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REPORT:

EPL 4818 SOIL ANALYSIS BASELINE REPORT, ERONGO REGION, NAMIBIA

PROJECT NUMBER: ECC-143-471-REP-17-A

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TERMS AND ABBREVIATIONS

TERM OR ABBREVIATION	DESCRIPTION
%	Percentage
Ca	Calcium
CEC	Cation exchange capacity
cm	Centimetre
cm/H	Centimetre per hour
Damaran Exploration	Damaran Exploration Namibia (Pty) Ltd
EAP	Environmental assessment practitioner
EIR	Infiltration rate measured in cm per hour (flow rate)
EC	Electrical conductivity
ECC	Environmental Compliance Consultancy (Pty) Ltd
ENE	East-Northeast
Epangelo	Epangelo Mining Company (Pty) Ltd
EPL	Exclusive prospective license
ESIA	Environmental and social impact assessment
FAO	Food and Agriculture Organisation of the United Nations
f_p	Particle size parameter (unitless)
f_{perm}	Profile-permeability class factor (unitless)
GPS	Global Positioning System
JV	Joint venture
K	Potassium
KCL	Potassium chloride
K-factor	Soil's erodibility
Kg	Kilogram
Mg	Magnesium
meq/L	Milliequivalents per litre.
Mg/Kg	Milligrams per kilogram
Mg/L	Milligrams per litre
ML	Mining license
mS/m	MilliSiemens per meter
Na	Sodium
P	Phosphorus
NW	Northwest
pH	Potential of hydrogen
P_{om}	percentage of organic matter (unitless)
SOM (%)	Percentage of soil organic matter
S_{struc}	Soil structure index (unitless)
TSF	Tailings storage facility
Wia Gold	WIA Gold Limited (Ltd)
WRD	Waste rock dump

1 INTRODUCTION

1.1 COMPANY BACKGROUND

Mandarin Investments (Pty) Ltd (hereafter referred to as “The Proponent”), is a joint venture (JV) between Damaran Exploration Namibia (Pty) Ltd (hereafter referred to as “Damaran Exploration”), and Epangelo Mining Company (Pty) Ltd (hereafter referred to as “Epangelo”) and is the holder of the license EPL 4818 as shown in Figure 1. Wia Gold Limited (Ltd) (hereafter referred to as “Wia Gold”), is the parent company of Damaran Exploration Namibia (Pty). The Proponent has concentrated on acquiring and developing potential gold projects in Namibia through extensive exploration programs. This advanced and successful exploration has led to the advanced and successful exploration within EPL 4818 and has informed the Proponent’s decision to progress to feasibility studies from the successful competition of exploration within EPL 4818 and led to the advancement of the Kokoseb Gold Mine Project (hereafter referred to as “the Project”). The proposed project will utilise a conventional open-pit mining method with a gold extraction process similar to that of existing gold mines in Namibia, such as the Otjikoto and Navachab Gold mines.

1.2 PURPOSE OF THIS REPORT

Environmental Compliance Consultancy (Pty) Ltd (ECC) has been engaged by Damaran Exploration Namibia (Pty) Ltd to act as their environmental assessment practitioner (EAP) for the undertaking of the environmental and social impact assessment (ESIA) for the application of an environmental clearance certificate as per the terms of the Environmental Management Act No. 7 of 2007 and its accompanying regulations of 2012. As part of the ESIA, a baseline study of the soil characteristics in the project area is required. This report aims to present the soil analysis findings conducted by ECC for the Kokoseb Gold Project.

This report provides a description of the soils present in the study area including a summary of soil composition, fertility, land use potential, and erodibility. The report establishes a reference point for future soil comparisons, enabling the monitoring and assessment of changes over time. This information is particularly valuable for environmental monitoring and will contribute to the rehabilitation and mine closure designs.

1.3 THE PROPONENT OF THE PROPOSED PROJECT

Table 1 - Proponent’s details

Company Representative:	Contact Details:
Mr Keith Webb Country Manager	Damaran Exploration Namibia (Pty) Ltd P O Box 12012 Ausspannplatz Windhoek, Namibia kwebb@wiagold.com.au

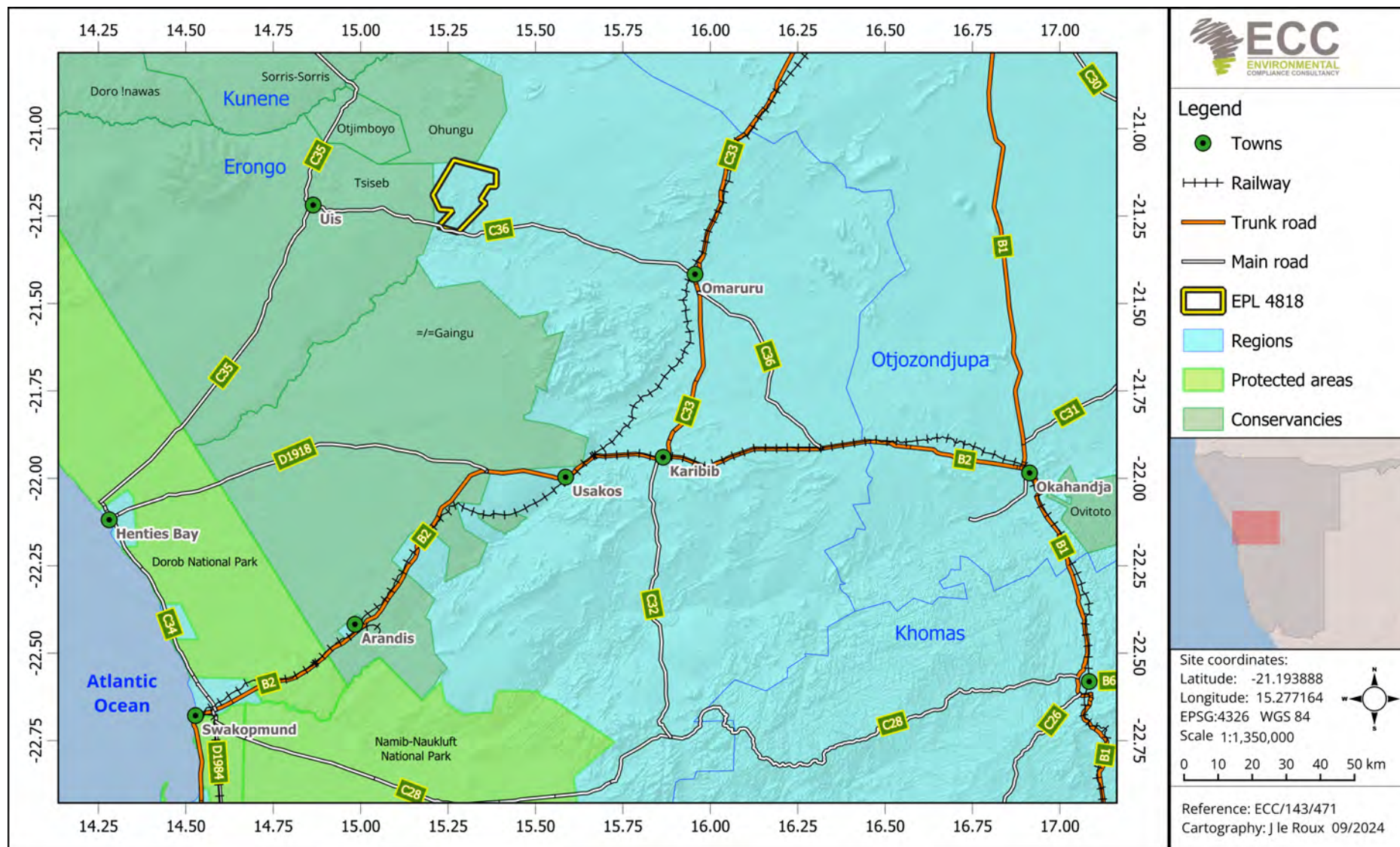


Figure 1 - Locality map of the Project area

1.4 SCOPE OF WORK

The scope of the soil assessment includes the definition and characterisation of the receiving environment including existing land use and land use capability and potential impacts on surrounding land users. The soil study may inform the quality and quantity of material available for rehabilitation to a similar state upon closure.

Six soil profiles were dug and soil samples collected from each for compositional analysis in an accredited laboratory based in South Africa. The results are used to determine the K-factor (soil erodibility factor) and the fertility potential of the soils in and around the planned mining site. These serve as a baseline against which future changes may be compared and inform suitability of soils for use in rehabilitation of the mine site.

2 SOIL ANALYSIS BASELINE

Soil is a valuable resource that performs a variety of ecosystem services such as:

- Production of food;
- Production of biomass;
- Storage, filtration and transformation of nutrients and water;
- Carbon storage and cycling; and
- Landscape and cultural environment.

Soils in an area are the result of the interaction of various factors known as the “soil-forming factors”, such as:

- Parent material;
- Climate;
- Topography;
- Vegetation and organisms including human action (contamination, industrial pollution and agriculture) (Dror, Yaron, & Berkowitz, 2022).

The following soil baseline description has been garnered from available literature, site visits and studies undertaken in proximity of the proposed Project.

2.1 IDENTIFICATION FACTORS

2.1.1 LOCATION

The proposed Project is within exclusive prospecting license (EPL 4818), where the resource is located and where a mining license (ML) will be applied for, once the resource has been defined. EPL 4818 is located 35 km east-northeast (ENE) of Uis and 25 km northwest (NW) of Okombahe in the Erongo Region (-21.176832, 15.172355). The EPL is bordered by the C36 main road as shown in Figure 1.

Six (6) soil sampling locations shown in Table 2 were selected based on satellite imagery, the topography of the EPL and where the majority of the mine infrastructure will be located, with two samples taken at each sampling site (topsoil and subsoil). Figure 2 shows the soil sampling locations within EPL 4818.

Table 2 - GPS coordinates of the soil profiles sampled

Soil profile	Latitude	Longitude
1	S 21° 07' 55.9"	E 015° 15' 27.4"
2	S 21° 08' 39.0"	E 015° 17' 07.8"
3	S 21° 09' 16.2"	E 015° 14' 28.5"
4	S 21° 09' 58.4"	E 015° 16' 12.5"
5	S 21° 10' 35.0"	E 015° 13' 32.1"
6	S 21° 11' 30.5"	E 015° 14' 57.3"

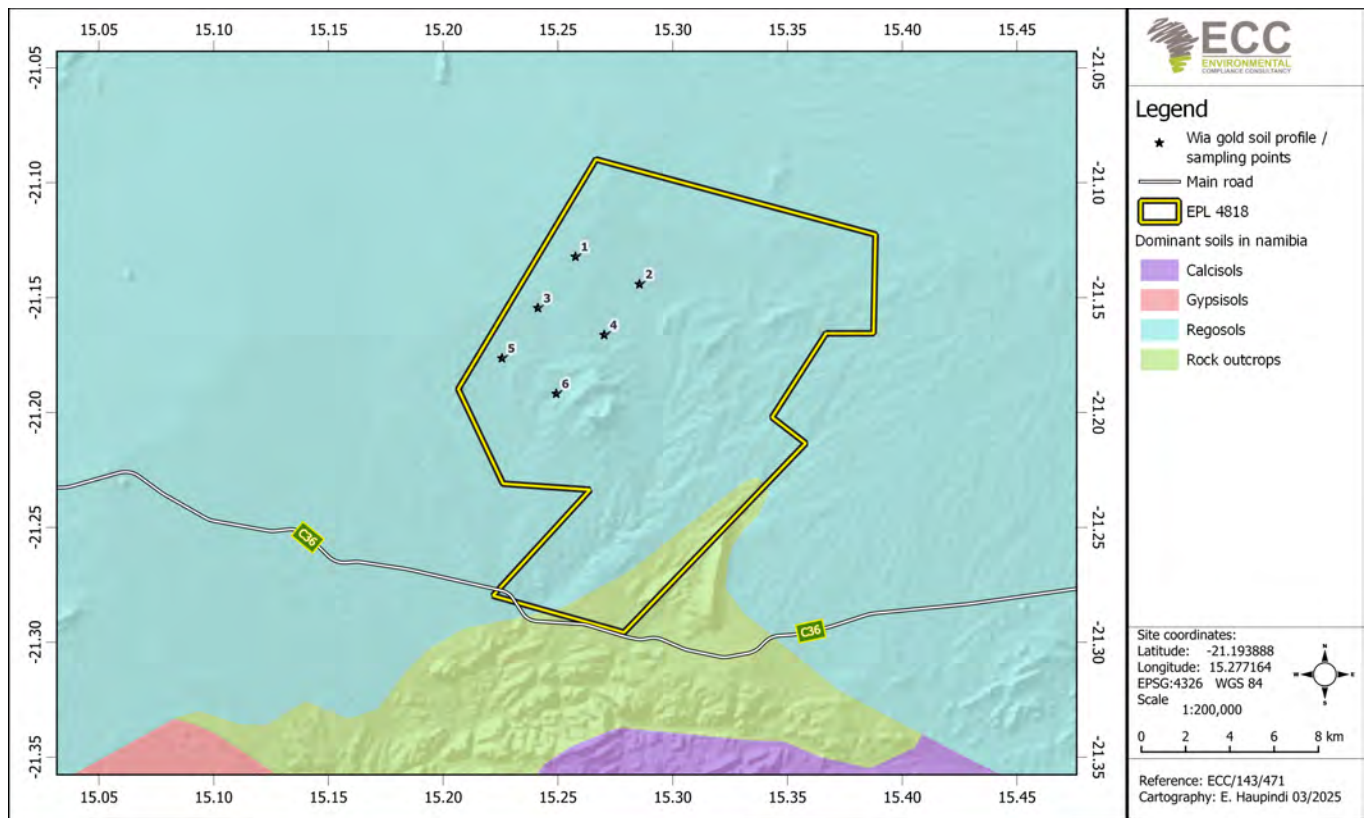


Figure 2 – Map of soil sampling locations with the 1:1 000 000 soil types of Namibia

2.1.2 CLIMATE

EPL 4818 is located in an area characterised as a hot desert climate (BWh) based on the Köppen-Geiger classification, with summer rainfall. Atlas of Namibia (2022) provides Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) derived estimates of annual rainfall (Table 3).

Table 3 – CHIRPS average month rainfall (mm)

Month	Rainfall (mm)
January	35
February	44
March	45
April	18
May	1
June	0
July	0
August	0
September	1
October	4
November	11
December	13
Total	172

Estimates of Reference Evapotranspiration (ET₀) were sourced from the Food and Agriculture Organisation of the United Nations (FAO's) AQUASTAT Tool. The resulting average monthly and annual total ET₀ estimates are presented in Table 4. ET₀ is noted as being estimated as 2,489mm. By comparison, the Atlas of Namibia (2022) indicates a Potential Evapotranspiration estimate of 2,509mm annually.

Table 4 - FAO Aquastat average monthly reference evapotranspiration

Month	Reference Evapotranspiration (ET ₀) (mm)
January	236
February	187
March	186
April	164
May	167
June	169
July	184
August	208
September	219
October	261
November	255
December	253
Total	2489

2.1.3 TOPOGRAPHY

The 25 metre contours sourced from the 30 metre ALOS World 3D digital surface model (DSM) are shown in Figure 3. The elevation generally decreases from north to south toward the SE flowing Omaruru River. Based on contour spacing, the slope is interpreted to be mild, below ~10%.

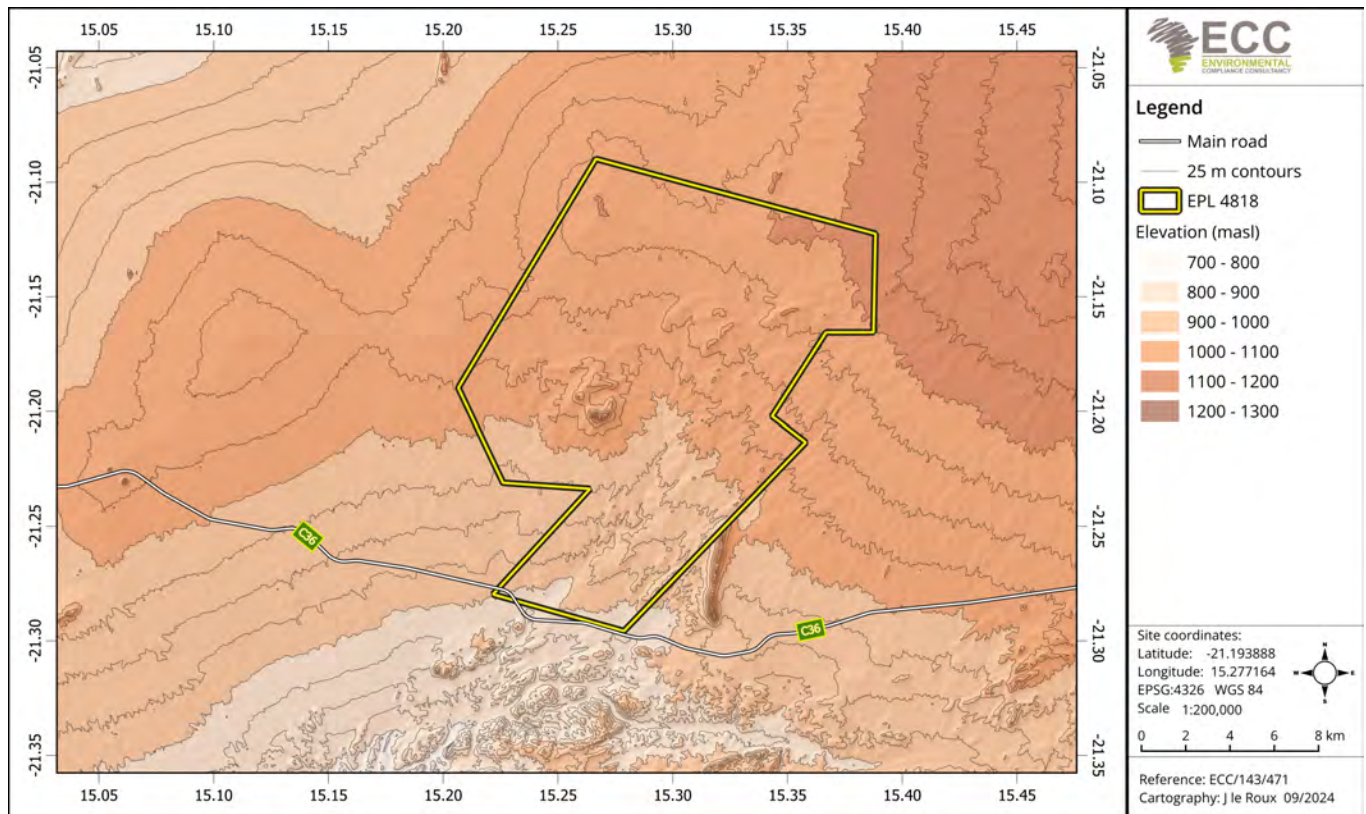


Figure 3 – Digital surface model elevations (25 m contour) of EPL 4818

2.1.4 GEOLOGY OF EPL 4818

The Kokoseb gold deposit is in the Northern Central Zone of the Pan-African Damara Orogenic Belt. The area consists of Neo-Proterozoic metasediments belonging to the Arandis, Karibib, and Kuiseb Formations of the Swakop Group of the Damara Super Group. Gold mineralisation occurs in the metasediments of the Kuiseb Formation, which are significantly intruded by late syn-tectonic and post-tectonic granites, along with minor mafic dykes trending north to south (N-S) to north-northeast to south-southwest (NNE-SSW). While exposure across the licence area is moderate to good, the Kuiseb Formation is often only sub-outcropping and is typically covered by thin layers of soil, colluvium, or pisolitic calcrete up to 2 meters thick.

In the Project area, the Kuiseb Formation forms a dome structure, cored by a post-tectonic leucogranite referred to as the "Central Granite Pluton." This pluton is primarily composed of medium-grained quartz, K-feldspar, and plagioclase, with smaller amounts of biotite, muscovite, magnetite, garnet, and tourmaline.

Granite dykes, granitic veinlets, and pegmatites cutting through the Kuiseb Formation are linked to this granite phase or later ones. Gold mineralisation forms an arc around this pluton, spanning approximately 3 km in diameter. A coarse-grained, pre-syn-tectonic porphyritic-feldspar granite encloses the mineralized schists to the west, east, and northeast. The schist units are dark grey, poorly foliated, quartz/plagioclase/K-feldspar-rich, biotite-bearing schists, as well as better-foliated black biotite schists. Gold occurs as native gold grains and, to a lesser extent, silver-

bearing gold grains, and is spatially associated with sulphides dominated by pyrrhotite, löllingite, and arsenopyrite.

2.1.5 SOIL CLASSIFICATION

Based on the 1:1 000 000 scale Namibian Soil Map of 2021 (Coetzee, 2021) the land type in the project area is dominated by Regosols (Figure 2). It is noted that the scale of the available dataset decreases certainty in soil identification and classification; however, observable geomorphological features and sample photographs aid to provide representative classification of soil samples collected from within the EPL.

The soil at the six different soil profile locations can be described as Eutric Skeletic Regosols (Beugler-Bell et al., 1993 and Isric World Soil Museum, 2024). Descriptions of the soil profiles are provided in Table 6 to Table 11.

Eutric Skeletic Regosols are young, weakly developed soils typically found in dynamic landscapes characterised by active erosion or deposition, and they exhibit distinct physical, chemical, and hydrological properties that influence their vegetation cover and limited land use potential. This is outlined below:

- **General Characteristics**
 - o Formation: Young soils formed on unconsolidated materials such as river alluvium, colluvium, or weathered parent rock, often in areas with active erosion or deposition.
 - o Profile: Minimal horizon differentiation; an A horizon (thin topsoil) overlies skeletal material (rock fragments, gravel, stones).
- **Physical Properties – Texture and Structure**
 - o Texture: Coarse, sandy to loamy, dominated by rock fragments (>40%).
 - o Structure: Weakly developed or granular due to limited soil development.
- **Chemical Properties – Nutrients and pH**
 - o Nutrient Content: Moderately fertile, with sufficient base cations due to recent weathering of parent material.
 - o pH: Near neutral to slightly alkaline, often depending on the parent material.
- **Hydrological Properties – Water Retention and Erosion**
 - o Water Retention: Limited due to coarse texture and skeletal content. Eutric Skeletic Regosols have excellent drainage properties because of their coarse texture. This rapid drainage can lead to low moisture levels in dry conditions but can also reduce waterlogging issues.
 - o Erosion: High susceptibility to erosion, especially on steep slopes or areas with sparse vegetation.
- **Vegetation and Land Use – Vegetation and Land Uses**
 - o Vegetation: Sparse grasslands, shrublands, or pioneer species.

- Land Use: Marginal agricultural use; commonly used for extensive grazing or left as natural vegetation.

3 METHODOLOGY

3.1 SAMPLING METHOD

Six (6) soil sampling locations were selected based on planned sampling through satellite imagery. Two members from ECC collected the soil samples in May 2024, with one person digging while the other logged the soil profiles.

3.1.1 EQUIPMENT AND MATERIALS

Equipment used during the sampling method includes:

- Personal protective equipment (PPE): gloves, boots, safety goggles, and high-visibility vests.
- Digging pick,
- Measuring tape for differentiating between the topsoil and subsoil,
- Clean container,
- Plastic sample bags,
- A marker for labelling,
- A camera for photographing soil profiles and
- A GPS device to record sampling points.

3.1.2 SAMPLING SITES SELECTION

The existing soil map is shown in Figure 2 was used to identify the sites with different types of soil. A random sampling technique was carried out within these sites

3.1.3 PROCEDURE FOR DIGGING SOIL PROFILE

- The digging area was marked, demarcating a rectangular area approximately 1 meter long by 0.5 meters wide.
- Excavation:
 - o They began digging with a spade to a depth of 1.5 meters or until reaching a compacted or impenetrable layer.
 - o They ensured the walls of the profile are vertical and smooth for clear observation.
- Soil disposal
 - o They then placed excavated soil at least 1m away from the to prevent collapse.
 - o Avoided mixing soil layers

3.1.4 LOGGING THE SOIL PROFILE

3.1.4.1 *general observations*

- The date, time, weather conditions, and GPS coordinates of the site were recorded.

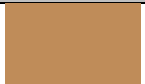
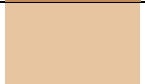
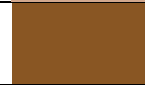
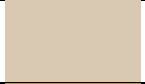
3.1.4.2 *layer description*

- Each distinct soil layer was identified by:

- **Depth:** Measuring and recording the upper and lower depth boundaries from the surface.
- **Colour:** Determined the soil colour using the soil colour chart.

Soil colour is an important indicator of its composition, drainage conditions, and organic matter content. To describe soil colour consistently, scientists use the Munsell Soil Colour Chart, a standardized tool that classifies colour based on three components: hue (the dominant colour), value (lightness or darkness), and chroma (colour intensity or saturation). By comparing a soil sample to the colour chips in the chart under natural light, one can accurately determine and record the soil's colour characteristics. The colour of the soil is determined by the Munsell Chart as shown in Table 5.

Table 5 - Munsell chart

Colour notation	Colour	Colour notation	Colour
2.5Y 9.5/2		7.5YR 6/6	
2.5YR 7/3		7.5YR 8/4	
5YR 7/4		10YR 6/4	
7.5YR 4/6		10YR 4/4	
7.5YR 7/4		10YR 8/4	
7.5YR 6/4		10YR 7/3	
7.5YR 5/4		10YR 8/2	
7.5YR 5/6		10YR 6/6	

- **Texture:** Described the texture (e.g., sandy, loamy, clayey) by feel.
- **Structure:** Observed and documented the soil structure (e.g., granular, blocky, platy).
- **Moisture:** Noted the moisture content (e.g., dry, moist, wet).
- **Inclusions:** Identified and described any inclusions (e.g., roots, rocks, minerals, organic matter).
- **Boundary Characteristics:** Documented the transition between layers (e.g., abrupt, gradual).

3.1.4.3 *photographic documentation*

They also then took clear photographs of the soil profile with a measuring scale visible.

3.1.4.4 soil profile 1



Table 6 - Soil Profile 1

	Humus	Topsoil	Subsoil
Depth (m)	0 - 0.02	0.02 - 0.38	0.38 - 0.43
Colour	10YR 6/4	10YR 4/4	2.5Y 9.5/2
Texture	Sandy	Sandy	Loamy
Structure	Granular	Granular	Blocky
Moisture	Dry	Moist	Dry
Inclusions	None	Rocks	Minerals
Total depth (m)	0.43		
Boundary characteristics	Gradual transition		

3.1.4.5 soil profile 2



Table 7 - Soil Profile 2

	Humus	Topsoil	Eluviation layer	Subsoil
Depth (m)	0 - 0.03	0.03 - 0.28	0.28 - 0.52	0.52 - 0.70
Colour	2.5Y 7/3	10YR 6/4	7.5YR 4/6	7.5YR 5/6
Texture	Sandy	Sandy	Sandy	Sandy
Structure	Granular	Granular	Granular	Granular
Moisture	Dry	Wet	Moist	Dry
Inclusions	None	Roots	Roots	Small rocks
Total depth (m)	0.70			
Boundary characteristics	Gradual transition			

3.1.4.6 soil profile 3



Table 8 - Soil profile 3

	Humus	Topsoil	Subsoil
Depth (m)	0 - 0.04	0.04 - 0.26	0.26 - 0.73
Colour	7.5YR 7/4	5YR 7/4	7.5YR 6/4
Texture	Sandy	Sandy	Sandy (coarse grained)
Structure	Granular	Granular	Granular
Moisture	Dry	Wet	Dry
Inclusions	None	None	Rocks
Total depth (m)	0.73		
Boundary characteristics	Abrupt transition		

3.1.4.7 soil profile 4



Table 9 - Soil Profile 4

	Humus	Topsoil	Eluviation layer	Subsoil
Depth (m)	0 - 0.01	0.01 - 0.15	0.15 - 0.39	0.39 - 0.43
Colour	10YR 8/4	7.5YR 7/4	7.5YR 5/4	2.5Y 9.5/2
Texture	Sandy	Loamy	Loamy	Loamy
Structure	Granular	Granular	Granular	Blocky
Moisture	Dry	Moist	Dry	Dry
Inclusions	None	Roots	Rocks	Rocks
Total depth (m)	0.43			
Boundary characteristics	Gradual transition			

3.1.4.8 soil profile 5



Table 10 - Soil Profile 5

	Humus	Topsoil	Subsoil
Depth (m)	0 - 0.03	0.03 - 0.41	0.41 - 0.93
Colour	10YR 7/3	7.5YR 5/6	7.5YR 6/6
Texture	Sandy	Sandy	Sandy
Structure	Granular	Granular blocky +	Granular blocky +
Moisture	Dry	Moist	Moist
Inclusions	None	Roots + rocks	Rocks
Total depth (m)	0.93		
Boundary characteristics	Gradual transition		

3.1.4.9 soil profile 6



Table 11 - Soil Profile 6

	Humus	Topsoil	Subsoil
Depth (m)	0 - 0.08	0.08 - 0.39	0.39 - 1.02
Colour	10YR 8/2	10YR 6/6	7.5YR 8/4
Texture	Sandy	Sandy	Sandy (coarse)
Structure	Granular	Granular	Granular
Moisture	Dry	Moist	Dry
Inclusions	None	Roots	Roots
Total depth (m)	1.02		
Boundary characteristics	Abrupt transition		

3.1.5 SAMPLE COLLECTION

- They then collected samples from each layer using a clean, labelled container.
- Labeled each sample with the site location, layer depth, and date.

3.1.6 POST-EXCAVATION ACTIVITIES

3.1.6.1 backfilling

- Refilled the excavation pit with the excavated soil in the reverse order of removal.

- Compacted the soil gently to minimise hazards and environmental impact.
 - 3.1.6.2 *Site Restoration*
- Restored the area to its original condition as much as possible.
- Removed all equipment and materials from the site.

3.2 DATA ANALYSIS

The soil samples were sent to Aquatico's NivroTek Lab for analysis of the soil's chemical properties such as pH, nutrient content, the particles that make up soil and contaminants.

4 RESULTS

4.1 THE K-FACTOR AND EIR

The Universal Soil Loss Equation (USLE) was developed by W.H. Wischmeier and D.D. Smith of the United States Department of Agriculture (USDA). The equation was originally formulated in the 1960s and later revised in 1978 (Wischmeier & Smith, 1978). The USLE is an empirical model designed to estimate average annual soil loss due to sheet and rill erosion, primarily on agricultural fields. It became a widely used tool for soil conservation planning.

The equation makes use of the soil erodibility factor (K) that corresponds to a quantitative depiction of the characteristic of a particular soil's erodibility; it is the extent to which soil particles detach and are washed away by rainwater and runoff. The soil erodibility factor can in some cases be described as the rate of erosion per unit index from a specific area. The erodibility factor reflects the susceptibility between different soils when all other impacting factors (infiltration rate, permeability rate, dispersion and total water capacity, abrasion, and rain splash) are all kept constant. The soil erodibility factor (K- factor) is highly influenced by soil texture, although other factors such as permeability, organic matter content, and structure play a contributing factor (Pacific Northwest National Laboratory, 2021).

Higher K values, as seen for clays, indicate a greater susceptibility to erosion. Better drainage can reduce erosion potential, but sand can still be easily moved by wind and water in dry conditions. The dry conditions experienced at EPL 4818 may play an important role in this.

The profile permeability class factor (Table 12) classifies the infiltration rate for each soil that was sampled. The estimated infiltration rate determined based on field observations was used to classify the infiltration rate. The soil structure index (Table 13) is used to determine the texture of the soil and a value is assigned to each of the soils that were sampled. The K-factor was calculated using the USLE as follows:

$$K_{fact} = (1.292) [2.1 \times 10^{-6} f_p^{1.14} (12 - P_{om}) + 0.0325 (S_{struc} - 2) + 0.025 (f_{perm} - 3)]$$

In which:

$$f_p = P_{silt} (100 - P_{clay})$$

Where:

f_p is the particle size parameter (unitless)

P_{om} is the percentage of organic matter (unitless)

S_{struc} is the soil structure index (unitless)

f_{perm} is the profile-permeability class factor (unitless)

Results range between 0.11-0.17 indicating all soils to predominantly classify as fine granular **Error! Reference source not found.** **Error! Reference source not found.** **Error! Reference source not found.** soil and slow infiltration rates, with low erodibility, some cohesion

and moderate permeability (see Table 15). Sandy soils make rehabilitation efforts easier as compared to clay rich soils.

Table 12 – The profile permeability class factor table.

The profile permeability class factor, f_{perm}	
1	For very slow infiltration
2	for slow infiltration
3	for slow to moderate infiltration
4	for moderate infiltration
5	for moderate to rapid infiltration
6	for rapid infiltration

Table 13 – Soil structure index.

The soil structure index, S_{struc}	
1	for very fine granular soil
2	for fine granular soil
3	for medium or coarse granular soil
4	for blocky, platy, or massive soil

Soil infiltration rate is an important factor because it determines how fast the transfer and distribution of water from surface to soil profile happens (Patle, et al., 2018). The infiltration rate was calculated by means of a literature analysis, as it was not conducted on-site. This entailed making use of the sand, silt, and clay percentages as determined by the laboratory analysis undertaken (see Table 14).

The First-Class method (Patle et al., 2018) was used to determine the Estimated Infiltration Rate (EIR) of the soil samples, and is represented by the following formula:

$$EIR = 14,195.35 - 141.75(sand\%) - 142.10(silt\%) - 142.56(clay\%)$$

It was observed (see Table 14) that sand content varies from 77% to 97%, with a mean value of 86%; silt content varies from 1% to 15%, with a mean value of 7.5%; and clay content varies from 2% to 10%, with a mean value of 6.5%. Results are included in Table 15. Samples with higher EIR values correlate to soils with higher sand content and low silt and clay content, thus the higher the value derived, the more effective the soil is at allowing water to infiltrate and the less susceptible it will be to erosion by rain and runoff.

Table 14 – Particle size proportion per sample (Aquatico, 2024).

Sample ID	CLAY	SILT	SAND
	%	%	%
SS 01A	2	1	97
SS 01B	2	1	97
SS 02A	8	10	82
SS 02B	10	9	81
SS 03A	8	15	77
SS 03B	8	13	79
SS 04A	6	10	84
SS 04B	6	10	84
SS 05A	6	5	89
SS 05B	10	8	82
SS 06A	6	3	91
SS 06B	6	5	89

Table 15 - Table of K-Factor (Kfact) and EIR calculation.

Sample	F _p	EIR (cm/H)	Fperm	Sstruc	Kfact
SS 01A	98	18.38	6	3	0.14
SS 01B	98	18.38	6	3	0.14
SS 02A	920	10.37	6	2	0.13
SS 02B	810	9.10	6	2	0.12
SS 03A	1380	8.62	6	2	0.14
SS 03B	1196	9.32	6	2	0.14
SS 04A	940	11.99	6	3	0.17
SS 04B	940	11.99	6	3	0.17
SS 05A	470	13.74	6	2	0.11
SS 05B	720	9.45	6	2	0.12
SS 06A	282	14.44	6	2	0.11
SS 06B	470	13.74	6	2	0.11

Table 16 - Erodibility description based on K-factor values.

K Range	Factor	Soil Type	Erodibility Description
0.02 – 0.10		Sandy Soils	Very low, erodibility; high permeability and low cohesion
0.10 – 0.20		Loamy Sands	Low erodibility; moderate permeability and some cohesion
0.20 – 0.30		Loams	Moderate erodibility; balanced texture with good cohesion
0.30 – 0.40		Silty Loams	Moderate to high erodibility; fine particles can be easily displaced
0.40 – 0.50		Clay Loams	High erodibility, fine texture and higher cohesion, but can erode under certain conditions
0.50 – 0.70		Silty Soils	High erodibility; fine particles are very susceptible to erosion, especially when wet
0.70 – 0.90		Clays	Very high erodibility; high water retention, but can erode when saturated
>0.90		Heavy Clay or Disturbed soils	Extremely high erodibility; significant erosion risk, especially when disturbed.

The K factor, or soil erodibility factor, is a measure used in the Universal Soil Loss Equation (USLE) to indicate how susceptible a soil is to erosion by rainfall and surface runoff. It reflects the soil's physical properties, including texture, structure, organic matter content, and permeability. Soils with high K values (e.g., silty soils) are more prone to erosion, while those with low values (e.g., sandy soils) are more resistant. The soil samples taken from EPL 4818 K-Factors ranged between 0.11 and 0.17 falling in the loamy sands soil type, meaning they have low erodibility moderate permeability, and the soil has some cohesion.

4.2 FERTILITY POTENTIAL

Based on the laboratory findings, soil samples 1, 2, 4, and 6 exhibit more neutral to slightly alkaline pH levels ranging from 8.1 to 7.0. While soil samples 3 and 5 are more acidic, ranging from 6.6 to 5.9 (Table 17).

Neutral to slightly acidic pH soils, typically ranging from 6 to 7, create favourable conditions for soil fertility. They support optimal nutrient availability, microbial activity, and soil structure, promoting robust plant growth (Aqarab Husnain Gonda et al., 2021). Essential nutrients like phosphorus, potassium, calcium, and magnesium are readily soluble within this pH range, facilitating plant uptake. Microbial communities contribute to soil fertility through nutrient cycling and organic matter decomposition. The well-balanced soil structure, characterized by adequate aggregation and porosity, fosters healthy root development and efficient water infiltration (Ajar Nath Yadav et al., 2021). Maintaining soil pH within this range sustains optimal nutrient availability, microbial activity, soil structure, and crop suitability, thus enhancing soil fertility potential and supporting sustainable agricultural practices.

The high calcium content, coupled with the alkali nature of the soils, precludes the requirement for agricultural lime dosing as soils are at present, not acidic.

Table 17 - Lab results of major ion concentrations calculated based on bulk densities.

Sample	pH (KCL)	Density (g/ml)	K (mg/l)	Na (mg/l)	Ca (mg/l)	Mg (mg/l)
SS 01A	8.1	1.49	59.6	11.9	2690.9	52.2
SS 01B	7.6	1.52	60.8	16.7	2307.4	69.9
SS 02A	7.2	1.28	276.5	19.2	4835.8	144.6
SS 02B	7.0	1.23	227.56	20.9	5094.7	139.0
SS 03A	6.6	1.3	330.2	14.3	4404.4	188.5
SS 03B	7.2	1.28	353.3	14.1	4704	218.9
SS 04A	7.5	1.35	379.4	13.5	4591.4	140.4
SS 04B	7.6	1.33	325.9	13.3	4593.8	141.0
SS 05A	6.5	1.37	132.9	21.9	1038.5	89.1
SS 05B	5.9	1.29	172.9	18.1	1192.0	153.5
SS 06A	7.5	1.38	162.8	13.8	3088.4	82.8
SS 06B	7.1	1.42	156.2	14.2	2902.45	90.9

Metal concentrations in the soil samples are shown in Table 18 and can be used as a baseline against which future samples can be compared after mining activities have commenced, and once they cease, to evaluate contamination. Further soil and metals analysis is recommended to bolster baseline records and provide an increased spatial distribution of soil quality before mining activities commence. In comparing the values in Table 16 to South African Soil Screening Values for contaminated land (GN 331) (Department of Environmental Affairs, 2012), it is clear that there is limited to zero contamination present in the sample results with concentrations remaining one to two orders of magnitude lower than permissible values for protection of soils for various land uses and (considering the Omaruru River to the south) the protection of water resources.

Table 18 - Trace metal concentrations in soil samples.

Sample	Zn	Mn	Cu	Fe	B
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SS 01A	0.1	0.6	0.1	0.7	0.0
SS 01B	0.1	0.3	0.1	0.4	0.1
SS 02A	0.2	1.5	0.3	0.9	0.1
SS 02B	0.2	1.5	0.3	0.9	0.1
SS 03A	0.3	2.0	0.4	1.3	0.1
SS 03B	0.3	1.6	0.5	1.3	0.2
SS 04A	0.2	1.8	0.3	1.0	0.1
SS 04B	0.2	2.0	0.3	1.0	0.1
SS 05A	0.5	2.1	0.2	2.0	0.1

Sample	Zn	Mn	Cu	Fe	B
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SS 05B	0.3	2.3	0.3	2.9	0.0
SS 06A	0.2	0.9	0.2	0.7	0.1
SS 06B	0.2	1.1	0.2	0.8	0.1

5 LAND USE

5.1 CURRENT AND POTENTIAL LAND USE

The Dâures Constituency is divided into centres, which constitute individual farms. The small villages in the Uis-Okombahe area are all situated in a semi-arid farming region and have a homogenous farming pattern, which is customarily stock-raising. Farming practices in communal Okombahe aim largely at the maintenance of flocks (Margaret Angula, 2010).

Communal farmers in Okombahe primarily raise goats, while Damara sheep are common in the Erongo Region, while also keeping smaller numbers of cattle, poultry and pigs. Livestock in this area are supported by abundant shrub vegetation which serves as the main food for small stock. Unlike grasses, these plants are perennial, offering more dependable sustenance, especially during periods of irregular rainfall (Eliphas !Owos-Oab, 2014).

The land use potential is for subsistence livestock farming currently being practised in the area. The soils have limited crop production potential, and the lack of available irrigation water makes large-scale crop production and commercial farming a non-viable land use (Erongo Regional Council, 2022).

5.2 SUITABILITY OF SOILS FOR REHABILITATION COVERS

Mine rehabilitation is enforced under the Namibian Environmental Management Act. Vegetation restoration is an important step in the process of ecosystem restoration on mined soils, as mined soils might result in slow or impaired plant growth due to it being a poor growth medium; this could, in turn, also impact the natural spread of vegetation. It has been found that most plant species' survival and growth were more successful in substrates with a higher calcium and clay content (Honghua He et al., 2015). The following properties are normally assessed in evaluating soil suitability: pH, elemental composition (Ca, Mg, P, K and Na, and total N), electrical conductivity, organic matter, organic carbon, calcium carbonate equivalent, and soil texture (sand, silt and clay) (Haimbili & Shiponeni, 2016).

The K factor values and particle percentages that were calculated support that the soils are dominated by loamy sand that can be stripped to be used in the rehabilitation process. The organic compound percentage is very low in all samples with moderate infiltration capacities, likely making the establishment of pastoral grasslands a challenge. Thus, a combination of the different soils and the import of organic material may be needed for the rehabilitation cover to have the best performance and for the plants to grow. This might not be practically possible as it may be too costly, and a detailed soil stripping and stockpiling plan should be developed as part of detailed designs for the waste rock dumps, tailings facilities and pits. The K-factor plays an important role, as it is immensely important that the cover is not from soil that will erode very easily, since the plants will need time to properly recolonise (thereby stabilising the soil surface)

in the new environment. As it is unrealistic to return the site to the “pre-mining” condition, it is recommended that topsoil (upper ~300 mm) stockpiling and retention of seedbanks be implemented early on in mine construction and maintenance thereof be carried forward through the environmental management plan. During pre-construction phases, topsoil and subsoil should be handled and stored separately. Typically, topsoil (300 mm) stockpiles should be stored at a height not exceeding 2 m to preserve soil quality and microbial activities. Effective stockpile management is likely to be required to minimise environmental impacts and preserve material quality. This includes implementing erosion control measures, dust suppression and proper management of drainage systems to prevent sediment runoff.

6 CONCLUSION

Soil profiling and sampling was conducted on EPL4818 to support the environmental impact assessment; allowing the impacts of mining activities to be evaluated on the soil quality through the establishment of a baseline.

Profiling and regional datasets concluded the predominant soil type to be that of Regosols (Eutric Skeletic Regosols). These soils are typically young, and unconsolidated, occur in areas of active erosion and have minimal topsoil layer overlying skeletal material (rock fragments and gravel). The texture is loamy sand with increased susceptibility to erosion in areas lacking vegetation.

Evaluation of the K-factor using the USLE produced values indicating moderate erosion susceptibility (as compared to clays), but dry conditions can exacerbate this (as is typical for the EPL 4818 area).

Chemically the soils are Ca-rich (due to the nature of the parent material) and predominantly near-neutral to alkali. Soils have limited fertility in that the topsoil (A-Horizon) shows limited development, however grazing for stock or natural vegetation remains feasible.

It is suggested that a detailed soil map depicting stripping depths and available cover soil volumes be created once the final site layout plans and detailed designs are available. These maps should be used to start the stripping and topsoil stockpiling plan, as well as inform the active topsoil balance for the life of mine. topsoil (upper ~300 mm) stockpiling and retention of seedbanks be implemented early on in mine construction and maintenance thereof be carried forward through the environmental management plan.

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APPENDIX A – TEST REPORT

FRM 168 version: 02, 2021-11-25

WO 147710:185765

PAGE: 1 of 2



Test Report

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Datum Ontvang/Date Received: 2024-03-19 Verslag nr./Report no.: WO 147710:185765
Datum Begin/Date Commenced: 2024-03-19 Datum Gerapporteer/Date Reported: 2024-04-03

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Lab Nummer	Sample Reference	pH KCl	P Bray1	K AmAc	Na AmAc	Ca AmAc	Mg AmAc	EXCH ACID KCl	Ca% AmAc	Mg% AmAc	K% AmAc	Na% AmAc	ACID SAT. AmAc	Ca:Mg AmAc	(Ca+Mg)/K AmAc	Mg:K AmAc	S-VALUE AmAc	Na:K AmAc	T-VALUE AmAc	Dens. g/ml	S AmAc
Lab Number	Monsterverwysing	-	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	cmol(+)/kg	%	%	%	%	%				cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	g/ml	mg/kg
G35-102866	50423 SS 001 Topsoil	8.06	2	40	8	1806	35	0.00	95.48	3.06	1.07	0.38	0.00	31.19	91.72	2.85	9.46	0.35	9.46	1.49	2.64
G35-102867	50424 SS 001 Subsoil	7.64	1	40	11	1518	46	0.00	93.51	4.65	1.25	0.59	0.00	20.11	78.71	3.73	8.12	0.48	8.12	1.52	1.31
G35-102868	50425 SS 002 Topsoil	7.16	10	216	15	3778	113	0.00	92.45	4.54	2.70	0.31	0.00	20.37	35.92	1.68	20.43	0.12	20.43	1.28	10.63
G35-102869	50426 SS 002 Subsoil	6.96	8	185	17	4142	113	0.00	93.35	4.19	2.13	0.33	0.00	22.30	45.75	1.96	22.18	0.15	22.18	1.23	11.35
G35-102870	50427 SS 003 Topsoil	6.60	18	254	11	3388	145	0.00	89.98	6.32	3.44	0.25	0.00	14.23	27.96	1.84	18.83	0.07	18.83	1.30	8.68
G35-102871	50428 SS 003 Subsoil	7.20	15	276	11	3675	171	0.00	89.50	6.84	3.44	0.23	0.00	13.09	28.04	1.99	20.53	0.07	20.53	1.28	12.04
G35-102872	50429 SS 004 Topsoil	7.53	11	281	10	3401	104	0.00	91.33	4.59	3.85	0.23	0.00	19.91	24.89	1.19	18.62	0.06	18.62	1.35	8.88
G35-102873	50430 SS 004 Subsoil	7.63	8	245	10	3454	106	0.00	91.79	4.63	3.34	0.24	0.00	19.81	28.90	1.39	18.82	0.07	18.82	1.33	7.62
G35-102874	50431 SS 005 Topsoil	6.46	21	97	16	758	65	0.00	81.63	11.54	5.33	1.50	0.00	7.07	17.48	2.17	4.64	0.28	4.64	1.37	1.54
G35-102875	50432 SS 005 Subsoil	5.94	25	134	14	924	119	0.00	77.04	16.26	5.70	1.00	0.00	4.74	16.38	2.86	6.00	0.17	6.00	1.29	1.00
G35-102876	50433 SS 006 Topsoil	7.51	18	118	10	2238	60	0.00	93.05	4.09	2.51	0.35	0.00	22.77	38.74	1.63	12.03	0.14	12.03	1.38	5.10
G35-102877	50434 SS 006 Subsoil	7.06	14	110	10	2044	64	0.00	92.34	4.73	2.55	0.38	0.00	19.53	38.10	1.86	11.07	0.15	11.07	1.42	5.12

Lab Nummer	Sample Reference	Zn DTPA	Cu DTPA	Mn DTPA	Fe DTPA	B (Hot WS)	CLAY	SILT	SAND	C WB	NH4-N	NO3-N	Resistance	SOM	EC (Sat-Paste)
Lab Number	Monsterverwysing	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	mg/kg	mg/kg	Ohm	%	mS/m
G35-102866	50423 SS 001 Topsoil	0.09	0.13	0.58	0.71	0.03	2	1	97	0.11	0.03	2.54	>4000	0.19	23.22
G35-102867	50424 SS 001 Subsoil	0.06	0.13	0.30	0.43	0.07	2	1	97	0.05	0.10	1.26	>4000	0.08	21.91
G35-102868	50425 SS 002 Topsoil	0.17	0.26	1.53	0.93	0.12	8	10	82	0.62	1.23	15.13	1334	1.06	46.50
G35-102869	50426 SS 002 Subsoil	0.16	0.29	1.49	0.86	0.10	10	9	81	0.59	0.59	16.40	1036	1.01	55.80
G35-102870	50427 SS 003 Topsoil	0.25	0.43	1.95	1.29	0.12	8	15	77	0.67	0.79	3.59	2307	1.16	30.70
G35-102871	50428 SS 003 Subsoil	0.26	0.45	1.62	1.34	0.15	8	13	79	0.58	0.37	5.38	2062	1.00	41.90
G35-102872	50429 SS 004 Topsoil	0.23	0.28	1.77	0.98	0.10	6	10	84	0.49	0.98	6.03	2145	0.84	45.50
G35-102873	50430 SS 004 Subsoil	0.22	0.32	1.97	0.95	0.08	6	10	84	0.47	0.26	12.59	1668	0.80	49.60
G35-102874	50431 SS 005 Topsoil	0.48	0.21	2.12	1.95	0.06	6	5	89	0.50	0.88	2.75	2783	0.86	23.69
G35-102875	50432 SS 005 Subsoil	0.25	0.30	2.34	2.93	0.04	10	8	82	0.28	0.12	2.95	2774	0.48	17.21
G35-102876	50433 SS 006 Topsoil	0.20	0.19	0.93	0.72	0.05	6	3	91	0.33	0.05	5.70	2107	0.57	30.90
G35-102877	50434 SS 006 Subsoil	0.20	0.21	1.13	0.82	0.05	6	5	89	0.24	0.02	8.72	1704	0.42	39.30

NOTAS / NOTES:

Verslag goedgekeur deur / Report approved by:

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TS: WIN 014, 031 & ICP-OES



Test Report

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Test	Method	Test	Method
pH(KCl)*	WIN 031	T-VALUE(AmAc)*	Calculation
P(Bray1)	WIN 073	Dens. - Density*	WIN 076
K(AmAc)	WIN 072	S (AmAc)	WIN 072
Na(AmAc)	WIN 072	Zn(DTPA)	WIN 050
Ca(AmAc)	WIN 072	Cu(DTPA)	WIN 050
Mg(AmAc)	WIN 072	Mn(DTPA)	WIN 050
EXCH ACID KCl	WIN 031	Fe(DTPA)	WIN 050
Ca%(AmAc)	WIN 072	B (Hot WS)*	WIN 075
Mg%(AmAc)	WIN 072	CLAY	WIN 062
K%(AmAc)	WIN 072	SILT	WIN 062
Na%(AmAc)	WIN 072	SAND	WIN 062
ACID SATURATION(AmAc)	WIN 072	Carbon(Walkley Black)	WIN 081
Ca:Mg(AmAc)	WIN 072	NH4-N(K2SO4 EXTR)	WIN 064
(Ca+Mg)/K (AmAc)	WIN 072	NO3-N(K2SO4 EXTR)	WIN 064
Mg:K(AmAc)	WIN 072	Resistance	WIN 066
S-VALUE(AmAc)	WIN 072	SOM - Soil Organic Matter	WIN 082
Na:K	WIN 072	EC (Saturated Paste)	WIN 033

End of Report