental Consultant	Compiling Scoping and EIA reports, public participation
Closure Costing						
Beeshoek Closure Assessment	2020	Northern Cape, South Africa	Assmang (Pty) Ltd	Mine closure Assessment	Technical Director	Mine Closure requirement assessment
Ergo Mining: Reclamation and Reprocessing of the City Deep Dumps	2018-current	Gauteng, South Africa	DRDGOLD (Pty) Ltd	Environmental Authorisations and IWULA	Principal Environmental Consultant	Closure and Rehabilitation costing
Ergo Mining: Reclamation and Reprocessing of the Rooikraal Tailings Storage Facility	2018-current	Gauteng, South Africa	DRDGOLD (Pty) Ltd	Environmental Authorisations and IWULA	Principal Environmental Consultant	Closure and Rehabilitation costing
Total Coal Mine Closure Application	July 2015 – June 2016	KwaZulu-Natal, South Africa	Total Coal	Mine closure application and Basic Assessment for the closure of the Steincoalspruit Coal Mine	Environmental Consultant	Project Manager, review of mine closure application document and Basic Assessment, client and authority liaison

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Project	Dates	Location	Client	Project Description	Position Held	Activities Performed
Diesel Storage Facilities	2011	South Africa	Basil Read	EMP and closure costings for the installations of various diesel storage facilities throughout South Africa.	Environmental Consultant	EMP and closure costing
Environmental Control Officer						
Black Rock Expansion Project - Environmental Control Officer	2013 – 2015	Northern Cape Province, South Africa	Assmang Black Rock	Black Rock Expansion Project	Environmental Control Officer	Environmental Officer duties which include environmental compliance site visits, managing of contractors and their procedures as per client's EMS
Sishen Ramp-Up Projects – Bucket & Bowl, Life of Mine and various Housing Projects	2011 – 2013	Northern Cape Province, South Africa	Kumba Iron Ore	Bucket & Bowl, Life of Mine and various Housing Projects	Environmental Control Officer	Environmental Officer duties which include environmental compliance site visits, managing of contractors and their procedures as per client's EMS
Sishen Ramp-Up Projects – Diesel Tanks 5 & 6, Aldag 1 extension, Lakutshona and Sesheng Housing Projects	2011 – 2013	Northern Cape Province, South Africa	Kumba Iron Ore	Diesel Tanks 5 & 6, Aldag 1 extension, Lakutshona and Sesheng Housing Projects	Environmental Control Officer	Environmental Officer duties which include environmental compliance site visits, managing of contractors and their procedures as per client's EMS
Auditing						

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Project	Dates	Location	Client	Project Description	Position Held	Activities Performed
GOSA 2024 Audits	2024	Mpumalanga and Kwa-Zulu Natal Provinces South Africa	Glencore Operations South Africa (Pty) Ltd	External audits of 60 Environmental Authorisations for the Coal operations in Mpumalanga	Technical Director / Environmental auditor	External Audit Technical review
GOSA 2023 Audits	2023	Mpumalanga and Kwa-Zulu Natal Provinces South Africa	Glencore Operations South Africa (Pty) Ltd	External audits of 60 Environmental Authorisations for the Coal operations in Mpumalanga	Technical Director / Environmental auditor	External Audit Technical review
GOSA 2022 Audits	2022	Mpumalanga and Kwa-Zulu Natal Provinces South Africa	Glencore Operations South Africa (Pty) Ltd	External audits of 60 Environmental Authorisations for the Coal operations in Mpumalanga	Technical Director / Environmental auditor	External Audit Technical review
GOSA 2021 Audits	2021	Mpumalanga and Kwa-Zulu Natal Provinces South Africa	Glencore Operations South Africa (Pty) Ltd	External audits of 60 Environmental Authorisations for the Coal operations in Mpumalanga	Environmental auditor	External Audit
GOSA 2020 Audits	2020	Mpumalanga Province South Africa	Glencore Operations South Africa (Pty) Ltd	External audits of 60 Environmental Authorisations for the Coal operations in Mpumalanga	Environmental auditor	External Audit
Sibanye External Audits	2019 - 2020	Gauteng, Mpumalanga and Free State Provinces South Africa	Sibanye-Stillwater (Pty) Ltd	External audits of EMPr's for the operations in Gauteng, Mpumalanga and Free State Provinces	Technical Director	Project Management, client liaison, technical review, Auditor
GOSA 2019 Audits	2019	Mpumalanga Province South Africa	Glencore Operations South Africa (Pty) Ltd	External audits of 60 Environmental Authorisations for the	Environmental auditor	External Audit

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Project	Dates	Location	Client	Project Description	Position Held	Activities Performed
				Coal operations in Mpumalanga		
GOSA 2018 Audits	2018	Mpumalanga Province South Africa	Glencore Operations South Africa (Pty) Ltd	External audits of 47 Environmental Authorisations for the Coal operations in Mpumalanga	Environmental auditor	External Audit
GOSA 2017	2017	Mpumalanga Province South Africa	Glencore Operations South Africa (Pty) Ltd	External audits of 47 Environmental Authorisations for the Coal operations in Mpumalanga	Environmental auditor	External Audit
Cronimet Legal Compliance	2012-2013	Limpopo Province, South Africa	Cronimet	Legal compliance auditing of Cronimet mine	Environmental auditor	Monthly environmental auditing of chrome mine facilities
PPC Legal Compliance	2005 - 2008	South Africa	PPC	Legal compliance auditing of various quarries across South Africa	Environmental auditor	Monthly environmental auditing of chrome mine facilities
Due Diligence						
Environmental, Social and Governance Due Diligence Services	2024	Morocco	Vantage Mezzanine Fund IV	ESD Due Diligence	Technical Director	ESD Due Diligence
Rustenburg Chrome Mine Gap Analysis	2023-2024	North West Province, South Africa	Clover Alloys (Pty) Ltd	Gap Analysis	Technical Director	Environmental Legal Gap Analysis
Glencore Greenfields Gap Analysis	2023	Mpumalanga Province South Africa	Glencore Operation (Pty) Ltd	Gap Analysis	Technical Director	Environmental Legal Gap Analysis
Glencore Brownfields Gap Analysis	2023	Mpumalanga Province South Africa	Glencore Operation (Pty) Ltd	Gap Analysis	Technical Director	Environmental Legal Gap Analysis
Glencore Brownfields Gap Analysis	2022	Mpumalanga Province South Africa	Glencore Operation (Pty) Ltd	Gap Analysis	Technical Director	Environmental Legal Gap Analysis

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Project	Dates	Location	Client	Project Description	Position Held	Activities Performed
Zonnebloem Complex	2018	Mpumalanga Province South Africa	Glencore Operation (Pty) Ltd	Gap Analysis	Principal Environmental Consultant	Environmental Legal Gap Analysis
Eastplats Due Diligence	2014	North West Province, South Africa	Eastplats	An environmental legislative overview with an associated environmental site assessment, which in turn assessed the availability and status of the various environmental authorizations, permits and licenses required for legislative compliance at the Eastern Plat Asset.	Environmental Consultant	Compiling environmental due diligence
PTM Waterberg Project Concept Study	2013	Limpopo Province, South Africa	Platinum Group Metals	Concept study for Platinum mine in the Waterberg.	Environmental Consultant	Environmental input into the Preliminary Economic Assessment
Facilitation						
AEH (MEH/TEH) Management Systems compilation	2019-2020	Mali Senegal Zambia	EBS Advisory (Pty) Ltd	Compilation of an Environmental Management System for AEH operations in Uganda, Zambia, Mali and Senegal	Support function to the Project Manager at EBS Advisory in the Johannesburg office, primarily with respect to understanding the French ESMS requirements.	Project Management and Client Meetings. Research and Preparation Gap Analysis and ESMS Mapping Report Writing and ESMS complication.
SNIM Iron Ore Project	2014 - 2015	Mauritania	SNIM	Feasibility Study for Iron Ore Plant upgrade	Environmental Consultant	Assisting with the liaison between the client and the engineering team,

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Project	Dates	Location	Client	Project Description	Position Held	Activities Performed
						interpretation services, translation of technical documents

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APPENDIX B:
Closure Costing

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Aspect Name	Description	Unplanned Closure 2024					
		Class	Quantity	Unit	Rate	Amount	Comments
	Libanon TSF						0
							0
	Demolish infrastructure						0
	-						Assume area of 50m x 100m
Reclamation site	Demolish steel structure	136	1650.00	m²	R456.90	R 753 888.86	Assume double steel structure
	Remove temporary office						Assume will be removed prior to closure
	Demolish shaded net carport	106	15.00	m²	R72.56	R 1 088.46	Assume 2x double carport (3m x 2.5m)
	Demolish fence	147	300.00	m	R20.36	R 6 107.41	0
							0
Pump station	Demolish Pump station						0
	Demolish steel structures, motors & pumps	L1	1	Sum	R12 504.68	R 12 504.68	0
	Demolish buildings, foundations, and concrete structures	L2	1	Sum	R79 717.35	R 79 717.35	0
	Bury concrete 1m underground	L3	1	Sum	R18 600.71	R 18 600.71	0
	Remove electric cables / powerlines	L4	1	Sum	R19 132.16	R 19 132.16	0
	-						0
	Demolition Total					**R 891 039.64**	0
							0
	Rehabilitation						0
							0
Unplanned	Side slopes						0
	Rehabilitation of side slopes	V1	72.18	ha	R343 729.00	R 24 810 359.22	The side slope vegetation include, Site Establishment and De-Establishment, Project Management, Leaching Equipment, Maintenance of Leach Equipment (18 months), Vegetation and side slope preparation. The total TSF area is 160.65ha, it was measured on GE that the upper surface is 88.47ha, thus the side slopes are 72.18ha. Used Agreenco Quotation from Driefontein 4 TSF.
							0
	Upper surface (Beach)						0
	Vegetate upper surface of the TSF	V2	0.00	ha	R97 278.00	R 0.00	As per GE, the TSF upper surface is vegetated and stable. No Allowance made. Total upper area = 88.47ha. Used Agreenco Quotation from Driefontein 4 TSF.
	Unplanned Rehabilitation Total					**R 24 810 359.22**	
							0
Planned							0
-							
Reclamation site	Shaping of footprint area - To ensure site drainage	G	160.65	ha	R40 454.33	R 6 498 988.05	
	Storm water management site establishment	H	1.00	Sum	R7 033.88	R 7 033.88	
	Radiation clearance	F	1.00	Sum	R144 000.00	R 144 000.00	
	Radiation clearance Soil samples	E	1.00	Sum	R66 493.26	R 66 493.26	
	Ripping, Lime Application (30 ton/ha) and Vegetation	X1	160.65	ha	R62 141.82	R 9 983 083.00	

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Pump station	Demolish Pump station						
	Demolish steel structures, motors & pumps	L1		Sum			
	Demolish buildings, foundations, and concrete structures	L2		Sum			
	Bury concrete 1m underground	L3		Sum			
	Remove electric cables / powerlines	L4		Sum			
							0
	Planned Rehabilitation Total					**R 16 699 598.19**	0

Appendix D8
Screening Report

SCREENING REPORT FOR AN ENVIRONMENTAL AUTHORIZATION AS REQUIRED BY THE 2014 EIA REGULATIONS – PROPOSED SITE ENVIRONMENTAL SENSITIVITY

EIA Reference number:

Project name: LIbanon Reclamation Project

Project title: LIbanon Reclamation Project

Date screening report generated: 09/04/2024 08:56:09

Applicant: Far West Gold Recoveries (Pty) Ltd

Compiler: Kongiwe (Pty) Ltd

Compiler signature: ... .

Application Category: Mining|Mining Right

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Table of Contents

Proposed Project Location 3
Orientation map 1: General location 3
Map of proposed site and relevant area(s) 4
Cadastral details of the proposed site 4
Wind and Solar developments with an approved Environmental Authorisation or applications under consideration within 30 km of the proposed area 5
Environmental Management Frameworks relevant to the application 5
Environmental screening results and assessment outcomes 5
Relevant development incentives, restrictions, exclusions or prohibitions 6
Proposed Development Area Environmental Sensitivity 6
Specialist assessments identified 6
Results of the environmental sensitivity of the proposed area. 9
MAP OF RELATIVE AGRICULTURE THEME SENSITIVITY 9
MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY 10
MAP OF RELATIVE AQUATIC BIODIVERSITY THEME SENSITIVITY 11
MAP OF RELATIVE ARCHAEOLOGICAL AND CULTURAL HERITAGE THEME SENSITIVITY 12
MAP OF RELATIVE CIVIL AVIATION THEME SENSITIVITY 13
MAP OF RELATIVE DEFENCE THEME SENSITIVITY 14
MAP OF RELATIVE PALEONTOLOGY THEME SENSITIVITY 15
MAP OF RELATIVE PLANT SPECIES THEME SENSITIVITY 16
MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY 17

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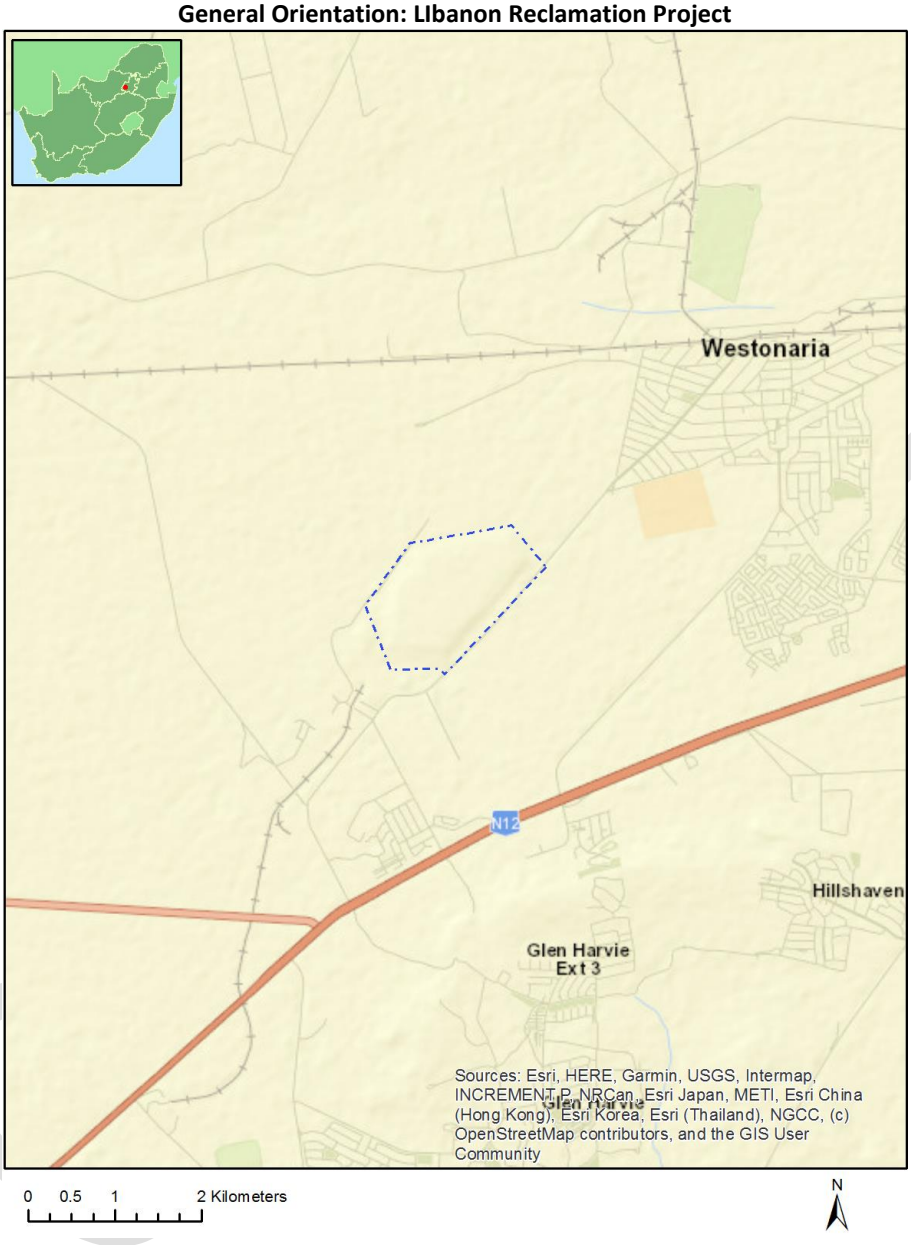
Proposed Project Location

Orientation map 1: General location

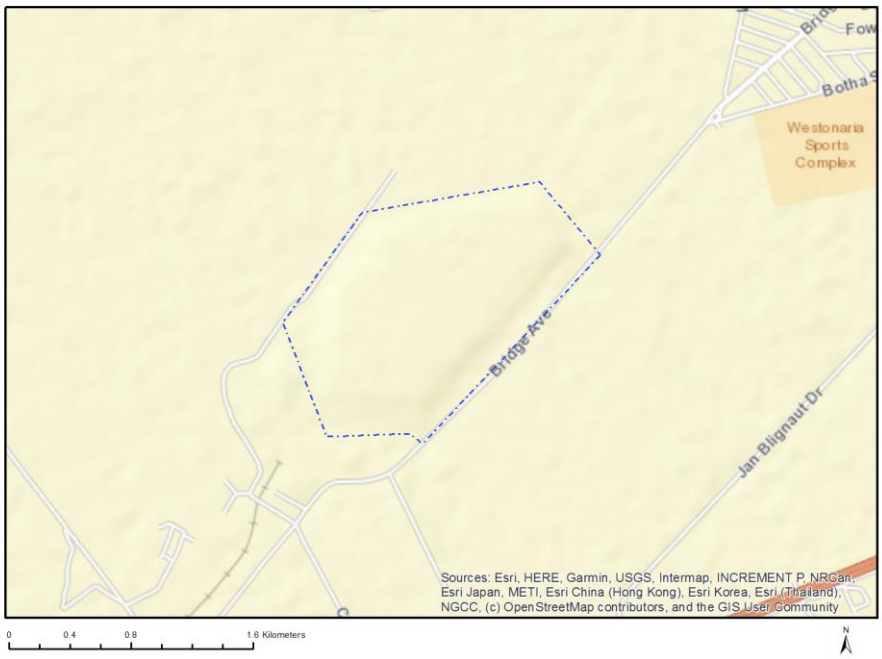
General Orientation: LIbanon Reclamation Project



Disclaimer applies

09/04/2024

Map of proposed site and relevant area(s)



Cadastral details of the proposed site

Property details:

No	Farm Name	Farm/ Erf No	Portion	Latitude	Longitude	Property Type
1	GEMSPOST	288	0	26°18'21S	27°37'49.55E	Farm
2	LIBANON OR WITKLEIGAT	283	0	26°20'49.98S	27°37'19.43E	Farm
3	VENTERSPOST	284	0	26°17'41.1S	27°35'56.37E	Farm
4	LIBANON OR WITKLEIGAT	283	0	26°21'6.11S	27°37'1.11E	Farm Portion
5	GEMSPOST	288	0	26°16'28.44S	27°38'16.06E	Farm Portion
6	LIBANON OR WITKLEIGAT	283	11	26°20'0.83S	27°37'40.45E	Farm Portion
7	VENTERSPOST	284	31	26°19'32.23S	27°36'37.16E	Farm Portion
8	GEMSPOST	288	41	26°19'43.52S	27°37'14.91E	Farm Portion

Development footprint[1] vertices:
No development footprint(s) specified.

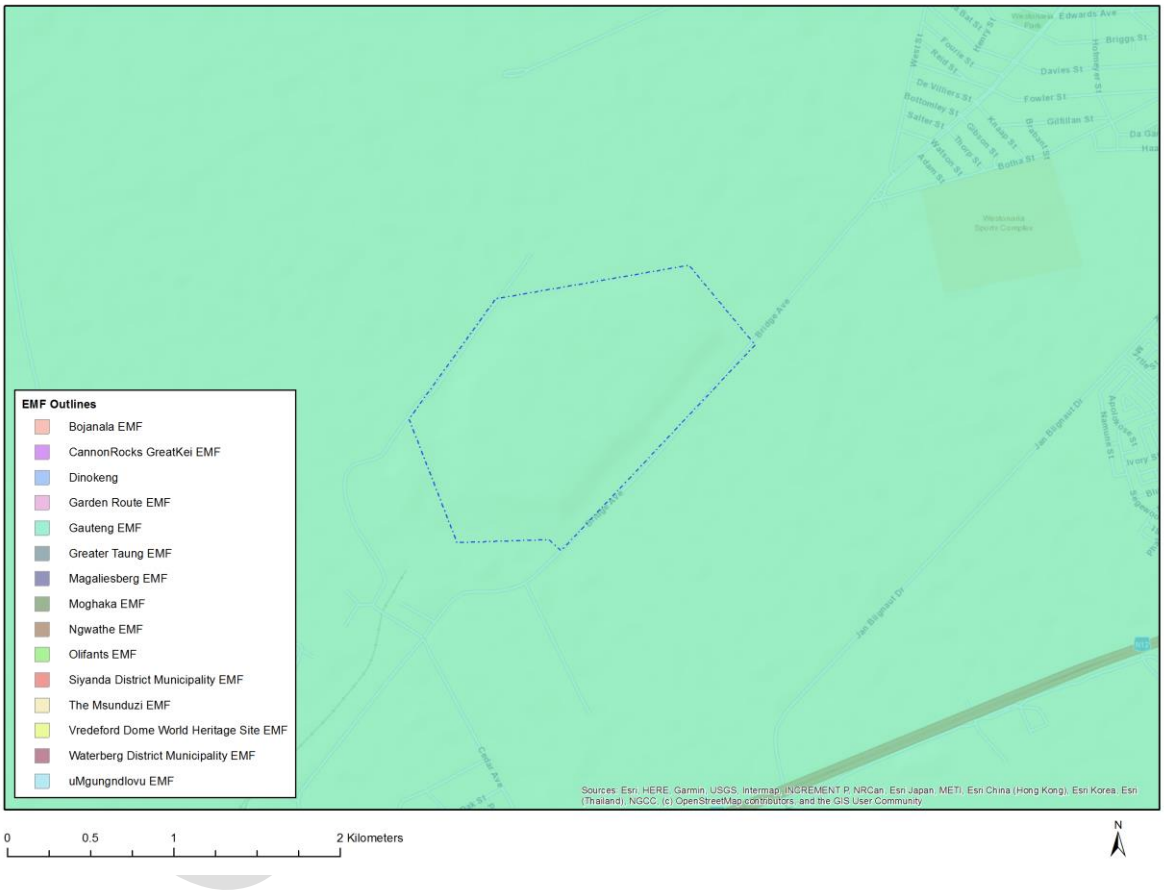
[1] "development footprint", means the area within the site on which the development will take place and incudes all ancillary developments for example roads, power lines, boundary walls, paving etc. which require vegetation clearance or which will be disturbed and for which the application has been submitted.

Disclaimer applies

Wind and Solar developments with an approved Environmental Authorisation or applications under consideration within 30 km of the proposed area

No	EIA Reference No	Classification	Status of application	Distance from proposed area (km)
1	12/12/20/2537/AM1	Solar PV	Approved	26.3
2	12/12/20/2537	Solar PV	Approved	29.2
3	12/12/20/2539	Solar PV	Approved	26.3
4	12/12/20/2537/AM3	Solar PV	Approved	26.3
5	12/12/20/2539/AM1	Solar PV	Approved	26.3
6	14/12/16/3/3/2/919	Solar PV	Approved	1.8

Environmental Management Frameworks relevant to the application



Environmental Management Framework	LINK
Gauteng EMF	https://screening.environment.gov.za/ScreeningDownloads/EMF/GPEMF_2021_Gazette_and_summary.pdf

Environmental screening results and assessment outcomes

The following sections contain a summary of any development incentives, restrictions, exclusions or prohibitions that apply to the proposed development site as well as the most environmental

sensitive features on the site based on the site sensitivity screening results for the application classification that was selected. The application classification selected for this report is: **Mining|Mining Right**.

Relevant development incentives, restrictions, exclusions or prohibitions

The following development incentives, restrictions, exclusions or prohibitions and their implications that apply to this site are indicated below.

Incentive, restriction or prohibition	Implication
Strategic Transmission Corridor-Central corridor	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/Combined_EGI.pdf
Strategic Gas Pipeline Corridors-Phase 3: Richards Bay to Gauteng	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/Combined_GAS.pdf
Main Electricity Distribution Substation	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/Distribution_Transmission.pdf

Proposed Development Area Environmental Sensitivity

The following summary of the development site environmental sensitivities is identified. Only the highest environmental sensitivity is indicated. The footprint environmental sensitivities for the proposed development footprint as identified, are indicative only and must be verified on site by a suitably qualified person before the specialist assessments identified below can be confirmed.

Theme	Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
Agriculture Theme			X	
Animal Species Theme			X	
Aquatic Biodiversity Theme				X
Archaeological and Cultural Heritage Theme				X
Civil Aviation Theme			X	
Defence Theme				X
Paleontology Theme	X			
Plant Species Theme			X	
Terrestrial Biodiversity Theme	X			

Specialist assessments identified

Based on the selected classification, and the known impacts associated with the proposed development, the following list of specialist assessments have been identified for inclusion in the assessment report. It is the responsibility of the EAP to confirm this list and to motivate in the assessment report, the reason for not including any of the identified specialist study including the provision of photographic evidence of the site situation.

No	Specialist assessment	Assessment Protocol
1	Agricultural Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Agriculture_Assessment_Pro

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		tocols.pdf
2	Landscape/Visual Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
3	Archaeological and Cultural Heritage Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
4	Palaeontology Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
5	Terrestrial Biodiversity Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_Terrestrial_Biodiversity_Assessment_Protocols.pdf
6	Aquatic Biodiversity Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_Aquatic_Biodiversity_Assessment_Protocols.pdf
7	Hydrology Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
8	Noise Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_Noise_Impacts_Assessment_Protocol.pdf
9	Radioactivity Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
10	Traffic Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
11	Geotechnical Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
12	Climate Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
13	Health Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
14	Socio-Economic Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
15	Ambient Air Quality Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
16	Seismicity Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_General_Requirement_Assessment_Protocols.pdf
17	Plant Species Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_Plant_Species_Assessment_Protocols.pdf
18	Animal Species Assessment	https://screening.environment.gov.za/ScreeningDownloads/Asse

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		ssmentProtocols/Gazetted_Animal_Species_Assessment_Protocols.pdf

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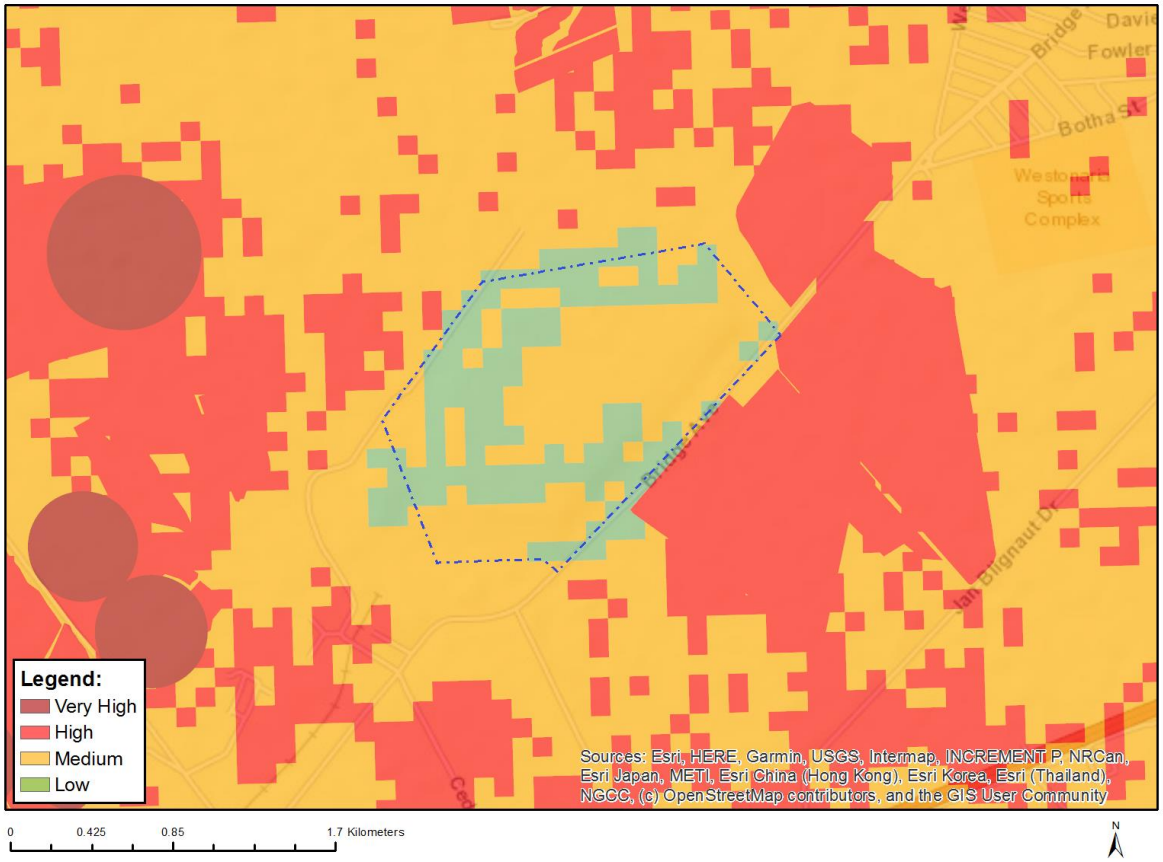
Results of the environmental sensitivity of the proposed area.

The following section represents the results of the screening for environmental sensitivity of the proposed site for relevant environmental themes associated with the project classification. It is the duty of the EAP to ensure that the environmental themes provided by the screening tool are comprehensive and complete for the project. Refer to the disclaimer.

MAP OF RELATIVE AGRICULTURE THEME SENSITIVITY

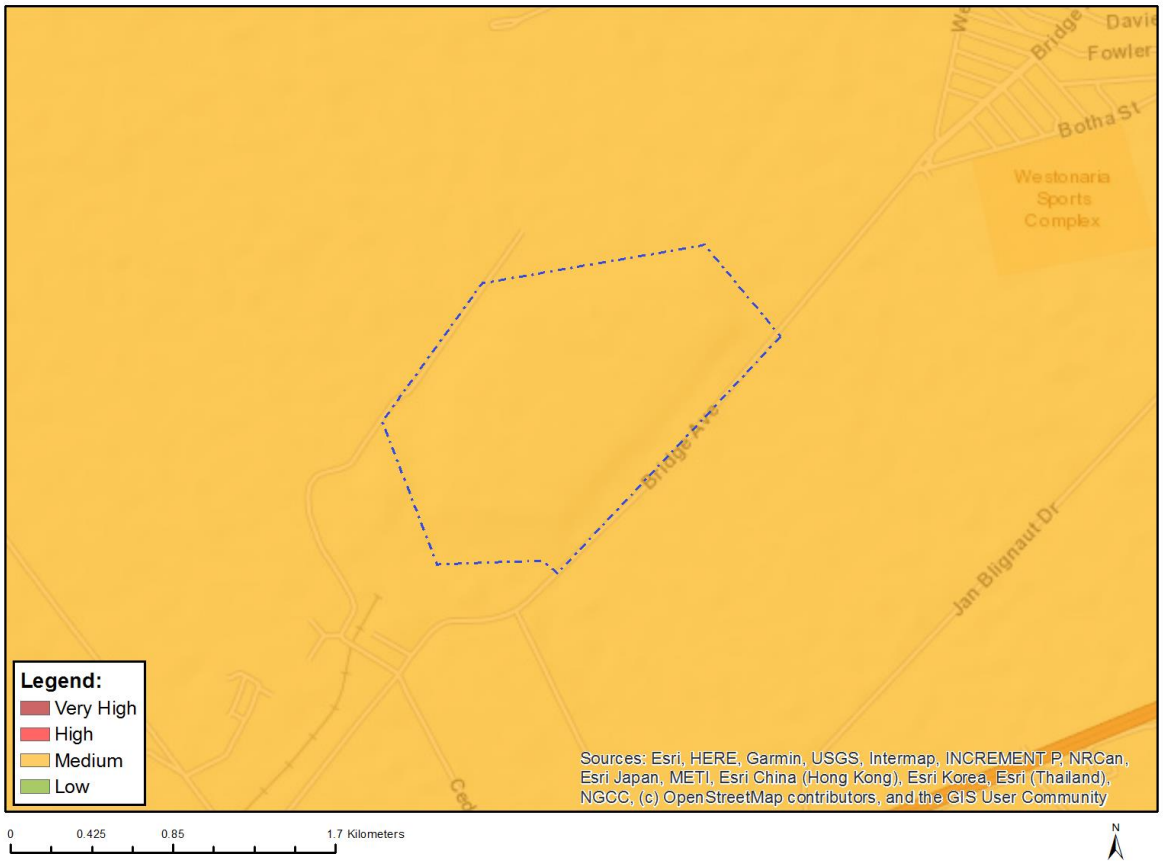


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Low	Land capability;01. Very low/02. Very low/03. Low-Very low/04. Low-Very low/05. Low
Medium	Land capability;06. Low-Moderate/07. Low-Moderate/08. Moderate

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



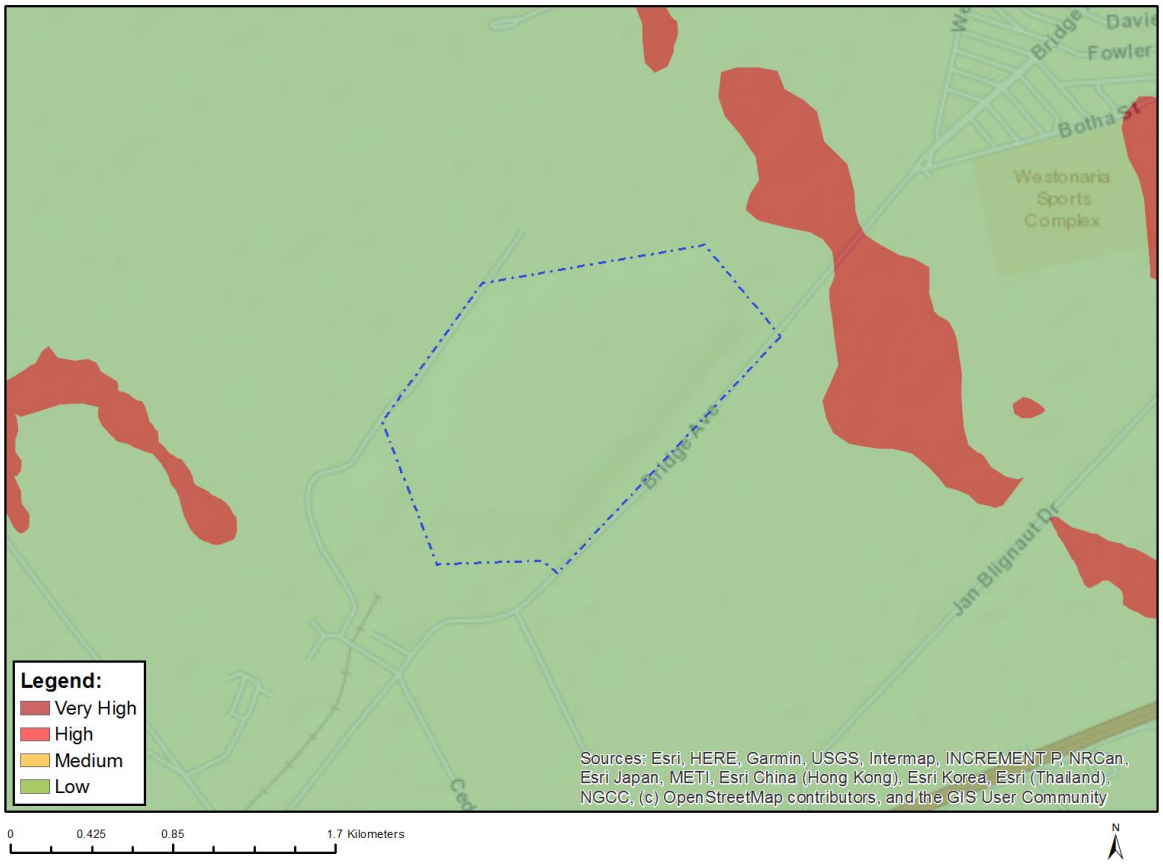
Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Insecta-Lepidochrysops praeterita
Medium	Mammalia-Crocidura maquassiensis
Medium	Mammalia-Hydrictis maculicollis
Medium	Invertebrate-Clonia uvarovi

MAP OF RELATIVE AQUATIC BIODIVERSITY THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low sensitivity

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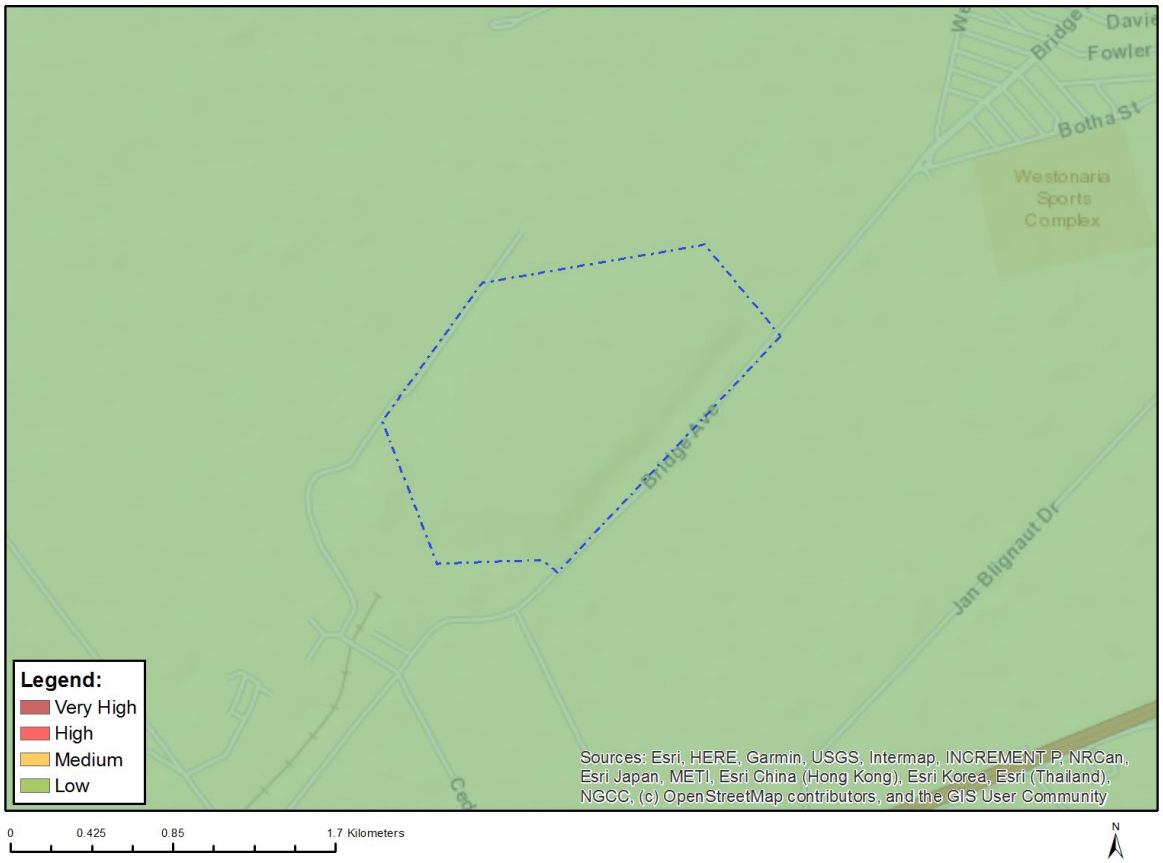
MAP OF RELATIVE ARCHAEOLOGICAL AND CULTURAL HERITAGE THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low sensitivity

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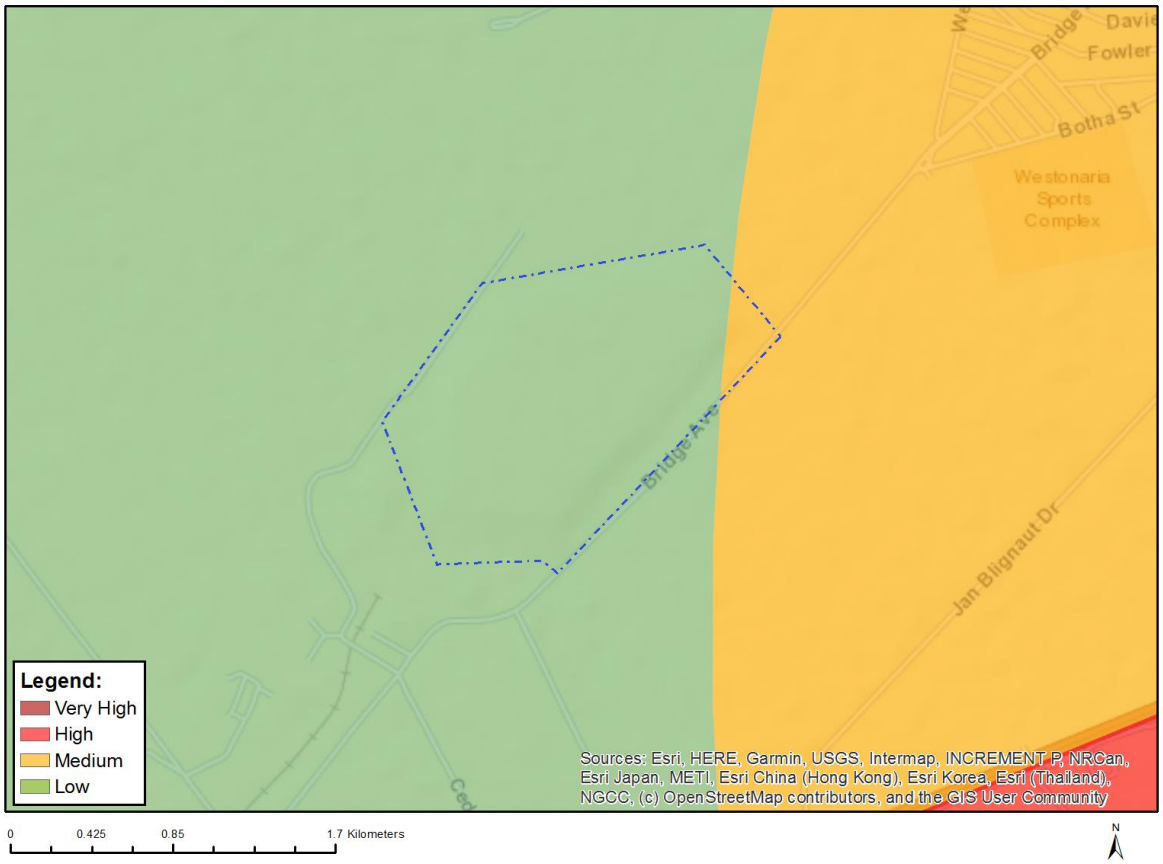
MAP OF RELATIVE CIVIL AVIATION THEME SENSITIVITY

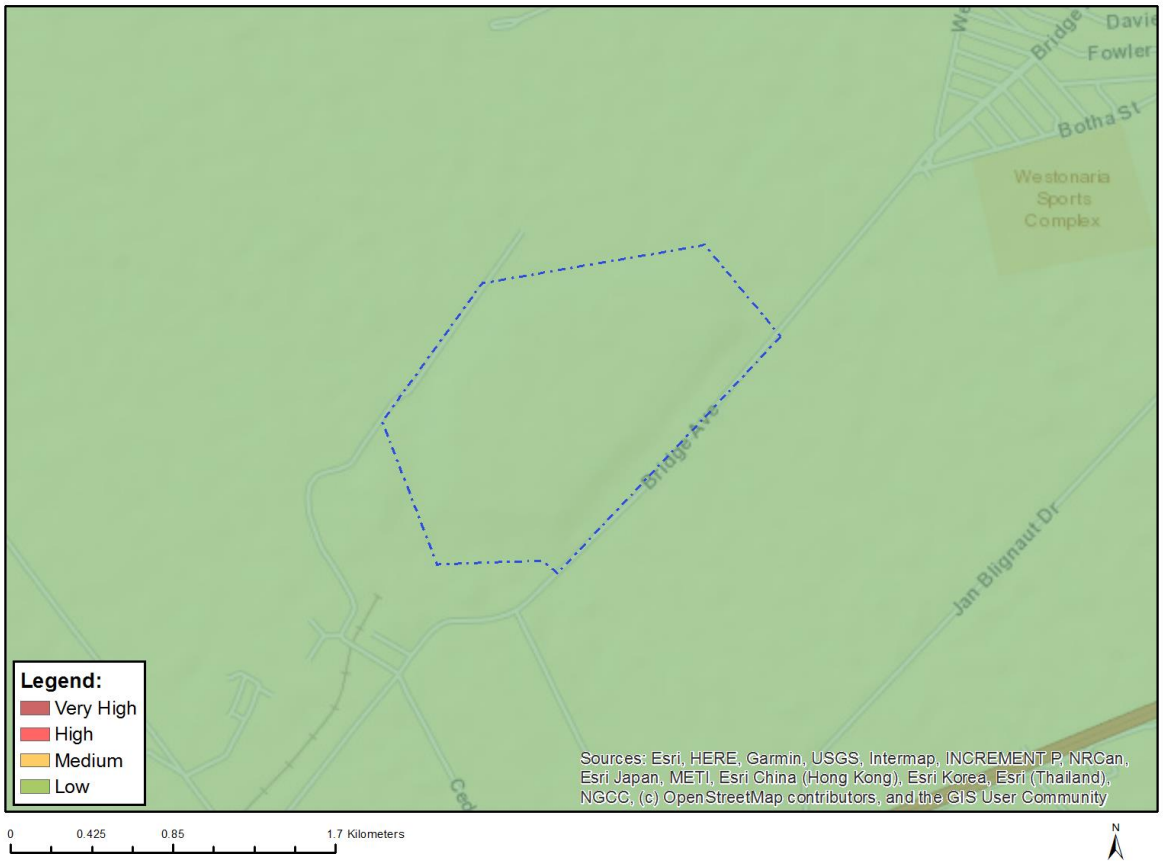


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low sensitivity
Medium	Between 8 and 15 km of other civil aviation aerodrome

MAP OF RELATIVE DEFENCE THEME SENSITIVITY



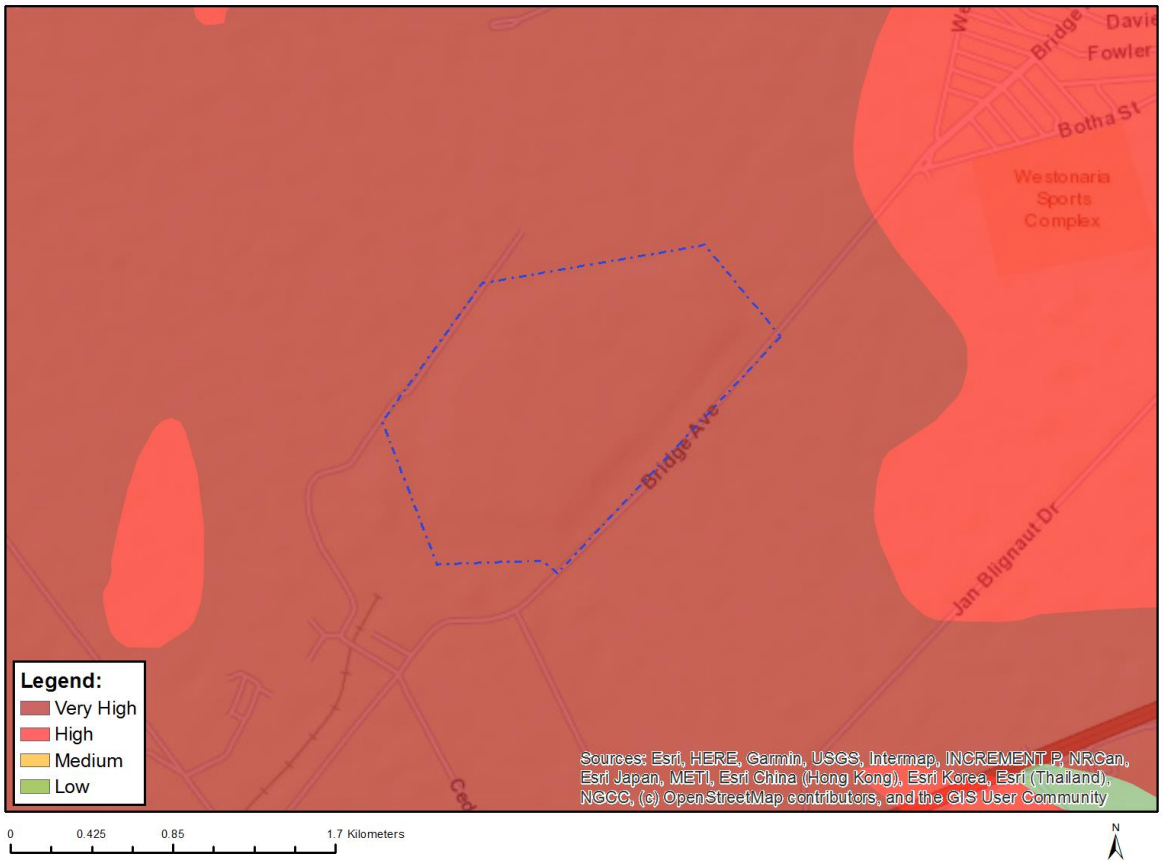
Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity

OFFICIAL

MAP OF RELATIVE PALEONTOLOGY THEME SENSITIVITY



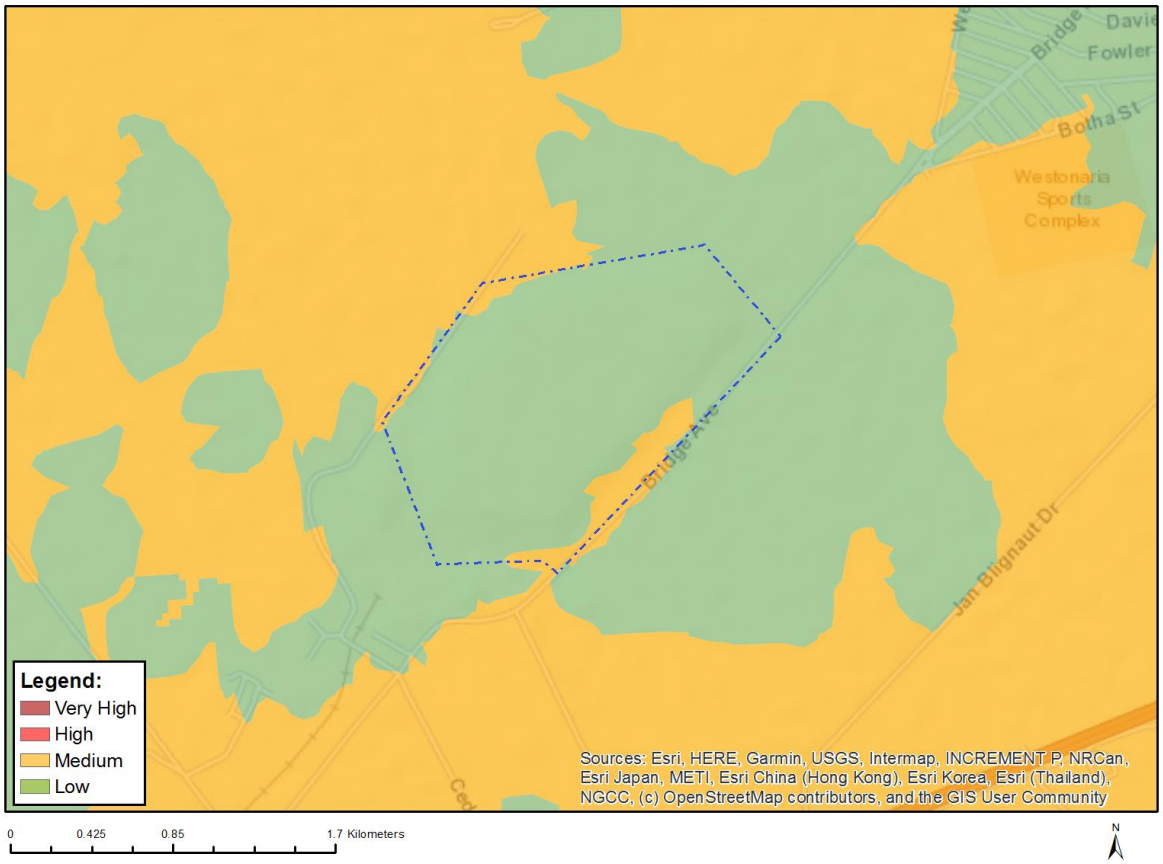
Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Very High	Features with a Very High paleontological sensitivity

Disclaimer applies

MAP OF RELATIVE PLANT SPECIES THEME SENSITIVITY



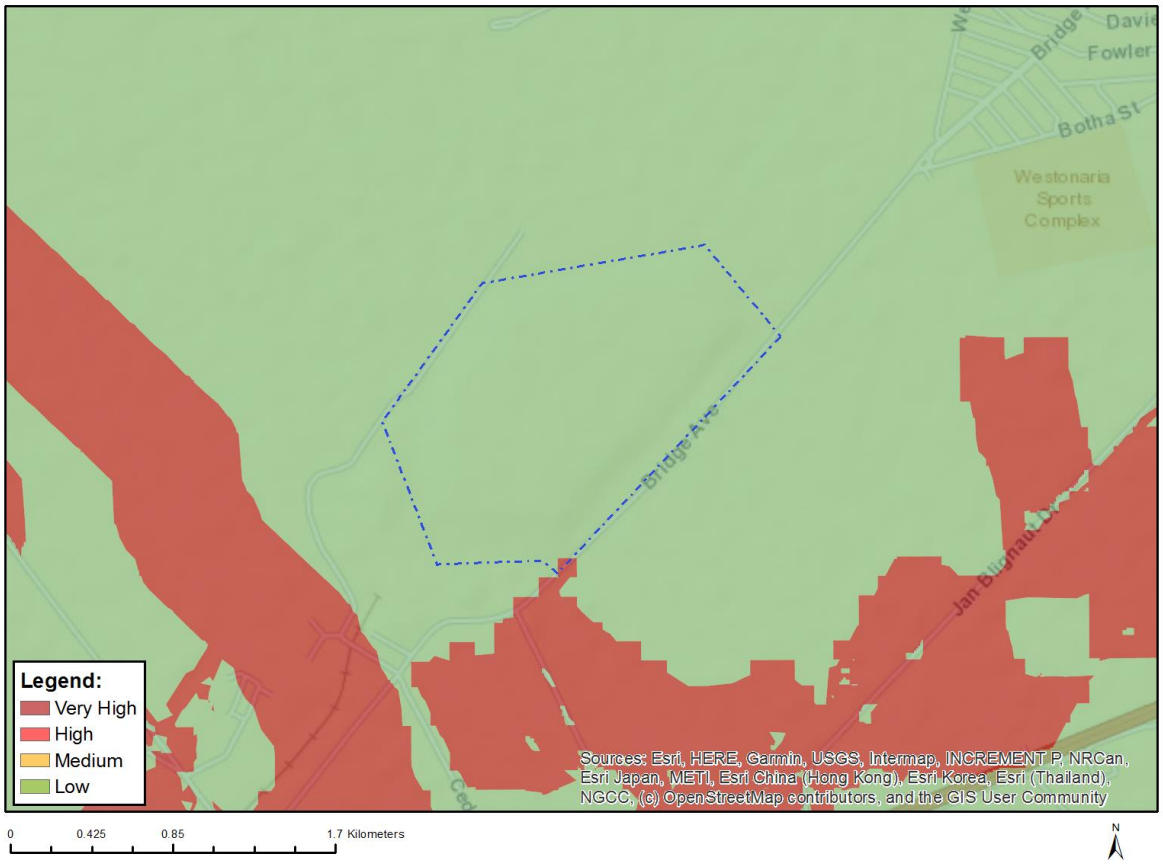
Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity
Medium	Khadia beswickii
Medium	Sensitive species 1147
Medium	Sensitive species 1248

MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity
Very High	National Protected Area Expansion Strategy (NPAES)

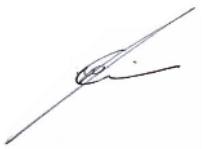
Disclaimer applies
09/04/2024

APPENDIX E:

Environmental Management Programme Report

FINAL ENVIRONMENTAL MANAGEMENT PROGRAMME INFORMATION

Project:	Libanon TSF Reclamation
Report Title:	Final Environmental Management Programme Report: The Reclamation of the Libanon Tailings Storage Facility in the Rand West City Local Municipality, Gauteng Province
Applicant:	Far West Gold Recoveries (Pty) Ltd
Project No:	DRDG#037
Compilation Date:	07 February 2025
Status of Report:	Final EMPr report

Verification	Capacity	Name	Signature	Date
Author:	EAP and Author	Foord Ceronio		07 February 2025
Reviewed by:	Project Manager EAP	Gerlinde Wilreker		12 December 2024
Reviewed by:	Legal Consultant	Michael Hennessy		18 December 2024
Authorised by	Chief Executive	Bradly Thornton		7 January 2025

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SECTION 1:

EXTRACTED FROM THE ENVIRONMENTAL IMPACT ASSESSMENT

Kongiwe Environmental (Pty) Ltd (Kongiwe) has been appointed by Far West Gold Recoveries (Pty) Ltd (FWGR), as the independent Environmental Service Provider (EAP) tasked with conducting the Scoping and Environmental Impact Assessment (S&EIA) process which is aimed at critically evaluating the potential environmental and social impacts of the proposed **Reclamation of the Libanon Tailings Storage Facility (TSF)** (hereafter the Proposed Project).

The Application for Environmental Authorisation (EA) was submitted to the Department of Mineral Resources and Energy[1] (DMRE), which is the Competent Authority (CA) for the Proposed Project, on **08 July 2024**. The Final Scoping Report (FSR) was submitted on **22 August 2024**. The DMR accepted the Application on 05 September 2024. The Draft Environmental Impact Assessment and Environmental Management Programme (Draft EIA/EMPr) will be made available for public review from 10 January 2025 to 10 February 2025.

Introduction and Project Background

FWGR was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSFs are being reprocessed at present at the Driefontein 2 Plant, with residue material to be disposed onto the Regional Tailings Storage Facility (RTSF).

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant, or any other future plant. Most of the pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised.

Required infrastructure will include:

- Pumpstation;
- Connecting pipelines for process water from Kloof Shaft 10#;
- Connecting slurry pipelines to existing pipelines;
- Pollution control paddock;
- Access roads;
- Laydown area; and
- Powerlines,

Reprocessed tailings will be deposited on the RTSF.

[1] Now the Department of Mineral Resources (DMR)

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Project Rehabilitation and Future Land use

The primary aim of rehabilitation, in the context of this document, is to:

- Reduce the actual or potential environmental threat.
- Reduce the potential risks so that unacceptable risks identified in this EIA are reduced to acceptable levels.
- Protect the future liability of the land by re-establishing a sustainable land use as close to, or similar, to its pre-mining condition.

Once the TSF has been reclaimed, rehabilitated, and cleared of radiation, the land will be shaped and revegetated to match the surrounding environment (wilderness). The land will then be made available to the landowner (Sibanye) to use at its discretion.

Project Alternatives

No alternatives have been investigated in terms of location. The Libanon TSF is an existing site and is earmarked to be reclaimed as part of various other reclamation projects currently undertaken by FWGR.

The Proposed Project will investigate one pipeline route to link into existing authorised slurry pipelines to convey slurry from the TSF to the Driefontein No. 2 Plant for reprocessing; and return process water to the project site for reclamation. The pipeline configuration will consist of one 550 mm diameter slurry pipeline and one 600 mm diameter process water pipeline. The connecting pipeline route would be approximately 1.5km long.

The proposed reclamation activity will require authorisation in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) for Section 21 water uses, the National Environmental Management Act, 1998 (Act No 107 of 1998) (NEMA) and the National Environmental Management: Waste Act, 2008 (Act No 59 of 2008), Category B Activities. An Integrated Water Use Licence Application (IWULA) will be prepared and submitted in accordance with the Water Use Licence Application and Appeals Regulations 2017 published in GNR 267 on 24 March 2017 and will be supported by a Technical Report and Integrated Water and Waste Management Plan (IWWMP).

Project Background and Motivation

The following points below summarise the project motivations:

- FWGR makes use of sophisticated metallurgical processes which would make it viable to retreat the historical Libanon TSF and extract the residual gold. With the upturn of the gold price, the grade in the Libanon TSF has become economically viable to exploit.
- Although there is a strong economic case for the project, the removal of this dumps also forms part of FWGR broader strategy to clean up and remove the remaining dumps across the West Rand of Gauteng and consolidate them in a mega facility known as the Regional TSF.

- FWGR will align to the National Environmental Management Act (Act 109, 1998) EIA 2014 Regulations, as amended, in accordance with the One-Environmental system for the reclamation of historical mine residue tailings.
- FWGR intends to remove a historical pollution point-source and rehabilitate the land to a state that is sustainable and functioning. This project forms part of the larger WRTRP (Licence No. 10/C22B/ACFGI/4976).
- The removal of the Libanon TSF will avail land to be used by the Landowner.

Environmental Impacts of the Libanon TSF Reclamation Project

The table overleaf represents a summary of the significance of impacts identified during the project lifetime for each environmental aspect. Impacts are expected to occur predominantly during the construction and operation phases, and to a lesser extent during decommissioning/closure and post decommissioning. The following positive benefits are expected:

- Job Security for staff and contractors currently contracted or employed by FWGR;
- Skills Development for those employed for the project;
- Economic growth and contribution to the economy;
- Improved surface water quality over time;
- Improved groundwater quality over time; and
- Improved ecosystem health and functioning over time.

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Risk Matrix of Assessed Project Impacts

Impact	Rating Pre-Mitigation	Construction	Operation	Decommissioning	Rating Post Mitigation	Construction	Operation	Decommissioning
Positive (+)	**Major (high)**				**Major (high)**			
Positive (+)	**Moderate (medium)**	❖ Social-Economic	❖ Social-Economic	❖ Social-Economic ❖ Groundwater	**Moderate (medium)**	❖ Social-Economic	❖ Social-Economic	❖ Social-Economic ❖ Groundwater
Positive (+)	**Minor (low)**		Groundwater	Groundwater	**Minor (low)**		Groundwater	Groundwater
No Impact	**No Impact**	❖ Noise	❖ Noise	❖ Noise	**No Impact**	❖ Noise	❖ Noise	❖ Noise
Negative (-)	**Minor (low)**	❖ Biodiversity ❖ Wetlands ❖ Heritage ❖ Groundwater	❖ Biodiversity ❖ Wetlands ❖ Heritage	❖ Biodiversity ❖ Wetlands ❖ Heritage	**Minor (low)**	❖ Biodiversity ❖ Wetlands ❖ Air Quality ❖ Heritage ❖ Surface Water ❖ Groundwater	❖ Biodiversity ❖ Wetlands ❖ Air Quality ❖ Heritage	❖ Biodiversity ❖ Wetlands ❖ Air Quality ❖ Heritage ❖ Surface Water
Negative (-)	**Moderate (medium)**	❖ Biodiversity ❖ Air Quality ❖ Social-Economic ❖ Surface Water	❖ Biodiversity ❖ Air Quality ❖ Social-Economic	❖ Biodiversity ❖ Air Quality ❖ Social-Economic	**Moderate (medium)**	❖ Social-Economic	❖ Social-Economic ❖ Surface Water ❖ Groundwater	❖ Social-Economic
Negative (-)	**Major (high)**		❖ Surface Water ❖ Groundwater	❖ Social-Economic ❖ Surface Water	**Major (high)**			

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Conclusions

An impact assessment has been undertaken using qualified specialists, which has incorporated extensive consultation with and participation of interested and affected parties. Applying the hierarchical approach to impact management, alternatives were firstly considered to avoid negative impacts, but where avoidance was not possible, to better mitigate and manage negative impacts. Where impacts were found to be potentially significant, various mitigation measures to manage and monitor the impacts of the project have been proposed. As a final option, offset strategies should be investigated, if feasible.

The findings of the impact assessment have shown that the Libanon Project would conclusively result in certain negative impacts during the operational phase on the environment, however, none of the specialist studies objected to the project. Moreover, the scientific specialist mitigation measures have been included into this EIA and EMP report to reduce the significance of all the identified negative impacts. Most of the negative impacts from the Proposed Project can be reduced through the implementation of mitigation measures.

Based on the information contained in this report, it is the opinion of the EAP that the negative environmental impacts resulting from the Project can be mitigated to within acceptable limits and that the project should be authorised. This opinion holds provided all the recommendations proposed in the specialist studies and the EIA and EMP report as well as legislative requirements are implemented and adhered to.

The proposed project area is underlain by Dolomite, and this provides a sensitive geological environment. It is advised that all mitigation and legally required measures be implemented by FWGR to ensure surface stability, protection of the water resources and that operation can be undertaken on site in a safe manner.

In conclusion, the EAP is of the reasoned opinion that the **project should be authorised to proceed** provided that the conditions of this EIA and the mitigation measures and objectives proposed by the EMPr are implemented by FWGR.

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Table of Contents

1 INTRODUCTION 1

1.1 Project Introduction 1

1.2 Description of the Project Location 2

2 DETAILS OF THE EAP 5

2.1.1 Contact Person and Corresponding Address 5

2.1.2 Expertise of the EAP 5

3 DESCRIPTION OF THE ASPECTS OF THE ACTIVITY 6
4 DESCRIPTION OF THE BASELINE ENVIRONMENT 6
5 COMPOSITE MAP 6
6 IMPACT MANAGEMENT OBJECTIVES 8

6.1 Aspects for Inclusions as Considerations of the Environmental Authorisation 8

6.2 Determination of Rehabilitation Objectives 10

6.2.1 Rehabilitation Principles 10

6.2.2 Decommissioning and Post-Decommissioning Phase Activities 11

6.2.3 Health and Safety 12

7 ROLES AND RESPONSIBILITIES 13

7.1 Government Departments 13

7.2 Project Developers 13

7.3 Site Manager 13

7.4 Contractors 13

7.5 Environmental Officer 14

8 IMPACT MITIGATION PER PHASE 15

8.1 Pre-Construction Phase Mitigation Measures 16

8.2 Construction Phase Mitigation Measures 23
8.3 Operational Phase Mitigation Measures 34
8.4 Decommissioning Mitigation Measures 41
8.5 Post-Decommissioning Mitigation Measures 46
9 SPECIFIC IMPACT MANAGEMENT PLANS 48
9.1 Environmental Awareness Plan 48
9.1.1 Communication Chain 48
9.1.2 Management Sector 48
9.1.3 Construction Workers Sector 49
9.1.4 Contractors 49
9.1.5 Environmental Officer 50
9.2 Strategic Communication Plan 50
9.2.1 Environmental Communication Strategies 50
9.3 Emergency Response Plan 53
9.3.1 Intent 54
9.3.2 Planning 54
9.4 Conceptual Stormwater Management Plan 57
9.4.1 Proposed Stormwater Management Measures 57
9.4.2 Surface Water Monitoring plans 62
9.5 Groundwater Monitoring and Seepage Prevention 64
9.5.1 Groundwater Management Measures 64
9.5.2 Groundwater Monitoring 66
9.6 Terrestrial monitoring 71

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9.7 Dust Fallout Monitoring Plan 78
9.8 Heritage Management Plans 78
9.8.1 Chance Find Procedure 79
9.8.2 Possible Finds during Construction and Operation (Reclamation Activities) 79
9.8.3 Timeframes 79
9.9 Social Management Plans 82
9.9.1 Stakeholder Engagement Plan 82
9.9.2 Grievance Mechanism 83
9.9.3 Human Rights 83
9.10 Socio Economic Monitoring Programme 84
9.11 Radiation Assessment 85
9.11.1 General 85
9.11.2 Monitoring Programme 85
9.11.3 Proposed Monitoring Points 86
9.12 Waste Management Plan 87
9.12.1 Waste Management Principles 87
9.12.2 Project Phase Waste Management 87
10 COMPLIANCE MONITORING MECHANISM 90
11 OATH UNDERTAKING 92

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Figures

Figure 1-1: Proposed project process diagram 2
Figure 1-2: Locality map of the Proposed Project 4
Figure 5-1: Libanon TSF Reclamation Site Infrastructure 7
Figure 9-1 - Earth Berm Detail 58
Figure 9-2: Proposed Stormwater Solution 61

Tables

Table 1-1: Property Details 2
Table 2-1: Details of the EAP 5
Table 2-2:Details of the Reviewer 5
Table 8-1: Summary table of the Activities associated with the pre-construction phase of the project 16
Table 8-2: Pre-Construction Phase Mitigation Measures 16
Table 8-3: Summary table of the Activities associated with the construction phase of the project 23
Table 8-4: Construction Phase Mitigation Measures 23
Table 8-5: Summary table of the Activities associated with the operational phase of the project 34
Table 8-6: Operational Phase Mitigation Measures 34
Table 8-7: Summary table of the Activities associated with this decommissioning phase of the project 41
Table 8-8: Closure and Decommissioning Phase Mitigation Measures 41
Table 8-9: Summary table of the Activities associated with this post-closure phase of the project 46
Table 8-10: Post-Closure Phase Mitigation Measures 46
Table 9-1: Emergency Scenario Contingency Planning 56
Table 9-2: Sampling Locations 62
Table 9-3: Surface water quality parameters 63
Table 9-4: General groundwater management measures 65
Table 9-5: Proposed Groundwater Monitoring Positions 67
Table 9-6: Groundwater monitoring requirements 68
Table 9-7:Terrestrial monitoring requirements 71
Table 9-8: National Dust Control Regulations (Government Notice No. 517, 2018). 78
Table 9-9: Lead times for permitting and mobilisation 79
Table 9-10 Lead times for permitting and mobilisation 80
Table 9-11: Proposed Socio-Economic Programme 84
Table 9-12: Summary of the environmental monitoring programme proposed for the project aimed at public radiation protection. 86
Table 10-1: Monitoring and Management Plan 90

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1 INTRODUCTION

Kongiwe Environmental (Pty) Ltd ('Kongiwe') has been appointed as the Independent Environmental Assessment Practitioner (EAP), tasked with conducting the Scoping and Environmental Impact Assessment (S&EIA) process which was aimed at critically evaluating the potential environmental and social impacts of the proposed **Reclamation of the Libanon Tailings Storage Facility (TSF)** (hereafter the Proposed Project).

1.1 Project Introduction

Far West Gold Recoveries (Proprietary) Limited (FWGR) was established in 2018 for the reprocessing of Tailings Storage Facilities (TSF) in the West Rand of Gauteng. The TSFs are being reprocessed at present at the Driefontein 2 Plant, with residue material to be disposed of onto Driefontein 4 TSF, until such stage as the Regional Tailings Storage Facility (RTSF) construction is completed and the TSF is commissioned.

It is FWGR's intention to reclaim and reprocess the gold residues of Libanon TSF, with the slurry being processed at the Driefontein No. 2 Plant. Pipelines linking the Libanon TSF with the Driefontein No. 2 Plant are already in existence and authorised.

Required infrastructure will include:

- Pumpstation;
- Connecting pipelines for process water from Kloof Shaft 10#;
- Connecting slurry pipelines to existing pipelines;
- Pollution control paddock;
- Access roads;
- Laydown area; and
- Powerlines,

Reprocessed tailings will be deposited on the RTSF.

Once the TSF has been reclaimed, rehabilitated, and cleared of radiation, the land will be shaped and revegetated to match the surrounding environment. The land will then be made available to the landowner (Sibanye) to use at their discretion.

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Figure 1-1: Proposed project process diagram

1.2 Description of the Project Location

This S&EIA process was conducted for an EA to reclaim the TSF and is confined to the Remaining Extent of Libanon or Witkleigat 283 IQ

This is a “Brownfield Project" as it is the reclamation of a historical mineral storage deposit with partly existing infrastructure. The potential negative and positive impacts of the Proposed Project on the environmental and social aspects were objectively considered though studies undertaken by specialist professionals during the EIA phase.

Table 1-1: Property Details

Application Area (ha)	The Proposed Project site covers an area of **170 Ha**.
Magisterial District	Ward 25 of Rand West City Local Municipality (RWLM)
Distance and Direction from Nearest Town	The site is located approximately 2 km west of Westonaria.

The area is predominantly surrounded by mining infrastructure, disturbed land and open land. Refer to **Appendix B** for more images of the Proposed Project site.

The following infrastructure is encountered in the area:

- Roads
- Power lines
- Mineworker hostel;
- Sibanye Libanon Gold Mine infrastructure;

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- Celamanzi Shaft;
- Sibanye Settling Dams; and
- Libanon Landfill Site.

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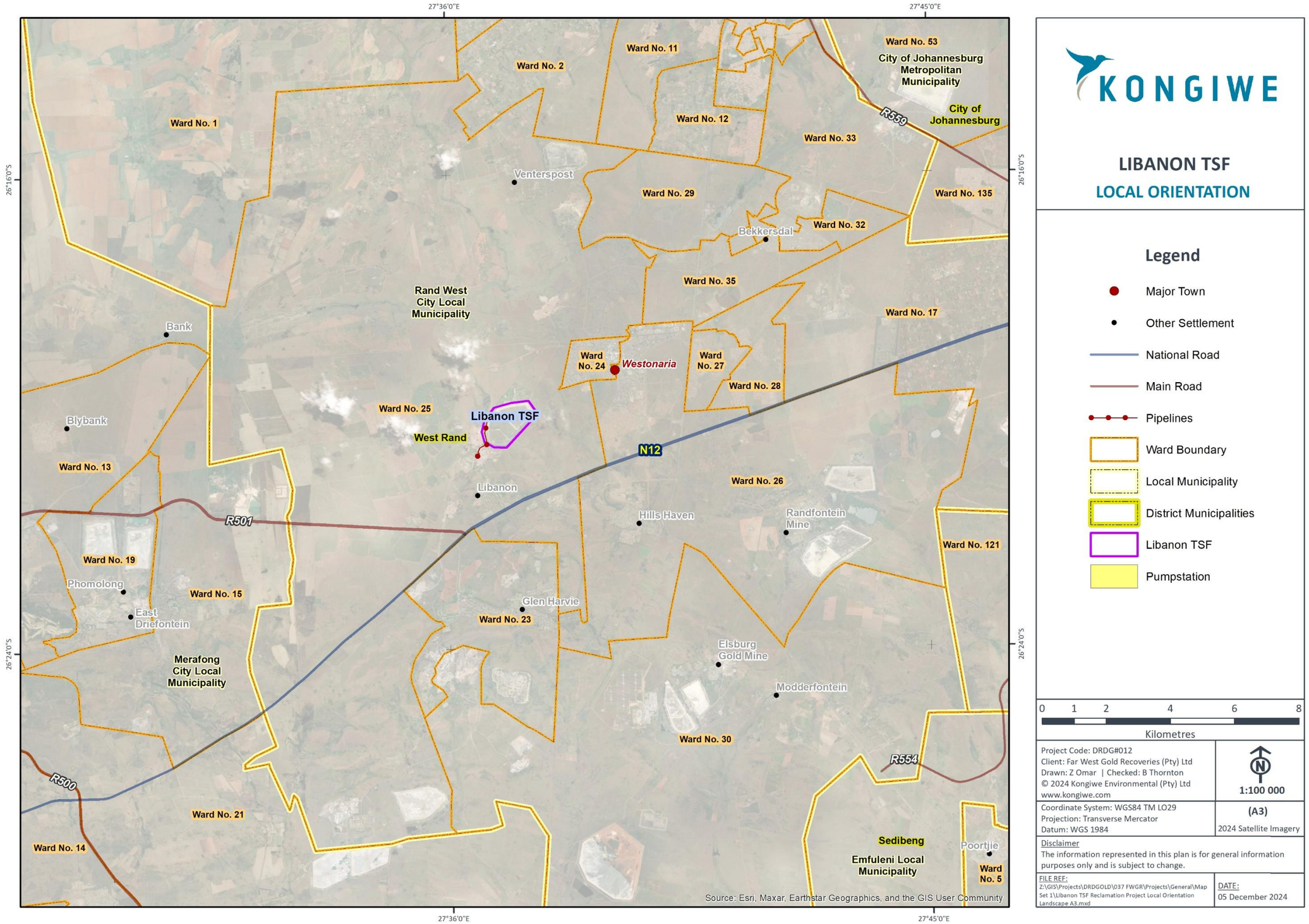

Figure 1-2: Locality map of the Proposed Project

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2 DETAILS OF THE EAP

Kongiwe Environmental (Pty) Ltd (Kongiwe) is a contemporary, problem-solving consultancy specialising in solving real-world environmental challenges. We pride ourselves in using the latest technology available to realise pragmatic solutions for our clients. The company was created with the essential intent: 'To solve environmental challenges for a world driven towards a sustainable future'.

Based in Johannesburg, South Africa, our team of professional Environmental Scientists are highly trained in various environmental disciplines and have significant, hands-on experience in an array of projects across various industries. The company has extensive environmental and project management experience in multiple sectors, with significant experience in South Africa, as well as internationally. Kongiwe focuses on the integration of environmental studies and processes into larger engineering and mining projects. Moreover, Kongiwe provides clients with strategic environmental assessments and compliance advice, the identification of environmental management solutions and mitigation / risk minimising measures throughout the project lifecycle.

2.1.1 Contact Person and Corresponding Address

Details of the Environmental Assessment Practitioner (EAP) who prepared the report are presented below

Table 2-1: Details of the EAP

Name of Practitioner	**Foord Ceronio**
EAP Registration No.	Cand. EAP 2020/2580
Tel No.	+27 (10) 140 6508
Fax No.	072 984 8574
E-mail Address	fceronio@kongiwe.com

2.1.2 Expertise of the EAP

Foord Ceronio's work experience has given him the required knowledge regarding project processes from pre-feasibility phase through to implementation and execution. He is adept at working in different contexts and on different tasks. He is a skilled problem solver with his team to meet client needs. His proficiency ranges from Environmental Authorisations and Auditing to onsite monitoring and ECO work and Environmental due diligence.

Foord Ceronio worked under direct supervision of Gerlinde Wilreker. The Report was Peer Reviewed and approved by Gerlinde Wilreker who is the registered EAP.

Table 2-2:Details of the Reviewer

Name of Practitioner	Gerlinde Wilreker, Kongiwe Environmental (Pty) Ltd
EAP registration No.	2019/1589
Tel No	+27 (10) 140 6508
Cell No	074 173 0023
e-mail address	gwilreker@kongiwe.com

Gerlinde Wilreker has a M.Sc. in Environmental Management degree from the previous Rand Afrikaans University (RAU), now the University of Johannesburg, and is a registered Environmental Assessment Practitioner (EAP) (2019-1589) and Professional Natural Scientist (Environmental Management) (Registration No:400261/09). Qualifications in Appendix A.

Gerlinde Wilreker has over 17 years' work experience as an Environmental Consultant, predominantly in the mining industry. Her practical experience in the mining and construction industry has given her a depth of knowledge regarding project processes from pre-feasibility phase through to implementation. She is adept at working in different contexts, and problem-solving with her team to meet client needs. She has particular expertise in relation to Environmental Authorisation Processes in terms of the South African legal regime.

3 DESCRIPTION OF THE ASPECTS OF THE ACTIVITY

This document must be read in conjunction with the EIA. To minimise repetition throughout the documentation, the EAP refers the reader to Chapter 2 and Chapter 3 of the EIA.

4 DESCRIPTION OF THE BASELINE ENVIRONMENT

This document is kept as concise as possible. For an overview of the baseline environment of this project please refer to Chapter 8 of the EIA.

5 COMPOSITE MAP

The figures below illustrate the preferred layout for the Libanon TSF Reclamation Project

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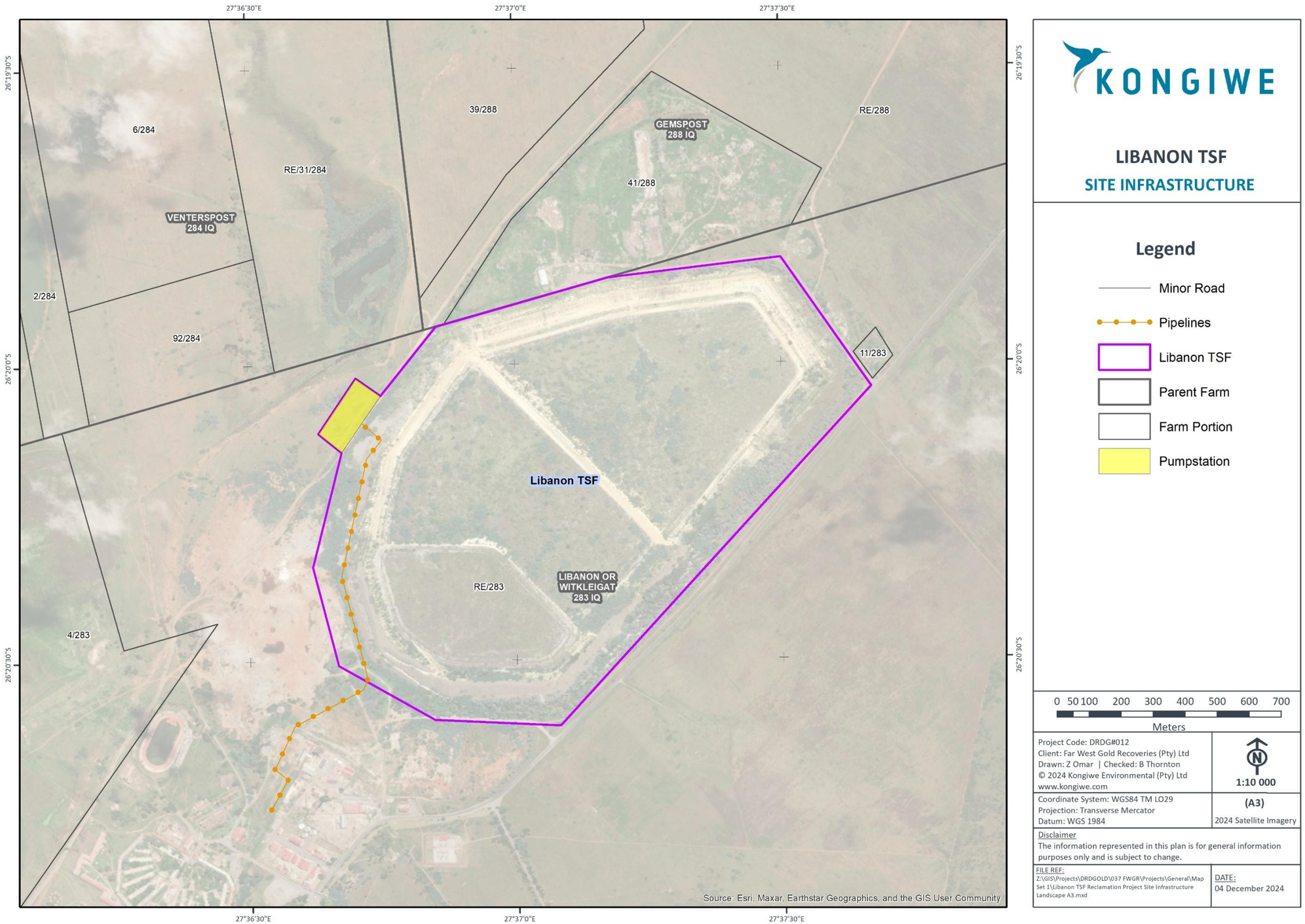

Figure 5-1: Libanon TSF Reclamation Site Infrastructure

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6 IMPACT MANAGEMENT OBJECTIVES

The EMPr was compiled with the aim of achieving a required end state that, as far as possible, ensures that environmental quality is maintained. The impact management objectives and outcomes for the Libanon TSF Reclamation Project are as follows:

- To minimise the negative environmental impacts as far as feasible;
- To maximise the positive and minimise the negative socio-economic impacts;
- To capture, contain and recycle all contaminated water arising from the mining operations on site and to prevent the discharge of contaminated water to the environment; and
- To maintain cordial relationships with local residents, authorities and other stakeholders via sustained open communication.

The EMPr describes how activities that have, or could have, an adverse impact on the environment will be mitigated, controlled and monitored. The EMPr will address the environmental impacts during the construction, operational, decommissioning (where applicable post-closure) phases of the Project. Due regard must be given to environmental protection during the entire the Libanon TSF Reclamation Project, and several environmental recommendations are made in this regard. These recommendations are aimed at ensuring that the contractor maintains adequate control over the Project to:

- Minimise the extent of an impact during the life of the Libanon TSF Reclamation Project;
- Maintain a state of Environmental Quality following completion of the Libanon TSF Reclamation Project;
- Ensure appropriate restoration of areas affected by the Libanon TSF Reclamation Project; and
- Prevent long term environmental degradation.

The management and mitigation measures identified within the EIA process are systematically addressed in this EMPr and ensure the minimisation of adverse environmental impacts to an acceptable level.

FWGR must ensure that the implementation of the project complies with the requirements of all environmental authorisations, permits and obligations emanating from relevant environmental legislation.

Should there be a conflict of interpretation between this EMPr and the Environmental Authorisation (EA) (once issued), the stipulations in the EA shall supersede those of this EMPr, unless otherwise agreed by the Competent Authority (CA) in writing. Similarly, any provisions in the legislation overrule any provisions or interpretations within this EMPr. This EMPr shall be binding on all parties involved in the operational phase and shall be enforceable at all levels of operational management.

This document must be adhered to and updated as relevant throughout the project life cycle.

6.1 Aspects for Inclusions as Considerations of the Environmental Authorisation

Should the Department of Mineral Resources (DMR) grant EA for this project, it should be subject to the following conditions:

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- The project may not commence prior to the EA being issued;
- The project should remain in full compliance with the requirements of the EMPr and with all regulatory requirements;
- The EMPr should be implemented by qualified environmental personnel who have the competence and credibility to interpret the requirements of the EMPr. Such persons must be issued with a written mandate by FWGR management to provide guidance and instructions to employees and contractors;
- FWGR must undertake external auditing of the environmental performance as per the conditions of the Environmental Authorisation and provide the DMR with a copy of the auditing report;
- The Applicant must report to the Department, with reason, if requirements of the EA have not been met.
- Stakeholder engagement must be maintained during the construction, operational and decommissioning/rehabilitation phases of the project, with the emphasis on the continuing provision of information;
- A community forum should be implemented by FWGR, with the aim of engaging Stakeholders and the public;
- All laydown, storage areas etc should be restricted to transformed areas close to the preferred option and existing roads should be used as far as possible;
- Implement the stormwater management plan;
- A dolomitic stability investigation be carried out around the Libanon TSF to confirm that the proposed reclamation method and stormwater containment on top of the TSF and in paddocks around the TSF is acceptable and in accordance with SANS 1936 and a dolomitic risk management plan be developed.
- Stormwater drainage shall be such that no surface water ponds other than in natural watercourses save for that associated with the attenuation of stormwater for a period not exceeding 6 hours;
- Prevent rainwater and the process water that has fallen on site from leaving the site in an uncontrolled and unregulated fashion;
- Prevent dust pollution during dry, windy conditions.
- All necessary authorisation must be in place prior to commencement of the project activities.
- All employees and contractors should receive induction that includes an environmental awareness component (noise). This is to allow employees and contractors to become aware of the potential noise risks that activities (especially night-time activities) pose to the surrounding environment.
- FWGR must adhere to the Rehabilitation Plan contained in the EMPr and attached as an appendix to this report.
- The Applicant must maintain all financial responsibility throughout all phases of the project lifespan, including monitoring.
- Should the economic gold price diminish and not be seen as favourable to continue reclamation activities, FWGR must continue to implement monitoring and rehabilitation requirements as set out in this EMP.
- The Applicant must ensure that there are sufficient funds set aside to complete the project fully.
- Management and Monitoring plans contained in the EMPr must be strictly adhered to.
- A Chance Find procedure for heritage resources and artefacts needs to be in place.

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6.2 Determination of Rehabilitation Objectives

Rehabilitation has been dealt with throughout this EIA. Mitigation / Management and Monitoring measures are proposed in the EMPr. Please refer to Section 2.4.8 of the EIA for more detail on the proposed rehabilitation plans. Please also refer to the Closure and rehabilitation plan provided in Appendix D.

The objective of the site rehabilitation (in accordance with the NEMA 2014 EIA Regulations, as amended) must be measurable, practical and is feasible to implement through:

Providing the vision, objectives, targets and criteria for final rehabilitation of the project;

- Outlining the principles for rehabilitation;
- Explaining the risk assessment approach and outcomes and link decommissioning activities to risk rehabilitation;
- Detailing the decommissioning and rehabilitation actions that clearly indicate the measures that will be taken to mitigate and/ or manage identified risks and describes the nature of residual risks that will need to be monitored and managed post closure;
- Identifying knowledge gaps and how these will be addressed and filled;
- Detailing the full closure costs for the life of project at increasing levels of accuracy as the project develops and approaches closure in line with the final land use proposed; and
- Outlining monitoring, auditing and reporting requirements.

This section **MUST** be read in conjunction with the EIA as well as follow the recommendations proposed by independent specialists.

6.2.1 Rehabilitation Principles

Final rehabilitation will be carried out once the Libanon TSF Reclamation Project goes into its decommissioning phase. The principles for proper rehabilitation, which should be followed, are:

- Preparing a comprehensive rehabilitation plan prior to the commencement of any activities on site;
- Stormwater management must be in place at the site prior to commencing with any activities;
- Landform design (shaping);
- Grassing;
- Maintenance management and eradication of invader species;
- A plan which negates how waste will be managed on site; and
- An Emergency Preparedness/Response plan .

The objective of the site rehabilitation (in accordance with the NEMA EIA Regulations of 2014, as amended) must be measurable, practical and be feasible to implement through:

- Providing the vision, objectives, targets and criteria for final rehabilitation of the project;
- Outlining the principles for rehabilitation;
- Explaining the risk assessment approach and outcomes and link decommissioning activities to risk rehabilitation;

- Detailing the decommissioning and rehabilitation actions that clearly indicate the measures that will be taken to mitigate and/ or manage identified risks and describes the nature of residual risks that will need to be monitored and managed post decommissioning;
- Identifying knowledge gaps and how these will be addressed and filled;
- Outlining monitoring, auditing and reporting requirements.

Mitigation / Management and Monitoring measures are proposed in the EMPr in Section 8.

6.2.2 Decommissioning and Post-Decommissioning Phase Activities

6.2.2.1 Decommissioning Phase Activities

During typical decommissioning activities all project infrastructure will be removed and a final radiological survey will be undertaken, after which rehabilitation can commence. The rehabilitation should invariably be evaluated in view of the future land use. If redevelopment is not proposed, it may still be necessary to carry out work on land to guard against future liability.

The property on which the Libanon TSF is situated currently belongs to Sibanye. As such, the rehabilitation will need to be in line with Sibanye's closure plans. At present Sibanye's closure plan indicates that the area must be rehabilitated to wilderness.

Once the TSF has been reclaimed, rehabilitated, and cleared of radiation, the land will be shaped and revegetated to match the surrounding environment. The land will then be made available to Sibanye to use at their discretion.

The rehabilitation plan is comprised of the following basic stages:

1. Removal of existing infrastructure;
2. Re-shaping of the landforms;
3. Re-vegetation of the landscape; and
4. Monitoring and maintenance.

This is described in more detail in Section 2.4.8 of the EIA.

NNR Certificate

Once reclamation of the TSF has been undertaken and depending on the desired end land use, it is highly recommended to assess the potential of residual radiation remaining and to identify possible latent environmental impacts remaining. This is important to ensure that once the land is handed over that there is no potential further risk to the land owners.

The National Nuclear Regulator (NNR) has set the level for gamma radiation, for which regulation is not required, below 500 Bq (Becquerel) per kg. Direct radiation originates from uranium, which is a common mineral associated in the reefs that contain gold and is contained within the slimes material. The Radiation Assessment should measure the gamma radiation emanating from the decaying of the uranium atoms.

In terms of release of radioactively contaminated land, the Safety Standards and Regulatory Practices, under section 5.4, specifies that a site used in the conduct of an authorised action may be released for unrestricted use provided that it is demonstrated that the radioactive contamination and radioactive materials which can reasonably be attributed to the authorised action have been removed from the site, or in the case of naturally occurring radioactive nuclides, have activity concentrations below the levels of exclusion. The end land use will be dependent on the findings of such an assessment and will determine if these sites could be utilised or released for unrestricted use.

Post-decommissioning activities will entail the assessment of rehabilitation and will address any further rehabilitation requirements. Monitoring must occur for at least five years after decommissioning and rehabilitation, or until satisfactory results are achieved. During this phase, preparatory work will be done to apply for closure as per the MPRDA requirements. Monitoring must occur for at least two years after closure and rehabilitation, or until satisfactory results are achieved.

6.2.2.2 Maintenance and Aftercare

Maintenance will specifically need to focus on the rehabilitated areas. Furthermore, groundwater and surface water monitoring will have to take place in accordance with the requirement of the specialist studies and the EMPr. The monitoring process will be used to assess whether the rehabilitation process has been successful or not and to indicate that no further deterioration on groundwater quality is foreseen.

Maintenance will specifically focus on the rehabilitated in accordance with the approved EMPr. Continuous erosion monitoring of rehabilitated areas and slopes should be undertaken and zones with excessive erosion should be identified. The cause of the erosion should be identified, and rectified. Zones with erosion will need to be repaired with topsoil. In addition, infiltration of contaminated water will be contained within paddocks.

6.2.3 Health and Safety

Regarding the safety of both the public and the employees, FWGR has completed a workers' safety assessment as well as a public safety assessment. The public safety assessment for all of the proposed operations of FWGR are currently being updated.

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7 ROLES AND RESPONSIBILITIES

To ensure the success of the EMPr, it is important to assign definite roles and responsibilities. Compulsory adherence to the EMPr is required. The obligations of the EMPr create a legally binding document in terms of environmental legislation and civil law. It is important that FWGR, its contractors and sub-contractors ensure that all relevant aspects of the EMPr are communicated to all of their employees. It is the duty of FWGR, its contractors, sub-contractors and their employees to fulfil the project objectives with specific reference to the prevention and mitigation of impacts caused by the project development activities. It is the responsibility of the DMR to ensure that the development takes place in accordance with relevant legislation.

7.1 Government Departments

As the responsibility for the protection of our natural heritage lies with the government departments, they have the power to conduct site inspections to ensure that the development complies with all legislation, regulations and standards. They may enforce penalties where non-compliance occurs.

7.2 Project Developers

The Project Developer is accountable for ensuring compliance with the EMPr and any conditions of approval from the competent authority (CA). Where required, an environmental officer (EO) must be contracted by the Project Developer to objectively monitor the implementation of the EMPr according to relevant environmental legislation, and the conditions of the environmental authorisation (EA). The Project Developer is further responsible for providing and giving mandate to enable the EO to perform responsibilities, and he must ensure that the EO is integrated as part of the project team while remaining independent. The Project Developer must:

- Be fully conversant with the conditions of the EA;
- Ensure that all stipulations within the EMPr are communicated and adhered to by its Contractor(s);
- Issuing of site instructions to the Contractor; and
- Ensure that periodic environmental performance audits are undertaken on the project implementation.

7.3 Site Manager

The Site Manager will oversee all the activities. He will be responsible for the activities on site and see to the implementation of the EMPr and will establish a communication network between the different components conducting the work. All incidents and reports will be made to the Site Manager. Ultimate responsibility in terms of compliance to the EMPr lies with the Site Manager.

7.4 Contractors

Where contractors are used during the life of the project, the on-site responsibility for environmental and social matters lies with the Contractor Engineer. He will be responsible for the day-to-day direction and management of the contractor's activities on the site throughout the life of the project.

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7.5 Environmental Officer

An Environmental Officer (EO) is appointed. It will be the responsibility of the EO to:

- Oversee that the day-to-day activities that will take place on site comply with the EMPr and the relevant legislation;
- Monitor the activities through monthly site inspections to ensure compliance to the EMPr;
- Assess the EMPr as to its effectiveness in mitigating and preventing impacts;
- Assess compliance to the EA;
- Identify any non-compliances and to advise to the immediate action and remediation;
- Ensure that the best environmental options are followed throughout;
- Prepare a detailed communication strategy for liaison with I&APs, stakeholders and contractors;
- Manage and document forward and backward information flows between the Site Manager, the Contractors, the I&APs and FWGR. This includes information pertaining to monitoring and evaluation;
- Assist FWGR upon request, with project communication with I&APs;
- Ensure meaningful participation with the I&APs, including capacity building exercises where the need is identified;
- Give induction and environmental awareness training;
- Ensure that a record keeping system is maintained; and
- Promote co-regulation, shared responsibility and a sense of ownership amongst all parties involved.

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8 IMPACT MITIGATION PER PHASE

The management measures have been organised in the following project phases:

- Pre-Construction Phase;
- Construction Phase;
- Operational Phase;
- Decommissioning Phase; and
- Post-Decommissioning Rehabilitation Phase.

The tables in this section provide the management measures (actions) recommended to manage the potential impacts rated during the different phases. In addition to the management measures provided the tables indicate the person responsible to ensure that these commitments are adhered to and implemented as well as specifying the priority of these commitments (either prior to a phase, during a phase and/ or ongoing), and the outcomes.

The construction, operation, decommissioning and where applicable post-decommissioning impacts associated with the Libanon TSF Reclamation Project are discussed for the following environmental aspects:

- Biodiversity;
- Wetlands;
- Surface water;
- Groundwater;
- Air quality;
- Heritage
- Socio-Economic

The objectives and EMPr tables are required to be reviewed and possibly modified whenever changes, such as the following, occur:

- Planned activities change (i.e., in terms of the components and/or layout of the facility);
- Modification to or addition to environmental objectives and targets;
- Additional or unforeseen environmental impacts are identified, and additional measures are required to be included in the EMPr to prevent deterioration or further deterioration of the environment;
- Relevant legal or other requirements are changed or introduced; and
- Significant progress has been made on achieving an objective or target such that it should be modified.

8.1 Pre-Construction Phase Mitigation Measures

Prior to initiating the Construction Phase, FWGR needs to ensure that the following is undertaken. FWGR will commence with the pre-construction and construction phase for its project related infrastructure in line with its approved environmental authorisations. During the construction phase the following activities will take place on site:

Table 8-1: Summary table of the Activities associated with the pre-construction phase of the project

Activity	Description
Pre-Construction:	
1	Conduct a further pre-construction baseline radiation walk-over survey
2	Removal of vegetation and site clearance
3	Preparation of access roads should this be required
4	Initiation of a community forum for engagement throughout the project life cycle
5	Start implementing monitoring plans, Authorisation, Licensing and EMPr condition.
6	Employment of workers should this be required (minimal)

Table 8-2: Pre-Construction Phase Mitigation Measures

Reference No.	Aspect	Activities	Impact	Size and Scale of Disturbance Post-Mitigation	Mitigation Measures	Compliance with standards	Time period for Implementation & Responsible Person	Outcomes
	Pre-Construction: Site Preparation and Design							
1	All	Permitting	Commencement of activities without relevant authorisations.	Site	❖ Ensure all necessary permits have been obtained prior to commencement of activities.	❖ National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) ❖ National Water Act, 1998 (Act No. 36 of 1998) (NWA) ❖ Heritage Resources Act, 1999 (Act No.25 of 1999) (HRA) ❖ National Nuclear Regulator Act, 1999 (Act No. 47 of 1999) (NNRA) ❖ City of Ekurhuleni Municipality By-Laws	When: ❖ Prior to commencement of Activities Responsibility: ❖ Licence holder	Prevention of undertaking of unauthorised activities.
2	Radiation	A walk-over survey A site safety Case	Baseline surface radiation	Site and local	❖ Undertake a radiation walk-over survey to determine the current surface radiation levels. ❖ Compile and submit a site safety case to the NNR. ❖ Ensure that the TSF has been included in the COR 281 before any activity commences on site.	❖ NNRA	When: ❖ Prior to commencement of Activities Responsibility: ❖ Licence holder	Determine the surface radiation level prior to reclamation.
3	Flora	Project Design	Project Design and infrastructure / vehicle placement could result in	Site	❖ A site walkthrough must be conducted prior to the construction phase. Priority must be the	❖ NEMA; ❖ NWA; ❖ Regulations on Use of Water for Mining and Related	When: ❖ Prior to commencement of Activities	Impact concentrated to proposed project area

Reference No.	Aspect	Activities	Impact	Size and Scale of Disturbance Post-Mitigation	Mitigation Measures	Compliance with standards	Time period for Implementation & Responsible Person	Outcomes
			destruction of sensitive habitats and vegetation		identification of any listed flora and fauna species. ❖ Any individual protected plant that may be observed needs a relocation or destruction permit for any individual that may be removed or destroyed as a result of the activities. Preferably, the plants should be relocated to an area that will not be impacted on by future activities. ❖ Development activities must as far as possible take place only within the 'Very Low' sensitivity areas. This includes laydown, material storage, cement mixing, earth deposition and storage etc. that will result from the construction activities. The proposed pipeline must be constructed within the existing road/pipe servitude or in close relation to the existing roads/pipelines. ❖ Areas of dense and healthy indigenous vegetation, even secondary communities outside of the direct project footprint, should not be fragmented or disturbed further. This is particularly relevant to the wetland habitats. ❖ Areas to be developed/disturbed must be specifically demarcated so that during the construction/activity phase, only the demarcated areas are to be impacted upon. ❖ No plant species, whether indigenous or exotic, may be brought into/taken from the Project Area (apart from plants used for rehabilitation purposes as part of the rehabilitation plan), to prevent the spread of exotic or invasive species or the illegal collection of plants. ❖ Leaking equipment and vehicles must be repaired immediately or be	Activities aimed at the Protection of Water Resources (GN R704 of 12 February 2010); ❖ Gauteng C-Plan.	Responsibility: ❖ Licence holder	

Reference No.	Aspect	Activities	Impact	Size and Scale of Disturbance Post-Mitigation	Mitigation Measures	Compliance with standards	Time period for Implementation & Responsible Person	Outcomes
					removed from Project Area to facilitate repair. ❖ A hydrocarbon spill management plan must be put in place to ensure that should there be any chemical spill out or over that it does not run into the surrounding areas.			
4	Fauna	Pre-construction and site clearance	Impact to local fauna due to pre-construction activities	Site	❖ No trapping, killing, or poisoning of any wildlife is to be allowed. Signs must be put up to enforce this. These actions are illegal in terms of provincial environmental legislation. ❖ A qualified environmental officer must be on site when clearing begins. The area must be walked though prior to construction to ensure that no faunal species remain in the habitat and get killed. Should animals not move out of the area on their own, relevant specialists must be contacted to advise on how the species can be relocated. ❖ Should any Species of conservation concern (SCC) fauna be observed nesting within the proposed footprint area before or during construction, all activities must cease immediately. A relevant faunal specialist must be consulted to facilitate the capture or removal of any SCC animals. ❖ FWGR must include the importance and sensitivity of surrounding areas and their functions, especially those that pertains to the partially functional wetland areas, into their induction and safety toolbox talks.	❖ The National Environmental Management: Protected Areas Act (Act No. 57 of 2003 (NEM:PAA)); ❖ NEMA; ❖ NEM:WA ❖ National Biodiversity Assessment (NBA) ❖ Gauteng C-Plan National Spatial Biodiversity Assessment (NSBA) National Freshwater Ecosystem Priority Areas (NFEPA's); ❖ The Environment Conservation Act (Act No. 73 of 1989) (ECA); ❖ Alien and Invasive Species Regulations, 2014 ; ❖ Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) (CARA); ❖ Mining and Biodiversity Guidelines. ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014;	When: ❖ Prior to commencement of Activities Responsibility: ❖ Licence holder	Impact concentrated to proposed project area
5	Alien Species	Pre-construction and site clearance	Pre-construction activities leading to the spread of Alien Species	Site	❖ The implementation of an AIP management plan is crucial, especially considering the widespread invasive species identified on site which, if left unchecked, will continue to grow and spread prolifically leading to further and more significant deterioration of the health of the	❖ NEM:PAA; ❖ NEMA; ❖ NEM:WA ❖ National Biodiversity Assessment (NBA) ❖ Gauteng C-Plan National Spatial Biodiversity Assessment (NSBA) National Freshwater Ecosystem Priority Areas (NFEPA's);	When: ❖ Prior to commencement of Activities Responsibility: ❖ Licence holder	Impact concentrated to proposed project area

Reference No.	Aspect	Activities	Impact	Size and Scale of Disturbance Post-Mitigation	Mitigation Measures	Compliance with standards	Time period for Implementation & Responsible Person	Outcomes
					natural environment nearby to the Project Area. The plan must especially pertain to any recently cleared and changed areas. ❖ It is recommended that all waste be removed from site on a weekly basis to prevent rodents and pests from entering the site and proliferating. ❖ A pest control plan must be put in place and implemented; it is imperative that poisons not be used.	❖ ECA; ❖ Alien and Invasive Species Regulations, 2014 ; ❖ CARA; ❖ Mining and Biodiversity Guidelines. ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014;		
6	Waste management	Pre-construction and site clearance	Mismanagement of waste generation on site leading to an impact to the environment.	Site	❖ Waste management must be a priority and all waste must be collected and stored adequately. ❖ Do not litter or dump any material outside of specially demarcated and managed zones. Protocols to be established to explain and enforce this. ❖ Portable toilets must be provided in the ratio as stipulated in the Health and Safety Act. Portable toilets must be regularly pumped dry by a licensed and reputable company to ensure that the system does not degrade over time and spill into the surrounding area. ❖ The Contractor must supply sealable and properly marked domestic waste collection bins and all solid waste collected must be disposed of at a licensed disposal facility. ❖ Under no circumstances may domestic waste be burned on site. Waste must never be stored in an open pit where it is susceptible to the elements such as wind and rain.	❖ NEMA, ❖ NEM:WA	When: ❖ At the start of the project. ❖ Daily Responsibility: ❖ Contractor. ❖ EO. ❖ Health and Safety Officer	Prevention of uncontrolled and unmanaged waste generation and disposal
7	Contractors	Contractor management	Lack of knowledge of EMPr and procedure could result in environmental degradation.	Site	❖ Contractors must be trained and given a copy of the EMPr and of the detailed site layout plans to ensure compliance with the requirements. ❖ Contractors must have a plan in place to implement the management measures set out in the EMPr.	None	When: ❖ At the start of the project. ❖ Annually for the LoO. ❖ During induction (at	Raising staff and contractor environmental awareness.

Reference No.	Aspect	Activities	Impact	Size and Scale of Disturbance Post-Mitigation	Mitigation Measures	Compliance with standards	Time period for Implementation & Responsible Person	Outcomes
					❖ The EO is to supervise the contractors to ensure that management measures are being adhered to. ❖ All personnel are to undergo Environmental Awareness Training. A signed register of attendance must be kept for proof. Discussions are required on all sensitive environmental receptors near to the Project Area to inform contractors and site staff of the presence of sensitive habitat features, such as wetland areas, and management requirements in line with the Environmental Authorisation and within the EMPr. ❖ Contractors and employees must all undergo an environmental induction and be made aware of the sensitive habitats nearby to the Project Area		the start of the project and annually). Responsibility: ❖ Contractor. ❖ EO	
8	Surface Water	Removal of vegetation and alteration to the topography.	Erosion and wash off of exposed soils leading to siltation in down gradient watercourses.	Site	❖ Clearance of vegetation must be limited as far as possible; ❖ Temporary erosion measures such as sediment nets should be employed around exposed working areas; ❖ The SWMP must be implemented as a first step during the construction phase; and ❖ Water quality monitoring must be implemented upstream and downstream of construction sites.	❖ Guideline Document for the Implementation of Regulations; ❖ GN R704.	When: ❖ Prior to commencement of Activities. Responsibility: ❖ Licence holder.	Reducing negative impacts on surface water resources i
9	Surface Water Groundwater	Site planning	Improper planning may lead to surface water and groundwater pollution during construction and operational phases.	Site	❖ Design a Stormwater Management Plan taking surface water quality proposed designs into account. ❖ Compilation of a Stormwater Management Plan aimed at reducing and/or eliminating adverse impacts on the receptors identified. These include existing private groundwater users, wetlands, rivers and streams. The Water Management Plan is to include the compilation of a Water Quality Monitoring Programme. ❖ An Emergency Response Plan to contain spills is required to be in place prior to construction and operation. ❖ Implement a groundwater and surface water monitoring programme	❖ Guideline Document for the Implementation of Regulations; ❖ GN R704.	When: ❖ Prior to commencement of Activities. Responsibility: ❖ Licence holder.	Reducing negative impacts on surface water resources in the event of spills.

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Reference No.	Aspect	Activities	Impact	Size and Scale of Disturbance Post-Mitigation	Mitigation Measures	Compliance with standards	Time period for Implementation & Responsible Person	Outcomes
					before reclamation and construction starts.			
10	Air Quality	Baseline dust fallout monitoring	Air pollution and dustfall	Site	❖ Initiate dust fallout monitoring prior to commencement of activities to establish baseline against which to monitor.	❖ National Standards for Ambient Air Quality for PM10 and for PM2.5; ❖ National Dust Control Regulations.	When ❖ Prior to commencement of Activities. Responsibility: ❖ Licence holder.	Establishing baseline air quality to measure baseline project life-span air quality.
11	Heritage	Site clearance	Destruction of heritage sites Impact on potential palaeontological resources potential discovery of heritage resources	Site	❖ Implement a chance to find procedures in case where possible heritage finds are uncovered. ❖ A detailed “walk down” of the final approved alignment will be required before construction commences. ❖ Any significant features of significance identified during this walkdown will require formal mitigation (i.e., permitting where required) or where possible a slight change in design could accommodate such resources. ❖ If fossil remains or trace fossils are discovered during any phase of construction, either on the surface or exposed by excavations the Chance Find Procedure must be implemented immediately and the Environmental Officer (EO) in charge of these developments must report to SAHRA. ❖ Before any fossil material can be collected from the development site the specialist involved would need to apply for a collection permit from SAHRA.	❖ Recommendations from South African Heritage Resources Agency (SAHRA) under Section 36 and 38 of NHRA.	When: ❖ Prior to commencement of Activities. Responsibility: ❖ Applicant. ❖ Heritage specialist. ❖ EO	Minimise risk of damaging heritage resources.
12	Social Noise	Recruitment Prior to activities	Community complaints Community engagement Noise impacts	Local Site	❖ Compilation of a Stakeholder Engagement Plan to be implemented for the life of the project. ❖ Instatement of a community liaison forum for community members to allow community member to participate in the project through engagement. ❖ All employees and contractors should receive induction that includes an environmental awareness component (noise). This is to allow employees and contractors to realize the potential noise risks that activities	❖ Stakeholder engagement plan; ❖ Emergency Preparedness and Response Plan.	When: ❖ Prior to commencement of activities. Responsibility: ❖ Applicant. ❖ EO. ❖ HR.	Minimise negative impacts on local communities.

Reference No.	Aspect	Activities	Impact	Size and Scale of Disturbance Post-Mitigation	Mitigation Measures	Compliance with standards	Time period for Implementation & Responsible Person	Outcomes
					(especially night-time activities) pose to the surrounding environment. ❖ Ensure a good working relationship between FWGR and all potentially noise-sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them (especially if work is to take place within 200 m from them at night). ❖ Compilation of an Emergency Preparedness and Response Plan to be implemented for the life of the project. ❖ Compilation of Employee Awareness Plans.			

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8.2 Construction Phase Mitigation Measures

FWGR will commence with the pre-construction and construction phase for its project related infrastructure in line with its approved environmental authorisations. During the construction phase the following activities will take place on site:

Table 8-3: Summary table of the Activities associated with the construction phase of the project

Activity	Description
Construction Phase	
7	Operation of construction machinery and vehicles
8	Install reclamation station and its associated infrastructure
9	Construction of pipelines and electricity reticulation and power line
10	Instatement of waste management and dust control measures on site
11	Desilting of existing facilities
12	Instatement of traffic signage, access, parking bays

Table 8-4: Construction Phase Mitigation Measures

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
Main activities: site clearance and preparation; access roads; placement of temporary infrastructure								
Biodiversity and Wetlands								
1	Vegetation and Habitats	Construction activities	Impact to the local flora and habitats due to the construction of the proposed activity.	❖ Laydown and construction preparation activities (such as cement mixing, temporary toilets, etc.) must be limited to already modified areas and should take up the smallest footprint possible. ❖ Develop post-mining environments, in conjunction with regional development plans; and the recreation of habitats, where possible; or structure altered landscapes to be compatible with regional habitats. ❖ Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should not be fragmented or disturbed further if possible. ❖ All vehicles and personnel must make use of existing roads and walking paths as far as possible, especially construction/operational vehicles. ❖ The clearing of vegetation must be minimised where possible. All activities must be restricted to within the authorised areas. ❖ All laydown, chemical toilets etc. should be restricted to disturbed areas and placed outside of any sensitive areas. Any materials may not be stored for extended periods of time and must	Local.	❖ NEM:PAA; ❖ NEMA; ❖ NEM:WA ❖ NBA ❖ Gauteng C-Plan National Spatial Biodiversity Assessment (NSBA) National Freshwater Ecosystem Priority Areas (NFEPA's); ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014 ; ❖ CARA; ❖ Mining and Biodiversity Guidelines. ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014;	When: ❖ Duration of the project. Responsibility: ❖ Contractor, EO. ❖ Health and Safety Officer	Minimise negative impacts on Flora.

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				be removed from the project area once the construction/closure phase has been concluded. ❖ All footprints to be rehabilitated after construction is complete. Rehabilitation of the disturbed areas existing in the project area must be made a priority. Topsoil must also be utilised, and any disturbed area must be re-vegetated with plant and grass species which are endemic to this vegetation type. ❖ A hydrocarbon spill management plan must be put in place to ensure that should there be any chemical spill out or over that it does not run into the surrounding areas. A TSF operational plan must be put in place to avoid tailings spillage. The Contractor shall be in possession of an emergency spill kit that must always be complete and available on site. ○ Drip trays or any form of oil absorbent material must be placed underneath vehicles/machinery and equipment when not in use. ○ No servicing of equipment on site unless necessary. ○ All contaminated soil / yard stone shall be treated in situ or removed and be placed in containers. ○ Appropriately contain any generator diesel storage tanks, machinery spills (e.g., accidental spills of hydrocarbons oils, diesel etc.) in such a way as to prevent them from leaking and entering the environment. ○ All vehicles and equipment must be maintained, and all re-fuelling and servicing of equipment is to take place in demarcated areas outside of the PAOI. ❖ Do not remove any indigenous plant species from the PAOI or bring any alien species in. This is to prevent the spread of exotic or alien species or the illegal collection of plants. ❖ All construction waste must be removed from site at the closure of the construction phase. ❖ Precautions must be taken against the erosion damage that would be caused				

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				by unplanned pipe leaks. A leak warning and detection system must be installed. Dense indigenous pioneer grass seeds should also be planted across all bare earth areas to prevent erosion.				
2	Fauna	Construction activities	Impact to local fauna due to the proposed construction activities.	❖ Clearing and disturbance activities must be conducted in a progressive linear manner, always outwards and away from the centre of the PAOI and over several days, so as to provide an easy escape route for all small mammals and herpetofauna. ❖ The areas to be disturbed must be specifically and responsibly demarcated to prevent the movement of staff or any individual into the surrounding environments, signs must be put up to enforce this. ❖ The duration of the activities should be minimised to as short a term as possible, to reduce the period of disturbance on fauna. ❖ Noise must be kept to an absolute minimum during the evenings and at night to minimise all possible disturbances to reptile species and nocturnal mammals. ❖ No trapping, killing, or poisoning of any wildlife is to be allowed and signs must be put up to enforce this. Monitoring must take place in this regard. ❖ Outside lighting should be designed and limited to minimise impacts on fauna. All outside lighting should be directed away from any sensitive areas. Fluorescent and mercury vapor lighting should be avoided, and sodium vapor (green/red) lights should be used wherever possible. ❖ All construction and maintenance motor vehicle operators should undergo an environmental induction that includes instruction on the need to comply with speed limits, to respect all forms of wildlife. Speed limits must be enforced to ensure that road killings and erosion is limited. ❖ Any holes/deep excavations must be dug in a progressive manner and shouldn't be left open overnight. Should any holes remain open	Local.		When: ❖ Duration of the project. Responsibility: ❖ Contractor. ❖ EO. ❖ Health and Safety officer	Minimise negative impacts on fauna.

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				overnight they must be properly covered temporarily to ensure that no small fauna species fall in. Holes must be subsequently inspected for fauna prior to backfilling. ❖ If fencing is required: wildlife-permeable fencing with holes large enough for mongoose and other smaller mammals should be installed, the holes must not be placed in the fence where it is next to a major road as this will increase road killings in the area.				
3	Alien Species	Construction activities	Spread of Alien Species due to the construction activities	❖ An Alien Invasive Plant (AIP) Management Plan must be compiled and implemented. This should regularly be updated to reflect the annual changed in AIP composition. ❖ The footprint area of the construction should be kept to a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas. Footprints of the roads must be kept to prescribed widths. ❖	Local.		When: ❖ Duration of the project. Responsibility: ❖ Contractor. ❖ EO. ❖ Health and Safety Officer	Minimise negative impacts on Biodiversity
4	Dust	Construction Activities	Generation of dust due to the construction activities	❖ Dust-reducing mitigation measures must be put in place and must be strictly adhered to. This includes the wetting of exposed soft soil surfaces. No non-environmentally friendly suppressants may be used as this could result in the pollution of water sources.	Local.		When: ❖ Duration of the project. Responsibility: ❖ Contractor. ❖ EO.	Minimise negative impacts on Biodiversity
5	Waste	Construction Activities	Negative impact of generated waste on the local environment	❖ Waste management must be a priority and all waste must be collected and stored effectively and responsibly according to a site-specific waste management plan. Dangerous waste such as metal wires and glass must only be stored in fully sealed and secure containers, before being moved off site as soon as possible. ❖ Litter, spills, fuels, chemical and human waste in and around the PAOI must be minimised and controlled according to the waste management plan. ❖ Toilets at the recommended Health and Safety standards must be provided. These should be emptied regularly and once no longer required,	Local.		When: ❖ Duration of the project. Responsibility: ❖ Contractor, ❖ EO, ❖ HR.	Minimise negative impacts on Fauna.

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				they must be pumped dry to prevent leakage into the surrounding environment and removed from site. ❖ The Contractor should supply sealable and properly marked domestic waste collection bins and all solid waste collected shall be disposed of at a licensed disposal facility. ❖ Refuse bins will be responsibly emptied and secured. Temporary storage of domestic waste shall be in covered and secured waste skips.				
6	Environmental Awareness Training	Construction Activities	Negative impacts to the local environment due to improper environmental awareness training	❖ All personnel and contractors are to undergo Environmental Awareness Training. A signed register of attendance must be kept for proof. ❖ Discussions are required on sensitive environmental receptors within the PAOI to inform contractors and site staff of the presence of protected species, their identification, conservation status and importance, biology, habitat requirements and management requirements in line with the Environmental Authorisation and within the EMPr.	Local		When: ❖ Duration of the project. ❖ construction Responsibility: ❖ Contractor. ❖ EO. ❖ Health and Safety Officer	Minimise negative impacts on the biodiversity
7	Erosion	Construction Activities	Negative impacts to the local environment due possible erosion	❖ Speed limits must be put in place to reduce erosion. Soil surfaces must be wetted as necessary to reduce the dust generated by the project activities. Speed bumps and signs must be erected to enforce slow speeds. ❖ Only existing access routes and walking paths may be made use of. ❖ Areas that are denuded during construction need to be re-vegetated with indigenous vegetation to prevent erosion during flood events etc. ❖ A stormwater management plan must be compiled and implemented if necessary.	Local		❖ Duration of the project. ❖ construction Responsibility: ❖ Contractor. ❖ EO. Health and Safety Officer	Minimise the possibility of erosion occurring.
8	Pipeline Leaks or Spills	Construction of pipelines	Negative impacts due to possible pipeline leaks or spills	❖ Leak detection or any similar monitoring tool must be incorporated to try identifying leaks.	Local		❖ Duration of the project. ❖ construction Responsibility: ❖ Contractor. ❖ EO. Health and Safety Officer	Minimise and mitigate any possible impact from pipeline leaks

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Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
9	Wetlands	Site clearing and preparation	Disturbance and degradation of wetland vegetation Increased bare surfaces, runoff and potential for erosion Introduction and spread of alien and invasive vegetation	❖ Prevent the unnecessary destruction and fragmentation of the vegetation community of the wetland areas; and ❖ Limit the construction area to the defined project areas and only impact those areas where it is unavoidable to do so otherwise. ❖ Adherence to the buffer areas. These should be visibly demarcated to avoid encroachment into these areas; ❖ Silt traps and sediment trapping berms must be in place around drainage lines around the construction site to prevent the movement of contaminated or sediment laden runoff from entering the wetlands; ❖ Erosion prevention and sediment control measures (wetland and drainage line) are imperative and need to be implemented throughout the entire project footprint area of the proposed development, access roads and temporary laydown / storage sites. Temporary erosion control methods may include silt fences, interceptor ditches, seeding and sodding, riprap of exposed embankments, erosion mats, and mulching; and ❖ All removed soil and material must not be stockpiled within the watercourse and buffers. Stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds. ❖ Loose soils are particularly prone to loss due to wind or water. It is therefore preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces; ❖ Practice good soil management across the construction footprint; ❖ Avoid the creation of concentrated flow paths wherever possible; ❖ Signs of erosion must be addressed immediately to prevent further erosion of the area to prevent head cut erosion from forming; ❖ Temporary and permanent erosion control methods may include silt fences, flotation silt curtains, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of	Local	❖ South Africa's National Biodiversity Strategy and Action Plan (NBSAP) ❖ NEM:PAA; ❖ NEMA; ❖ NEM:WA ❖ NBA ❖ Gauteng C-Plan National Spatial Biodiversity Assessment (NSBA) National Freshwater Ecosystem Priority Areas (NFEPA's); ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014 ; ❖ CARA; ❖ Mining and Biodiversity Guidelines. ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014; ❖ DWS Risk Assessment Protocol; ❖ National Wetland Classification Systems (NWCS).	When: ❖ Duration of the project. ❖ Construction. Responsibility: ❖ Applicant ❖ Contractor. ❖ EO.	Minimise the impact on the wetland system.
10	Wetlands	Excavation, levelling and installation of the structures.	Increased sediment loads to downstream reaches Contamination of wetlands with hydrocarbons due to leaks and spillages from machinery, equipment & vehicles as well as Contamination and eutrophication of wetland systems with human sewerage and litter.		Local		When: ❖ Duration of the project. ❖ Construction. Responsibility: ❖ Applicant. ❖ Contractor. ❖ EO.	Minimise the impact on the wetland system.
11	Wetlands	Routine operation and maintenance of the structures	Degradation of wetland vegetation. Proliferation of alien and invasive species		Local		When: ❖ Duration of the project. ❖ Construction. Responsibility: ❖ Applicant. ❖ Contractor. ❖ EO.	Minimise the impact on the wetland system.

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				exposed embankments, erosion mats, and mulching; ❖ Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil; ❖ Relandscape to gentler gradients and re-vegetate all cleared areas, which includes the areas adjacent to the proposed infrastructure, as soon as possible to limit erosion potential. Sandbags and geotextiles should be used to assist until vegetation has established in these reworked areas; ❖ Stem any head cut/ erosion gulley as it occurs by bulldozing, filling, re-contouring to gentler gradients and re-vegetating; and ❖ The rehabilitation of watercourse banks must take place following construction. Key areas where erosion has occurred should be rehabilitated through bank reprofiling to gentler gradients and the revegetation of the wetland periphery areas. ❖ The wetland areas outside of the specific project site area must be avoided where possible; ❖ The construction vehicles and machinery must make use of existing access routes as much as possible, before adjacent areas are considered for access; ❖ Laydown yards, camps and storage areas must be beyond the wetland areas. Where possible, the construction of the road and crossings must take place from the existing paths; ❖ Prevent uncontrolled access of vehicles through the watercourses that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas; ❖ All chemicals and toxicants to be used for the construction must be stored outside the watercourse areas and their respective buffers and in a bunded area; ❖ All machinery and equipment should be inspected regularly for faults and				

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				possible leaks, these should be serviced off-site in a designated area; ❖ All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good "housekeeping"; ❖ Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel within the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation); ❖ Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems; ❖ The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly; ❖ All removed soil and material must not be stockpiled within the system. Stockpiling should take place outside of the watercourse buffers. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds; ❖ Mixing of concrete must under no circumstances take place within the drainage or wetland systems. Scrape the area where mixing and storage of sand and concrete occurred to clean once finished; ❖ No dumping of construction material on-site may take place; ❖ All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported; and ❖ Consideration should be given to implementing an alien invasive plant management plan post construction to control any current invaded areas and prevent the growth of alien invasive species on cleared areas.				

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Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
Surface Water and Groundwater								
12	Surface Water	Removal of vegetation and alteration to the topography.	Erosion and wash off of exposed soils leading to siltation in down gradient watercourses.	❖ Clearance of vegetation must be limited as far as possible; ❖ Temporary erosion measures such as sediment nets should be employed around exposed working areas; ❖ The SWMP must be implemented as a first step during the construction phase; and ❖ Water quality monitoring must be implemented upstream and downstream of construction sites.	Regional	❖ DWAF Best Practice Guidelines ❖ Guideline Document for the Implementation of Regulations ❖ GN R704	When: ❖ Duration of the project – specifically construction. Responsibility: ❖ Contractor. ❖ EO.	Minimise soil erosion and reduce deterioration of water quality.
13	Groundwater	Construction Activities	Impact on the local groundwater quality	❖ Implement a groundwater monitoring program at Libanon TSF before reclamation starts to effectively measure the groundwater status and impacts of the reclamation activities on the groundwater environment and changes in groundwater qualities and levels. ❖ Develop sound surface runoff management plans to ensure that all dirty runoff is contained and diverted to the paddocks. No pooling of water on surface allowed. ❖ Ensure that paddocks are designed to contain all dirty water generated during the reclamation process, to prevent overflows and spillages.	Local.	❖ DWAF Best Practice Guidelines ❖ Guideline Document for the Implementation of Regulations ❖ GN R704	When: ❖ Duration of the project – specifically construction phase. Responsibility: ❖ Contractor. ❖ EO.	Minimise soil erosion and reduce deterioration of water quality.
Air Quality								
14	Air Quality	PM2.5 and PM10 Clearance of vegetation	Stripping of vegetation from the surface of a TSF and wind erosion from exposed areas causes the emission of particulate matter into the air, thus increasing existing ambient air concentrations of criteria pollutants (both PM10 and PM2.5) at receptors.	❖ Restriction of the stripped band to a width of 40 metres; ❖ Restriction of the use of storage piles; ❖ Removing all tailings material down to 'red earth' as the area of work progresses and not leaving remnants of tailings material behind which could be exposed to wind erosion.	Local	❖ National Standards for Ambient Air Quality for PM10 and for PM2.5; ❖ National Dust Control Regulations.	When ❖ Duration of the construction phase of the project. Responsibility: ❖ Contractor. ❖ EO.	Minimise generation of PM.
Heritage								
15	Heritage	Main Activities	Damage or destruction of historical residential structures. Impact on potential palaeontological resources	❖ Implement a chance to find procedures in case where possible heritage finds are uncovered. ❖ A detailed "walk down" of the final approved alignment will be required before construction commences.	Local.	❖ Recommendations from SAHRA under Section 36 and 38 of NHRA.	When: ❖ Prior to commencement of Activities.	Minimise risk of damaging heritage resources.

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
			Potential discovery of heritage resources	❖ Any significant features of significance identified during this walkdown will require formal mitigation (i.e., permitting where required) or where possible a slight change in design could accommodate such resources. ❖ If fossil remains or trace fossils are discovered during any phase of construction, either on the surface or exposed by excavations the Chance Find Procedure must be implemented immediately and the Environmental Officer (EO) in charge of these developments must report to SAHRA. ❖ Before any fossil material can be collected from the development site the specialist involved would need to apply for a collection permit from SAHRA.			❖ Duration of the construction phase of the project. ❖ Duration of the operation phase of the project. Responsibility: ❖ Licence holder. ❖ Heritage specialist.	
Social								
16	Social	Main Activities	Employment and Income	❖ FWGR should consider a local internship/job shadowing strategy that could benefit talented youth from the local communities in Wards 23 and 25 ❖ Develop a database of potential suppliers within the local area (including the wards around the project). ❖ Preference should be given to capable subcontractors who based within the local municipal area. ❖ Encourage the company's existing suppliers to enter into a Joint Venture (JV) with local SMMEs to aid with the transfer of skills. ❖ Develop skills development and training targets for local procurement and include these in contractor management plans. ❖ Communicate the local employment strategy clearly to the local communities adjacent to the mine.	Local.	❖ NEMA; ❖ Occupational Health and Safety (Act No. 85 of 1993); ❖ National Spatial Development Framework; ❖ NEM:AQA; ❖ National Dust Control Regulations (Government Notice No. R827, 2013).	When: ❖ Duration of the construction phase of the project. Responsibility: ❖ Contractor. ❖ EO. ❖ FWGR	Minimise, as far as possible, Negative social impacts. Maximise, as far as possible, positive social impacts.
17	Social	Main Activities	Potential contribution to social funds	❖ Develop skills development and training targets for local procurement and include these in contractor management plans. ❖ Communicate the local employment strategy clearly to the local communities adjacent to the mine.	Local.	❖ NEMA; ❖ OSHA;. ❖ National Spatial Development Framework; ❖ NEM:AQA National Dust Control Regulations	When: ❖ Duration of the construction phase of the project Responsibility: ❖ Contractor ❖ EO	Minimise, as far as possible, Negative social impacts Maximise, as far as possible, positive social impacts

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				❖ Communicate the local employment strategy clearly to the local communities adjacent to the mine.		(Government Notice No. R827, 2013)	❖ FWGR	
18	Social	Main Activities	Impact on community health and safety	❖ Strict security measures to apply at the Project. ❖ The company to cooperate with the local SAPS and community safety forums. ❖ Establish a communication strategy and network with the local community in Wards 23 and 25. The communication strategy should include protocols to lodge complaints, complaints register, speedy resolution of complaints and meetings with community leaders on a regular (quarterly) basis. ❖ Strict adherence to the mitigation measures of the air quality impact report.	Local.	❖ NEMA; ❖ OSHA;. ❖ National Spatial Development Framework; ❖ NEM:AQA National Dust Control Regulations (Government Notice No. R827, 2013)	When: ❖ Duration of the construction phase of the project Responsibility: ❖ Contractor ❖ EO ❖ FWGR	Minimise, as far as possible, Negative social impacts Maximise, as far as possible, positive social impacts
19	Social	Main Activities	Influx of people to the project area	❖ Engage with local representatives to communicate the recruitment strategy of the Project and to register complaints related to increase level of influx into informal settlements. ❖ Solutions to address service delivery require interventions from the local authorities. However, the applicant can address potential issues that could lead to unrest by ensuring that an effective grievance mechanism is put in place to ensure that stakeholders are provided with a platform to raise their concerns/complaints.	Local.	❖ NEMA; ❖ OSHA;. ❖ National Spatial Development Framework; ❖ NEM:AQA National Dust Control Regulations (Government Notice No. R827, 2013)	When: ❖ Duration of the construction phase of the project Responsibility: ❖ Contractor ❖ EO ❖ FWGR	Minimise, as far as possible, Negative social impacts Maximise, as far as possible, positive social impacts
20	Social	Main Activities	Increase in nuisance factors	❖ Strict adherence to the mitigation measures of the traffic and air quality impact reports. ❖ A grievance management mechanism should be in place to receive incident related queries.	Local.	❖ NEMA; ❖ OSHA;. ❖ National Spatial Development Framework; ❖ NEM:AQA National Dust Control Regulations (Government Notice No. R827, 2013)	When: ❖ Duration of the construction phase of the project Responsibility: ❖ Contractor ❖ EO ❖ FWGR	Minimise, as far as possible, Negative social impacts Maximise, as far as possible, positive social impacts
Infrastructure (Offices & Workshops)								
21	Surface water	Workshop and office activities. Chemical storage facilities.	The potential incorrect disposal of hazardous wastes and workshop effluent (if any), as well as	❖ Implement the SWMP to separate clean and dirty water and to capture dirty water and prevent dirty water from leaving the site. ❖ Spill kits must be present on site.	Local.	❖ DWAF Best Practice Guidelines; ❖ Guideline Document for the Implementation of Regulations;	When: ❖ Duration of the project. Responsibility: ❖ Site/Site manager.	Reduction of the deterioration of water quality.

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
			spills and leaks at the temporary infrastructure. The potential incorrect disposal of domestic waste at the offices and ablutions.	❖ Drip trays must be placed under vehicles and equipment parked overnight. ❖ Use biodegradable hydraulic fluids where possible. ❖ No waste may be disposed at the site. Waste should be segregated and recycled, and non-recyclable waste and hazardous waste is to be disposed of at a registered landfill site. ❖ Hazardous chemicals and waste must be stored in an impermeable, fit-for purpose, bunded area. ❖ Hazardous chemical spills must be cleaned up immediately. ❖ Implement an emergency response procedure for if an emergency were to occur.		❖ Regulations on Use of Water for Mining and Related Activities aimed at the Protection of Water Resources (GN R704 of 12 February 2010).	❖ EO. ❖ Contractor.	

8.3 Operational Phase Mitigation Measures

The following activities are planned by the Applicant for the operation phase of the project.

Table 8-5: Summary table of the Activities associated with the operational phase of the project

Activity	Description
Operational Phase	
13	Reclamation Activities (including concurrent rehabilitation)
14	Operation of pipes
15	Operation of pump station and the associated infrastructure
16	Continued community engagement

Table 8-6: Operational Phase Mitigation Measures

Reference no.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
Main activities: reclamation, pumping slurry, monitoring, engagement, gold recovery, waste disposal, residual slurry deposition, return water.								
Biodiversity and Wetlands								
1	Vegetation and Habitats	Operational activities	Operational activities leading to an impact to local Flora and habitats	❖ Develop post-mining environments, in conjunction with regional development plans; and the recreation of habitats, where possible; or	Local.	❖ NEM:PAA; ❖ NEMA; ❖ National Biodiversity Assessment (NBA)	When: ❖ Duration of the project.	Minimise negative impacts on flora and habitats

Reference no.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				structure altered landscapes to be compatible with regional habitats. ❖ The clearing of vegetation must be minimised where possible. All activities must be restricted to within the authorised areas. ❖ All laydown, chemical toilets etc. should be restricted to disturbed areas and placed outside of any sensitive areas. Any materials may not be stored for extended periods of time and must be removed from the project area once the construction/closure phase has been concluded. ❖ Areas that are denuded during construction need to be re-vegetated with indigenous vegetation, to prevent erosion during flood and wind events and to promote the regeneration of functional habitat. This will also reduce the likelihood of encroachment by alien invasive plant species. All grazing mammals must be kept out of the areas that have recently been re-planted. ❖ All footprints to be rehabilitated after construction is complete. Rehabilitation of the disturbed areas existing in the project area must be made a priority. Topsoil must also be utilised, and any disturbed area must be re-vegetated with plant and grass species which are endemic to this vegetation type. ❖ A hydrocarbon spill management plan must be put in place to ensure that should there be any chemical spill out or over that it does not run into the surrounding areas. A TSF operational plan must be put in place to avoid tailings spillage. The Contractor shall be in possession of an emergency spill kit that must always be complete and available on site. ○ Drip trays or any form of oil absorbent material must be placed underneath vehicles/machinery and equipment when not in use. ○ No servicing of equipment on site unless necessary. ○ All contaminated soil / yard stone shall be treated in situ or removed and be placed in containers. ○ Appropriately contain any generator diesel storage tanks, machinery spills (e.g., accidental spills of hydrocarbons oils, diesel etc.) in such a way as to prevent them from leaking and entering the environment. ○ All vehicles and equipment must be maintained, and all re-fueling and servicing of equipment is to take place in demarcated areas outside of the PAOI.		❖ Gauteng C-Plan National Spatial Biodiversity Assessment (NSBA) National Freshwater Ecosystem Priority Areas (NFEPA's) ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014 ❖ CARA; ❖ Mining and Biodiversity Guidelines	❖ Operation. Responsibility: ❖ Contractor. ❖ EO.	

Reference no.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				❖ Do not remove any indigenous plant species from the PAOI or bring any alien species in. This is to prevent the spread of exotic or alien species or the illegal collection of plants. ❖ Precautions must be taken against the erosion damage that would be caused by unplanned pipe leaks. A leak warning and detection system must be installed. Dense indigenous pioneer grass seeds should also be planted across all bare earth areas to prevent erosion.				
2	Fauna	Operational activities	Operational activities on site leading to an impact to local fauna.	❖ The areas to be disturbed must be specifically and responsibly demarcated to prevent the movement of staff or any individual into the surrounding environments, signs must be put up to enforce this. ❖ Noise must be kept to an absolute minimum during the evenings and at night to minimise all possible disturbances to reptile species and nocturnal mammals. ❖ No trapping, killing, or poisoning of any wildlife is to be allowed and signs must be put up to enforce this. Monitoring must take place in this regard. ❖ Outside lighting should be designed and limited to minimise impacts on fauna. All outside lighting should be directed away from any sensitive areas. Fluorescent and mercury vapor lighting should be avoided, and sodium vapor (green/red) lights should be used wherever possible. ❖ All construction and maintenance motor vehicle operators should undergo an environmental induction that includes instruction on the need to comply with speed limits, to respect all forms of wildlife. Speed limits must be enforced to ensure that road killings and erosion is limited. ❖	Local.		When: ❖ Duration of the project. ❖ Operation. Responsibility: ❖ Contractor. ❖ EO.	Minimise negative impacts on fauna
3	Alien Species	Operational Activities	Operational activities leading to the spread of alien species	❖ An Alien Invasive Plant (AIP) Management Plan must be compiled and implemented. This should regularly be updated to reflect the annual changed in AIP composition. ❖ The footprint area of the construction should be kept to a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas. Footprints of the roads must be kept to prescribed widths. ❖	Local.		When: ❖ Duration of the project. ❖ Operation. Responsibility: ❖ Contractor. ❖ EO.	Minimise negative impacts on Biodiversity.
4	Dust	Operational activities	Operational Activities leading to dust generation	❖ Dust-reducing mitigation measures must be put in place and be strictly adhered to, particularly for all dirt roads and any earth dumps. This includes the wetting of exposed soft soil surfaces and not conducting activities on windy days which will	Local		When ❖ Duration of the project ❖ rehabilitation Responsibility:	Minimise negative impacts on Biodiversity.

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Reference no.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				increase the likelihood of dust being generated. Only environmentally friendly suppressants may be used to avoid the pollution of water sources.			❖ Contractor EO	
5	Waste management	Operational Activities	Operational activities leading to the generation of waste on site.	❖ Waste management must be a priority and all waste must be collected and stored effectively and responsibly according to a site-specific waste management plan. Dangerous waste such as metal wires and glass must only be stored in fully sealed and secure containers, before being moved off site as soon as possible. ❖ Litter, spills, fuels, chemical and human waste in and around the PAOI must be minimised and controlled according to the waste management plan. ❖ Toilets at the recommended Health and Safety standards must be provided. These should be emptied regularly and once no longer required, they must be pumped dry to prevent leakage into the surrounding environment and removed from site. ❖ The Contractor should supply sealable and properly marked domestic waste collection bins and all solid waste collected shall be disposed of at a licensed disposal facility.. ❖ Refuse bins will be responsibly emptied and secured. Temporary storage of domestic waste shall be in covered and secured waste skips.	Local.		When: ❖ Duration of the project ❖ Operation Responsibility: ❖ Contractor ❖ EO	Minimise negative impacts on Biodiversity.
6	Erosion	Operational Activities	Operational activities leading to erosion.	❖ Speed limits must be put in place to reduce erosion. Soil surfaces must be wetted as necessary to reduce the dust generated by the project activities. Speed bumps and signs must be erected to enforce slow speeds. ❖ Only existing access routes and walking paths may be made use of. ❖ Areas that are denuded during construction need to be re-vegetated with indigenous vegetation to prevent erosion during flood events etc. ❖ A stormwater management plan must be compiled and implemented if necessary.	Local.		When: ❖ Duration of the project ❖ Operation Responsibility: ❖ Contractor EO	Minimise negative impacts on Biodiversity.
7	Pipeline Leaks or Spills	Operational Activities	Negative impacts to the local environment due to Pipeline leaks or spills	❖ Leak detection or any similar monitoring tool must be incorporated to try identifying leaks.	Local.		When: ❖ Duration of the project ❖ Operation Responsibility: ❖ Contractor ❖ EO	Minimise negative impacts on Biodiversity.

Reference no.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
8	Wetlands	Routine operation and maintenance of the structures	Degradation of wetland vegetation. Proliferation of alien and invasive species	❖ Silt traps and sediment trapping berms must be in place around drainage lines around the construction site to prevent the movement of contaminated or sediment laden runoff from entering the wetlands; ❖ Erosion prevention and sediment control measures (wetland and drainage line) are imperative and need to be implemented throughout the entire project footprint area of the proposed development, access roads and temporary laydown / storage sites. Temporary erosion control methods may include silt fences, interceptor ditches, seeding and sodding, riprap of exposed embankments, erosion mats, and mulching; and ❖ All removed soil and material must not be stockpiled within the watercourse and buffers. Stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds. ❖ Avoid the creation of concentrated flow paths wherever possible; ❖ Signs of erosion must be addressed immediately to prevent further erosion of the area to prevent head cut erosion from forming; ❖ Temporary and permanent erosion control methods may include silt fences, flotation silt curtains, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed embankments, erosion mats, and mulching; ❖ Relandscape to gentler gradients and re-vegetate all cleared areas, which includes the areas adjacent to the proposed infrastructure, as soon as possible to limit erosion potential. Sandbags and geotextiles should be used to assist until vegetation has established in these reworked areas; ❖ Stem any head cut/ erosion gulley as it occurs by bulldozing, filling, re-contouring to gentler gradients and re-vegetating; and ❖ The rehabilitation of watercourse banks must take place following construction. Key areas where erosion has occurred should be rehabilitated through bank reprofiling to gentler gradients and the revegetation of the wetland periphery areas. ❖ The wetland areas outside of the specific project site area must be avoided where possible; ❖ Prevent uncontrolled access of vehicles through the watercourses that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas;	Local	❖ South Africa's National Biodiversity Strategy and Action Plan (NBSAP) ❖ NEM:PAA; ❖ NEMA; ❖ NEM:WA ❖ National Biodiversity Assessment (NBA) ❖ Gauteng C-Plan National Spatial Biodiversity Assessment (NSBA) National Freshwater Ecosystem Priority Areas (NFEPA's); ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014 ; ❖ CARA; ❖ Mining and Biodiversity Guidelines. ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014; ❖ DWS Risk Assessment Protocol; ❖ National Wetland Classification Systems (NWCS).	When: ❖ Duration of the project ❖ Operation Responsibility: ❖ Contractor ❖ EO	Minimise negative impacts on Wetland.

Reference no.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				❖ All chemicals and toxicants must be stored outside the watercourse areas and their respective buffers and in a bunded area; ❖ All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site in a designated area; ❖ All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good "housekeeping"; ❖ Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel within the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation); ❖ Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems; ❖ The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly; ❖ All removed soil and material must not be stockpiled within the system. Stockpiling should take place outside of the watercourse buffers. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds; ❖ Mixing of concrete must under no circumstances take place within the drainage or wetland systems. Scrape the area where mixing and storage of sand and concrete occurred to clean once finished; ❖ All waste generated on-site must be adequately managed. Separation and recycling of different waste materials should be supported; and ❖ Consideration should be given to implementing an alien invasive plant management plan to control any current invaded areas and prevent the growth of alien invasive species on cleared areas.				
Surface Water and Groundwater								
9	Surface Water	Uncontained runoff from the operational area at the TSF.	Runoff into the downslope watercourses impacting on water quality.	❖ Implementation of the proposed SWMP. It must be ensured that stormwater measures are designed, constructed and operated, in order to ensure that stormwater does not spill more than once in 50 years, to be compliant with GN R704 regulations; and	Local.	❖ DWAF Best Practice Guidelines; ❖ Guideline Document for the Implementation of Regulations; ❖ GN R704.	When: ❖ During operations. Responsibility: ❖ Site/Site manager.	Reduction of the deterioration of water quality and quantity.

Reference no.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				❖ Water quality monitoring must continue upstream and downstream of the proposed project.				
10	Surface Water	Poor maintenance of stormwater infrastructure.	Silted paddocks and eroded berms can lead to spills in the downslope watercourses.	❖ Implementation of the stormwater monitoring detailed in the EMPr.	Local.	❖ DWAF Best Practice Guidelines; ❖ Guideline Document for the Implementation of Regulations; ❖ GN R704	When: ❖ During operations. Responsibility: ❖ Site/Site manager.	Reduction of the deterioration of water quality and quantity.
11	Groundwater Quality	Main Activities	Groundwater pollution during reclamation	❖ Develop sound surface runoff management plans to ensure that all dirty runoff is contained and diverted to the paddocks. No pooling of water on surface allowed. ❖ Commit to remove all tailings material and to monitor the quality of soils in the footprint areas. If soil monitoring suggests unacceptably high salt and metal concentrations, soil amelioration should be considered. ❖ Monitor groundwater quality in all boreholes identified. The groundwater monitoring network efficiency must be assessed and new monitoring boreholes drilled, if required. Additional mitigation measures need to be implemented if pollution is migrating off site. ❖ Ensure that paddocks can contain all dirty water generated during the reclamation process to prevent overflows and spillages.	Local.	❖ DWAF Best Practice Guidelines ❖ Guideline Document for the Implementation of Regulations ❖ GN R704	When ❖ During operations Responsibility: ❖ Site manager ❖ EO	Prevention of additional groundwater contamination.
12	Groundwater Quantity	Main Activities	Reduction in aquifer yield	❖ Develop sound surface runoff management plans to ensure that all dirty runoff is contained and diverted to the paddocks. No pooling of water on surface allowed. ❖ Ensure that paddocks can contain all dirty water generated during the reclamation process to prevent overflows and spillages. ❖ Monitor groundwater levels in all boreholes.	Local.	❖ DWAF Best Practice Guidelines ❖ Guideline Document for the Implementation of Regulations ❖ GN R704	When ❖ During operations Responsibility: ❖ Site manager ❖ EO	Prevention of groundwater quantity affect
Air Quality								
13	Social	Refer to construction mitigation measures as these are applicable to operation as well.						
Heritage								
14	Air Quality	Refer to construction mitigation measures as these are applicable to operation as well.						
Social								
15	Heritage	Refer to construction mitigation measures as these are applicable to operation as well.						
Radiation								
16	Radiation	Air emissions pathways Groundwater pathways	Potential for radiological impacts on human health	❖ Ensure that radiation exposure is below the regulatory compliance criteria (i.e., the dose constraint). ❖ Optimise the radiation protection by applying the ALARA principle.	Local.	❖ NNRA; ❖ Nuclear Energy Act (NEA) (Act No. 46 of 1999). ❖ Safety Standards (Regulation No. 388 dated 28 April 2006).	When: ❖ Duration of the operation	Prevent radiological impacts emanating from air, groundwater or

Reference no.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
		Surface Water Pathways		❖ Implement the radiological monitoring programme. ❖ Implement dust fallout monitoring . ❖ Ensuring that unused areas remain covered with available vegetation as far as possible. ❖ Implement the stormwater management plant proposed in the surface water hydrology impact assessment, to ensure that the surface water in the area is contained and that the volume of water leaving the project area is kept to the minimum.			phase of the project. Responsibility: ❖ Contractor. ❖ FWGR. ❖ NNR.	surface water pathways.

8.4 Decommissioning Mitigation Measures

The following activities are planned by the Applicant for the decommissioning phase of the project.

Table 8-7: Summary table of the Activities associated with this decommissioning phase of the project

Activity	Description
Decommissioning Phase	
17	Decommissioning and rehabilitation activities: Demolition of temporary infrastructure such as: screens, the pump station and pipelines, and Rehabilitation of the project area.
18	Closure forum to be established with key stakeholders.

Table 8-8: Closure and Decommissioning Phase Mitigation Measures

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
CESSION OF ACTIVITIES REMOVAL OF SITE TEMPORARY INFRASTRUCTURE AND REHABILITATION ACTIVITIES								
Biodiversity								
1	Flora and Habitat	Decommissioning activities	Decommissioning activities leading to a possible negative impact to the environment.	❖ Develop post-mining environments, in conjunction with regional development plans; and the recreation of habitats, where possible; or structure altered landscapes to be compatible with regional habitats. ❖ All laydown, chemical toilets etc. should be restricted to disturbed areas and placed outside of any sensitive areas. Any materials may not be stored for extended periods of time and must be removed from the project area once the construction/closure phase has been concluded. ❖ A hydrocarbon spill management plan must be put in place to ensure that should there be any chemical spill out or over that it does not run into the surrounding areas. A TSF operational plan must be put in place to avoid tailings spillage. The	Local.	❖ NEMA; ❖ National Biodiversity Assessment (NBA); ❖ Gauteng C-Plan; NEM:BA ❖ Alien and Invasive Species Regulations, 2013; ❖ NEM:BA Alien and Invasive Species Lists, 2016.	When: ❖ Duration of the project. ❖ Rehabilitation. Responsibility: ❖ Contractor. ❖ EO.	Minimise negative impacts on Biodiversity.

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				Contractor shall be in possession of an emergency spill kit that must always be complete and available on site. ○ Drip trays or any form of oil absorbent material must be placed underneath vehicles/machinery and equipment when not in use. ○ No servicing of equipment on site unless necessary. ○ All contaminated soil / yard stone shall be treated in situ or removed and be placed in containers. ○ Appropriately contain any generator diesel storage tanks, machinery spills (e.g., accidental spills of hydrocarbons oils, diesel etc.) in such a way as to prevent them from leaking and entering the environment. ○ All vehicles and equipment must be maintained, and all re-fueling and servicing of equipment is to take place in demarcated areas outside of the PAOI. ❖ No staff member must remove any indigenous plant species from the PAOI or bring any alien species in. This is to prevent the spread of exotic or alien species or the illegal collection of plants. ❖ Precautions must be taken against the erosion damage that would be caused by unplanned pipe leaks. A leak warning and detection system must be installed. Dense indigenous pioneer grass seeds should also be planted across all bare earth areas to prevent erosion.				
2	Fauna	Decommissioning activities	Decommissioning activities leading to a negative impact to the local fauna.	❖ The areas to be disturbed must be specifically and responsibly demarcated to prevent the movement of staff or any individual into the surrounding environments, signs must be put up to enforce this. ❖ Noise must be kept to an absolute minimum during the evenings and at night to minimise all possible disturbances to reptile species and nocturnal mammals. ❖ No trapping, killing, or poisoning of any wildlife is to be allowed and signs must be put up to enforce this. Monitoring must take place in this regard. ❖ Outside lighting should be designed and limited to minimise impacts on fauna. All outside lighting should be directed away from any sensitive areas. Fluorescent and mercury vapor lighting should be avoided, and sodium vapor (green/red) lights should be used wherever possible. ❖ All construction and maintenance motor vehicle operators should undergo an environmental induction that includes instruction on the need to	Local.		When ❖ Duration of the project. ❖ Rehabilitation. Responsibility: ❖ Contractor. ❖ EO.	Minimise negative impacts on Biodiversity.

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
				comply with speed limits, to respect all forms of wildlife. Speed limits must be enforced to ensure that road killings and erosion is limited. ❖ Schedule activities and operations during least sensitive periods, to avoid migration, nesting, and breeding seasons. In this case, activities should take place during the day.				
3	Alien Species	Decommissioning activities	Decommissioning activities leading to a negative impact to the local biodiversity	❖ An Alien Invasive Plant (AIP) Management Plan must be compiled and implemented. This should regularly be updated to reflect the annual changed in AIP composition. ❖ The footprint area of the construction should be kept to a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas. Footprints of the roads must be kept to prescribed widths.	Local.	❖ NEMA ❖ National Biodiversity Assessment (NBA) ❖ Gauteng C-Plan ❖ NEM:BA Alien and Invasive Species Regulations, 2013 ❖ NEM:BA Alien and Invasive Species Lists, 2016	When ❖ Duration of the project ❖ rehabilitation Responsibility: ❖ Contractor ❖ EO	Minimise negative impacts on Biodiversity.
4	Dust	Decommissioning activities	Decommissioning activities leading to a negative impact to the local biodiversity	❖ Dust-reducing mitigation measures must be put in place and be strictly adhered to, particularly for all dirt roads and any earth dumps. This includes the wetting of exposed soft soil surfaces and not conducting activities on windy days which will increase the likelihood of dust being generated. Only environmentally friendly suppressants may be used to avoid the pollution of water sources.	Local		When ❖ Duration of the project ❖ rehabilitation Responsibility: ❖ Contractor ❖ EO	Minimise negative impacts on Biodiversity.
5	Waste Management	Decommissioning activities	Decommissioning activities leading to the generation of waste.	❖ Waste management must be a priority and all waste must be collected and stored effectively and responsibly according to a site-specific waste management plan. Dangerous waste such as metal wires and glass must only be stored in fully sealed and secure containers, before being moved off site as soon as possible. ❖ Litter, spills, fuels, chemical and human waste in and around the PAOI must be minimised and controlled according to the waste management plan. ❖ Toilets at the recommended Health and Safety standards must be provided. These should be emptied regularly and once no longer required, they must be pumped dry to prevent leakage into the surrounding environment and removed from site. ❖ The Contractor should supply sealable and properly marked domestic waste collection bins and all solid waste collected shall be disposed of at a licensed disposal facility.. ❖ Refuse bins will be responsibly emptied and secured. Temporary storage of domestic waste shall be in covered and secured waste skips.	Local		When ❖ Duration of the project ❖ rehabilitation Responsibility: ❖ Contractor ❖ EO	Minimise negative impacts on Biodiversity.

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
6	Erosion	Decommissioning activities	Decommissioning activities leading to Erosion	❖ Speed limits must be put in place to reduce erosion. Soil surfaces must be wetted as necessary to reduce the dust generated by the project activities. Speed bumps and signs must be erected to enforce slow speeds. ❖ Only existing access routes and walking paths may be made use of. ❖ Areas that are denuded during construction need to be re-vegetated with indigenous vegetation to prevent erosion during flood events etc. ❖ A stormwater management plan must be compiled and implemented if necessary.	Local		When ❖ Duration of the project ❖ rehabilitation Responsibility: ❖ Contractor ❖ EO	Minimise negative impacts on Biodiversity.
7	Pipeline Leaks or Spill	Decommissioning Activities	Pipeline Spills during the decommissioning phase	❖ Leak detection or any similar monitoring tool must be incorporated to try identifying leaks.	Local		When ❖ Duration of the project ❖ rehabilitation Responsibility: ❖ Contractor EO	Minimise negative impacts on Biodiversity.
8	Wetland	Removal of pipeline infrastructure	Degradation of wetland vegetation and proliferation of alien and invasive species Disruption of wetland soil profile and alteration of hydrological regime	❖ See mitigation for the impacts during the construction and operational phase.	Local	❖ South Africa's National Biodiversity Strategy and Action Plan (NBSAP) ❖ NEM:PAA; ❖ NEMA; ❖ NEM:WA ❖ National Biodiversity Assessment (NBA) ❖ Gauteng C-Plan National Spatial Biodiversity Assessment (NSBA) National Freshwater Ecosystem Priority Areas (NFEPA's); ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014 ; ❖ CARA; ❖ Mining and Biodiversity Guidelines. ❖ ECA; ❖ Alien and Invasive Species Regulations, 2014; ❖ DWS Risk Assessment Protocol; ❖ National Wetland Classification Systems (NWCS).	When ❖ Duration of the project ❖ rehabilitation Responsibility: ❖ Contractor ❖ EO	Minimise negative impacts on Wetlands
Surface Water and Groundwater								
9	Surface Water	Exposure of potential contaminated soils during the closure and rehabilitation	Erosion and wash off of contaminated soils resulting in water quality issues in the surrounding watercourses.	❖ Runoff must be contained onsite through the implementation of paddocks and the lined catchment paddock and sump until contaminated soils are removed;	Local.	❖ DWAF Best Practice Guidelines; ❖ Guideline Document for the Implementation of Regulations; ❖ (GN R704.	When: ❖ During rehabilitation operations.	Reduction of the deterioration of water quality.

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Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
		phase once the dumps have been removed.		❖ Once contaminated soils are removed, the area must be backfilled with uncontaminated soils, and levelled to its original functioning topography; and ❖ Water quality monitoring must continue upstream and downstream until the site has been fully rehabilitated.			Responsibility: ❖ Site manager. ❖ Contractor. ❖ EO.	
10	Groundwater	Decommissioning activities	Water quality impacts when TSF has been removed	❖ Monitor groundwater quality in all boreholes. ❖ Maintain sound surface runoff management to ensure that all dirty runoff is contained and diverted to the paddocks and lined catchment paddock, sump and other stormwater management infrastructure.	Local.	❖ DWAF Best Practice Guidelines ❖ Guideline Document for the Implementation of Regulations ❖ GN R704	When: ❖ During rehabilitation operations Responsibility: ❖ Site manager. ❖ Contractor. ❖ EO	Reduction of the formation of AMD.
11	Groundwater	Groundwater Quantity	Reduction in Aquifer Yield	❖ Monitor groundwater levels in all boreholes.	Local.	❖ DWAF Best Practice Guidelines ❖ Guideline Document for the Implementation of Regulations ❖ GN R704	When: ❖ During rehabilitation operations Responsibility: ❖ Site manager. ❖ Contractor. ❖ EO.	Reduction of the formation of AMD.
Air Quality								
12	Air Quality	Refer to construction mitigation measures as these are applicable to decommissioning as well.						
Social								
13	Social	Refer to construction mitigation measures as these are applicable to decommissioning as well.						
Radiation								
14	Radiation	Implementation of the NNR approved decommissioning plan for the project	To ensure that radiation exposure is below the regulatory compliance criteria (i.e., the dose constraint), and to optimise the radiation protection by applying the ALARA principle.	❖ Adhere to the SWMP. ❖ Adhere to the Groundwater monitoring programme. ❖ Adhere to the dust fallout monitoring programme. ❖ Submit any reportable incidents to the Relevant Department head. ❖ Undertake a decommissioning radiation walk-over study. ❖ Abide by the Public Safety Assessment guidelines and recommendations to ensure that the site is cleared of radiation. ❖ Remove all contaminated soils for land to be rehabilitated.	Local	❖ NNRA ❖ NEA Safety Standards (Regulation No. 388 dated 28 April 2006)	When ❖ Duration of the decommissioning phase of the project Responsibility: ❖ Contractor ❖ FWGR ❖ NNR	A plan which is in line with what is required by NNR Ensure the site is does not pose a human health threat.

8.5 Post-Decommissioning Mitigation Measures

The following activities are expected to occur during the post-closure phase of the project.

Table 8-9: Summary table of the Activities associated with this post-closure phase of the project

Activity	Description
Post-Closure	
19	Post-Closure Monitoring
20	Rehabilitation activities

Table 8-10: Post-Closure Phase Mitigation Measures

Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
Monitoring								
1	Surface water Groundwater	Water quality monitoring	Water pollution	❖ Monitor and maintain surface water and groundwater management structures until the completion of the rehabilitation phase and the property has been handed back to the rightful land owner. ❖ Monitor surface water and groundwater quality. ❖ No pooling of water on surface allowed. ❖ Effective stormwater management that captures and contains all site runoff; ❖ Removal of all tailings material and successful rehabilitation of the area to a free draining area that is vegetated; and ❖ Water quality monitoring upstream and downstream of the proposed project until rehabilitation is successfully completed.	Local	❖ DWAF Best Practice Guidelines ❖ Guideline Document for the Implementation of Regulations ❖ GN R704	When ❖ Post closure timeframe Responsibility: ❖ Site manager ❖ EO	Water quality improvement
Social								
2	Social	Decommissioning Activities	Land Restoration	❖ Develop future land use plan in consultation with the local authority.	Local	❖ NEMA; ❖ OSHA;. ❖ National Spatial Development Framework; ❖ NEM:AQA National Dust Control Regulations (Government Notice No. R827, 2013)	When: ❖ Duration of the construction phase of the project Responsibility: ❖ Contractor ❖ EO	Minimise, as far as possible, Negative social impacts Maximise, as far as possible, positive social impacts
3	Social	Decommissioning Activities	Decrease/cessation of employment	❖ Consider implementing a portable skills programme for the existing workforce. ❖ Consider placement of workers in other FWGR operations.	Local	❖ NEMA; ❖ OSHA;. ❖ National Spatial Development Framework;	When: ❖ Duration of the construction	Minimise, as far as possible, Negative social impacts

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Reference No.	Aspect	Activities	Impact	Mitigation Measures	Size and Scale of Disturbance Post-Mitigation	Compliance with Standards	Time Period for Implementation & Responsible Person	Outcomes
						❖ NEM:AQA National Dust Control Regulations (Government Notice No. R827, 2013)	phase of the project Responsibility: ❖ Contractor ❖ EO	Maximise, as far as possible, positive social impacts
4	Social	Decommissioning Activities	Cessation of Social funds	❖ Plan social programmes with clear exit strategies well ahead of the closure of the project (e.g. handing over to other entities or clearly communicate limited timeframe to communities). ❖ Avoid social spending on infrastructure projects that would require long-term operational and maintenance funding. ❖ Focus social programmes on local capacity building and training.	Local	❖ NEMA; ❖ OSHA;. ❖ National Spatial Development Framework; ❖ NEM:AQA National Dust Control Regulations (Government Notice No. R827, 2013)	When: ❖ Duration of the construction phase of the project Responsibility: ❖ Contractor ❖ EO	Minimise, as far as possible, Negative social impacts Maximise, as far as possible, positive social impacts
5	Social	Decommissioning Activities	Improved community safety	❖ The applicant to apply for a land clearance certificate from the NNR-upon approval of the clearance certificate after complying with the conditions stipulated in the clearance certificate	Local	❖ NEMA; ❖ OSHA;. ❖ National Spatial Development Framework; ❖ NEM:AQA National Dust Control Regulations (Government Notice No. R827, 2013)	When: ❖ Duration of the construction phase of the project Responsibility: ❖ Contractor ❖ EO	Minimise, as far as possible, Negative social impacts Maximise, as far as possible, positive social impacts
6	Social	Decommissioning Activities	Potential land invasions	❖ Communicate upfront the proposed end land uses envisaged for the area once the reclamation process has been completed. ❖ Mine security patrols should monitor the perimeters of the project site thereby providing an increased security presence. ❖ FWGR to collaborate with the RWLM and implement RWLMs land use management system to prevent illegal settlements.	Local	❖ NEMA; ❖ OSHA;. ❖ National Spatial Development Framework; ❖ NEM:AQA National Dust Control Regulations (Government Notice No. R827, 2013)	When: ❖ Duration of the construction phase of the project Responsibility: ❖ Contractor ❖ EO	Minimise, as far as possible, Negative social impacts Maximise, as far as possible, positive social impacts

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9 SPECIFIC IMPACT MANAGEMENT PLANS

The impact management actions per Phase are detailed in Section 8 of this report. The impact management outcomes for the project are as follows:

- Maintain the footprint of the activity and restrict activities to the TSF and designated areas. Avoid and protect all sensitive areas/no-go areas
- Protect sensitive areas as far as practicable;
- Minimise dust fallout during construction and reclamation;
- Reduce groundwater pollution and seepage and sinkhole formation due to the underlying dolomite;
- Reduce surface water pollution;
- Prevent further land, stream and wetland contamination;
- Maintain transparent engagement and communication; and
- Ensure the full rehabilitation of a site by removing sources of pollution and aligning rehabilitation of the land for its intended future use.

The following compliance mechanisms are required by FWGR on an annual basis or as determined by the Environmental Authorisation:

- An environmental audit of the EMPr should be undertaken on an annual basis by an independent auditor.
- An internal audit should be undertaken annually.

9.1 Environmental Awareness Plan

9.1.1 Communication Chain

The communication of the environmental risks for each phase of the project will take place for the management, administrative and site worker sectors of the site, as well as contractors and sub-contractors.

9.1.2 Management Sector

A workshop will be conducted to inform all management of the risks associated with the project. The risks for all aspects will be explained and the appropriate management options discussed. The workshop will also elaborate on the monitoring programmes that will be implemented to identify and monitor the level of impact on the environment and discuss various remediation actions, should there be deterioration.

The evaluation process is integral in the assurance that the site reduces any possible environmental risks associated with the project. The workshop will be conducted prior to the construction phase to ensure that all risks are discussed before there is any chance of the impacts occurring.

The workshop may be repeated at certain stages during the construction phase, in the case of new employees.

This workshop will seek to explain the following necessary actions:

- Risks associated with each aspect will be discussed to ensure that there is an understanding of how each action of the project may impact on the environment.
- The mitigation of the environmental risk will be elaborated on.
- It is important that each person understands these management strategies as it ensures that the impact on the environment is kept to a minimum.
- Data collection regarding each aspect will also be explained to ensure that each aspect is monitored according to those protocols specified by the authorisations and licence. Along with data collection, the reporting of findings will be discussed.
- This workshop will take place before the construction phase begins, thus ensuring a full understanding of the project and its associated environmental risks before any construction activity is undertaken.
- The workshop will be repeated at the beginning of the operational phase as part of a handover to the next responsible party.
- The following communication channels and media will/ can be used to communicate environmental and social issues with FWGR employees during construction:
    - Head of Department (HOD) Meetings: The Site Manager communicates information to senior management on environmental issues and the information is minuted.
    - HSEC Meetings: 'Environmental issues' should be an agenda item on monthly safety, health & environmental meeting agendas.
    - Publications: Leaflets, posters etc. are produced by the relevant department or other designated persons, for use on notice boards, and distribution.
    - EMS Database: Feedback from line management on objectives, targets and actions.
    - Daily/ Weekly Safety Meeting: All meetings are scheduled to commence with a discussion on safety, health & environmental topics.

9.1.3 Construction Workers Sector

The workers associated with the activities on site will attend an induction course to ensure that each person is aware of the environmental risks associated with the project. This induction will form part of the health and safety induction. The environmental risks of each aspect as well as the mitigation will be elaborated on.

A debriefing should take place when the project moves from one phase to the next. A Job Hazard Analysis (JHA) or Issue Base Risk Assessment could also be conducted to identify potential risks associated with the project.

Furthermore, weekly toolbox talks / green meetings must cover topics raising awareness on environmental and social issues relating to the project.

9.1.4 Contractors

A Risk Conversancy Training (RCT) is conducted and is applicable to all contactors. Here focus will be on activities that carry an environmental risk, actions to be taken to reduce these risks, and procedures to be followed in the event of an incident.

Furthermore, weekly toolbox talks / meetings must cover topics raising awareness on environmental and social issues relating to the project.

9.1.5 Environmental Officer

The EO will oversee environmental awareness induction training to all contractor staff. The EO will ensure that the necessary environmental induction training takes place and that records of attendance are maintained and up to date.

An EO must also be present on site during the pre-construction and construction phases of the project to ensure compliance and the implementation of the EA, WUL and EMPr condition.

9.2 Strategic Communication Plan

9.2.1 Environmental Communication Strategies

FWGR Management are required to establish procedures for the internal communication between the various levels and functions of the organisation, and receiving, documenting and responding to environmental risks for each phase of the project will take place for the management, administrative and worker sectors of the site, as well as contractors. The organisation shall conduct processes for external communication on its significant environmental aspects and record its decision in line with FWGR communication policy as well as conditions stated in any EA or License.

9.2.1.1 Stakeholder Engagement Plan

A Stakeholder Engagement Plan (SEP) and Grievance Mechanism (GM) must be compiled for a project. The SEP needs to provide guidance for engagement with Stakeholders.

9.2.1.2 Internal Communication

Internal communication is done within the Administrative Sector.

9.2.1.3 External Communication Strategies

The following communication channels and media can be used to communicate environmental issues to individuals who are not employed by FWGR or its subcontractors:

- **Environmental Stakeholder Engagement Forum:** An Environmental Stakeholder engagement forum must be established and used to keep interested and affected parties informed of the significant environmental aspects identified through the Environmental Impact Assessments and Management Plans. This forum should preferable be initiated prior to commencing with any activities on site. This is also the forum where interested and affected parties get the opportunity to raise environmental concerns. Records must be kept of all decisions and concerns. The Environmental Stakeholder engagement meetings must be chaired by the personal of FWGR, or another appropriately appointed competent individual.

- **Publications:** Selected publications should be produced and used to communicate environmental issues to outside parties. Examples include newsletters and Annual Reports.
- **Communication from External Parties and Employees:** A clear communication point is established within the company through the FWGR communication procedure that determines who is responsible for liaison with the media in respect of any crisis that may arise. A complete procedure for media liaison is available to all employees. Communication from external interested and affected parties may be received by email, fax, telephonically or by mail. Where required, a written response will be sent, on receiving such communication, by the appropriately appointed individual under signature of the Site Manager, to the respective interested and / or affected party. All telephonic or facsimile correspondence received on the site must be forwarded to the relevant department for action. All events or concerns will be captured and actioned on an existing and / or future database.
- **E-mail:** E-mail communication received must be stored, with replies, in an appropriate folder on a server. E-mail messages, relevant to environmental management, should be kept for a minimum of two years before deletion.
- **Mail:** Correspondence received by mail must be filed, along with the response (where relevant), within the relevant department's filing system for a minimum period of two years. Paper correspondence will be archived in this department.
- **Storage of Correspondence:** All original correspondence must be retained by the Site Manager for a minimum period of two years.
- **Environmental Reports:** Copies of relevant specialist study reports and Environmental Impact Assessments will be available on request from an external party by the Site Manager.
- **Queries from Interested and Affected Parties:** Response to queries about environmental impacts and aspects will be addressed by the relevant department and approved by the Site Manager.

9.2.1.4 Evaluation of the Environmental Awareness Plan

The evaluation of the environmental awareness and training plan will be conducted by FWGR management. This evaluation will entail the auditing of the operation in both the construction and operation phase once activity has commenced. The environmental awareness and training plan described above is sufficient to make all those involved in the project aware of those risks that may occur as well as the necessary mitigation required to minimize these risks.

The environmental awareness and training plan indicate that FWGR is serious about the environments well-being and empowerment of the local people. Environmental issue will be highlighted at monthly meetings scheduled at the site.

9.2.1.5 Emergency Incident Reporting

Environmental incident reporting is a vital part of communication at the Libanon TSF Reclamation Project.. Employees are required to report all environmentally related problems, incidents and pollution, so that the appropriate litigator action can be implemented timeously. In the event of an Environmental Incident, the incident must be reported according to the Incident Reporting Procedure.

An Emergency Incident Preparedness and Response Plan needs to be developed.

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9.2.1.6 Induction

All full-time staff and contractors are required to attend an induction session. Employees are inducted when they start on the project. Any contractor, who works on the project is required to undergo FWRG's prescribed induction training. This induction will form part of the health and safety induction.

Environmental issues and aspects related to the project will be addressed in the induction sessions. All environmental impacts and aspects and their mitigatory measures will be discussed, explained and communicated to employees. The induction sessions will be modified according to the level of employee attending the induction session so that all employees gain a suitable understanding of environmental issues and pollution.

The records of all individuals attending induction sessions to be kept; the records to be kept include names, ID, contact details, designation and signature.

9.2.1.7 On the Job Training

On the job training is an essential tool in environmental awareness. Employees will be given details of the expected environmental issues and concerns specifically related to their occupation. Employees will be trained on how to respond if an environmental problem or source of environmental pollution arises. The training will be on-going, and all new employees will be provided with the same standard of training as existing employees. In addition, contractors working on the project will be subjected to a Risk Conversancy Training (RCT).

The records of all individuals receiving on the job training to be kept; the records to be kept include names, employee number, contact details, designation and signature.

9.2.1.8 Hazardous Substances

Individuals dealing with potential hazardous situations and risks that could lead to hazardous spills, pollution incidents, excessive dust or other forms of environmental damage should receive appropriate job specific training on the risks and potential consequences of their appointment and work situation, how to avoid environmental impacts and how to respond during an environmental incident or emergency situation. All these actions will be done in accordance to the FWGR procedures on management of hazardous substances.

9.2.1.9 Dust mitigation

Individuals dealing with potential situations and risks that could lead to excessive dust should receive appropriate job-specific training on the risks and potential consequences of their appointment and work situation, how to avoid environmental impacts and how to respond during an environmental incident or emergency situation.

9.2.1.10 Fire Incidents

Individuals dealing with potential hazardous situations and risks that could lead to fire incidents or emergencies should receive appropriate job-specific training on the risks and potential consequences of their

appointment and work situation, how to avoid environmental impacts and how to respond during an environmental incident or emergency situation.

9.2.1.11 Pollution Incidents or Forms of Environmental Damage

Any incident or form of environmental damage must be dealt with in accordance with the Incident management procedure. This document is held with FWGR.

Individuals dealing with potential situations and risks that could lead pollution incidents or other forms of environmental damage to receive appropriate job-specific training on the risks and potential consequences of their appointment and work situation, how to avoid environmental impacts and how to respond during an environmental incident or emergency situation.

9.2.1.12 Waste Management

Site personnel and contractors responsible for the operation and safe handling of the various waste streams will receive appropriate job-specific training on the risks and potential consequences of their appointment and work situation, how to avoid environmental impacts and how to respond during an environmental incident or emergency situation. FWGR must ensure that training and awareness programmes cover the safe transportation, handling, storage, transfer, handling, use and disposal of all waste streams, and the location of waste receptacles for each waste stream. All waste management activities must be done in accordance to the FWGR procedures, the EMPr and in terms of registers dealing with storage of waste in specific areas.

Staff awareness training programme will accommodate training, on which bin to use for organic waste and on sealing the lid on the bin once organic waste has been discarded.

9.2.1.13 Water Management

All persons responsible for active water management will receive appropriate job-specific training on the risks and potential consequences of their appointment and work situation, how to avoid environmental impacts and how to respond during an environmental incident or emergency.

9.2.1.14 Water Consumption and Use

All staff will receive training on minimising water consumption and how to use water sparingly.

9.3 Emergency Response Plan

An Environmental Emergency Response Plan defines the process to follow to respond rapidly and effectively to and manage emergency situations that may arise as a result of the Libanon TSF Reclamation Project. This plan must be initiated when an emergency:

- Cannot be immediately brought under control;
- Has the potential to extend beyond site boundaries;
- Has the potential to significantly impact on the environment and/or community; and

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- Requires assistance from External Emergency Services.

FWGR will develop an Emergency Response Plan for the Libanon TSF Reclamation Project.

This plan outlines response actions for potential incidents of any size. It details response procedures that will minimise potential health and safety hazards, environmental damage, and clean-up efforts. The plan has been prepared to ensure quick access to all the information required in responding to an emergency event. The plan will ensure that Contractors comply with all procedures described in this document.

9.3.1 Intent

A Work Method Statement should be prepared prior to the commencement of any activities, detailing how this plan is to be implemented as well as details of relevant responsible parties for the implementation. The method statement must also reflect conditions of the IFC Performance Standard 1 and include the following:

- Areas where accidents and emergency situations may occur;
- Communities and individuals that may be impacted, as read in the specialist studies;
- Response procedure;
- Provisions of equipment and resources;
- Designation of responsibilities; and
- Communication, both internally and externally.

The purpose of this plan is to define the emergency response structure and process of the Libanon TSF Reclamation Project. The objectives of the plan are:

- To ensure communication of all vital information as soon as possible;
- To provide clear guidance in the management of emergencies that have the potential to impact on life, property, environment and community;
- Clearly define roles and responsibilities;
- To facilitate the reorganisation and reconstruction activities so that normal operations can be resumed;
- For employees to be able to take prompt effective action to reduce the risk of injury, minimise environmental impact and property damage likely to result from possible emergencies;
- To specify the emergency communication process necessary to establish links with key site personnel.

The Emergency Preparedness and Response Code of Practice will be compiled in accordance with the Occupational Health and Safety OHSAS 18001, and the Site Health and Safety Act, 1996 (Act No. 29 of 1996).

9.3.2 Planning

There are three levels of emergency, these are delineated as follows:

- Local Emergency: An alert confined to a specific locality.
- Site Emergency: An alert that cannot be localised and which presents danger to other areas within the site boundary or outside the site boundary.

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- Evacuation: An alert when all personnel are required to leave the affected area and assemble in a safe location.

If there is any doubt as to whether any hazardous situation constitutes an emergency, then it must be treated as an Evacuation, and every effort must be made to reduce or stop the cause of any emergency provided it is safe to do so. Factors effecting the success of the emergency response strategy include:

- The type and scale of incident/accident will govern the type of response.
- The scale of the incident, accident or emergency will govern the resources required to bring under control.
- Communications after which an incident or emergency is first reported governs scale, type and resources required to maintain effective control and bring to resolution.

To facilitate the effective implementation of the procedures, copies of the Environmental Emergency Response Plan must be placed in accessible and visible locations around the site.

Table 9-1: Emergency Scenario Contingency Planning

Incident	Prevention Measures	Procedures	Designation
Spill which would result in the contamination of land, surface or groundwater.	❖ All equipment refuelling, servicing and maintenance activities should only be undertaken within appropriately sealed/contained or bunded designated areas. ❖ No refuelling, storage, servicing, or maintenance of equipment should take place within sensitive environmental resources to reduce the risk of contamination by spills. ❖ Any fluids drained from the machinery during servicing should be collected in leak-proof containers and taken to an appropriate disposal or recycling facility. ❖ A spill must be given the highest priority, and clean-up turn-around time must be as fast as possible, ❖ Ensure all paddocks and stormwater systems are desilted prior to commencing with construction. ❖ Ensure all paddocks and stormwater systems have sufficient capacity to hold dirty water – especially during rainfall events. ❖ Adhere to the stormwater management plan for this EMPr. ❖ Signage to be placed around the dams to ensure no persons use the paddocks for recreational purposes. ❖ If these activities result in damage or accumulation of contaminated slimes on the bare soil, the contaminated soil must be stripped and disposed of as hazardous waste. ❖ Chemical toilets used during construction must be regularly cleaned. Care and due diligence should always be taken. ❖ Contact details of emergency services and HazMat Response Contractors are to be clearly displayed on the site. All staff are to be made aware of these details and must be familiar with the procedures for notification in the event of an emergency.	1. Spill or release identified. 2. Assess person safety, safety of others and environment. 3. Stop the spill if safely possible. 4. Contain the spill to limit entering surrounding areas. 5. Identify the substance spilled. 6. Quantify the spill {under or over guideline/threshold levels). 7. Notify the Site Manager and emergency response crew and authorities {in the event of major spill). 8. Inform users {and downstream users) of the potential risk. 9. Clean up of the spill as fast as possible. 10. Record of the spill incident on company database.	Contractor, Site Manager, EO

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FWGR's EO Representative, who is responsible for managing the day-to-day on-site implementation of this Plan, must act as liaison and advisor on all environmental and related issues.

It is necessary to prevent land from becoming sterilised due to a spill. Criteria that may be considered for restoring the affected area include natural biodegradation of oil, replacement of soil and revegetation. Further, a radiation walk-over should be undertaken for spills of a reportable size and affecting large expanses of land which is intended for future use as residential housing or commercial property. Results from the survey must be reported back to the Competent Authority and National Nuclear Regulator.

Once a spill of reportable size has been contained, the EO and the relevant Authority must be consulted to confirm that the appropriate clean up levels are met.

9.4 Conceptual Stormwater Management Plan

Please refer to Section 8.7.9 of the EIA and the surface water Impact assessment in Appendix D for a detailed description of the Conceptual Stormwater Management Plan. The water quality monitoring requirements can also be found in the Surface water Impact Assessment.

9.4.1 Proposed Stormwater Management Measures

The purpose of the conceptual Stormwater Management Plan (SWMP) is to ensure that clean and dirty water are adequately separated, by diverting clean water away from dirty areas, and ensuring that dirty water from the operation is captured, contained and managed appropriately in accordance with GN R704 regulations and DWS best practice guidelines.

9.4.1.1 Libanon East and West.

Earth Berm along the Southern Side of Bridges Avenue

The proposed stormwater attenuation measure for the Libanon East and West catchments are shown in Figure 9-2.

It is proposed to construct an earth berm immediately to the south of Bridges Avenue adjacent to the Libanon TSF to the existing culvert under Bridges Avenue, described as follows:

- An earth berm top width 1 m, side slopes 1 vertical to 2 horizontal, 1 m high from point A to point B, a length of 1 845 m;

The berm detail is shown in Figure 9-1 below:

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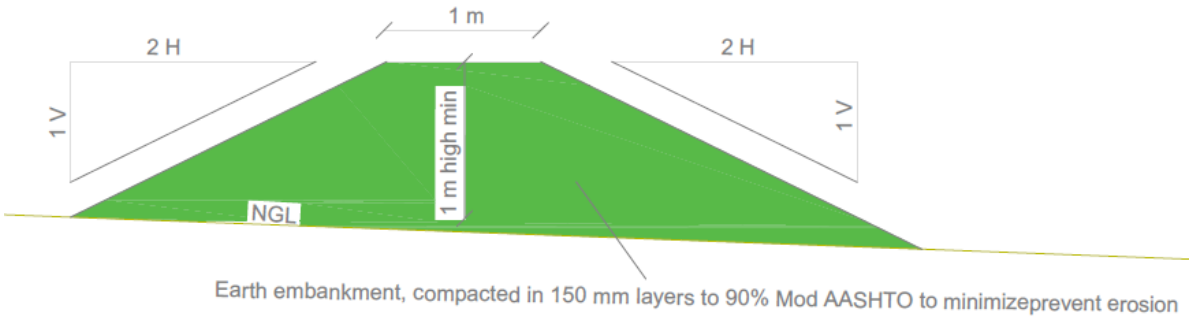

Figure 9-1 - Earth Berm Detail

The above structure will collect all the runoff from the Libanon East catchment, and 60% of the runoff from the Libanon West catchment.

The existing culvert under Bridges Avenue must be cleaned out and reinstated to its original design state. The size of the culvert could not be ascertained, but normally these structures are designed to handle the 1 in 5 year incident. In the event of the 1 in 50 year storm, the balance of the water not going through the culvert will flow across the road surface.

9.4.1.2 Libanon TSF and Paddocks

It is proposed to contain all stormwater falling on the top surface of the TSF within a berm located on the outside edge of the TSF top surface, as well as to contain all stormwater falling on the slopes of the TSF and in the paddocks at the toe of the side slopes of the TSF within these paddocks.

Due to the underlying dolomitic condition, the requirements of SANS 1936 must be adhered to. This will require the following to be carried out:

- Dolomitic stability investigation
  - General
    - Investigations shall conform to the requirements of SANS 1936-2 (4.3.2 and 4.3.3). The investigator/Competent Person (geo-professional) shall, during the investigation, confirm and refine the Inherent Hazard Zone and the associated Dolomite Area Designations and confirm that the mandatory precautions associated with a designation have been observed;
    - The investigator/Competent Person (geo-professional) shall, as a minimum to comply with the above requirements, interact with suitably qualified professionals and the person responsible for the development of the parcel of land or the relevant portions thereof concerning appropriate planning, design of infrastructure, buildings, and structures; and,
    - The investigator/Competent Person (geo-professional) shall develop a risk management plan strategy specific to the development in accordance with the requirements of SANS 1936;

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- Report
  - The investigator/Competent Person (geo-professional) shall prepare a report including the following:
    - a method description of the work undertaken;
    - a drawing indicating the location of the points profiled in the service trenches;
    - records of all profiles, boreholes and tests;
    - records of any geotechnically problematic conditions intercepted, such as paleokarts structures, sinkholes etc.;
    - a description of any additional geotechnical investigations undertaken;
    - a description of any precautionary or remedial measures applied to problematic conditions identified during the design-level inspections;
    - a site/development layout drawing which confirms the Inherent Hazard Classes and Dolomite Area Designations, in accordance with the requirements of SANS 1936;
    - an indication where the dolomite designations have been changed and provide a motivation for such changes;
    - a comprehensive list and description of any ongoing monitoring required;
    - an identification of monitoring area designations where a risk management plan has been developed; and,
    - an indication that amended water precautionary measures shall apply;
- Additional Requirements for **Attenuation Dams, Retention Dams, Reservoirs** and Public Swimming Pools:
  - The requirements for dams, reservoirs and public swimming pools shall comply with the requirements of SANS 1936-2, Annex A (A.8). The investigation shall also include the following:
    - a gravity survey over the site at 30 m grid spacing with a minimum of three lines;
    - additional investigations for alternative sites in the event that Inherent Hazard Class 3, 5, 6, 7 and 8 conditions (refer to SANS 1936) are encountered;
    - inspection of the excavation to verify the stability zonation and to check for paleokarst structures;
    - investigation of potential paleosinkhole structures wherever they are exposed; and,
    - where justified, supplementary geotechnical site investigations.

Note 1: The proposed site for dams and reservoirs should be at least 100 m from the nearest housing or commercial development.

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- Compilation of a Dolomite Risk Management Plan

An appropriate Dolomite Risk Management Plan is to be compiled in accordance with SANS 1936. The Dolomite Risk Management Plan is to be site specific and based on all data gathered until that time, taking cognisance of final precautionary measures, site layout and shall also contain the final Monitoring Designations. The Dolomite Risk Management Plan shall outline the responsibilities and actions of the relevant Authority and the Client Department. It is a compulsory requirement for the appointed professional service provider to prepare a site specific Dolomite Risk Management Plan (DRMP) for the development in accordance with the requirements of SANS 1936-4.

9.4.1.3 Recommendations for the Stormwater Management Plan

The following is recommended:

- The existing berm/channel system around the TSF are reinstated where damaged, and maintained. This system acts as the containment of the dirty water from the Libanon TSF side slopes;
- The “clean” runoff from the high lying areas above the Libanon TSF is deviated away from the Libanon TSF by an earth berm constructed immediately to the south of Bridges Avenue, up to the existing culvert under Bridges Avenue to the east of the Libanon TSF. The existing culvert is in a poor state of repair and will have to be reinstated; and,
- **A dolomitic stability investigation be carried out around the Libanon TSF to confirm that the proposed reclamation method and stormwater containment on top of the TSF and in paddocks around the TSF is acceptable and in accordance with SANS 1936, and a dolomitic risk management plan be developed**.
- **Stormwater drainage shall be such that no surface water ponds, other than in natural watercourses save for that associated with the attenuation of stormwater, for a period not exceeding 6 hours**

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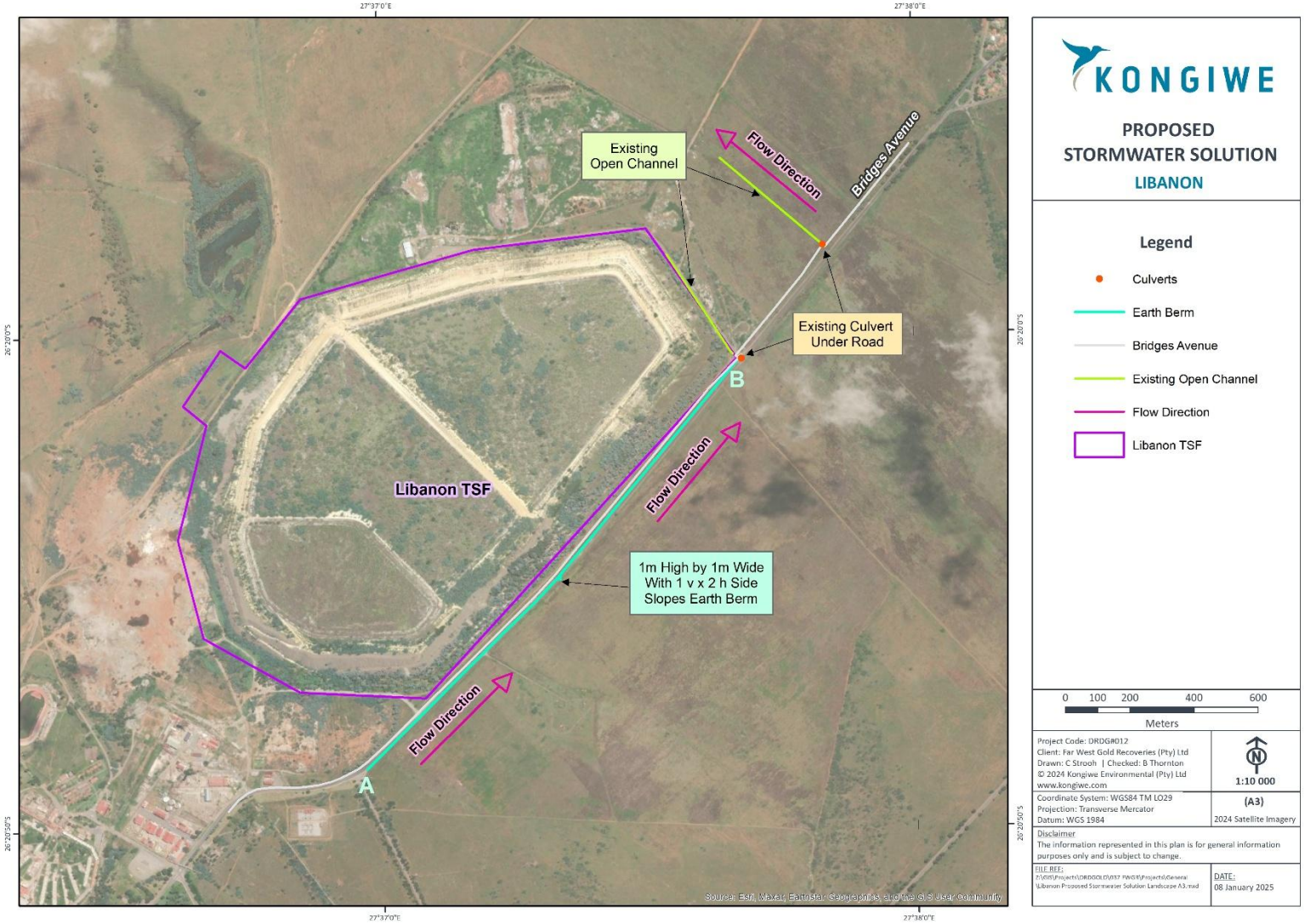

Figure 9-2: Proposed Stormwater Solution

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9.4.2 Surface Water Monitoring plans

9.4.2.1 Surface water quality

A surface water quality monitoring programme is essential as a management tool to detect negative water quality impacts as they arise and to ensure that the necessary mitigation measures are implemented. Should the project be approved, it is recommended that sampling points SW4 and SW5 in Table 9-2, form part of the water quality monitoring programme and that the parameters specified in Table 9-3.

Table 9-2: Sampling Locations

Sampling Point	Description	Latitude	Longitude
SW1	Kloof Mine Biodam	26°19'55.27"S	27°36'44.67"E
SW4	1 m pipeline upstream of the project	26°17'19.58"S	27°40'9.18"E
SW5	Wonderfonteinspruit downstream of the project	26°18'14.54"S	27°35'33.34"E
WS001	1 m pipeline upstream of the project	26°17'19.58"S	27°40'9.26"E
WS006	Outlet of the 1 m pipeline near Carletonville	26°19'41.58"S	27°24'25.69"E
WS107	Outlet of the Kloof Mine Biodam	26°19'47.30"S	27°36'40.35"E

Water quality sampling should be done in accordance with the DWS Best Practice Guideline G3: Water Monitoring Systems. Samples must be kept cool (+-4°C), out of direct sunlight, and should be transported immediately to an accredited laboratory for water quality analysis within 24 hours of sampling. The impacts on water quality should be determined by comparing the monitoring results against the guideline limits provided in Table 9-3 (or as specified by the DWS), and importantly against previous results, to determine any deviations in trends over time. If the trend analysis indicates any deviations to the baseline monitoring, in terms of deteriorating water quality, then an immediate investigation must be undertaken to determine whether the operation may be responsible. If responsible, urgent action must be undertaken to implement mitigation measures to prevent further contamination.

Reporting should be done on a quarterly basis (or as recommended by the DWS). It is recommended that monitoring reports include trend analyses. It is further recommended that the water quality from upstream monitoring points is compared to downstream monitoring points.

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Table 9-3: Surface water quality parameters

Parameter	Units	DWS TWQR: Irrigation Limit	DWS TWQR: Livestock Watering Limit	DWS TWQR: Aquatic Eco-systems Limit	RQO Limit
pH	pH	6.5-8.4	-	-	-
Electrical conductivity (EC)	mS/m	90	153	-	111
Total dissolved solids (TDS)	mg/l	585	1000	-	722**
Total Alkalinity	mg $CaCO_3$/l	-	-	-	-
Chloride (Cl)	mg/l	100	1500	-	-
Sulphate (SO_4)	mg/l	-	1000	-	500
Nitrate (NO_3) as N	mg/l	-	100	-	4
Total oxidised nitrogen as N	mg/l	-	-	-	-
Ammonium (NH_4) as N	mg/l	-	-	-	-
Orthophosphate (PO_4) as P	mg/l	-	-	-	0.125
Fluoride (F)	mg/l	2	2	0.75	3
Calcium (Ca)	mg/l	-	1000	-	-
Magnesium (Mg)	mg/l	-	500	-	-
Sodium (Na)	mg/l	70	2000	-	-
Potassium (K)	mg/l	-	-	-	-
Aluminium (Al)	mg/l	5	5	0.01	0.15
Iron (Fe)	mg/l	5	10	-	-
Manganese (Mn)	mg/l	10	10	0.18	1.3
Chromium (Cr)	mg/l	-	-	-	-
Copper (Cu)	mg/l	0.2	0.5	0.0014*	0.008
Nickel (Ni)	mg/l	0.2	1	-	-
Zinc (Zn)	mg/l	1	20	0.002	0.036
Cobalt (Co)	mg/l	0.05	1	-	-
Cadmium (Cd)	mg/l	0.01	0.01	0.0004*	0.005
Lead (Pb)	mg/l	0.2	0.1	0.0012*	0.013*
Total hardness	mg $CaCO_3$/l	-	-	-	-
Total suspended solids (TSS)	mg/l	50	-	-	-
Dissolved Uranium (U)	mg/l	0.1	-	-	0.015

9.4.2.2 Stormwater Infrastructure

Water infrastructure (paddocks, channels, berms and slurry sumps) should be monitored on a monthly basis during the dry season, and on a weekly basis during the wet season. They should further be monitored immediately after any large storm events. Should blockages, silted up structures or breaches occur, immediate action should be undertaken to remove debris and repair breaches. Monitoring should be undertaken by the onsite Environmental Officer (EO) or maintenance manager. Inspections should be recorded and should include the following:

- Date of inspection;
- Rainfall amount received prior to inspection;
- Photographs of blockages, silted up structures or breaches witnessed;
- What action was undertaken to fix issues, and the amount of time taken to address them; and
- Photographs post action taken.

Inspection reports should be kept ready and supplied to the DWS when requested, or as part of the WUL conditions.

9.5 Groundwater Monitoring and Seepage Prevention

Please refer to Chapter 15, 16 and 17 of the Groundwater report in Appendix D for a detailed view of the required groundwater management and monitoring requirements.

9.5.1 Groundwater Management Measures

To monitor and prevent the spread of groundwater contamination, groundwater management procedures and practices must be implemented that are in line with accepted practices and in accordance with the requirements of the Environmental Management Plan (EMP). The key objectives and targets for groundwater management during and after the completion of the reclamation project are:

- Implement a management plan aimed at reducing and/or eliminating adverse impacts on the receptors identified, including vertical flow to the residual and weathered dolomitic aquifers as well as horizontal flow to watercourses. The management plan must be earmarked at achieving conditions comparable to the at least likely case scenario presented in this report. Where possible, conditions applied for the best-case scenario should be planned for.
- Track and record the progress of implementation of all groundwater management measures.
- Implement sufficient monitoring procedures to measure the effectiveness of groundwater management measures.
- Analyse the information obtained from all monitoring programmes against compliance targets to establish trends and to determine the need to trigger additional actions to reduce adverse impacts.
- Should the trends indicate adverse impacts on groundwater levels and/or quality, implement suitable measures within the shortest possible time to remediate and/or eliminate such adverse impacts identified.

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The following over-arching groundwater management measures should be implemented for the project to minimise impacts on the groundwater environment, during all phases.

Table 9-4: General groundwater management measures

Construction Phase
A dedicated groundwater monitoring network must be established in the new boreholes.
Make provision for sufficient groundwater level and quality monitoring budget to implement the groundwater monitoring programme, before the reclamation starts.
Develop effective surface runoff management plans to ensure that all dirty runoff is contained and removed off site as soon as possible. Avoid ponding of water over exposed areas.
Ensure that cut-off trenches with sumps are designed to contain all dirty water generated during the desilting to prevent overflows and spillages.
Implement sound house-keeping measures to prevent and clean spills, address leaks and undertake regular inspections. Ensure that the record-keeping procedure is in place and that instructions given are carried out.
Measure rainfall on site.
A dedicated groundwater monitoring network must be established in the new boreholes.
Operational Phase
Complete regular inspections of trenches and sumps, specifically noting incidences of overflow and leakage. If the latter is identified, measures must be taken to rectify immediately.
Maintain sound house-keeping measures to prevent spills and leaks.
Continue with the groundwater monitoring program.
Measure rainfall on site.
Record all groundwater-related complaints and deal with each complaint within the agreed upon timeframe.
Decommissioning and Closure Phase
Complete all reclamation and rehabilitation to a satisfactory level, focussing specifically on the water drainage and collection system.
Ensure that all tailings material is removed from the footprint. Soils must be tested to identify potential risks to groundwater contamination post closure.
Continue with the groundwater monitoring for a minimum of three years after completion of the rehabilitation. The continued need for groundwater monitoring will depend on the outcome of the final closure assessment.

The following specific groundwater management measures are recommended, based on the outcome of this assessment. The measures are related to two broad impacts, namely the availability of groundwater and the quality of groundwater.

Groundwater Availability:

It is noted that the weathered dolomitic aquifer is regionally dewatered, which significantly reduces groundwater availability in the area. Despite this, the following specific measures are recommended to minimise and/or eliminate the impacts on groundwater levels and availability:

- Groundwater levels must be monitored on a quarterly basis in the new monitoring boreholes to establish trends and to flag possible impacts. It is noted that the project is not expected to affect groundwater levels significantly.

- The private borehole identified during the hydrocensus is not located within the zones of impact delineated as part of this assessment.
- Ensure that an effective surface water collection and retention system is in place to ensure that all flow and collected water is directed towards the cut-off trenches with sumps and not allowed to freely drain away from the various silt holding areas. This will also reduce long-term impacts on groundwater quality, as discussed above.

Groundwater Quality:

The following specific measures are recommended to minimise and/or eliminate the impacts on groundwater quality:

- The following specific measures are recommended to reduce the risk of deterioration of effluent quality and the volume of leachate available for infiltration to the aquifers:
  - To minimise negative long-term impacts associated with the project, it is important that tailings reclamation must be completed to soil level at the site. All tailings must be removed.
  - No ponding must be allowed on exposed areas. Process water that is allowed to pond uncontrolled will increase the risk of infiltration to the underlying aquifers as well as the risk of deterioration in groundwater quality.
  - After rehabilitation, the footprint area must be made free draining to minimise infiltration of water to the aquifers.
  - Ensure that clean and dirty water is separated at the reclamation and drying areas, and that dirty water is contained. Contain dirty water in adequately sized and lined sumps. Prevent dirty water runoff from leaving the area.
- FWGR must implement a groundwater quality monitoring program in the new boreholes during reclamation. If the results of the monitoring indicate deterioration of quality to within the criteria specified for the worst-case scenario in this assessment, FWGR must investigate the sources of contamination and rectify any activity that results in acidification of leachate or ponding of leachate for extended periods of time. This will reduce the risk to groundwater quality in the long-term.
- A re-run of the contaminant transport simulations must be undertaken at least 5 years before closure once additional monitoring information is available, to improve long-term impact prediction and to ensure that closure groundwater management measures are effective.

9.5.2 Groundwater Monitoring

To monitor and prevent the spread of groundwater contamination, groundwater management procedures and practices must be implemented that are in line with accepted practices and in accordance with the requirements of the Environmental Management Plan (EMP). It is recommended to implement the groundwater monitoring program presented in this report to establish the extent of contamination in the shallow weathered and deeper fractured aquifers, during and after the reclamation activities. The key objectives of the groundwater monitoring program are to:

- Detect short and long-term trends;
- Recognise changes in groundwater quality and levels;
- Measure impacts and implement mitigation measures; and
- Develop improved monitoring systems.

Groundwater monitoring must be undertaken to establish the extent of contamination in the shallow weathered and deeper fractured aquifers, during and after the reclamation activities.

9.5.2.1 Monitoring Locations

A groundwater monitoring program must be implemented in the six new shallow and deep monitoring boreholes before reclamation commences and be maintained throughout the life of the project. It is not anticipated that additional monitoring boreholes will be required, based on the outcome of the impact assessment completed. The three sets of boreholes are close enough to the TSF to enable effective monitoring (Table 9-5). It is acknowledged that two sets of boreholes are currently dry. These should however continuously be checked and sampled if they are rewatered.

Table 9-5: Proposed Groundwater Monitoring Positions

		Borehole ID	Lib-BH 1s	Lib-BH 1d	Lib-BH 2s	Lib-BH 2d	Lib-BH 3s	Lib-BH 3d
Borehole Location	WGS84	Latitude	26°20'03.12"S	26°20'02.78"S	26°20'25.33"S	26°20'20.09"S	26°20'05.07"S	26°20'04.77"S
		Longitude	27°37'37.77"E	27°37'38.00"E	27°36'40.63"E	27°36'39.13"E	27°36'45.05"E	27°36'45.14"E
		Elevation	1599 mamsl	1598 mamsl	1616 mamsl	1609 mamsl	1602 mamsl	1601 mamsl
Borehole Data	Borehole Depth (m)		30	60	18	50	30	80
	Blow Yield (L/hr)		Dry	Dry	Dry	Dry	Seepage	Seepage
	Water Strike depth (m)		None	None	None	None	None	None
	Main Strike Geology		--	--	--	--	--	--
	Borehole Geology		Clays, chert, dolomite	Quartzite, clays, dolomite Cavity at 48-60m	Quartzite, clays	Sandstone, quartzite, clays	Lava, sandstone, quartzite, clays	Lava, sandstone, quartzite, clays, dolomite
	Solid Steel Casing (170mm ID)		0 – 18m	0 - 48m	0 – 6m	0 - 30m	0 – 18m	0 - 48m
	Perforated Steel Casing (170mm ID)		18 – 30m	none	6 – 18m	none	18 – 30m	none
	Static Water Level (mbgl)		Dry	Dry	Dry	Dry	20.87	77.17

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	Borehole ID	Lib-BH 1s	Lib-BH 1d	Lib-BH 2s	Lib-BH 2d	Lib-BH 3s	Lib-BH 3d
	Depth of Weathering (m)	25	30	18+	35	30+	32

**Even though these boreholes are dry at present, continuous monitoring should be implemented, and the boreholes must be sampled for quality analyses if they are rewatered.*

9.5.2.2 Monitoring Requirements

It is recommended that groundwater levels are monitored in all the boreholes listed in Table 9-5 on a quarterly basis. This information is important to improve the understanding of water level fluctuations and groundwater level rise and fall in response to rainfall. This information will be interpreted at the hand of on-site rainfall figures and will be used to improve the conceptual understanding of the aquifers.

The monitoring program must be used to establish sound baseline conditions against which future impact assessments can be evaluated. To keep continuity with the baseline information presented in this report, it is recommended that the elements listed in the groundwater quality analyses in this report are included in the monitoring program. These represents the most significant elements applicable to the project. The monitoring requirements are presented in Table 9-6.

Table 9-6: Groundwater monitoring requirements

Monitoring parameter	Element for analysis	Monitoring frequency	Monitoring trigger-response criteria
Depth to groundwater level in boreholes	Groundwater level	Quarterly	Variations by more than 3 m for 2 consecutive months should be investigated.
Water quality analysis in all boreholes and surface water monitoring positions listed in Table 9 5	All elements included in the current analysis	Quarterly	Variations in concentrations by more than 15% for major cations and anions and more than 7% for metal concentrations for more than 2 consecutive months should be investigated. Any result that exceeds specified water quality objectives must be investigated when it occurs.
Rainfall	Rain depth (mm)	Daily on site	None

The monitoring trigger-response criteria listed in Table 9-6 must be reviewed on an annual basis and updated, based on the outcome of the monitoring programme results. All monitoring information must be entered into a spreadsheet for record keeping and analysis. Copies of the certificates of analyses must be kept on file for inspection. If significant exceedances are recorded during the monitoring programme, the following actions should be taken:

- Log the exceedances in the incident reporting system within 24-hours of it occurring.
- Undertake an investigation to identify causes of the exceedances.
- Implement the necessary remedial actions according to the outcome of the investigation and consultation with the affected parties.

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- Report significant exceedances to the Environmental and General Managers as well as to the regulatory authority and track the incident until completion.

The results of the monitoring programme must be reported on a quarterly and annual basis for the purpose of internal FWGR water management. These reports must also be submitted to the authorities for review.

9.5.2.3 Groundwater Monitoring Reports

Monitoring reports must contain the following information:

- Monitoring borehole location map;
- Geology map;
- All coordinates of the groundwater sampling sites;
- Certificates of analysis must be included for quality assurance. Monitoring results will be compared to South African National Standards (SANS241) and the relevant catchment guideline limits;
- Time-series graphs for key indicator elements (e.g., pH, EC, TDS, Fe, Mn, Al, NO_3, SO_4);
- A discussion regarding observed trends and potential groundwater contamination; and
- Recommendations regarding possible amendments or additions to the groundwater monitoring programme, based on trends and other information observed.

9.5.2.4 Quality Assessment and Quality Control

Quality assurance means:

- Developing a system of activities to ensure that measurements meet defined standards of quality with a stated level of confidence;
- Defining monitoring objectives, quality control procedures to be followed and quality assessment;
- To define data quality objectives, including accuracy, precision, completeness, representativeness and comparability; and
- Designing a network, selecting sampling sites, selecting instruments and designing the sampling system, as discussed above.

All monitoring equipment must be maintained as required, and calibration must be undertaken on a regular basis.

To ensure that the Groundwater Monitoring Strategy complies with the above, it is important that analytical laboratories used should be accredited for each type of analysis required, to ensure that accurate analytical methods are used.

While only one or two of the common major ions found in waters may be specified as key indicators, it is necessary to analyse for the full suite of common ions for quality control purposes and to detect discrete events and long-term trends in anion composition.

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Special attention must be paid to sampling methods and to preservation and handling of samples prior to analysis. pH and conductivity must be measured in the field.

Close attention must be given to siting, logging and construction of monitoring boreholes and assessment of their condition must be made quarterly.

The following sampling protocol is proposed:

- Sterilised plastic bottles, with a plastic cap and no liner within the cap are required for the sampling. Sample bottles should be marked clearly with the borehole name, date of sampling, water level depth and the sampler's name.
- Water levels should be measured prior to taking the sample, using a dip meter (m bgl).
- Each borehole to be sampled should be purged (to ensure sampling of the aquifer and not stagnant water in the casing) using a submersible pump or a clean, sterile bailer. At least three borehole volumes of water should be removed through purging; or through continuous water quality monitoring, until the electrical conductivity value stabilizes.
- The following field measurements should be recorded on a field form for each sampling point: pH, EC and temperature.
- Samples should be kept cool in a cooler box in the field and kept cool prior to being submitted to the laboratory.
- The pH and EC meter used for field measurements should be calibrated daily using standard solutions obtained from the instrument supplier.

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9.6 Terrestrial monitoring

Table 9-7:Terrestrial monitoring requirements

Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Management outcome: Vegetation and Habitats				
Laydown and construction preparation activities (such as cement mixing, temporary toilets, etc.) must be limited to already modified areas and should take up the smallest footprint possible.	Construction Phase	Project manager, Environmental Officer	Development footprint	Ongoing
Develop post-mining environments, in conjunction with regional development plans; and the recreation of habitats, where possible; or structure altered landscapes to be compatible with regional habitats.	Life of operation	Project manager, Environmental Officer	Development footprint	Ongoing
Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should not be fragmented or disturbed further if possible.	Construction Phase	Project manager, Environmental Officer	Development footprint	Ongoing
All vehicles and personnel must make use of existing roads and walking paths as far as possible, especially construction/operational vehicles.	Construction Phase	Project manager, Environmental Officer	Development footprint	Ongoing
The clearing of vegetation must be minimised where possible. All activities must be restricted to within the authorised areas.	Life of operation	Project manager, Environmental Officer	Areas of indigenous vegetation	Ongoing
All laydown, chemical toilets etc. should be restricted to Very Low SEI areas. Any materials may not be stored for extended periods of time and must be removed from the project area once the construction/closure phase has been concluded.	Construction and Operational Phase	Environmental Officer, Design Engineer, and Contractor	Laydown areas and material storage & placement.	Ongoing
Areas that are denuded during construction need to be re-vegetated with indigenous vegetation, to prevent erosion during flood and wind events and to promote the regeneration of functional habitat. This will also reduce the likelihood of	Operational phase	Environmental Officer & Contractor	Assess the state of rehabilitation and	Quarterly for up to two years after the closure

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Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
encroachment by alien invasive plant species. All grazing mammals must be kept out of the areas that have recently been re-planted.			encroachment of alien vegetation	
All footprints to be rehabilitated after construction is complete. Rehabilitation of the disturbed areas existing in the project area must be made a priority. Topsoil must also be utilised, and any disturbed area must be re-vegetated with plant and grass species which are endemic to this vegetation type.	Life of Operation	Environmental Officer & Contractor	Rehabilitation	Quarterly monitoring
A hydrocarbon spill management plan must be put in place to ensure that should there be any chemical spill out or over that it does not run into the surrounding areas. A TSF operational plan must be put in place to avoid tailings spillage. The Contractor shall be in possession of an emergency spill kit that must always be complete and available on site. • Drip trays or any form of oil absorbent material must be placed underneath vehicles/machinery and equipment when not in use. • No servicing of equipment on site unless necessary. • All contaminated soil / yard stone shall be treated in situ or removed and be placed in containers. • Appropriately contain any generator diesel storage tanks, machinery spills (e.g., accidental spills of hydrocarbons oils, diesel etc.) in such a way as to prevent them from leaking and entering the environment. • Construction activities and vehicles could cause spillages of lubricants, fuels and waste material negatively affecting the functioning of the ecosystem. • All vehicles and equipment must be maintained, and all re-fueling and servicing of equipment is to take place in demarcated areas outside of the PAOI.	Life of operation	Environmental Officer & Contractor	Spill events, Vehicles dripping.	Ongoing

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Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Do not remove any indigenous plant species from the PAOI or bring any alien species in. This is to prevent the spread of exotic or alien species or the illegal collection of plants.	Life of operation	Project manager, Environmental Officer	Any instances	Ongoing
All construction waste must be removed from site at the closure of the construction phase.	Construction phase	Environmental Officer & Contractor	Construction waste	During Phase
Precautions must be taken against the erosion damage that would be caused by unplanned pipe leaks. A leak warning and detection system must be installed. Dense indigenous pioneer grass seeds should also be planted across all bare earth areas to prevent erosion.	Life of operation	Project manager, Environmental Officer	Damaged pipes and unplanned leaks	Weekly
Management outcome: Fauna				
Clearing and disturbance activities must be conducted in a progressive linear manner, always outwards and away from the centre of the PAOI and over several days, so as to provide an easy escape route for all small mammals and herpetofauna.	Construction Phase	Environmental Officer & Contractor	Progressive land clearing operations and the movement of fauna	Ongoing
The areas to be disturbed must be specifically and responsibly demarcated to prevent the movement of staff or any individual into the surrounding environments, signs must be put up to enforce this.	Construction/Operational Phase	Project manager, Environmental Officer	Infringement into these areas	Ongoing
The duration of the activities should be minimised to as short a term as possible, to reduce the period of disturbance on fauna.	Construction	Project manager, Environmental Officer & Design Engineer	Construction/Closure Phase	Ongoing
Noise must be kept to an absolute minimum during the evenings and at night to minimise all possible disturbances to reptile species and nocturnal mammals.	Construction/Operational Phase	Environmental Officer	Noise levels	Ongoing

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Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
No trapping, killing, or poisoning of any wildlife is to be allowed and signs must be put up to enforce this. Monitoring must take place in this regard.	Life of operation	Environmental Officer	Evidence of trapping etc	Ongoing
Outside lighting should be designed and limited to minimise impacts on fauna. All outside lighting should be directed away from any sensitive areas. Fluorescent and mercury vapor lighting should be avoided, and sodium vapor (green/red) lights should be used wherever possible.	Construction/Operational Phase	Project manager, Environmental Officer & Design Engineer	Light pollution and period of light	Ongoing
All construction and maintenance motor vehicle operators should undergo an environmental induction that includes instruction on the need to comply with speed limits, to respect all forms of wildlife. Speed limits must be enforced to ensure that road killings and erosion is limited.	Life of operation	Health and Safety Officer	Compliance to the training	Ongoing
Any holes/deep excavations must be dug in a progressive manner and shouldn't be left open overnight. Should any holes remain open overnight they must be properly covered temporarily to ensure that no small fauna species fall in. Holes must be subsequently inspected for fauna prior to backfilling.	Planning and Construction	Environmental Officer & Contractor, Engineer	Presence of trapped animals and open holes	Ongoing
If fencing is required: wildlife-permeable fencing with holes large enough for mongoose and other smaller mammals should be installed, the holes must not be placed in the fence where it is next to a major road as this will increase road killings in the area.	Planning and construction	Environmental Officer & Contractor, Engineer	Fauna movement corridor	Ongoing
Management outcome: Alien Species				
An Alien Invasive Plant (AIP) Management Plan must be compiled and implemented. This should regularly be updated to reflect the annual changed in AIP composition.	Life of operation	Project manager, Environmental Officer & Contractor	Manage and assess presence and encroachment of alien vegetation	Twice a year
The footprint area of the construction should be kept to a minimum. The footprint area must be clearly demarcated to avoid	Construction/Operational Phase	Project manager, Environmental Officer & Contractor	Footprint Area	Life of operation

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Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
unnecessary disturbances to adjacent areas. Footprints of the roads must be kept to prescribed widths.				
Management outcome: Dust				
Dust-reducing mitigation measures must be put in place and must be strictly adhered to. This includes the wetting of exposed soft soil surfaces. No non-environmentally friendly suppressants may be used as this could result in the pollution of water sources.	Construction phase	Contractor	Dustfall	Dust monitoring program.
Management outcome: Waste Management				
Waste management must be a priority and all waste must be collected and stored effectively and responsibly according to a site-specific waste management plan. Dangerous waste such as metal wires and glass must only be stored in fully sealed and secure containers, before being moved off site as soon as possible.	Life of operation	Environmental Officer & Contractor	Waste Removal	Weekly
Litter, spills, fuels, chemical and human waste in and around the PAOI must be minimised and controlled according to the waste management plan.	Construction/Closure Phase	Environmental Officer & Health and Safety Officer	Presence of Waste	Daily
Toilets at the recommended Health and Safety standards must be provided. These should be emptied regularly and once no longer required, they must be pumped dry to prevent leakage into the surrounding environment and removed from site.	Life of operation	Environmental Officer & Health and Safety Officer	Number of toilets per staff member. Waste levels	Daily
The Contractor should supply sealable and properly marked domestic waste collection bins and all solid waste collected shall be disposed of at a licensed disposal facility.	Life of operation	Environmental Officer & Health and Safety Officer	Availability of bins and the collection of the waste	Ongoing
Refuse bins will be responsibly emptied and secured. Temporary storage of domestic waste shall be in covered and secured waste skips.	Life of operation	Environmental Officer, Contractor & Health and Safety Officer	Management of bins and collection of waste	Ongoing, every 10 days

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Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Management outcome: Environmental Awareness Training				
All personnel and contractors are to undergo Environmental Awareness Training. A signed register of attendance must be kept for proof. Discussions are required on sensitive environmental receptors within the PAOI to inform contractors and site staff of the presence of protected species, their identification, conservation status and importance, biology, habitat requirements and management requirements in line with the Environmental Authorisation and within the EMPr.	Pre-construction phase	Health and Safety Officer, Environmental Officer	Compliance to the training	Ongoing
Management outcome: Erosion				
Speed limits must be put in place to reduce erosion. Soil surfaces must be wetted as necessary to reduce the dust generated by the project activities. Speed bumps and signs must be erected to enforce slow speeds.	Life of operation	Project manager, Environmental Officer	Water Runoff from road surfaces	Ongoing
Only existing access routes and walking paths may be made use of.	Life of operation	Project manager, Environmental Officer	Routes used within the area	Ongoing
Areas that are denuded during construction need to be re-vegetated with indigenous vegetation to prevent erosion during flood events etc.	Life of operation	Project manager, Environmental Officer	Re-establishment of indigenous vegetation	Progressively
A stormwater management plan must be compiled and implemented if necessary.	Life of operation	Project manager, Environmental Officer	Management plan	Before construction phase: Ongoing
Management outcome: Pipeline Leak or Spill				

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Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Leak detection or any similar monitoring tool must be incorporated to try identifying leaks. Dense indigenous pioneer grass seeds should also be planted across all bare earth areas to prevent erosion.	Life of operation	Environmental Officer, Health and Safety Officer	Detection of leaks	Weekly

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9.7 Dust Fallout Monitoring Plan

Dustfall monitoring should be conducted to demonstrate that mitigation measures are being strictly implemented. Ongoing dustfall monitoring should be implemented as far prior to the start of the project as possible (preferably 12 months to cover all seasons), to establish a baseline against which the impacts of the reclamation activities can be assessed.

The samplers must be operated in accordance with the National Dust Control Regulations (Government Notice No. 517, 2018). As part of this monitoring programme, monthly reports must be produced. If the measured dustfall shows a marked increase from pre-operational phase levels, and particularly if the measured dustfall rates exceed the regulated dustfall rate (Table 9-8), urgent measures must be undertaken to further mitigate emissions.

This emphasises the importance of monitoring through all seasons prior to the commencement of reclamation activities, as the development of a baseline will make it possible to evaluate the project's actual contribution to dustfall levels more accurately and by inference to evaluate the project's contribution to ambient concentrations of PM.

Table 9-8: National Dust Control Regulations (Government Notice No. 517, 2018).

Level	Dustfall Rate (d) (mg/m^2/day) (30-days average)	Permitted Frequency of exceeding Dustfall Rate
Residential area	D < 600	Two within a year, not sequential months.
Non-residential area	D ≤ 1 200	Two within a year, not sequential months.

* The method to be used for measuring dustfall rate and the guideline for locating sampling points shall be the latest version of ASTM D1739.

9.8 Heritage Management Plans

The project will encompass a range of activities during the construction phase, including ground clearance and small-scale infrastructure development associated with the project.

It is possible that cultural material will be exposed during construction and may be recoverable, keeping in mind that delays can be costly during construction and must be minimised - development surrounding infrastructure and construction of facilities results in a significant disturbance. However, holes offer a window into the past, and it is possible to rescue some data and materials.

During the construction and mining phase, it is essential to recognise any significant material being unearthed, correctly judging which actions should be taken. It is recommended that the following chance find procedure should be implemented.

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9.8.1 Chance Find Procedure

- An appropriately qualified heritage practitioner / archaeologist must be identified to be called upon if any possible heritage resources or artefacts are identified.
- Should an archaeological site or cultural material be discovered during construction (or operation), the area should be demarcated, and construction activities halted.
- The qualified heritage practitioner / archaeologist will then need to come out to the site and evaluate the extent and importance of the heritage resources and make the necessary recommendations for mitigating the find and the impact on the heritage resource.
- The contractor therefore should have some sort of contingency plan so that operations could move elsewhere temporarily while the materials and data are recovered.
- Construction can commence as soon as the site has been cleared and signed off by the heritage practitioner / archaeologist.

9.8.2 Possible Finds during Construction and Operation (Reclamation Activities)

The study area occurs within a greater historical and archaeological site, as identified during the desktop and fieldwork phase. Soil clearance for infrastructure as well as the proposed reclamation activities could uncover the following:

- Stone tools and pottery;
- Unmarked burial grounds and graves;

9.8.3 Timeframes

It must be kept in mind that mitigation and monitoring of heritage resources discovered during construction activity will require permitting for collection or excavation of heritage resources and lead times must be worked into the construction time frames. Table 9-9 gives guidelines for lead times on permitting.

Table 9-9: Lead times for permitting and mobilisation

Action	Responsibility	Timeframe
Preparation for field monitoring and finalisation of contracts	The contractor and service provider	1 month
Application for permits to do necessary mitigation work	Service provider – Archaeologist and SAHRA	3 months
Documentation, excavation, and archaeological report on the relevant site	Service provider – Archaeologist	3 months
Handling of chance finds – Graves/Human Remains	Service provider – Archaeologist and SAHRA	2 weeks
Relocation of burial grounds or graves in the way of the development	Service provider – Archaeologist, SAHRA, local government and provincial government	6 months

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Table 9-10 Lead times for permitting and mobilisation

Area and site no.	Mitigation measures	Phase	Timeframe	The responsible party for implementation	Monitoring Party (frequency)	Target	Performance indicators (Monitoring tool)
General project area	❖ Implement a chance to find procedures in case where possible heritage finds are uncovered. ❖ A detailed "walk down" of the final approved alignment will be required before construction commences. ❖ Any significant features of significance identified during this walkdown will require formal mitigation (i.e., permitting where required) or where possible a slight change in design could accommodate such resources.	Construction and Reclamation	During construction and. mining	Applicant EO Heritage Specialist	EO (monthly / as or when required)	Ensure compliance with relevant legislation and recommendations from SAHRA under Section 34-36 and 38 of NHRA	EO Monthly Checklist/Report
Palaeontological resources	❖ If fossil remains or trace fossils are discovered during any phase of construction, either on the surface or exposed by excavations the Chance Find Procedure must be implemented immediately and the Environmental Officer (EO) in charge of these developments must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax:	Construction and Reclamation	During construction and. mining	Applicant EO Palaeontologist	EO (monthly / as or when required)	Ensure compliance with relevant legislation and recommendations from SAHRA under Section 35 and 38 of NHRA	EO Monthly Checklist/Report

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Area and site no.	Mitigation measures	Phase	Timeframe	The responsible party for implementation	Monitoring Party (frequency)	Target	Performance indicators (Monitoring tool)
	+27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation can be carry out by a palaeontologist. ❖ Before any fossil material can be collected from the development site the specialist involved would need to apply for a collection permit from SAHRA. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012). ❖ These recommendations should be incorporated into the Environmental Management Plan for the proposed development.						

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9.9 Social Management Plans

The following chapter sets out the framework for the Social Management Plan which is established to assure that the proposed mitigation measures as included in the SIA are effectively implemented during the life of the project and are continually refined and modified as necessary on the basis of actual field conditions and circumstances which may not have been anticipated at the time of the SIA preparation.

9.9.1 Stakeholder Engagement Plan

On-going stakeholder engagement is recommended to understand issues on the ground. To ensure effective consultation with community members during the authorisation, construction, operation and decommissioning phases of FWGR reclamation projects with RWLM, it is recommended that a Community Consultation Forum (Forum) be established. In establishing the Forum, that FWGR needs to take the following into consideration:

- Communities should democratically elect representatives to voluntarily sit on the Forum, which meets quarterly.
- Representatives would be responsible for disseminating project information to community members, and FWGR would be responsible for taking minutes and attendance registers at Forum meetings.
- The composition of the Forum might include the following Committee members:
    - Community members from the communities within the Projects area of interest (RWLM Wards 24 and 25);
    - Representatives from the Municipal Authorities; and
    - FWGR's representatives from the following divisions: Community Relations; Social Labour Plan and Environmental Management.
- Forum members would be required to hold meetings with their communities and provide FWGR with copies of the attendance registers and minutes of these meetings.
- Solutions to address service delivery require interventions from the local authorities. However, the applicant can address potential issues that could lead to unrest by ensuring that an effective grievance mechanism is put in place to ensure that stakeholders are provided with a platform to raise their concerns/complaints.
- Collaborate with the unit of the DMR that deals with illegal mining-related issues and the SAPS to establish standard operating procedures for the control and/or removal of unauthorised individuals.

Additionally, a Stakeholder Engagement Plan (SEP) will assist in outlining the approach on how to effectively communicate with community members. It is recommended that the SEP is updated annually ensure that it stays relevant and that it addresses relevant concerns/comments raised by stakeholders. The following section provides key objectives to be included in the SEP.

The purpose of a SEP:

- To identify and assess the processes and/or mechanisms that will improve the communication between local communities, the wider community and FWGR;

- To provide a guideline on how to effectively share information with community members-information must be communicated to stakeholders early in ways that are meaningful and accessible. Communication should be continued throughout the life of the project;
- To serve as a tool to facilitate grievance management – accessible and responsive means for stakeholders to raise concerns and grievances about the project must be established throughout the life of the project.

9.9.2 Grievance Mechanism

A grievance mechanism is a formal, legal or non-legal complaint process that can be used by individuals, workers, communities and/or civil society organisations that are being negatively affected by certain business activities and operations. A grievance mechanism plan aims to prevent, defuse and resolve community complaints and disputes.

The World Bank Group (2005:72) states that a company's grievance procedures should be communicated to all stakeholders, community members should be made aware of the procedures to follow, that is, people should know where to go and whom to talk to if they have a complaint and understand what the process will be for handling the complaint. Communication with stakeholders should be provided in a format and language that will be understood by stakeholders. It is recommended information is communicated orally in areas where literacy levels are low.

A grievance mechanism provides stakeholders with an opportunity to raise their concerns and provides them with confidence that their issues will be addressed- this encourages better community relations and good reputation for the company.

FWGR will request communities to democratically elect representatives to voluntarily sit on the Forum, which meets quarterly. Representatives would be responsible for disseminating project information to community members.

It is recommended that the composition of the community forum members represent a good geographic, racial and gender balance and have local standing. The forum could comprise of the following members :

- Community members from the communities within the Project area;
- Representatives from the local authority; and
- FWGR Community Liaison.

Committee members would be required to hold meetings with their communities and provide FWGR with copies of the attendance registers and minutes of these meetings.

9.9.3 Human Rights

The applicant should establish a human rights policy and aim to have zero human rights infringements in the workplace and community throughout the life of the project.

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9.10 Socio Economic Monitoring Programme

The proposed socio-economic monitoring programme below should be implemented during the construction phase, continue into operations, and throughout the life of the project.

Table 9-11: Proposed Socio-Economic Programme

Item	Parameters	Frequency	Responsible person
Procurement Management Plan	Procurement awards	Ongoing- throughout the life of the project	FWGR: Human Resources Manager/ Finance Manager and the Procurement officer.
Recruitment/retrenchment plan	Number of recruited candidates (sourced locally) Retrenchment-linked with training programme and continued Professional Development of staff	Ongoing- throughout the life of the project	FWGR: Human Resources Manager/ Finance Manager.
Training programmes/Learnerships/Internships	Number of training programmes offered and the effectiveness	Ongoing- results to be included in the SLP	FWGR: Human Resources Manager/ Finance Manager.
Health and Safety Plan	Number of reported health and safety incidents	Ongoing-Monthly	FWGR: Human Resources Manager/ Finance Manager, Safety, Health, Environment and Quality Officer
Commitments Register	Fulfilling commitments made in EIA, SIA as well as those made throughout the stakeholder engagement process	Ongoing-annual reviews	FWGR: Human Resources Manager/ Finance Manager/Environmental Manager/Stakeholder

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9.11 Radiation Assessment

Once reclamation of the TSF has been undertaken and depending on the desired end land use, it is highly recommended to assess the potential of residual radiation remaining and to identify possible latent environmental impacts remaining. This is important to ensure that once the land is handed over that there is no potential further risk to the land owners.

The National Nuclear Regulator (NNR) has set the level for gamma radiation, for which regulation is not required, below 500 Bq (Becquerel) per kg. Direct radiation originates from uranium, which is a common mineral associated in the reefs that contain gold and is contained within the slimes material. The Radiation Assessment should measure the gamma radiation emanating from the decaying of the uranium atoms.

In terms of release of radioactively contaminated land, the Safety Standards and Regulatory Practices, under section 5.4, specifies that a site used in the conduct of an authorised action may be released for unrestricted use provided that it is demonstrated that the radioactive contamination and radioactive materials which can reasonably be attributed to the authorised action have been removed from the site, or in the case of naturally occurring radioactive nuclides, have activity concentrations below the levels of exclusion. The end land use will be dependent on the findings of such an assessment and will determine if these sites could be utilised or released for unrestricted use.

A baseline radiological assessment must be undertaken by a registered professional prior to any activity undertaken on site. FWGR has the required National Nuclear Regulator (NNR) Certificate of Registration (COR) 281 for the TSF. This COR is owned by FWGR and authorises them to carry out activities associated with radioactive materials as set out, and on the site as identified, in section 2.1 of the mention authorisation.

9.11.1 General

The NNR regulatory process requires CoR holders to submit a public Radiation Protection Programme (RPP) for approval by the NNR. The basis for the definition of the public RPP is the outcome of the comprehensive radiological public safety assessment and includes a monitoring programme, a surveillance programme and a control programme.

9.11.2 Monitoring Programme

Table 9-12 summarises the proposed monitoring programme aimed at public radiation protection. The responsibility for the implementation and execution of the monitoring programme lies with the Radiation Protection Function (RP Function) that include legally appointed persons consisting of a Radiation Protection Monitor(s) (RPM), a Radiation Protection Officer (RPO), and a Radiation Protection Specialist (RPS).\

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Table 9-12: Summary of the environmental monitoring programme proposed for the project aimed at public radiation protection.

Monitoring Element	Comment	Frequency
Surface water	Full-spectrum analysis (U-238, U-235, Th-232 and progeny)	Annually
	Total Uranium and Thorium	Quarterly
Sediments	Full-spectrum analysis (U-238, U-235, Th-232 and progeny)	Once every two years
	Total Uranium and Thorium	Biannually
Groundwater	Full-spectrum analysis (U-238, U-235, Th-232 and progeny)	Once every two years
	Total Uranium and Thorium	Biannually
Radon gas	Environmental radon using Radon Gas Monitors (RGMs)	Quarterly for a period of 2 to 3 month

A full-spectrum analysis is suitable for detailed dose analysis but is an expensive procedure with long lead times to perform the analysis, which is why less frequent intervals are proposed. The total uranium and thorium analysis are relatively inexpensive with fast turnaround times. These results will monitor variations in activity concentration over the monitoring period.

Large variations in the activity concentration over a short period are not expected in groundwater, as opposed to surface water, for example. Therefore, a less frequent sampling schedule is proposed for groundwater. The same principle applies to the sediment samples at the same locations as the surface water sample.

The RGMs to monitor the variation in radon gas works in monitoring periods of 2 to 3 month, after which the RGMs are replaced with new RGMs for the next monitoring period.

9.11.3 Proposed Monitoring Points

Most of the monitoring points proposed to be part of the monitoring programme coincide with the monitoring programme for the environmental pathways. The following can be noted:

- The surface water monitoring locations should coincide with the existing or proposed surface water monitoring points. The principle to be applied is that the monitoring locations should be upstream and downstream of the area in potentially affected surface water streams, as well as upstream and downstream of specific discharge points.
- The sediment monitoring locations should coincide with the surface water monitoring points, applying the same principles.
- The groundwater monitoring points should coincide with the existing and proposed groundwater monitoring points. The principle to be applied is that the monitoring locations should be upstream and downstream of the area. The exact location will be determined by the availability of water-bearing boreholes in the specific area.
- The environmental radon monitoring locations do not have to coincide with specific locations. The principle to apply is that it should be around the extraction area and in the dominant wind direction where receptors are located, complemented with monitoring locations in what can be considered as background. The exact location is often influenced by whether a secured location is available to improve the recovery rate of the RGMs.

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As part of the rehabilitation, decommissioning and closure, FWGR will need to ensure that the land is cleared of possible radioactive contamination and that all the required clearance and closure certificates have been received. This would require the remaining post reclamation surface (rehabilitated surface) to have a non-radioactive level of radiation which would need to be in accordance with the requirements stipulated by the NNRA.

9.12 Waste Management Plan

The Waste Management Plan (WMP) plays a key role in achieving sustainable waste management throughout all phases of the project. The plan prescribes measures for the collection, temporary storage and safe disposal of the various waste streams associated with the project and includes provisions for the recovery, re-use and recycling of waste. The purpose of this plan is therefore to ensure that effective procedures are implemented for the handling, storage, transportation and disposal of waste generated from the project activities on site.

This management plan was formulated based on waste stream information available at the time of compilation. Construction and operation activities must be assessed on an ongoing basis to determine the efficacy of the plan and whether further revision of the plan is required. This plan should be updated throughout the life-cycle of the project, as required to ensure that appropriate measures are in place to manage and control waste and to ensure compliance with relevant legislation.

Prior to the commencement of construction, a detailed Waste Management Method Statement for the site should be compiled by the Contractor.

9.12.1 Waste Management Principles

An integrated approach to waste management is needed on site. It is important to ensure that waste is managed with the following objectives in mind during all phases of the project:

- Reducing volumes of waste is the greatest priority;
- If reduction is not feasible, the maximum amount of waste is to be recycled; and
- Waste that cannot be recycled is to be disposed of in the most environmentally responsible manner

9.12.2 Project Phase Waste Management

A plan for the management of waste during all phases of the project is detailed below.

9.12.2.1 Waste Inventory

- The Environmental Officer (EO), or designated staff member, must develop, implement and maintain a waste inventory reflecting all waste generated during the project life cycle for both general and hazardous waste streams.
- Construction methods and materials should be carefully considered in view of waste reduction, re-use, and recycling opportunities, to be pro-actively implemented.

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- Once a waste inventory has been established, targets for the recovery of waste (minimisation, re-use, recycling) should be set.
- The EO must conduct waste classification and rating in terms of SANS 10288 and Government Notice 634 published under the NEM: WA.

9.12.2.2 Waste Collection, Handling and Storage

- Waste manifests and waste acceptance approvals (i.e. receipts) from designated waste facilities must be kept on file at the site office, to record and prove continual compliance for future auditing.
- Septic tanks and portable toilets must be monitored by the EO or responsible subcontractor and maintained regularly.
- Waste collection bins and hazardous waste containers must be provided by the principal contractor and subcontractors and placed at strategic locations around the site for the storage of organic, recyclable and hazardous waste.
- A dedicated waste area must be established on site for the storage of all waste streams before removal from site. The storage period must not trigger listed waste activities as per the NEMWA, GN 921 of November 2013.
- Signage/ colour coding must be used to differentiate disposal areas for the various waste streams (i.e. paper, cardboard, metals, food waste, glass etc.).
- The SHE Manager must develop, implement and maintain a waste inventory reflecting all waste generated during operation for both general and hazardous waste streams.
- Adequate waste collection bins at site must be supplied. Separate bins should be provided for general and hazardous waste.
- Recyclable waste must be removed from the waste stream and stored separately.
- All waste must be stored in appropriate temporary storage containers (separated between different operation wastes, and contaminated or wet waste).
- Waste storage shall be in accordance with all best-practice guidelines and under no circumstances may waste be burnt on site.
- Waste generated on site must be removed on a regular basis throughout the operation phase.
- Waste must be removed by a suitably qualified contractor and disposed of at an appropriately licensed landfill site. Proof of appropriate disposal must be provided by the contractor and kept on site.

9.12.2.3 Record Keeping

The success of waste management practices is determined by measuring criteria such as waste volumes, cost recovery from recycling and cost of disposal. Recorded data can indicate the effect of training and education, or the need for education. It will provide trends and benchmarks for setting goals and standards. It will provide clear evidence of the success or otherwise of the plan.

- Documentation (waste manifest, certificate of issue or safe disposal) must be kept detailing the quantity, nature, and fate of any regulated waste for audit purposes.
- Waste management must form part of the monthly reporting requirements in terms of volumes generated, types, storage and final disposal.

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9.12.2.4 Monitoring of Waste Management Activities

Records must be kept of the volumes/ mass of the different waste streams that are collected from the site throughout the life of the project. The appointed waste contractor is to provide monthly reports to the operator containing the following information:

- Monthly volumes/ mass of the different waste streams collected;
- Monthly volumes/ mass of the waste that is disposed of at a landfill site;
- Monthly volumes/ mass of the waste that is recycled;
- Data illustrating progress compared to previous months.

This report will aid in monitoring the progress and relevance of the waste management procedures that are in place. This report must from part of the EO's reports on a monthly basis.

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10 COMPLIANCE MONITORING MECHANISM

Table 10-1 depicts the monitoring and management plan for the management measures and actions identified in the impact assessment. Where specific monitoring and management plans are required, these are detailed in Section 9.

Table 10-1: Monitoring and Management Plan

Impact Management Action	Monitoring / Management Action	Monitoring Frequency	Roles and Responsibilities	Compliance Mechanism	Compliance Reporting Frequency	Monitoring trigger response criteria
Groundwater						
Groundwater level	Groundwater levels	6 Monthly	FWGR/EO	-	6 Monthly	Variations by more than 3m for 2 consecutive months should be investigated.
Water quality analysis	❖ All boreholes and surface water monitoring positions listed in the Groundwater impact assessment Monitoring ❖ Privately owned boreholes available ❖ Proposed new boreholes.	6 Monthly	FWGR/EO	South African National Standards (SANS241) and the Blesbokspruit catchment guideline limits;	6 Monthly	Variations in concentrations by more than 15% for major cations and anions and more than 7% for metal concentrations for more than 2 consecutive months should be investigated. Any result that exceeds specified water quality objectives must be investigated when it occurs.
Rainfall	Rain depth (mm)	daily	FWGR/EO		6 Monthly	none
Surface Water						
Surface water quality monitoring	The DWS Best Practice Guideline G3: Water Monitoring Systems	Quarterly (or as suggested by the DWS) prior to the commencement of construction	FWGR/EO	❖ DWS best practice guidelines G3: Water Monitoring Systems. ❖ South African National Accreditation System (SANAS) accredited laboratory for analysis. ❖ Compare against baseline quality.	Quarterly	A continued decrease in water quality below the standards listed on a continual basis. If there is a clear reduction in water quality due to the activities.
		Quarterly (or as suggested by the DWS) basis during the life of the project	FWGR/EO		Quarterly	
		Quarterly (or as suggested by the DWS) until the project has completely and successfully been rehabilitated.	FWGR/EO		Quarterly	
Stormwater infrastructure	Stormwater management infrastructure	Monthly Basis during the dry season. Weekly basis during the wet season	FWGR/EO		Monthly	Any storm events. Or flooding due to mismanagement and improper maintenance
		Monitored immediately after a stormwater event	FWGR/EO/Maintenance Manager		Immediately	
Reporting	Monitoring reports to include trend analyses. Sampling of water quality from upstream monitoring points must be compared to downstream monitoring points	Monitoring reports submitted to DHSWS.	FWGR/EO		Quarterly (or as recommended by the DHSWS)	
Air Quality						
Dust: / Wet suppression/ Chemical stabilization of unpaved roads	Visually	Daily	❖ Project Site manager ❖ Contractor EO ❖ Contractor EO	Internal audit by FWGR in house specialists	Monthly	Visual observation of heavy dust generated by traffic or activities. Any formal complaints received by local communities.
	Dust Fallout Monitoring	Starting as far prior to construction as possible. Monthly during construction, operational and decommissioning phases	FWGR/EO	❖ Internal audit by FWGR in house specialists ❖ National Dust Control Regulations.	Monthly	Table 9-8: National Dust Control Regulations (Government Notice No. 517, 2018).

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Impact Management Action	Monitoring / Management Action	Monitoring Frequency	Roles and Responsibilities	Compliance Mechanism	Compliance Reporting Frequency	Monitoring trigger response criteria
Heritage						
Possible finds	Chance find procedure	Prior to site clearance During construction and operation	❖ FWGR ❖ Project EO ❖ Heritage Specialist	Ensure compliance with relevant legislation and recommendations from SAHRA under Section 35 and 38 of NHRA	Monthly Checklist/Report	If any form of heritage is discovered or unearthed on site. If any graves are discovered.
Radiation						
Refer to Section 9.11.2 for the radiological monitoring programme						
Social						
Refer to section 9.9 for the social related management and monitoring requirements						

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11 OATH UNDERTAKING

The EAP hereby confirms:

- The correctness, to the best of her knowledge, of the information provided in the specialist reports and on information provided by FWGR. The information was accepted as being as reliable as information generated during an EIA and a feasibility study, and provided in good faith, can be;
- The inclusion of comments and inputs from stakeholders and I&APs;
- The inclusion of inputs and recommendations from the specialist reports where relevant; and
- The acceptability of the project in relation to the finding of the assessment and level of mitigation proposed.

Kongiwe Environmental (Pty) Ltd

Company Name

Gerlinde Wilreker

Name of the Environmental Assessment Practitioner **Signature**

2025/02/07

Date