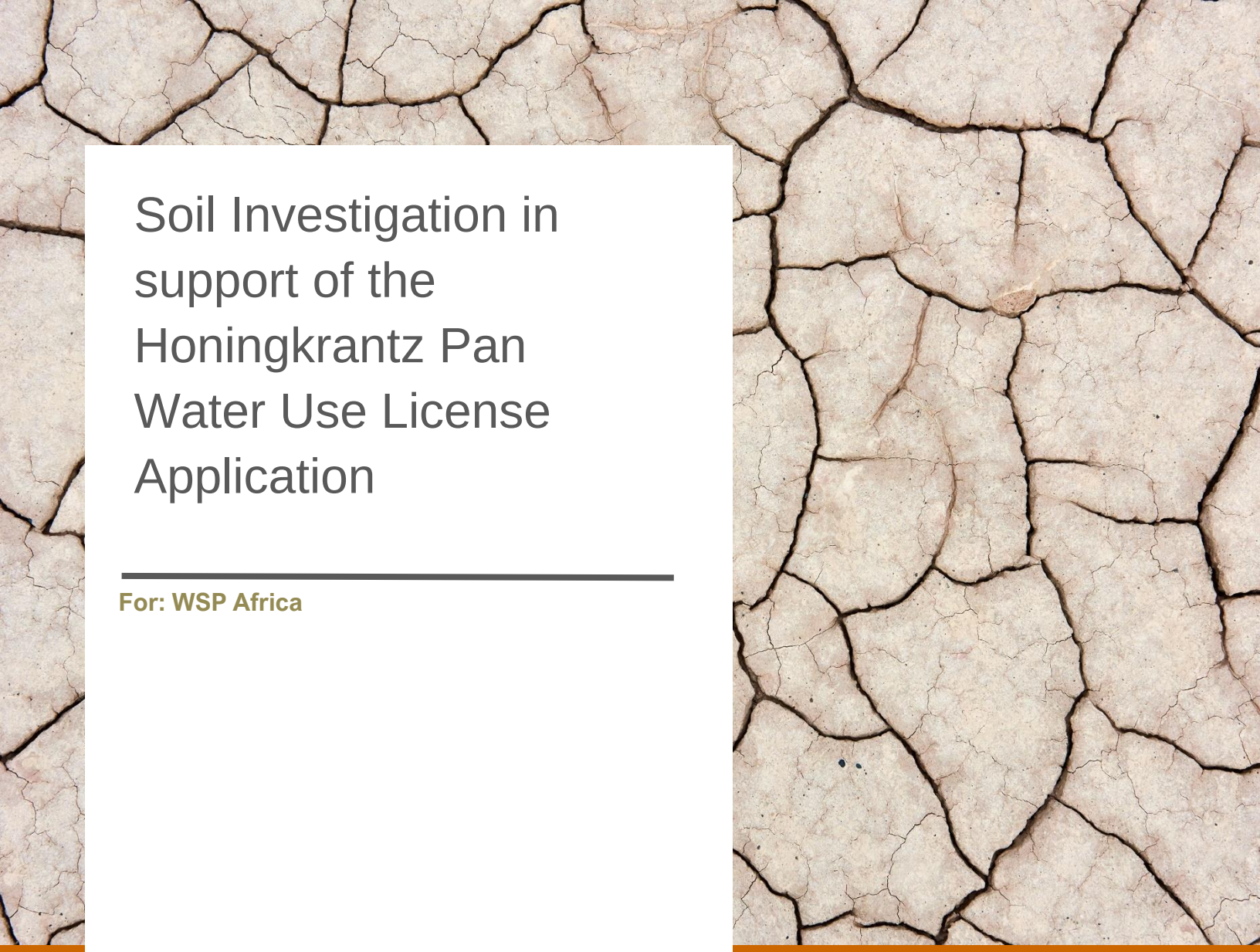

Soil Investigation in support of the Honingkrantz Pan Water Use License Application

For: WSP Africa

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SOIL ADVISORY SERVICES (PTY) LTD

Executive summary

Seriti Power (Ltd) Pty (Seriti) is in the process of submitting a new WULA for the mining of the Honingkrantz Block (Pit A) at their New Largo coal mine. The technical work supporting this application must address comments made by the DWS in their letter dated 11 July 2023. DWS' comments indicated that the extent of historical soil contamination in and around the New Largo Pan due to discharge of poor-quality water into the pan by previous activities must be determined, as part of the updated wetland offset strategy. A soil investigation at New Largo Pan was thus undertaken in support of the water use license application.

The objective of the soil investigation was to chemically and physically characterise and assess the soil in the basin of the New Largo pan, and in doing so, establish whether the New Largo Pan soils require further intervention to address the potential contaminant risk the pan soils may pose to the receiving environment.

The soil investigation was conducted in two phases, namely:

- Phase 1 – Pan soil screening assessment: comprised a literature review, sampling of the New Largo and Honingkrantz pan soils, followed by laboratory analyses, data evaluation (soil characterisation and waste assessment), and identification of potential constituents of concern which require further assessment (i.e., Phase 2).

- Phase 2: Further data evaluation of the identified potential constituents of concern, and additional pan soil sampling and analysis of a pan functioning similarly to New Largo pan. Pan 7, located west of the mining right area was selected as an appropriate reference pan for this purpose as it functions similarly to the New Largo pan.

In summary, the New Largo pan, Honingkrantz pan and Pan 7 soils can be described as follows:

- **New Largo Pan**: Soils are black to greyish gleyed, friable to firm, coarse, sand to clay loam to clay material, varying in thickness from 35 – 100 cm thick, abrupt transition to hard rock. Surface salt precipitates were also observed at the perimeter of the pan basin. Chemically the soils are neutral, slightly saline, with quartz and kaolinite being the dominant minerals in the soil, and has low potential for acid generation. Total concentrations of certain metals are elevated in the soils, but are still below the national baseline threshold (where available) for these metals. Metal solubility is also generally low, thus reducing the potential contaminant risk associated with the total metal exceedances. The water soluble PCoC's may affect the aquatic environment, more so during the dry season, when PCoC's are more concentrated in the soil solution.

- **Honingkrantz pan**: Soils are very dark brown to black, firm, sandy clay loam to clay; covered by thick layer of grass roots, humified material, transitioning to hard rock at shallow depth. Chemically the soils are slightly acidic to neutral, slightly to strongly saline, with quartz, muscovite and kaolinite being the dominant minerals in the soil, and has low potential for acid generation. Certain metals and major anions are elevated in the soils, and may affect the aquatic environment during the dry season. The pan's ecological status is moderately modified (i.e., a moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.). This suggests that the wetland still functions despite the elevated PCoCs.

- **Pan 7**: Soils are very dark brown to black, firm to friable, sandy clay to clay, varying in thickness, abrupt transition to hard rock, with distinct salt precipitate along the perimeter of the pan basin. Certain metals

are elevated in the soils, but are generally below the national baseline, with the exception of As and Pb. Water soluble levels of certain constituents are also elevated above the screening guidelines, but are most likely inherent to salt pans of this type.

Generally, the total metal PCoCs found in the New Largo pan soils, have low solubility, and thus low potential contaminant risk. The total metal PCoCs are also within range of that detected in the reference soil samples. The elevated water soluble PCoCs in the New Largo pan soils are also mostly similar to that detected in the reference soil samples. The elevated concentration of water soluble Zn in the New Largo pan soils can most likely be attributed to the pan water quality rather than inherent soil chemistry, since the total Zn concentration of the soils are relatively low. The reference soil's soluble Zn concentrations are below detection, but the Zn concentration of the pan water exceeds the aquatic acute effect value. Though the Honingkrantz pan does not completely function similarly to the New Largo and Pan 7 pans, its chemistry represents a largely natural pan's soil chemistry. The soluble Zn levels detected in the Honingkranz pan is above the aquatic chronic acute value and that found in the New Largo pan soils. The Honingkrantz pan functions well despite the elevated levels of certain PCoCs, including elevated Zn. Thus, it is probable that the elevated levels of soluble Zn in the New Largo pan soils, poses less of an impact on the functioning of the aquatic ecosystem within the New Largo pan.

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1. Introduction

Seriti Power (Ltd) Pty (Seriti) is in the process of submitting a new WULA for the mining of the Honingkrantz Block (Pit A) at their New Largo coal mine. The technical work supporting this application must address comments made by the DWS in their letter dated 11 July 2023. DWS' comments indicated that the extent of historical soil contamination in and around the New Largo Pan due to discharge of poor-quality water into the pan by previous activities must be determined, as part of the updated wetland offset strategy. A soil investigation at New Largo Pan was thus undertaken in support of the water use license application.

This report details the findings of the soil investigation conducted in support of the water use licence application.

2. Objectives

The objective of the soil investigation was to chemically and physically characterise and assess the soil in the basin of the New Largo pan, and in doing so, establish whether the New Largo Pan soils require further intervention to address the potential contaminant risk the pan soils may pose to the receiving environment.

3. Approach

The soil investigation was conducted in two phases, namely:

- Phase 1 – Pan soil screening assessment: comprised a literature review, sampling of the New Largo and Honingkrantz pan soils, followed by laboratory analyses, data evaluation (soil characterisation and waste assessment), and identification of potential constituents of concern which require further assessment (i.e., Phase 2).

- Phase 2: Further data evaluation of the identified potential constituents of concern, and additional pan soil sampling and analysis of a pan functioning similarly to New Largo pan. Pan 7, located west of the mining right area was selected as an appropriate reference pan for this purpose as it functions similarly to the New Largo pan.

4. Phase 1 – Pan soil screening assessment

4.1. Literature review

The desktop review of available information was done at the onset of the project to gain an understanding of the environmental conditions as well as to inform the soil sampling plan.

4.2. Field work and laboratory programme

The soil sampling was conducted on 12 April 2024 at the New Largo pan. The soil sampling of the Honingkrantz pan was done at a later stage (15 May 2024), due to waterlogged conditions during April.

A set of three locations per pan were sampled (Figure 1 and Figure 2). At each location, a sample of the clay layer was collected (where this was distinguishable). At one of the locations, two depth intervals (20 – 80 cm and 80 – 100 cm, at New Largo pan, and 0 – 20 cm and 20 –40 cm at Honingkrantz pan) were sampled. The laboratory programme and laboratories which undertook the various analyses are listed in Table 1.

Table 1. Laboratory programme for soil investigation

Analytical suite	No. of samples	Laboratory
▪ Total digestion (aqua regia) followed by an elemental ICP-MS scan) ▪ Neutral, Acid and Alkaline Leach testing - Australian Standard Leach Procedure (ASLP): Water extract (1:20) (Shake flask test) followed by an elemental ICP-MS scan, cations and anions including Ca, Na, K, Mg, SO_4^{2-}, Cl^-, F^-, NH_4^+, NO_3^-), total sulphur and total alkalinity; pH, EC and TDS ▪ Total organic carbon	8	Element Materials Technology
▪ XRD (on selected samples) ▪ Sulphur speciation	4 8	Waterlab
▪ Cation exchange capacity (CEC) ▪ 3 fraction particle size analysis	8	Eco analytica
▪ Saturated hydraulic conductivity	4	Soil Lab

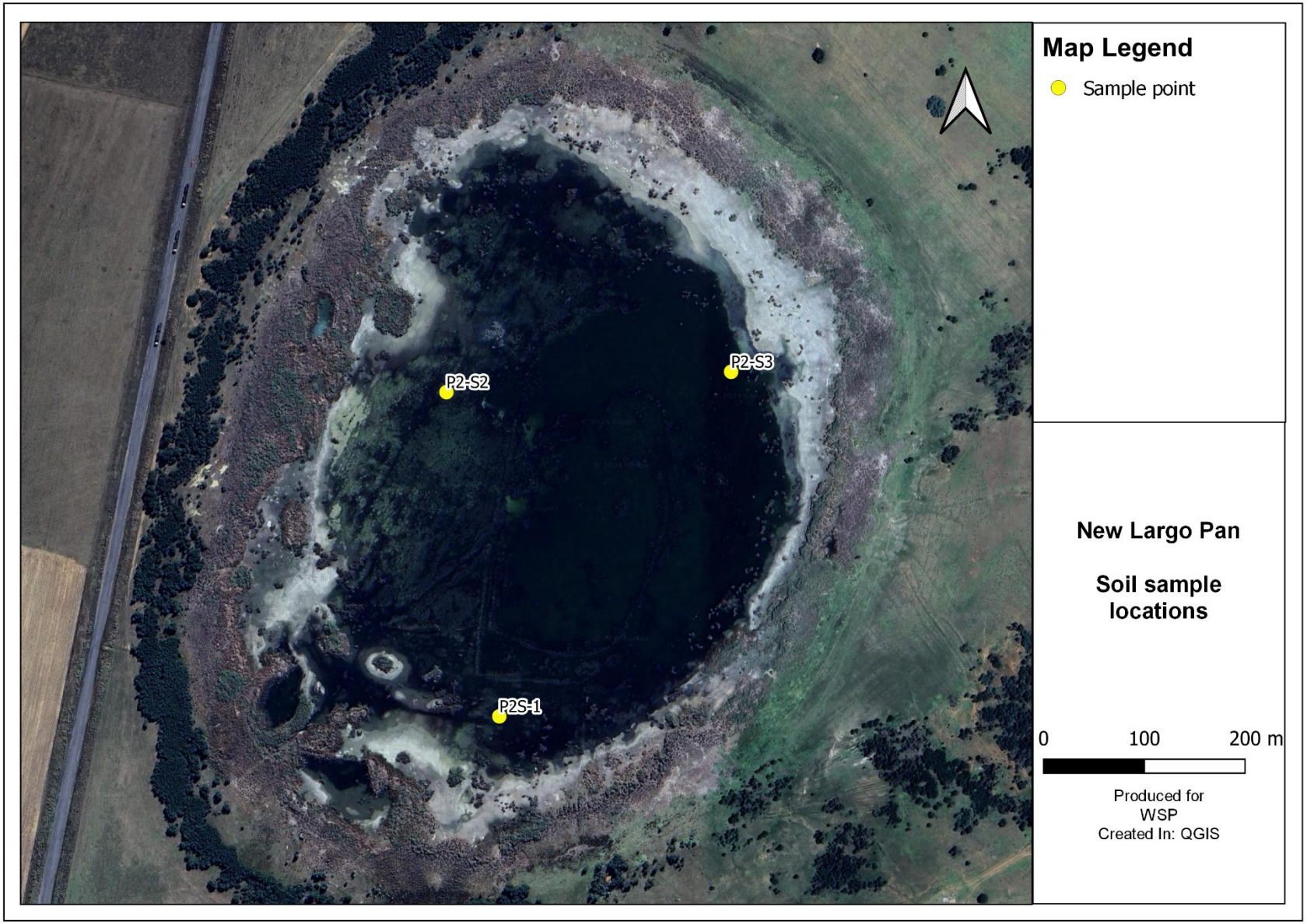

Figure 1. Locations of soil sample points at New Largo Pan

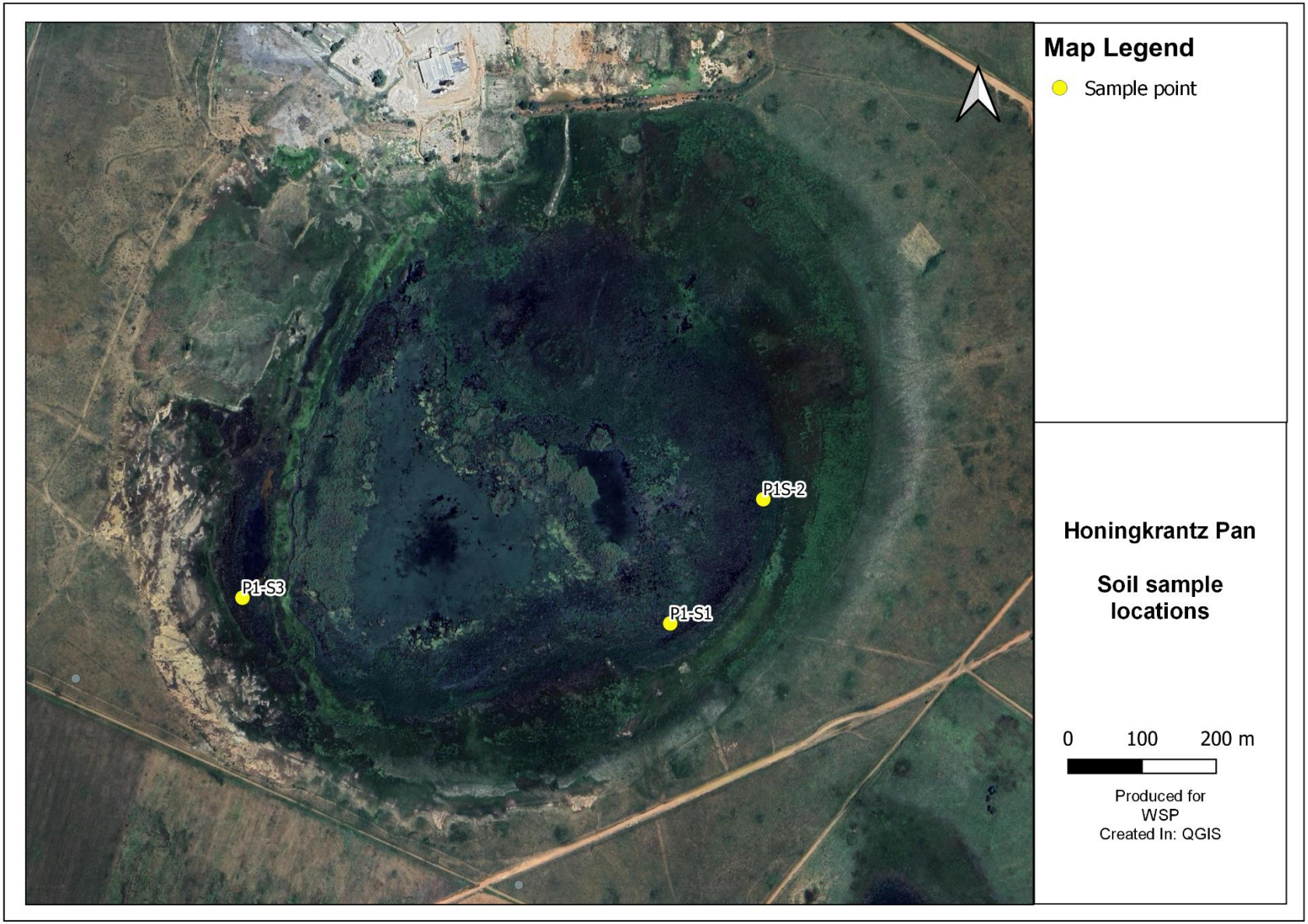

Figure 2. Locations of soil sample points at Honingkrantz Pan

4.3. Results

4.3.1. Soil physical properties

4.3.1.1. Field observations

During the site visits, a set of 3 points were evaluated per pan. As mentioned, the main purpose of the site visit was to assess the soil physical conditions of the pan soils, and to collect soil samples for laboratory analysis. The key features noted during the site visit are listed in Table 2. Generally, the pan soils have the following physical characteristics:

- **New Largo Pan**: black to greyish gleyed, friable to firm, coarse sand to clay loam to clay material, varying in thickness from 35 – 100 cm thick, abrupt transition to hard rock, with surface salt precipitates noted along portions of the pan perimeter (Figure 4, Figure 7).

- **Honingkrantz Pan**: very dark brown to black, firm, sandy clay loam to clay; covered by thick layer of grass roots, humified material, soil at S1-S3, transitioning to hard rock at shallow depth (Figure 6).

Figure 3. New Largo pan

Figure 4. Top fraction of soil profile at New Largo Pan sampling points P2-S1, P2-S2 and P2-S3 (from left to right)

Figure 5. Honingkrantz pan

Figure 6. Soil sampling at Honingkrantz pan -Left: thick vegetation mat on soil surface, right: very dark brown clayey soil

Table 2. Soil descriptions for New Largo and Honingkrantz pans

Pan	Observation point	Sample ID	Soil depth (cm)	Sample collected	Description
New Largo Pan	PS - S1	P2-S1.0	0 – 25		Wet; black; friable, coarse, loamy sand, with thick grass roots and organic matter on surface
		P2-S1.1	25 - 60		Wet; grey / gley; loose to friable coarse sand
		P2-S1.2	60 +	x	Wet; grey / gley; firm, fine to medium clay loam to clay, few yellow mottles
	PS - S2	P2-S2.0	0 – 20		Wet; grey; very firm, fine clay, with abundant Fe-staining on surface
		P2-S2.1	20 – 80	x	Wet; brown to grey; very firm, fine clay
		P2-S2.2	80 - 100	x	Wet; black; very firm, fine clay, on hard rock at 90/100cm
	P2 - S3	P2-S3.0	0 - 5	x	Wet; grey-brown; firm; firm silty sand; olive- grey silty crust
		P2-S3.1	5 - 35		Wet; black; friable; coarse loamy sand
		P2-S3.2	35 +		Hard rock
Honingkrantz Pan	P1 - S1	P1-S1.1	0 – 10/20	x	Wet; black to very dark brown; firm, fine, sandy clay, with thick grass roots and organic matter on surface
		P1-S1.2	10/20 - 40	x	Wet; very dark brown; firm, fine, clay
	P1 - S2	P1-S2	0 – 15	x	Wet; very dark brown transitioning to grey; firm, medium, sandy clay loam, with thick grass roots and organic matter on surface
	P1 - S3	P1-S3	0 – 15	x	Wet; black to very dark brown; firm, fine, clay loam, with thick grass roots and organic matter on surface

Figure 7. Iron staining on soil surface at P2-S2 (left) and salt precipitate on surface near sampling point P2-S3 (right)

4.3.1.2. Texture and saturated hydraulic conductivity

The texture was determined from a 3-fraction particle size analysis for the New Largo pan and Honingkrantz pan soil samples. A subset of these samples were submitted for falling head permeability. The remainder of the soil samples' saturated hydraulic conductivity was estimated using the USDA Soil Water Characteristics Tool (Saxton & Rawls, 2006). The soil physical properties of the pan are presented in Table 3. The soil texture triangle in Figure 8 shows the range of soil textural classes at each of the pans.

For the New Largo pan soil samples, low saturated hydraulic conductivities are reported, for the clay soils at sampling point P2-S2. The estimated hydraulic conductivities for the sandier samples at New Largo pan are high due to the coarse nature of the soil material. The Honingkrantz soil samples which were submitted for permeability analysis, had unusually high conductivities for the high clay content of these samples. This may be due to an incorrect remoulding density used at the laboratory for the analysis. A saturated hydraulic conductivity (as determined using the Soil Water Characteristics Tool) based on the particle size distribution and organic matter content of 0.26 mm/hr and 0.06 mm/hr for the sandy clay and clay Honingkrantz soils would be more expected for these types of soils.

Table 3. Soil physical properties of analysed soil samples

Pan	Sample ID	Sand	Silt	Clay	Texture Class	Ksat
	Units	(% < 2mm)				mm/hr
New Largo Pan	P2-S1	87.0	6.7	6.3	Loamy sand	90.78*
	P2-S2.1	9.0	28.9	62.1	Clay	0.132
	P2-S2.2	15.4	35.8	48.8	Clay	0.038
	P2-S3	81.5	9.4	9.0	Loamy sand	60.28*
Honingkrantz Pan	P1-S1.1	52.0	1.8	46.2	Sandy clay	38.5
	P1-S1.2	38.9	5.4	55.7	Clay	39.9
	P1S2	61.5	4.7	33.8	Sandy clay loam	2.67*
	P1S3	22.4	39.4	38.2	Clay loam	1.86*

Notes: * estimated using the USDA soil water characteristics tool

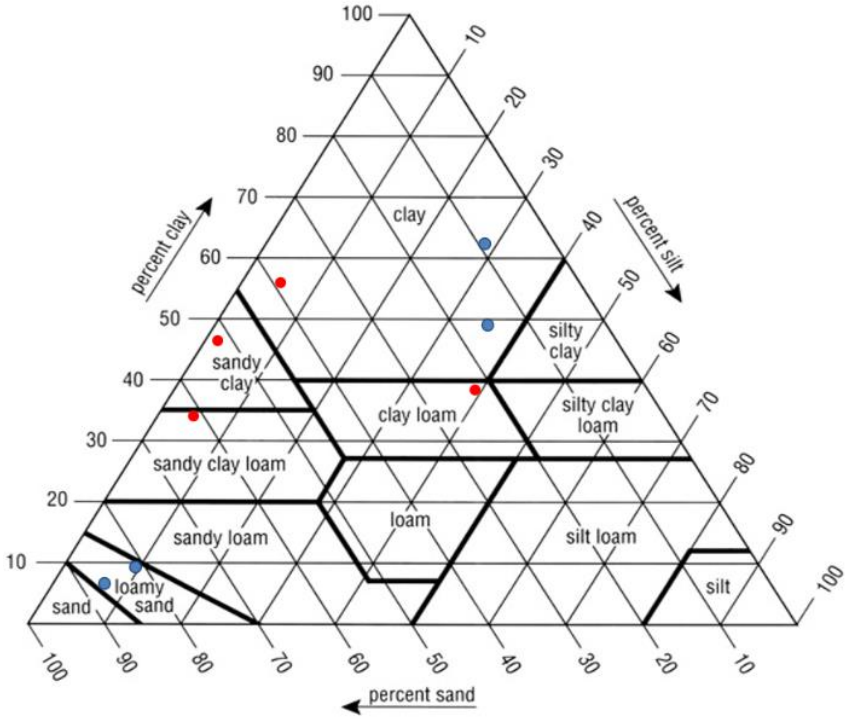

Figure 8. Soil texture triangle indicating soil texture classes for the Honingkrantz pan soils (red), and New Largo pan soils (blue)

4.3.2. Soil chemical properties

The chemical properties of the soils at the New Largo pan and Honingkrantz pan can be summarised as follows:

New Largo Pan

- Soils have neutral pH ranging from 7.2 – 7.9, and are slightly to moderately saline (paste EC ranging from 335 – 480 mS/m).
- For the sandier samples, the cation exchange capacity is moderate, whereas the CEC of the clayey soil, is double that of the sandy material at the pan.
- Soil organic carbon levels range from 0.2 – 1.2 %

Honingkrantz pan

- Soils are slightly acidic to alkaline with pH ranging from 5.8 – 7.4, and are non-saline to strongly saline (EC ranging from 58 – 863 mS/m).
- The cation exchange capacity of the soils is moderate to high, as expected for finer textured soils.
- Soil organic carbon levels range from 0.2 – 3.5 %

On average the water-soluble calcium and magnesium levels and sulphate in the New Largo soils are notably higher in comparison to the Honingkrantz soils. The Honingkrantz soils are however more saline, with higher water-soluble sodium levels. The range of major cations and anions in the two pans and the New Largo pan water quality is presented in the below table. The saturated paste extract EC of the New Largo soils are comparable to the EC of the pan water. The presented soil major cations and anion results in Table 4 are for a 1:20 water extract, thus more diluted than would be found for a saturated paste extract. An ammonium acetate exchangeable cation analysis or a 1:1 soil water extract would likely indicate higher levels of exchangeable Ca and Mg in the soils, than the 1:20 extract.

Table 4. Pan soil chemical properties compared to pan water qualities

		New Largo pan					Honingkrantz pan				
Parameter	**units**	Pan water	P2-S1	P2-S2-1	P2-S2-2	P2-S3	Pan water	P1-S1.1	P1-S1.2	P1S2	P1S3
Calcium	mg/l	427.7	3.9	13.8	18.7	21.6	21.7	4.9	4.1	2.4	1.6
Magnesium	mg/l	405.74	2.4	10.3	20.6	16.9	13.22	2.5	2.5	1.1	0.7
Potassium	mg/l	73.4	2.1	7.3	14.8	6	18.4	19.4	21.1	11.1	1.8
Sodium	mg/l	161.78	9.8	8.2	9.1	6.2	34.34	66.4	65.9	41.6	1.8
Sulphate	mg/l	3 360	38.8	102.9	199.8	152.2	11.69	74.7	140.7	42.4	13
Fluoride	mg/l	3.98	0.8	<0.3	<0.3	0.9	0.47	2.4	2.3	1.6	<0.3
Chloride	mg/l	56.5	1	1.6	1.2	2.4	48.9	24.6	35.7	8.9	0.6
Nitrate	mg/l	18	<0.2	<0.2	<0.2	2.1	<0.442	0.8	0.7	0.6	<0.2
TDS	mg/l	4 774	118	174	272	261	278	923	829	480	<35
EC*	mS/m	435	335	368	405	480	53.9	673	863	331	58
pH	pH units	4.6	7.47	7.99	7.24	7.44	6.12	6.89	7.15	7.41	5.83
CEC	cmol(+)/kg		7.5	13.5	21.7	10.2		26.5	33.3	19.4	21.1
Total organic carbon	%		0.22	0.75	1.23	0.56		1.49	0.71	0.22	3.57

Notes: * EC of saturated paste extract of soils

4.3.2.1. Total constituents

The soil solid elemental concentration chemistry was compared to the following screening guidelines:

- Soil screening values (SSV1) for the protection of water resources (GN R. 331 of May 2014)
- South African national baseline concentration of metals in soils based on clay content (Herselman, 2007).
- Australian and New Zealand Environment and Conservation Council (ANZECC) Sediment Quality Default Guideline Value (DGV) = indicate the concentrations below which there is a low risk of unacceptable effects occurring.
- ANZECC Sediment Quality Guideline Value High (GV-high) = provide an indication of concentrations at which you might already expect to observe toxicity-related adverse effects.

The purpose of using the above screening guidelines was to establish which elemental constituents in the pan soils may potentially pose an unacceptable risk to the environment. The South African national baseline soil metal concentrations and the South African soil screening values for the protection of water resources were considered most appropriate for the contamination screening of the soils collected in this study. Since the soils in both pans support aquatic biota, an additional screening guideline, namely the ANZECC (Australian and New Zealand Environment and Conservation Council) sediment quality guidelines were also employed. The ANZECC sediment guideline are primarily designed for assessing sediment quality in aquatic environments.

The screening assessment (presented in Table 5) of the total elemental analysis indicates that the concentration of total copper in the New Largo pan soils and Honingkrantz pan soils exceed the soil screening value for the protection of water resources. The concentration of copper was however below the national baseline threshold for Cu in high clay content soils.

Arsenic was also detected in the soils at both pans, though apart from New Largo pan sample P2-S2.1 which has total As equal to soil screening value for As (i.e., 5.8 mg/kg), all other samples' total arsenic are below the soil screening value.

When the results were screened against the ANZECC sediment guidelines, the concentrations of antimony, total chromium and nickel exceed the default guideline value in at least one sample from each pan. Low levels of mercury were also detected in one sample at the Honingkrantz pan, which is slightly above the ANZECC default guideline value, but below the SSV1. The concentration of total chromium and nickel are also below the national baseline threshold for total Cr and Ni in high clay content soils. Note: No national baseline threshold values are available for arsenic, antimony and mercury.

The potential risk the exceedances of total Cu, Sb, Cr(III), Ni and Hg in the soils in the pans pose to the aquatic environment are considered in more detail in Section 5.

Table 5. Soil total constituents compared to quality guideline values

Constituent	Units	LOD	SSV1	National baseline	ANZECC Default Guideline value	ANZECC SQG High	New Largo pan soils P2-S1	P2-S2-1	P2-S2-2	P2-S3	Honingkrantz pan soils P1-S1.1	P1-S1.2	P1S2	P1S3
Aluminium	mg/kg	<50					1985	45140	47130	6838	24340	22640	14280	45830
Antimony		<1			2	25	<1	3	2	<1	2	2	1	3
Arsenic		<0.5	5.8	n/a	20	70	<0.5	5.8	3.5	1.4	5.6	5.2	3.6	5
Barium		<1			ng	ng	36	80	182	126	313	317	226	107
Beryllium		<0.5			ng	ng	<0.5	1.4	1.5	<0.5	2.2	2.2	2.1	1.3
Cadmium		<0.1	7.5	n/a	1.5	10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium		<500					661	2635	4742	9137	2901	5527	4957	1446
Chromium		<0.5	46000	301	80	370	11.7	101.8	106	24.9	84.4	83.5	47.2	135.5
Cobalt		<0.5	300	54	ng	ng	1.4	9.1	11.9	5.3	16.9	15	10.8	10.5
Copper		<1	16	80	65	270	4	40	44	10	26	27	22	31
Iron		<20					1931	55000	47090	7959	30100	32980	19440	39560
Lead		<5	20	49	50	220	<5	16	14	<5	9	9	8	15
Magnesium		<25			ng	ng	308	1178	2175	2143	5144	4602	3098	1108
Manganese		<1	740	3735	ng	ng	22	161	240	156	108	405	150	253
Mercury		<0.1	0.93	n/a	0.15	1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	0.2
Molybdenum		<0.1			ng	ng	0.1	2	1.3	0.1	0.4	0.1	0.4	1.8
Nickel		<0.7	91	189	21	52	3.2	27	33	11.1	33.3	33.7	26.9	34.9
Phosphorus		<10					15	666	716	120	77	59	56	647
Potassium		<5					612	1592	3353	3337	10740	10080	6715	1635
Selenium		<1			ng	ng	<1	1	2	<1	<1	1	<1	1
Sodium		<5			ng	ng	65	353	439	219	2298	2635	1375	210
Thallium		<1			ng	ng	<1	<1	<1	<1	<1	<1	<1	<1
Vanadium		<1	150	382	ng	ng	6	130	111	17	55	54	34	106
Boron		<0.25			ng	ng	0.48	<0.25	1.78	3.86	7.02	5.65	3.49	1.66
Zinc		<5	240	91	200	410	<5	37	42	12	26	25	17	51
Chromium (VI)		<0.3	6.5				<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Total Organic Carbon	%	<0.02					0.22	0.75	1.23	0.56	1.49	0.71	0.22	3.57

4.3.2.2. Water soluble constituents and pan water quality

The 1:20 leachate results and water quality results were compared to the South African Water Quality (SAWQ) Guidelines for Aquatic Ecosystems (chronic and acute effect values) and Agriculture (suitability for irrigation and adverse chronic effects values for livestock) use. The following definitions are important to understand with regard to the SAWQ guidelines for Aquatic Ecosystems :

- ***Target Water Quality Range*** *(TWQR) is a management objective that is used to specify the desired or ideal concentration range and/or water quality requirements for a particular constituent.*
- *The **Chronic Effect Value** (CEV) is a criterion that is used, in certain special cases where the TWQR is exceeded. The setting of water quality requirements or objectives at the CEV protects aquatic ecosystems from acute toxicity effects.*
- *The **Acute Effect Value** (AEV) is a criterion used to identify those cases requiring urgent management attention because the aquatic environment is threatened, even if the situation persists only for a brief period.*

These limits were used to provide an understanding of the worst-case potential risk the soil leachate may pose for these particular uses.

The soil leachate results were also compared to the US EPA Phytotoxicity threshold value to assess whether the soil solution quality may affect plant growth. Note: the phytotoxicity threshold value considers general plant growth, and is not specific to aquatic or wetland plants which may have varying phytotoxicity tolerances.

A summary of the exceeding water-soluble constituents per sample are provided in Table 6. The water-soluble constituents and water quality thresholds are presented in Table 7 and Table 8.

Table 6. Summarised list of constituents exceeding screening guidelines per sample

Location	Sample ID	Water quality guideline exceeded		Phytotoxicity threshold
		Aquatic	Agriculture	
New Largo Pan	P2-S1	Al, Zn, Cl, F		
	P2-S2-1	Al, Zn, Cl		
	P2-S2-2	Al, Zn, Cl	B, Mn,	
	P2-S3	Al, Zn, Cl, P, F	B,	
Honingkrantz Pan	P1-S1.1	Al, Cu, P, Zn, Cl, F		Al, As,
	P1-S1.2	Al, Cu, P, Zn, Cl, F	Mn	Al
	P1S2	Al, Cu, P, Zn, Cl, F		
	P1S3	Al, Zn, P, Cl	Mn	Al

The water-soluble concentrations of fluoride in two of the samples, and the manganese in one of the samples from the New Largo pan soils, exceed the target water quality range, meaning that these constituents exceed the ideal concentration range and/or water quality requirements for fluoride and manganese in an aquatic environment. The analysis of soil samples from the New Largo pan also shows that the water-soluble concentrations of aluminium and chloride exceeds the acute effect value. The water-soluble levels of zinc and phosphorus (though only in sample S2-S3) exceeds the aquatic chronic effect value. The New Largo pan soils water soluble boron (and manganese in one sample) also exceeds the water quality guideline for irrigation use. No exceedances of the

water quality guideline for livestock use or of the phytotoxicity threshold were noted in the New Largo pan samples. The concentrations of Mn, Cu, Zn and Cl in the New Largo pan water sample also exceed the acute effect value, with the concentration Al in the water sample exceeding the chronic effect value. The selenium concentration in the new Largo pan water sample exceeds the target water quality range. The concentrations of B, Mn and Na in the New Largo water sample also exceeds the water quality guideline for irrigation use, with the concentration of Mn also exceeding the water quality guideline for livestock use.

For the Honingkrantz pan soils, the water-soluble concentrations of phosphorus (and zinc in one sample) exceeds the target water quality range, with the levels of aluminium and copper in the soils exceeding the acute effect value. The water-soluble concentration of zinc and fluoride in the majority of the Honingkrantz pan soils exceed the chronic effect value. The water-soluble concentrations of manganese in two of the Honingkrantz pan soil samples, exceed the water quality guideline for irrigation use. No exceedances of the agricultural water quality guideline for livestock use were noted. The water-soluble concentration of aluminium (and arsenic in one sample) also exceeds the phytotoxicity threshold. For the Honingkrantz pan water quality, the concentrations of Cu, Mn, Zn and Cl exceed the acute effect value, with the concentration Se in the water sample reported as equal to the chronic effect value. The fluoride concentration in the pan water sample exceeds the target water quality range. The concentrations of Mn and Na in the Honingkrantz pan water sample also exceeds the water quality guideline for irrigation use.

When comparing the soil leachate quality and pan water quality, it is noticeable that certain elevated constituents (such as Cu, Mn, Zn, Cl and F) in the soil leachate correspond with the same constituents being elevated in the pan waters.

Important to note is that the soil leachate quality exceedances of the water quality guidelines present a worst-case scenario (Note: a 1:20 water extract was used). The surface water quality at the sample points is likely to be more diluted than a 1:20 soil water extract (particularly during the wet season). The results are however still useful, as it provides an indication of the soil leachable (mobile) fraction, and how it may impact the surface water quality. It also highlights a worst-case scenario risk the soil poses to the receptors. The noted exceedances in the 1:20 leachate can be considered as an early indicator of a potential surface water quality issue.

Table 7. Water soluble constituents compared to aquatic water quality guidelines

Constituent / Parameter	Units	LOD	DWAF water quality guidelines - Aquatic			New Largo Pan water	New Largo pan soils				Honing krantz pan water	Honingkrantz pan soils			
			TWQR	CEV	AEV		P2-S1	P2-S2-1	P2-S2-2	P2-S3		P1-S1.1	P1-S1.2	P1S2	P1S3
Aluminium	mg/L	<0.02	0.01	0.02	0.15	**0.08**	**0.233**	0.022	0.101	0.125	<0.05	**0.538**	**1.341**	**0.206**	**0.422**
Antimony		<0.002				0.056	<0.002	<0.002	<0.002	<0.002	0.056	<0.002	<0.002	<0.002	<0.002
Arsenic		<0.0025	0.01	0.02	0.13	0.006	<0.0025	<0.0025	<0.0025	<0.0025	0.006	0.0043	<0.0025	<0.0025	<0.0025
Barium		<0.003				0.176	0.161	0.081	0.098	0.068	0.432	0.145	0.2	0.082	0.02
Beryllium		<0.0005				0.013	<0.0005	<0.0005	<0.0005	<0.0005	0.013	<0.0005	<0.0005	<0.0005	<0.0005
Boron		<0.012				0.92	0.304	0.335	0.506	0.545	<0.1	0.016	<0.012	<0.012	<0.012
Cadmium		<0.0005	0.00025	0.0005	0.006	<0.0001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0001	<0.0005	<0.0005	<0.0005	<0.0005
Calcium		<0.3				691	3.9	13.8	18.7	21.6	59.1	4.9	4.1	2.4	1.6
Chromium (III)		<0.0015	0.007	0.014	0.2	<0.001	<0.0015	<0.0015	<0.0015	<0.0015	<0.001	<0.0015	0.0024	<0.0015	<0.0015
Chromium (VI)		<0.006	0.007	0.014	0.2	<0.007	<0.006	<0.006	<0.006	<0.006	<0.007	<0.006	<0.006	<0.006	<0.006
Cobalt		<0.002				<0.001	<0.002	<0.002	<0.002	<0.002	<0.001	0.003	0.002	<0.002	<0.002
Copper		<0.007	0.0008	0.0015	0.0046	**0.008**	<0.007	<0.007	<0.007	<0.007	**0.005**	**0.022**	**0.029**	**0.012**	<0.007
Lead		<0.005	0.0005	0.001	0.007	<0.001	<0.005	<0.005	<0.005	<0.005	<0.001	<0.005	<0.005	<0.005	<0.005
Iron		<0.02				<0.005	0.166	<0.02	0.039	0.095	0.92	1.071	1.701	0.23	0.194
Magnesium		<0.2				1 207.10	2.4	10.3	20.6	16.9	61.60	2.5	2.5	1.1	0.7
Manganese		<0.002	0.18	0.37	1.3	**10.8**	<0.002	0.015	0.152	<0.002	**0.683**	0.008	0.029	0.002	0.16
Mercury		<0.001	0.00004	0.00008	0.0017	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
Molybdenum		<0.002				0.054	<0.002	<0.002	<0.002	<0.002	0.054	<0.002	<0.002	<0.002	<0.002
Nickel		<2				0.059	<0.002	<0.002	<0.002	<0.002	0.019	0.015	0.015	0.005	<0.002
Potassium		<0.1				503	2.1	7.3	14.8	6	120	19.4	21.1	11.1	1.8
Phosphorus		<0.005	0.005	0.025	0.25		<0.005	<0.005	<0.005	0.056		0.017	0.013	0.005	0.006
Selenium		<0.003	0.002	0.005	0.03	0.004	<0.003	<0.003	<0.003	<0.003	**0.005**	<0.003	<0.003	<0.003	<0.003
Sodium		<0.1				982.45	9.8	8.2	9.1	6.2	281.66	0.0664	0.0659	0.0416	0.0018
Thallium		<0.003				0.003	<0.003	<0.003	<0.003	<0.003	0.003	<0.003	<0.003	<0.003	<0.003
Vanadium		<0.0015				<0.001	<0.0015	<0.0015	<0.0015	0.0047	<0.001	0.0147	0.0143	0.0068	<0.0015
Zinc		<0.003	0.002	0.0036	0.036	**0.17**	0.021	0.023	0.026	0.01	**0.079**	0.028	0.013	0.01	0.003
Sulphate		<0.5				11 990	38.8	102.9	199.8	152.2	2.749	74.7	140.7	42.4	13
Fluoride		<0.3	0.75	1.5	2.54	0.113	0.8	<0.3	<0.3	0.9	0.788	2.4	2.3	1.6	<0.3
Chloride		<0.3	0.0002*	0.00035*	0.005*	**326.7**	**1**	**1.6**	**1.2**	**2.4**	**118.3**	**24.6**	**35.7**	**8.9**	**0.6**
Nitrate		<0.2				<0.1	<0.2	<0.2	<0.2	2.1	<0.1	0.8	0.7	0.6	<0.2
Ammonium		<0.03				12.586	<0.03	<0.03	<0.03	<0.03	2.462	0.05	0.06	<0.03	0.48
Total Dissolved Solids		<35				8160	118	174	272	261	1090	923	829	480	<35
Electrical Conductivity*	µS/cm	<2				10240	243	109	376	312	1319	396	470	231	52
pH		<2.00				8.36	7.47	7.99	7.24	7.44	7.84	6.89	7.15	7.41	5.83

Notes: EC is for a 1:20 water extract. Saturated paste extract EC is provided in Table 4.

Table 8. Water soluble constituents compared to water quality guidelines for agricultural use

Constituent / Parameter	units	LOD	Phytotoxicity in soil solution (US EPA, 1997)	DWAF Water quality guideline - Agriculture		New Largo Pan	New Largo pan soils				Honing Krantz Pan	Honingkrantz pan soils			
				Irrigation	Livestock	water	P2-S1	P2-S2-1	P2-S2-2	P2-S3	water	P1-S1.1	P1-S1.2	P1S2	P1S3
Aluminium	mg/L	<0.02	0.3	5	5	0.08	0.233	0.022	0.101	0.125	<0.05	0.538	1.341	0.206	0.422
Antimony		<0.002				0.056	<0.002	<0.002	<0.002	<0.002	0.056	<0.002	<0.002	<0.002	<0.002
Arsenic		<0.0025	0.001	0.1	1	0.006	<0.0025	<0.0025	<0.0025	<0.0025	0.006	0.0043	<0.0025	<0.0025	<0.0025
Barium		<0.003				0.176	0.161	0.081	0.098	0.068	0.432	0.145	0.2	0.082	0.02
Beryllium		<0.0005	0.5			0.013	<0.0005	<0.0005	<0.0005	<0.0005	0.013	<0.0005	<0.0005	<0.0005	<0.0005
Boron		<0.012	1	0.5	5	0.92	0.304	0.335	0.506	0.545	<0.1	0.016	<0.012	<0.012	<0.012
Cadmium		<0.005	0.1	0.01	0.01	<0.0001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0001	<0.0005	<0.0005	<0.0005	<0.0005
Calcium		<0.0003			1000	691	3.9	13.8	18.7	21.6	59.1	4.9	4.1	2.4	1.6
Chromium (III)		<0.0015	0.05	0.1	1	<0.001	<0.0015	<0.0015	<0.0015	<0.0015	<0.001	<0.0015	0.0024	<0.0015	<0.0015
Chromium (VI)		<0.006				<0.001	<0.006	<0.006	<0.006	<0.006	<0.001	<0.006	<0.006	<0.006	<0.006
Cobalt		<0.002	0.06	0.05	1	0.008	<0.002	<0.002	<0.002	<0.002	0.005	0.003	0.002	<0.002	<0.002
Copper		<0.007	0.06	0.2	0.5	<0.001	<0.007	<0.007	<0.007	<0.007	<0.001	0.022	0.029	0.012	<0.007
Lead		<0.005	0.02	0.2	0.1	<0.005	<0.005	<0.005	<0.005	<0.005	0.92	<0.005	<0.005	<0.005	<0.005
Iron		<0.02	10	5	10	1207.1	0.166	<0.02	0.039	0.095	61.6	1.071	1.701	0.23	0.194
Magnesium		<0.2			500	10.8	2.4	10.3	20.6	16.9	0.683	2.5	2.5	1.1	0.7
Manganese		<0.002	4	0.02	10	<0.0001	<0.002	0.015	0.152	<0.002	<0.0001	0.008	0.029	0.002	0.16
Mercury		<0.001	0.005		0.001	0.054	<0.001	<0.001	<0.001	<0.001	0.054	<0.001	<0.001	<0.001	<0.001
Molybdenum		<0.002	0.5		0.01	0.059	<0.002	<0.002	<0.002	<0.002	0.019	<0.002	<0.002	<0.002	<0.002
Nickel		<0.002	0.5	0.2	1	503	<0.002	<0.002	<0.002	<0.002	120	0.015	0.015	0.005	<0.002
Potassium		<0.0001				0.004	2.1	7.3	14.8	6	0.005	19.4	21.1	11.1	1.8
Phosphorus		<0.005				982.45	<0.005	<0.005	<0.005	0.056	281.66	0.017	0.013	0.005	0.006
Selenium		<0.003	0.7	0.02	0.05	0.003	<0.003	<0.003	<0.003	<0.003	0.003	<0.003	<0.003	<0.003	<0.003
Sodium		<0.0001		70	2000	<0.001	9.8	8.2	9.1	6.2	<0.001	0.0664	0.0659	0.0416	0.0018
Thallium		<0.003	0.05			0.17	<0.003	<0.003	<0.003	<0.003	0.079	<0.003	<0.003	<0.003	<0.003
Vanadium		<0.0015	0.2	0.1	1	0.08	<0.0015	<0.0015	<0.0015	0.0047	<0.05	0.0147	0.0143	0.0068	<0.0015
Zinc		<0.003	0.4	1	20	0.056	0.021	0.023	0.026	0.01	0.056	0.028	0.013	0.01	0.003
Sulphate		<0.5				11 990	38.8	102.9	199.8	152.2	2.749	74.7	140.7	42.4	13
Fluoride		<0.3				0.113	0.8	<0.3	<0.3	0.9	0.788	2.4	2.3	1.6	<0.3
Chloride		<0.3				326.719	1	1.6	1.2	2.4	118.256	24.6	35.7	8.9	0.6
Nitrate		<0.2				<0.1	<0.2	<0.2	<0.2	2.1	<0.1	0.8	0.7	0.6	<0.2
Ammonium		<0.03				12.586	<0.03	<0.03	<0.03	<0.03	2.462	0.05	0.06	<0.03	0.48
Total Dissolved Solids		<35				8160	118	174	272	261	1090	923	829	480	<35
Electrical Conductivity	µS/cm	<2				10240	243	109	376	312	1319	396	470	231	52
pH		<2.00				8.36	7.47	7.99	7.24	7.44	7.84	6.89	7.15	7.41	5.83

4.3.3. Soil mineralogy

As an initial s creening for the acid generation potential of the soils, a subset of samples from each pan were submitted for X-ray diffraction (XRD) mineralogy determination, sulphur speciation analysis and determination of the pH of a saturated paste extract. The results of the XRD and sulphur speciation are presented in Table 9 and Table 10 respectively.

In terms of mineralogy, the New Largo soil samples are largely composed of quartz and kaolinite. The Honingkrantz samples are also largely quartz with muscovite and some kaolinite (both non-swelling clays). The percentage mineral composition of the analysed soil samples is shown in Figure 9.

Based on the mineralogy and sulphur speciation results, the New Largo pan soils and the Honingkrantz pan soils have very low potential for acid generation (i.e., no sulphur containing minerals detected, and low sulphide sulphur (0.01 – 0.03%)).

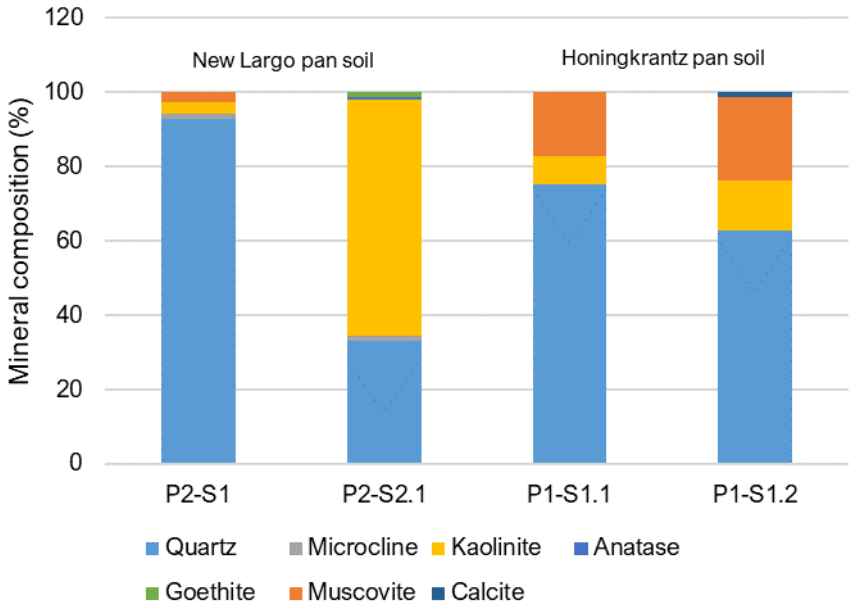

Figure 9. Mineral composition of soil samples from New Largo pan and Honingkrantz pan

Table 9. Mineral composition of soil samples from New Largo pan and Honingkrantz pan

Mineral	Formula	New Largo pan		Honingkrantz pan	
		P2-S1	P2-S2.1	P1-S1.1	P1-S1.2
		Composition (%)			
Quartz	SiO_2	92.76	33.11	75.1	62.7
Microcline	$KAlSi_3O_8$	1.33	1.26	0	0
Muscovite	$KAl_2(Si_3Al)O_{10}(OH)_2$	2.84	0	17.1	22.4
Kaolinite	$Al_2Si_2O_5(OH)_4$	3.08	63.61	7.9	13.6
Anatase	TiO_2	0	0.76	0	0
Goethite	$FeO(OH)$	0	1.26	0	0
Calcite	$CaCO_3$	0	0	0	1.4

Table 10. Sulphur speciation results for New Largo pan soils

Analyses	New Largo pan samples				Honingkrantz pan samples			
	P2-S1	P2-S2.1	P2-S2.2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3
Total Sulphur (%)	0.02	0.11	0.34	0.12	0.063	0.072	0.022	0.059
Sulphate Sulphur as S (%)	<0.01	0.1	0.32	0.09	0.018	0.005	<0.002	0.015
Sulphide Sulphur (%)	0.02	0.01	0.01	0.03	0.044	0.067	0.002	0.044

4.3.4. Waste classification and assessment

The purpose of conducting the waste assessment according to the relevant waste regulations was to establish, i) whether the pan soils are potentially hazardous, and ii) if disposal of the soil is to be considered as a rehabilitation option, what the waste type and associated disposal requirements would be.

4.3.4.1. SANS 10234 classification

Classification of the waste according to GN R.634 of 2013 and SANS 10234 (based on the Global Harmonised System) indicating physical, human health and aquatic environmental hazards. The SANS 10234 covers the harmonized criteria for classification of potentially hazardous substances and mixtures, including wastes, in terms of its intrinsic properties/hazards. The South Africa Bureau of Standards published SANS 10234:2019 (edition-2) in December 2019. As per SANS 10234, the percentage concentration of chemical constituents of the waste material will be screened in terms of physical, human health and environmental hazards as per the cut off limits presented in Table 11.

Table 11 Hazard classes and associated cut-off concentration limits

Hazard class	Cut-off value (concentration limit) %
Acute toxicity	> 1.0
Skin corrosion	> 1.0
Skin irritation	> 1.0
Serious damage to eyes	> 1.0
Eye irritation	> 1.0
Respiratory sensitization	> 1.0
Skin sensitization	> 1.0
Mutagenicity: Category 1 Category 2	 > 0.1 > 1.0
Carcinogenicity	> 0.1
Reproductive toxicity	> 0.1
Target organ systemic toxicity	> 1.0
Hazardous to the aquatic environment	> 1.0

The SANS 10234 classification for the soil is as follows:

- Physical hazards – soils from both pans are not explosive, flammable (combustible through friction), self-reactive (exothermic decomposition), pyrophoric (ignite when in contact with air), self-heating or oxidising and does not release toxic gases when in contact with water or acid. Therefore, it is not hazardous in terms of physical characteristics.

- Health hazards – The percentage concentration of constituents obtained from the acid digestion analysis was compared to the cut-off values/concentration limits for hazard classes. The total Al and Fe

concentrations in the Honingkrantz pan soils, and the New Largo pan soil sample P2-S2-1 and P2-S2.2 exceeded the 1% cut-off values but the soluble/leachable concentrations were <0.1%. No carcinogens or mutagens were present in concentrations >0.1%. The soils from both pans therefore do not pose a hazard to human health.

- Environmental hazard – As noted above, the total concentration of Al and Fe in most of the soil samples exceed that 1% cut-off value for aquatic environments. The solubility of constituents in the soil samples are however low (<0.1%), but in the case of Al, is reported above the chronic effect value for Al in the case of the New Largo pan soils, and above the acute effect value for the Honingkrantz pan soils (no local CEV or AEV is available for Fe). According to the SANS 10234 cut-off and based on the water quality screening results presented in Section 4.3.2.2 the soils may be harmful to the aquatic environment.

4.3.4.2. Waste assessment

The potential level of risk associated with materials/wastes can be determined by following the prescribed and appropriate leach test protocols in terms of the GN R.635 of 23 August 2013. The analytical results need to be screened against the four levels of thresholds for leachable and total concentrations, which in combination, determines the waste type and potential risk posed to the environment. The thresholds for the total concentrations (TC in mg/kg) and leachable concentrations (LC in mg/l) are defined for the set of chemical constituents published in GN R.635 of 23 August 2013.

The waste type (low to high risk) is defined as follows:

- Type 4: LC ≤ LCT0 and TC ≤ TCT0;
- Type 3: LC ≥ LCT0 but ≤ LCT1 and TC ≤ TCT1;
- Type 2: LC > LCT1 but ≤ LCT2 and TC ≤ TCT1;
- Type 1: LC > LCT2 but ≤ LCT3 or TC > TCT1 ≤ TCT2; and
- Type 0: LC > LCT3 or TC > TCT2.

The analytical results of soils from the two pans were screened against the TCT and LCT levels are presented in Table 13 - Table 16Table 14. A summary of constituents exceeding the threshold levels and the waste types are shown in Table 12.

Apart from New Largo pan sample P2-S1 which classified a Type 4 waste (LC ≤ LCT0 and TC ≤ TCT0), all other samples from the New Largo pan, and all samples from the Honingkrantz pan soils are Type 3 wastes due to TC≥TCT0 but ≤TCT1 and LC≥LCT0 but ≤LCT1.

Table 12 Waste assessment summary

Sample point	TC ≥TCT0 but <TCT1	LC ≥ LCT0 but <LCT1			Waste Type
		Water leach	Tetraborate leach	Acetic acid leach	
P2-S1		-	As, Ba		Type 4
P2-S2-1	Ba, Cu		As		Type 3
P2-S2-2	Ba, Cu	B	As	Mn, SO4,	Type 3
P2-S3	Ba	B	As	Mn	Type 3
P1-S1.1	Ba, Cu		F, TDS	TDS	Type 3
P1-S1.2	Ba, Cu	F		Mn, TDS	Type 3
P1S2	Ba, Cu	F	Ba	Mn	Type 3
P1S3	Ba, Cu	F		Mn	Type 3

Table 13. Soil total constituents compared to GN R.635 total concentration thresholds

					New Largo pan soils				Honingkrantz pan soils			
CoC	**Units**	**TCT0**	**TCT1**	**TCT2**	P2-S1	P2-S2-1	P2-S2-2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3
Antimony	mg/kg	10	75	300	<1	3	2	<1	2	2	1	3
Arsenic		5.8	500	2000	<0.5	5.8	3.5	1.4	5.6	5.2	3.6	5
Barium		62.5	6250	25000	36	80	182	126	313	317	226	107
Cadmium		7.5	260	1040	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium		46000	800000	N/A	11.7	101.8	106	24.9	84.4	83.5	47.2	135.5
Cobalt		50	5000	20000	1.4	9.1	11.9	5.3	16.9	15	10.8	10.5
Copper		16	19500	78000	4	40	44	10	26	27	22	31
Lead		20	1900	7600	<5	16	14	<5	9	9	8	15
Manganese		1000	25000	100000	22	161	240	156	108	405	150	253
Mercury		0.93	160	640	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	0.2
Molybdenum		40	1000	4000	0.1	2	1.3	0.1	0.4	0.1	0.4	1.8
Nickel		91	10600	42400	3.2	27	33	11.1	33.3	33.7	26.9	34.9
Selenium		10	50	200	<1	1	2	<1	<1	1	<1	1
Vanadium		150	2680	10720	6	130	111	17	55	54	34	106
Boron		150	15000	60000	0.48	<0.25	1.78	3.86	7.02	5.65	3.49	1.66
Zinc		240	160000	640000	<5	37	42	12	26	25	17	51
Chromium (VI)		6.5	500	2000	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

Table 14. Soil leachable (ASLP 1:20 deionised water leach) constituents compared to GN R.635 leachable concentration thresholds

						New Largo pan soils				Honingkrantz pan soils			
CoCs	**units**	**LCT0**	**LCT1**	**LCT2**	**LCT3**	P2-S1	P2-S2-1	P2-S2-2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3
Antimony	mg/L	0.02	1	2	8	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic		0.01	0.5	1	4	<0.0025	<0.0025	<0.0025	<0.0025	0.0043	<0.0025	<0.0025	<0.0025
Barium		0.7	35	70	280	0.161	0.081	0.098	0.068	0.145	0.2	0.082	0.02
Boron		0.5	25	50	200	0.304	0.335	0.506	0.545	0.016	<0.012	<0.012	<0.012
Cadmium		0.003	0.15	0.3	1.2	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium		0.1	5	10	40	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	0.0024	<0.0015	<0.0015
Cobalt		0.5	25	50	200	<0.002	<0.002	<0.002	<0.002	0.003	0.002	<0.002	<0.002
Copper		2	100	200	800	<0.007	<0.007	<0.007	<0.007	0.022	0.029	0.012	<0.007
Lead		0.01	0.5	1	4	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese		0.5	25	50	200	<0.002	0.015	0.152	<0.002	0.008	0.029	0.002	0.16
Mercury		0.006	0.3	0.6	2.4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum		0.07	3.5	7	28	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Nickel		0.07	3.5	7	28	<0.002	<0.002	<0.002	<0.002	0.015	0.015	0.005	<0.002
Selenium		0.01	0.5	1	4	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Vanadium		0.2	10	20	80	<0.0015	<0.0015	<0.0015	0.0047	0.0147	0.0143	0.0068	<0.0015

CoCs	units					New Largo pan soils				Honingkrantz pan soils			
		LCT0	LCT1	LCT2	LCT3	P2-S1	P2-S2-1	P2-S2-2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3
Zinc		5	250	500	2000	0.021	0.023	0.026	0.01	0.028	0.013	0.01	0.003
Sulphate		250	12500	25000	100000	38.8	102.9	199.8	152.2	74.7	140.7	42.4	13
Fluoride		1.5	75	150	600	0.8	<0.3	<0.3	0.9	2.4	2.3	1.6	<0.3
Chloride		300	15000	30000	120000	1	1.6	1.2	2.4	24.6	35.7	8.9	0.6
Nitrate		11	550	1100	4400	<0.2	<0.2	<0.2	2.1	0.8	0.7	0.6	<0.2
Chromium (VI)		0.05	2.5	5	20	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
TDS		1000	12500	25000	100000	118	174	272	261	923	829	480	<35

Table 15. ASLP 1:20 acetic acid leach constituents compared to GN R.635 leachable concentration thresholds

CoCs	Units					New Largo pan soils				Honingkrantz pan soils			
		LCT0	LCT1	LCT2	LCT3	P2-S1	P2-S2-1	P2-S2-2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3
Antimony	mg/L	0.02	1	2	8	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic		0.01	0.5	1	4	<0.0025	<0.0025	<0.0025	0.003	<0.0025	<0.0025	<0.0025	<0.0025
Barium		0.7	35	70	280	0.625	0.256	0.231	0.965	0.376	0.345	0.541	0.475
Boron		0.5	25	50	200	0.18	0.154	0.22	0.232	<0.012	<0.012	<0.012	<0.012
Cadmium		0.003	0.15	0.3	1.2	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium		0.1	5	10	40	<0.0015	<0.0015	<0.0015	<0.0015	0.0026	0.0032	0.002	0.0018
Cobalt		0.5	25	50	200	<0.002	0.003	0.006	<0.002	0.002	0.005	0.014	0.012
Copper		2	100	200	800	<0.007	<0.007	<0.007	<0.007	0.011	<0.007	<0.007	<0.007
Lead		0.01	0.5	1	4	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese		0.5	25	50	200	0.085	0.445	1.26	0.951	0.14	0.748	2.214	1.865
Mercury		0.006	0.3	0.6	2.4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum		0.07	3.5	7	28	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Nickel		0.07	3.5	7	28	<0.002	0.003	0.006	0.005	0.007	0.008	0.006	0.006
Selenium		0.01	0.5	1	4	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Vanadium		0.2	10	20	80	<0.0015	<0.0015	0.0021	0.0063	0.0098	0.0063	<0.0015	0.0016
Zinc		5	250	500	2000	0.292	0.106	0.124	0.114	0.014	0.023	0.035	0.032
Sulphate		250	12500	25000	100000	33.7	89.8	264.7	96.9	3.4	76.2	6.5	1.3
Chloride*		300	15000	30000	120000	2.5	3.3	3	3.8	19	28	0.7	<0.3
Nitrate		11	550	1100	4400	<0.2	<0.2	<0.2	1.5	2	1.2	0.4	0.4
Chromium (VI)		0.05	2.5	5	20	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Fluoride*		1.5	75	150	600	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
TDS		1000	12500	25000	100000	179	304	562	781	4962	4380	518	<35

Table 16. ASLP 1:20 sodium tetraborate leach constituents compared to GN R.635 leachable concentration thresholds

						New Largo pan soils				Honingkrantz pan soils			
CoCs	**Units**	**LCT0**	**LCT1**	**LCT2**	**LCT3**	P2-S1	P2-S2-1	P2-S2-2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3
Antimony	mg/L	0.02	1	2	8	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic		0.01	0.5	1	4	0.1076	0.108	0.1036	0.107	0.0034	<0.0025	0.0042	<0.0025
Barium		0.7	35	70	280	1.347	0.358	0.469	0.337	0.556	0.659	1.052	0.033
Cadmium		0.003	0.15	0.3	1.2	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium		0.1	5	10	40	0.0091	0.008	0.0072	0.007	0.002	<0.0015	<0.0015	0.0062
Cobalt		0.5	25	50	200	<0.002	<0.002	<0.002	<0.002	0.004	0.004	<0.002	<0.002
Copper		2	100	200	800	0.038	0.032	0.031	0.032	0.023	0.017	0.014	<0.007
Lead		0.01	0.5	1	4	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese		0.5	25	50	200	0.005	<0.002	0.024	0.01	0.009	0.007	<0.002	0.027
Mercury		0.006	0.3	0.6	2.4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum		0.07	3.5	7	28	0.025	0.025	0.024	0.024	<0.002	<0.002	<0.002	<0.002
Nickel		0.07	3.5	7	28	<0.002	<0.002	<0.002	<0.002	0.011	0.009	<0.002	<0.002
Selenium		0.01	0.5	1	4	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Vanadium		0.2	10	20	80	0.0427	0.0487	0.0558	0.0187	0.0398	0.0287	0.0134	0.0691
Zinc		5	250	500	2000	0.043	0.023	0.025	0.029	<0.003	<0.003	<0.003	<0.003
Fluoride		1.5	75	150	600	1.1	0.8	1.4	0.7	1.6	1.4	1.1	0.6
Sulphate		250	12500	25000	100000	1.2	2.2	168.4	65.7	23.7	9.5	1.6	5.6
Chloride		300	15000	30000	120000	13.1	12.2	12	12.9	24.8	22.7	7.6	3.9
Nitrate		11	550	1100	4400	<0.2	0.3	0.3	1.9	0.9	0.8	0.7	<0.2
Chromium (VI)		0.05	2.5	5	20	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
TDS		1000	12500	25000	100000	<35	<35	<35	422	1764	342	433	<35

4.4. Soil screening assessment - findings and recommendations

The soil screening assessment in Sections 4.3.2.1and 4.3.2.2 was used to identify potential constituents of concern (PCoC) in the soils. It is Soil Advisory Services' opinion that soil is uncontaminated or requires further assessment under the following conditions:

- *When the concentrations of potential constituents of concern (PCoC) exceed the appropriate SSV but are below the national baseline level or background concentration, the soil is considered uncontaminated.*
- *When the concentrations of PCoCs do not exceed the appropriate SSV or the national baseline level or background concentration, the soil is considered uncontaminated.*
- *When PCoC concentrations exceed the appropriate SSV and the national baseline level or background concentration, the potential contamination warrants further assessment.*
- *When the concentrations of PCoCs do not exceed the appropriate SSV but exceed the national baseline level or background concentration, the potential contamination warrants further assessment*.

Furthermore, if a particular PCoC's total concentration exceeds a screening value, but the water soluble concentration is low, and the soil conditions limit solubility, the potential risk the PCoC poses to the environment can be considered to be low.

Taking the above into consideration, the following is understood regarding the identified PCoCs. The total metals in the soils, Cu, Sb, Cr(III), Ni and As in the soils in both pans were above the screening values. The concentrations of Cu, Cr(III) and Ni are however below the national baseline threshold. The solubility of Sb, Cr(III), As and Ni is however low (in most cases below detection), under neutral conditions. The level of Hg in one sample (P1-S3) from the Honingkrantz pan was above the ANZECC default guideline value, but below the SSV1, the water soluble concentration of Hg for this sample was also below detection.

The water-soluble concentration of Cu in the New Largo soils was below detection, but for the Honingkrantz soils, the water-soluble Cu concentration exceeded the acute effect value for the aquatic ecosystems. In addition to Cu, the water-soluble levels of Al, Zn, Cl, F and P in the Honingkrantz soils also indicate a potential risk to the aquatic ecosystem environment, most likely possible during the dry season when the pan's soil to water ratio is at its lowest. Note: The volume of pan water to soil (solid:liquid) within the pans is not known. The Honingkrantz pan basin however remains largely inundated throughout the year, with the water levels along the perimeter of the pan likely decreasing during the dry season, thus reducing the soil to water ratio. Under drier conditions, the risk of PCoCs affecting the aquatic environment thus likely increases.

In the case of the New Largo pan, the identified water-soluble potential constituents of concern are Al, Zn, Cl, Mn, F and P. Though the current soil to water ratio is likely greater than 1:20 in the basin in the pan, the seasonal changes in water volume in the pan, may reach conditions similar (or more concentrated) to the soil to water ratio of 1:20, particular under drier conditions.

The risk for potential acid generation from the weathering of the New Largo and Honingkrantz pan soil minerals is discussed in Section 4.3.3, and indicates a low potential for acid generation. The potential for the constituents of concern mobilizing under acidic conditions in the pan is thus low based on the understood mineral reactivity.

New Largo pan has been used for the discharge of underground mine water. The water quality in the pan is saline (EC = 435 mS/m). The saturated paste extract electrical conductivity results for the pan soils are within range of the pan water. It is theorised that the New Largo pan, was historically a saline / salt pan. The historical image from 1939 appears to have a white feature along the perimeter of the pan basin, which is thought to be the salt precipitate during the dry season. Given these characteristics, the following was recommended for the second phase of the assessment:

- Conduct sampling and analysis of soils from an unimpacted salt pan (with similar functioning and recharge mechanisms) in the Highveld to be used a reference site (background). This information will be used to establish whether the identified PCoCs are linked to the discharged mine water or are inherent to the soil chemistry of salt pans in the Highveld.

- If PCoC's of New Largo pan soils are not within range of reference site, perform further sampling (with higher sample density and depth) and analyse the identified PCoCs to confirm the extent of areas of concern in the pan to guide pan remedial actions.

5. Phase 2 - Further evaluation of potential constituents of concern

Based on the understanding that the New Largo pan may have historically been a salt pan, a similar functioning salt pan within the same catchment needed to be identified, to serve as an appropriate unimpacted reference (background) pan for the study. Wetland Consulting Services (WCS), identified Pan 7, located ~20km west of the New Largo pan (Figure 12), as a suitable reference pan for this purpose. The present ecological status of Pan 7 is " *largely natural*".

Soil from Pan 7 was sampled in September 2024 and submitted for laboratory analysis of the total and water-soluble constituents. Soil sample locations are shown in Figure 13. The laboratory certificates of the results are presented in Appendix A. The Pan 7 soil chemistry was compared to the soil screening guidelines and the New Largo pan soil chemistry. The Pan 7 soils have the following soil physical and chemical features:

- Very dark brown to black, firm to friable, sandy clay to clay, varying in thickness, abrupt transition to hard rock, with surface salt precipitates observed along the perimeter of the basin of the pan (Figure 11)

- In terms of soil chemistry, the pan soils are saline and alkaline (pH ranging from 8.8 – 9.4). The total concentrations of arsenic, copper, lead, nickel and manganese exceed the soil screening values (SSV1) for the protection of water resources. The levels of Cu, Ni and Mn are however below the national baseline levels of these metals. The concentration of Pb in one of the samples however exceed both the SSV1 and national baseline level for Pb. The water soluble concentrations of aluminium, arsenic, copper, phosphorus and chloride exceed the aquatic water quality guidelines.

- In terms of total potential constituents of concern, the New Largo pan soils and Pan 7 soils are generally similar. Thus the elevated concentrations of total Cu, Sb, Cr(III), Ni and As reported in the New Largo pan soils are most likely inherent rather than associated with a potential contaminant source.

- The water soluble levels of Al and P in the two pans are similar, but levels of Mn, Zn and F in the New Largo pan exceed that found in the Pan 7 soils. The Mn level is however below the aquatic screening guideline. The concentration of Zn in the New Largo pan water is elevated, and is likely the source of the elevated water soluble Zn in the soil (note: the total Zn concentrations are relatively low in all New Largo pan soil samples). The concentration of fluoride in the New Largo soil samples are only slightly above the target water quality range for fluoride (i.e., > 0.7 mg/L). Fluoride is however found in most Karoo sediments,

and possibly in this case, at levels below the XRD instrument detection limit. The noted elevated levels of fluoride in the New Largo soils are most likely related to the mineralogy, than due to the mine water chemistry.

- The comparative table below (Table 19) highlights that the levels of most PCoCs detected in the New Largo pan soils are either below or within range within the Pan 7 soils.

Table 17. . Soil total constituents (mg/kg) of Pan 7 compared to quality guideline values

CoC	LOD	SSV1	National baseline	ANZECC		P7.1	P7.2	P7.3	P7.4
				Guideline value	SQG High				
Aluminium	<50					11610	5920	8690	25850
Antimony	<1			2	25	<1	1	<1	1
Arsenic	<0.5	5.8	n/a	20	70	7.2	18.2	5.3	7.7
Barium	<1			ng	ng	423	157	342	485
Beryllium	<0.5			ng	ng	1	1	0.7	1.6
Cadmium	<0.1	7.5	n/a	1.5	10	<0.1	<0.1	<0.1	<0.1
Calcium	<500					35760	19530	20780	25720
Chromium	<0.5	46000	301	80	370	45.6	63.3	72.5	109.9
Cobalt	<0.5	300	54	ng	ng	8.8	8.9	7.1	13.2
Copper	<1	16	80	65	270	35	30	29	47
Iron	<20					14320	10330	13220	27340
Lead	<5	20	49	50	220	25	58	7	17
Magnesium	<25			ng	ng	9980	3614	5506	12980
Manganese	<1	740	3735	ng	ng	577	393	546	878
Mercury	<0.1	0.93	n/a	0.15	1	<0.1	<0.1	<0.1	<0.1
Molybdenum	<0.1			ng	ng	<0.1	0.2	<0.1	<0.1
Nickel	<0.7	91	189	21	52	24	28.1	20.2	39.1
Phosphorus	<10					96	91	115	125
Potassium	<5					6193	3170	4941	12250
Selenium	<1			ng	ng	<1	<1	<1	<1
Sodium	<5			ng	ng	1476	1013	1504	2819
Thallium	<1			ng	ng	<1	<1	<1	<1
Vanadium	<1	150	382	ng	ng	48	58	36	106
Boron (Aqua Regia Soluble)*	<0.25			ng	ng	7.31	3.7	<0.25	13.64
Zinc	<5	240	91	200	410	33	41	27	37
Total Organic Carbon (%)	<0.02					0.64	0.13	1.1	0.74

Table 18. Water soluble constituents of Pan 7 soils compared to aquatic water quality guideline

CoC	Aquatic			P7.1	P7.2	P7.3	P7.4
	TWQR	CEV	AEV				
Aluminium	0.01	0.02	0.15	0.36	0.351	0.343	1.083
Antimony				0.003	<0.002	<0.002	<0.002
Arsenic	0.01	0.02	0.13	0.019	0.0068	0.0242	0.0194
Barium				0.007	0.012	0.015	0.01
Beryllium				<0.0005	<0.0005	<0.0005	<0.0005
Boron				<0.012	<0.012	<0.012	0.013
Cadmium	0.00025	0.0005	0.006	<0.0005	<0.0005	<0.0005	<0.0005
Calcium				1.4	1.3	2	1.1
Chromium	0.007	0.014	0.2	<0.0015	<0.0015	<0.0015	0.0032
Cobalt				<0.002	<0.002	<0.002	<0.002
Copper	0.0008	0.0015	0.0046	<0.007	<0.007	0.01	<0.007
Lead	0.0005	0.001	0.007	<0.005	<0.005	<0.005	<0.005
Iron				0.285	0.291	0.351	0.891
Magnesium				0.5	0.5	0.8	0.6
Manganese	0.18	0.37	1.3	<0.002	<0.002	<0.002	0.007
Mercury	0.00004	0.00008	0.0017	<0.001	<0.001	<0.001	<0.001
Molybdenum				<0.002	<0.002	<0.002	<0.002
Nickel				<0.002	<0.002	0.004	0.003

CoC	Aquatic			P7.1	P7.2	P7.3	P7.4
	TWQR	CEV	AEV				
Potassium				10.6	7.6	10.8	9.8
Phosphorus	0.005	0.025	0.25	0.014	0.009	0.036	0.161
Selenium	0.002	0.005	0.03	<0.003	<0.003	<0.003	<0.003
Sodium				39	30.2	45.3	57.3
Thallium				<0.003	<0.003	<0.003	<0.003
Vanadium				0.0584	0.0294	0.0647	0.2472
Zinc	0.002	0.0036	0.036	<0.003	<0.003	<0.003	<0.003
Sulphate				9.2	7.1	<0.5	<0.5
Fluoride	0.75	1.5	2.54	0.5	<0.3	0.3	0.5
Chloride	0.0002*	0.00035*	0.005*	3.4	2.2	9.2	4.5
Nitrate as NO3				0.3	<0.2	0.6	0.5
Ammoniacal Nitrogen - NH4				0.33	<0.03	0.27	0.04
Electrical Conductivity				113	165	233	276
Total Dissolved Solids				142	111	170	188
pH				9.28	9.22	8.88	9.45

Table 19. Comparison of PCoCs in New Largo pan soils vs Pan 7 soils

Total PCoCs	Status	Water soluble PCoCs	Status
As	NL pan < Pan 7	Cu	NL pan < Pan 7
Cr(III)	within range	Mn	NL pan > Pan 7
Cu	within range	P	NL pan < Pan 7
Pb	NL pan < Pan 7	Zn	NL pan > Pan 7
Mn	NL pan < Pan 7	F	NL pan > Pan 7
Ni	within range	Cl	NL pan < Pan 7
		EC	NL pan > Pan 7

Notes: NL – New Largo

Figure 10. Pan 7

Figure 11. Salt precipitate on surface at Pan 7 (left), and very dark brown to black sandy clay to clay pan soil (right)

Figure 12. Location of Pan 7 and New Largo Pan

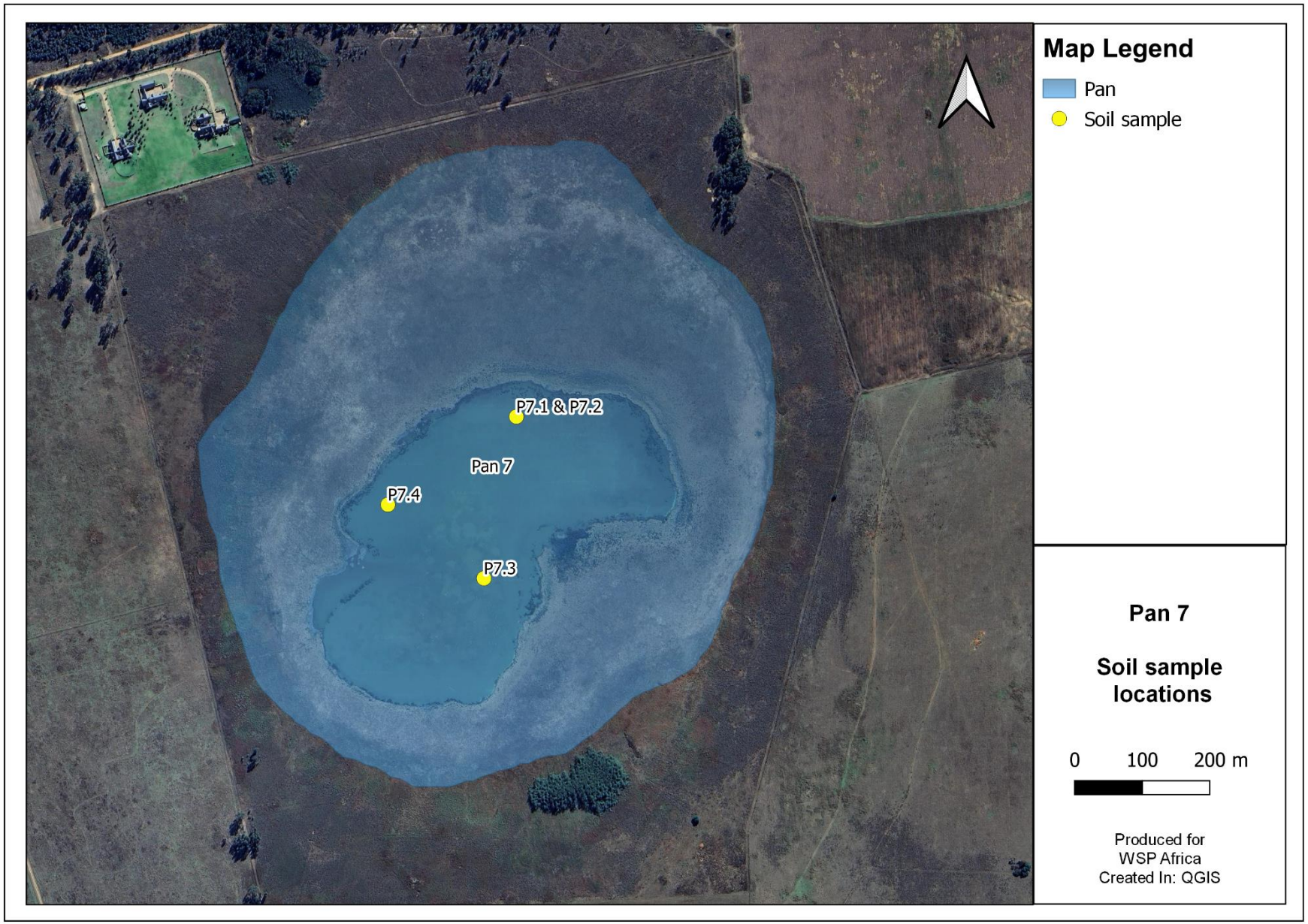

Figure 13. Locations of Pan 7 soil samples

6. Conclusions

The objective of the soil screening assessment and soil characterisation study was to, i) chemically and physically characterise the soil in the New Largo pan and Honingkrantz pan, and ii) establish the potential risk (if any) the New Largo pan soils pose to the receiving environment.

Considering the above findings, New Largo pan, Honingkrantz pan and Pan 7 soils can be described as follows:

- **New Largo Pan**: Soils are black to greyish gleyed, friable to firm, coarse, sand to clay loam to clay material, varying in thickness from 35 – 100 cm thick, abrupt transition to hard rock. Chemically the soils are neutral, slightly saline, with quartz and kaolinite being the dominant minerals in the soil, and has low potential for acid generation. Total concentrations of certain metals are elevated in the soils, but are still below the national baseline threshold (where available) for these metals. Metal solubility is also generally low, thus reducing the potential contaminant risk associated with the total metal exceedances. The water soluble PCoC's may affect the aquatic environment, more so during the dry season, when PCoC's are more concentrated in the soil solution.

- **Honingkrantz pan**: Soils are very dark brown to black, firm, sandy clay loam to clay; covered by thick layer of grass roots, humified material, transitioning to hard rock at shallow depth. Chemically the soils are slightly acidic to neutral, slightly to strongly saline, with quartz, muscovite and kaolinite being the dominant minerals in the soil, and has low potential for acid generation. Certain metals and major anions are elevated in the soils, and may affect the aquatic environment during the dry season. The pan's ecological status is moderately modified (i.e., a moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.). This suggests that the wetland still functions despite the elevated PCoCs.

- **Pan 7**: Soils are very dark brown to black, firm to friable, sandy clay to clay, varying in thickness, abrupt transition to hard rock, with distinct salt precipitate along the perimeter of the pan basin. Certain metals are elevated in the soils, but are generally below the national baseline, with the exception of As and Pb. Water soluble levels of certain constituents are also elevated above the screening guidelines, but are most likely inherent to salt pans of this type.

Generally, the total metal PCoCs found in the New Largo pan soils, have low solubility, and thus low potential contaminant risk. The total metal PCoCs are also within range of that detected in the reference soil samples. The elevated water soluble PCoCs in the New Largo pan soils are also mostly similar to that detected in the reference soil samples. The elevated concentration of water soluble Zn in the New Largo pan soils can most likely be attributed to the pan water quality rather than inherent soil chemistry, since the total Zn concentration of the soils are relatively low. The reference soil's soluble Zn concentrations are below detection, but the Zn concentration of the pan water exceeds the aquatic acute effect value. Though the Honingkrantz pan does not completely function similarly to the New Largo and Pan 7 pans, its chemistry represents a largely natural pan's soil chemistry. The soluble Zn levels detected in the Honingkranz pan is above the aquatic chronic acute value and that found in the New Largo pan soils. The Honingkrantz pan functions well despite the elevated levels of certain PCoCs, including elevated Zn. Thus, it is probable that the elevated levels of soluble Zn in the New Largo pan soils, poses less of an impact on the functioning of the aquatic ecosystem within the New Largo pan.

7. Authorship

This report document was compiled by Ilse Snyman (MSc) with technical review by Elize Herselman (PhD).

8. References

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SOIL ADVISORY SERVICES (PTY) LTD.

APPENDICES

Appendix A. Laboratory certificates

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

W: www.element.com

Soil Advisory Services
8 Landau Terrace
Richmond
Johannesburg
South Africa
2092

Attention :	Ilse Snyman
Date :	26th June, 2024
Your reference :	SAS20230906 & SAS20230112
Our reference :	Test Report 24/460 Batch 1 & 24/8459 Batch 2
Location :	N/A
Date samples received :	22nd April, 2024 & 28th May, 2024
Status :	Final report
Issue :	202405171300

Four samples were received for analysis on 22nd April, 2024 of which four were scheduled for analysis. Four samples were received for analysis on 28th May, 2024 of which four were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

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

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

The greenhouse gas emissions generated (in Carbon – Co2e) to obtain the results in this report are estimated as:

Scope 1&2 emissions - 14.77 kg of CO2

Scope 1&2&3 emissions - 34.904 kg of CO2

Authorised By:

Jeanri Stevens
Operations Manager

Inorganics Laboratory:

Aubrey Lindi
Technical Signatory (Inorganics)

Client Name: Soil Advisory Services
Reference: SAS20230906 & SAS20230112
Location: N/A
Contact: Ilse Snyman
EMT Job No: 24/460 & 24/8459

Report : Solid

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

EMT Sample No.	1-2	3-4	5-6	7-8	13-14	15-16	17-18	19-20			LOD/LOR	Units	Method No.
Sample ID	P2-S1	P2-S2-1	P2-S2-2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3					
Depth													
COC No / misc													
Containers	T	T	T	T	B	B	B	B					
Sample Date	<>	<>	<>	<>	<>	<>	<>	<>					
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil					
Batch Number	1	1	1	1	2	2	2	2					
Date of Receipt	22/04/2024	22/04/2024	22/04/2024	22/04/2024	28/05/2024	28/05/2024	28/05/2024	28/05/2024					
Aluminium*	1985	45140	47130	6838	24340	22640	14280	45830			<50	mg/kg	UK_TM30/UK_PM15
Antimony*	<1	3	2	<1	2	2	1	3			<1	mg/kg	UK_TM30/UK_PM15
Arsenic*	<0.5	5.8	3.5	1.4	5.6	5.2	3.6	5.0			<0.5	mg/kg	UK_TM30/UK_PM15
Barium*	36	80	182	126	313	317	226	107			<1	mg/kg	UK_TM30/UK_PM15
Beryllium*	<0.5	1.4	1.5	<0.5	2.2	2.2	2.1	1.3			<0.5	mg/kg	UK_TM30/UK_PM15
Cadmium*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	mg/kg	UK_TM30/UK_PM15
Calcium*	661	2635	4742	9137	2901	5527	4957	1446			<500	mg/kg	UK_TM30/UK_PM15
Chromium*	11.7	101.8	106.0	24.9	84.4	83.5	47.2	135.5			<0.5	mg/kg	UK_TM30/UK_PM15
Cobalt*	1.4	9.1	11.9	5.3	16.9	15.0	10.8	10.5			<0.5	mg/kg	UK_TM30/UK_PM15
Copper*	4	40	44	10	26	27	22	31			<1	mg/kg	UK_TM30/UK_PM15
Iron*	1931	55000$_{AA}$	47090$_{AA}$	7959	30100	32980	19440	39560			<20	mg/kg	UK_TM30/UK_PM15
Lead*	<5	16	14	<5	9	9	8	15			<5	mg/kg	UK_TM30/UK_PM15
Magnesium*	308	1178	2175	2143	5144	4602	3098	1108			<25	mg/kg	UK_TM30/UK_PM15
Manganese*	22	161	240	156	108	405	150	253			<1	mg/kg	UK_TM30/UK_PM15
Mercury*	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	0.2			<0.1	mg/kg	UK_TM30/UK_PM15
Molybdenum*	0.1	2.0	1.3	0.1	0.4	0.1	0.4	1.8			<0.1	mg/kg	UK_TM30/UK_PM15
Nickel*	3.2	27.0	33.0	11.1	33.3	33.7	26.9	34.9			<0.7	mg/kg	UK_TM30/UK_PM15
Phosphorus*	15	666	716	120	77	59	56	647			<10	mg/kg	UK_TM30/UK_PM15
Potassium*	612	1592	3353	3337	10740	10080	6715	1635			<5	mg/kg	UK_TM30/UK_PM15
Selenium*	<1	1	2	<1	<1	1	<1	1			<1	mg/kg	UK_TM30/UK_PM15
Sodium*	65	353	439	219	2298	2635	1375	210			<5	mg/kg	UK_TM30/UK_PM15
Thallium*	<1	<1	<1	<1	<1	<1	<1	<1			<1	mg/kg	UK_TM30/UK_PM15
Vanadium*	6	130	111	17	55	54	34	106			<1	mg/kg	UK_TM30/UK_PM15
Boron (Aqua Regia Soluble)*	0.48	<0.25	1.78	3.86	7.02	5.65	3.49	1.66			<0.25	mg/kg	UK_TM30/UK_PM15
Zinc*	<5	37	42	12	26	25	17	51			<5	mg/kg	UK_TM30/UK_PM15
Natural Moisture Content	-	-	-	-	35.0	36.9	27.4	54.6			<0.1	%	PM4/PM0
Hexavalent Chromium*	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3			<0.3	mg/kg	TM38/PM20
Total Organic Carbon*	0.22	0.75	1.23	0.56	1.49	0.71	0.22	3.57			<0.02	%	TM21/PM24

Client Name: Soil Advisory Services
Reference: SAS20230906 & SAS20230112
Location: N/A
Contact: Ilse Snyman
EMT Job No: 24/460 & 24/8459

Report : ASLP (20:1) - Reagent Water

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

EMT Sample No.	1-2	3-4	5-6	7-8	13-14	15-16	17-18	19-20			LOD/LOR	Units	Method No.
Sample ID	P2-S1	P2-S2-1	P2-S2-2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3					
Depth													
COC No / misc													
Containers	T	T	T	T	B	B	B	B					
Sample Date	<>	<>	<>	<>	<>	<>	<>	<>					
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil					
Batch Number	1	1	1	1	2	2	2	2					
Date of Receipt	22/04/2024	22/04/2024	22/04/2024	22/04/2024	28/05/2024	28/05/2024	28/05/2024	28/05/2024					
Dissolved Aluminium*	233	22	101	125	538	1341	206	422			<20	ug/l	UK_TM30/UK_PM14
Dissolved Antimony*	<2	<2	<2	<2	<2	<2	<2	<2			<2	ug/l	UK_TM30/UK_PM14
Dissolved Arsenic*	<2.5	<2.5	<2.5	<2.5	4.3	<2.5	<2.5	<2.5			<2.5	ug/l	UK_TM30/UK_PM14
Dissolved Barium*	161	81	98	68	145	200	82	20			<3	ug/l	UK_TM30/UK_PM14
Dissolved Beryllium*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5			<0.5	ug/l	UK_TM30/UK_PM14
Dissolved Boron*	304	335	506	545	16	<12	<12	<12			<12	ug/l	UK_TM30/UK_PM14
Dissolved Cadmium*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5			<0.5	ug/l	UK_TM30/UK_PM14
Dissolved Calcium*	-	-	-	-	4.9	4.1	2.4	1.6			<0.2	mg/l	UK_TM30/UK_PM14
Dissolved Chromium*	<1.5	<1.5	<1.5	<1.5	<1.5	2.4	<1.5	<1.5			<1.5	ug/l	UK_TM30/UK_PM14
Dissolved Cobalt*	<2	<2	<2	<2	3	2	<2	<2			<2	ug/l	UK_TM30/UK_PM14
Dissolved Copper*	<7	<7	<7	<7	22	29	12	<7			<7	ug/l	UK_TM30/UK_PM14
Dissolved Iron*	166	<20	39	95	1071	1701	230	194			<20	ug/l	UK_TM30/UK_PM14
Dissolved Lead*	<5	<5	<5	<5	<5	<5	<5	<5			<5	mg/l	UK_TM30/UK_PM14
Dissolved Magnesium*	-	-	-	-	2.5	2.5	1.1	0.7			<0.1	mg/l	UK_TM30/UK_PM14
Dissolved Manganese*	<2	15	152	<2	8	29	2	160			<2	ug/l	UK_TM30/UK_PM14
Dissolved Mercury*	<1	<1	<1	<1	<1	<1	<1	<1			<1	ug/l	UK_TM30/UK_PM14
Dissolved Molybdenum*	<2	<2	<2	<2	<2	<2	<2	<2			<2	ug/l	UK_TM30/UK_PM14
Dissolved Nickel*	<2	<2	<2	<2	15	15	5	<2			<2	ug/l	UK_TM30/UK_PM14
Dissolved Potassium*	-	-	-	-	19.4	21.1	11.1	1.8			<0.1	mg/l	UK_TM30/UK_PM14
Dissolved Phosphorus*	<5	<5	<5	56	17	13	5	6			<5	ug/l	UK_TM30/UK_PM14
Dissolved Selenium*	<3	<3	<3	<3	<3	<3	<3	<3			<3	ug/l	UK_TM30/UK_PM14
Dissolved Sodium*	-	-	-	-	66.4	65.9	41.6	1.8			<0.1	mg/l	UK_TM30/UK_PM14
Dissolved Thallium*	<3	<3	<3	<3	<3	<3	<3	<3			<3	ug/l	UK_TM30/UK_PM14
Dissolved Vanadium*	<1.5	<1.5	<1.5	4.7	14.7	14.3	6.8	<1.5			<1.5	ug/l	UK_TM30/UK_PM14
Dissolved Zinc*	21	23	26	10	28	13	10	3			<3	ug/l	UK_TM30/UK_PM14
Dissolved Calcium	3.9	13.8	18.7	21.6	-	-	-	-			<0.3	mg/l	SA_TM27/SA_PM0
Dissolved Magnesium	2.4	10.3	20.6	16.9	-	-	-	-			<0.2	mg/l	SA_TM27/SA_PM0
Dissolved Potassium	2.1	7.3	14.8	6.0	-	-	-	-			<0.1	mg/l	SA_TM27/SA_PM0
Dissolved Sodium	9.8	8.2	9.1	6.2	-	-	-	-			<0.1	mg/l	SA_TM27/SA_PM0
Fluoride	0.8	<0.3	<0.3	0.9	-	-	-	-			<0.3	mg/l	SA_TM27/SA_PM0
Chloride	1.0	1.6	1.2	2.4	-	-	-	-			<0.3	mg/l	SA_TM27/SA_PM0
Nitrate as NO3	<0.2	<0.2	<0.2	2.1	-	-	-	-			<0.2	mg/l	SA_TM27/SA_PM0
Sulphate	38.8	102.9	199.8	152.2	-	-	-	-			<0.5	mg/l	SA_TM27/SA_PM0
Sulphate as SO4	-	-	-	-	74.7	140.7	42.4	13			<0.5	mg/l	TM38/PM0
Fluoride	-	-	-	-	2.4	2.3	1.6	<0.3			<0.3	mg/l	TM173/PM0
Chloride	-	-	-	-	24.6	35.7	8.9	0.6			<0.3	mg/l	TM38/PM0
Nitrate as NO3	-	-	-	-	0.8	0.7	0.6	<0.2			<0.2	mg/l	TM38/PM0
Ammoniacal Nitrogen as NH4	<0.03	<0.03	<0.03	<0.03	-	-	-	-			<0.03	mg/l	SA_TM27/SA_PM0
Ammoniacal Nitrogen as NH4	-	-	-	-	0.05	0.06	<0.03	0.48			<0.03	mg/l	TM38/PM0
Total Alkalinity as CaCO3	12	16	5	17	-	-	-	-			<3	mg/l	SA_TM32/SA_PM0
Total Alkalinity as CaCO3	-	-	-	-	80	100	94	18			<1	mg/l	TM75/PM0
Electrical Conductivity @25C	243	109	376	312							<2	uS/cm	SA_TM28/SA_PM0
Electrical Conductivity @25C	-	-	-	-	396	470	231	52			<2	uS/cm	TM76/PM0

Element Materials Technology

Client Name: Soil Advisory Services
Reference: SAS20230906 & SAS20230112
Location: N/A
Contact: Ilse Snyman
EMT Job No: 24/460 & 24/8459

Report : ASLP (20:1) - Reagent Water

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-2	3-4	5-6	7-8	13-14	15-16	17-18	19-20			LOD/LOR	Units	Method No.
Sample ID	P2-S1	P2-S2-1	P2-S2-2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3					
Depth													
COC No / misc													
Containers	T	T	T	T	B	B	B	B					
Sample Date	<>	<>	<>	<>	<>	<>	<>	<>					
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil					
Batch Number	1	1	1	1	2	2	2	2					
Date of Receipt	22/04/2024	22/04/2024	22/04/2024	22/04/2024	28/05/2024	28/05/2024	28/05/2024	28/05/2024					
Hexavalent Chromium*	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006			<0.006	mg/l	UK_TM38/UK_PM0
Total Dissolved Solids	118	174	272	261	-	-	-	-			<35	mg/l	SA_TM20/SA_PM80
Total Dissolved Solids	-	-	-	-	923	829	480	<35			<35	mg/l	TM20/PM0
pH	7.47	7.99	7.24	7.44	-	-	-	-			<2.00	pH units	SA_TM19/SA_PM0
pH	-	-	-	-	6.89	7.15	7.41	5.83			<0.01	pH units	TM73/PM0

Please see attached notes for all abbreviations and acronyms

Client Name: Soil Advisory Services
Reference: SAS20230906 & SAS20230112
Location: N/A
Contact: Ilse Snyman
EMT Job No: 24/460 & 24/8459

Report : ASLP (20:1) - Tetraborate

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

EMT Sample No.	1-2	3-4	5-6	7-8	13-14	15-16	17-18	19-20			LOD/LOR	Units	Method No.
Sample ID	P2-S1	P2-S2-1	P2-S2-2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3					
Depth													
COC No / misc													
Containers	T	T	T	T	B	B	B	B					
Sample Date	<>	<>	<>	<>	<>	<>	<>	<>					
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil					
Batch Number	1	1	1	1	2	2	2	2					
Date of Receipt	22/04/2024	22/04/2024	22/04/2024	22/04/2024	28/05/2024	28/05/2024	28/05/2024	28/05/2024					
Dissolved Aluminium*	83	218	56	78	321	158	106	900			<20	ug/l	UK_TM30/UK_PM14
Dissolved Antimony*	<2	<2	<2	<2	<2	<2	<2	<2			<2	ug/l	UK_TM30/UK_PM14
Dissolved Arsenic*	107.6	108.0	103.6	107.0	3.4	<2.5	4.2	<2.5			<2.5	ug/l	UK_TM30/UK_PM14
Dissolved Barium*	1347	358	469	337	556	659	1052	33			<3	ug/l	UK_TM30/UK_PM14
Dissolved Beryllium*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5			<0.5	ug/l	UK_TM30/UK_PM14
Dissolved Cadmium*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5			<0.5	ug/l	UK_TM30/UK_PM14
Dissolved Calcium*	13.3	16.0	24.9	26.2	33.1	24.4	22.4	3.1			<0.2	mg/l	UK_TM30/UK_PM14
Dissolved Chromium*	9.1	8.0	7.2	7.0	2.0	<1.5	<1.5	6.2			<1.5	ug/l	UK_TM30/UK_PM14
Dissolved Cobalt*	<2	<2	<2	<2	4	4	<2	<2			<2	ug/l	UK_TM30/UK_PM14
Dissolved Copper*	38	32	31	32	23	17	14	<7			<7	ug/l	UK_TM30/UK_PM14
Dissolved Iron*	152	41	<20	<20	750	277	73	662			<20	ug/l	UK_TM30/UK_PM14
Dissolved Lead*	<5	<5	<5	<5	<5	<5	<5	<5			<5	ug/l	UK_TM30/UK_PM14
Dissolved Magnesium*	5.1	4.8	6.5	10.3	16.7	14.5	13.4	0.8			<0.1	mg/l	UK_TM30/UK_PM14
Dissolved Manganese*	5	<2	24	10	9	7	<2	27			<2	ug/l	UK_TM30/UK_PM14
Dissolved Mercury*	<1	<1	<1	<1	<1	<1	<1	<1			<1	ug/l	UK_TM30/UK_PM14
Dissolved Molybdenum*	25	25	24	24	<2	<2	<2	<2			<2	ug/l	UK_TM30/UK_PM14
Dissolved Nickel*	<2	<2	<2	<2	11	9	<2	<2			<2	ug/l	UK_TM30/UK_PM14
Dissolved Phosphorus*	23	403	497	249	11	25	6	394			<5	ug/l	UK_TM30/UK_PM14
Dissolved Potassium*	12.9	12.8	20.2	10.5	41.8	40.1	24.3	3.7			<0.1	mg/l	UK_TM30/UK_PM14
Dissolved Selenium*	<3	<3	<3	<3	<3	<3	<3	<3			<3	ug/l	UK_TM30/UK_PM14
Dissolved Thallium*	36	33	34	33	<3	<3	<3	<3			<3	ug/l	UK_TM30/UK_PM14
Dissolved Vanadium*	42.7	48.7	55.8	18.7	39.8	28.7	13.4	69.1			<1.5	ug/l	UK_TM30/UK_PM14
Dissolved Zinc*	43	23	25	29	<3	<3	<3	<3			<3	ug/l	UK_TM30/UK_PM14
Fluoride*	1.1	0.8	1.4	0.7	1.6	1.4	1.1	0.6			<0.3	mg/l	UK_TM173/UK_PM0
Sulphate as SO4*	1.2	2.2	168.4	65.7	23.7	9.5	1.6	5.6			<0.5	mg/l	UK_TM38/UK_PM0
Chloride*	13.1	12.2	12.0	12.9	24.8	22.7	7.6	3.9			<0.3	mg/l	UK_TM38/UK_PM0
Nitrate as NO3*	<0.2	0.3	0.3	1.9	0.9	0.8	0.7	<0.2			<0.2	mg/l	UK_TM38/UK_PM0
Hexavalent Chromium*	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006			<0.006	mg/l	UK_TM38/UK_PM0
Total Dissolved Solids	<35	<35	<35	422	-	-	-	-			<35	mg/l	SA_TM20/SA_PM80
Total Dissolved Solids	-	-	-	-	1764	342	433	<35			<35	mg/l	TM20/PM80
pH	-	-	-	-	9.32	9.31	9.39	9.29			<0.01	pH units	TM73/PM0
Ammoniacal Nitrogen as NH3	-	-	-	-	0.06	0.07	0.05	0.42			<0.03	mg/l	TM38/PM0

Client Name: Soil Advisory Services
Reference: SAS20230906 & SAS20230112
Location: N/A
Contact: Ilse Snyman
EMT Job No: 24/460 & 24/8459

Report : ASLP (20:1)-Acetate pH 5 or 2.9

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

EMT Sample No.	1-2	3-4	5-6	7-8	13-14	15-16	17-18	19-20			LOD/LOR	Units	Method No.
Sample ID	P2-S1	P2-S2-1	P2-S2-2	P2-S3	P1-S1.1	P1-S1.2	P1S2	P1S3					
Depth													
COC No / misc													
Containers	T	T	T	T	B	B	B	B					
Sample Date	<>	<>	<>	<>	<>	<>	<>	<>					
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil					
Batch Number	1	1	1	1	2	2	2	2					
Date of Receipt	22/04/2024	22/04/2024	22/04/2024	22/04/2024	28/05/2024	28/05/2024	28/05/2024	28/05/2024					
Dissolved Aluminium	55	63	31	27	883	1278	335	497			<20	ug/l	UK_TM30/UK_PM14
Dissolved Antimony	<2	<2	<2	<2	<2	<2	<2	<2			<2	ug/l	UK_TM30/UK_PM14
Dissolved Arsenic	<2.5	<2.5	<2.5	3.0	<2.5	<2.5	<2.5	<2.5			<2.5	ug/l	UK_TM30/UK_PM14
Dissolved Barium	625	256	231	965	376	345	541	475			<3	ug/l	UK_TM30/UK_PM14
Dissolved Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5			<0.5	ug/l	UK_TM30/UK_PM14
Dissolved Boron	180	154	220	232	<12	<12	<12	<12			<12	ug/l	UK_TM30/UK_PM14
Dissolved Cadmium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5			<0.5	ug/l	UK_TM30/UK_PM14
Dissolved Calcium	17.7	46.8	118.7	153.8	41.4	40.3	17.2	15.1			<0.2	mg/l	UK_TM30/UK_PM14
Dissolved Chromium	<1.5	<1.5	<1.5	<1.5	2.6	3.2	2.0	1.8			<1.5	ug/l	UK_TM30/UK_PM14
Dissolved Cobalt	<2	3	6	<2	2	5	14	12			<2	ug/l	UK_TM30/UK_PM14
Dissolved Copper	<7	<7	<7	<7	11	<7	<7	<7			<7	ug/l	UK_TM30/UK_PM14
Dissolved Iron	99	24	80	<20	1429	1531	4089	5971			<20	ug/l	UK_TM30/UK_PM14
Dissolved Lead	<5	<5	<5	<5	<5	<5	<5	<5			<5	ug/l	UK_TM30/UK_PM14
Dissolved Magnesium	5.9	14.0	18.7	18.0	26.1	22.6	5.6	5.2			<0.1	mg/l	UK_TM30/UK_PM14
Dissolved Manganese	85	445	1260	951	140	748	2214	1865			<2	ug/l	UK_TM30/UK_PM14
Dissolved Mercury	<1	<1	<1	<1	<1	<1	<1	<1			<1	ug/l	UK_TM30/UK_PM14
Dissolved Molybdenum	<2	<2	<2	<2	<2	<2	<2	<2			<2	ug/l	UK_TM30/UK_PM14
Dissolved Nickel	<2	3	6	5	7	8	6	6			<2	ug/l	UK_TM30/UK_PM14
Dissolved Phosphorus	7	<5	70	710	22	<5	<5	<5			<5	ug/l	UK_TM30/UK_PM14
Dissolved Potassium	8.3	12.5	26.1	13.5	61.1	55.8	5.7	4.9			<0.1	mg/l	UK_TM30/UK_PM14
Dissolved Selenium	<3	<3	<3	<3	<3	<3	<3	<3			<3	ug/l	UK_TM30/UK_PM14
Dissolved Thallium	<3	<3	<3	<3	<3	<3	<3	<3			<3	ug/l	UK_TM30/UK_PM14
Dissolved Vanadium	1.5	<1.5	2.1	6.3	9.8	6.3	<1.5	1.6			<1.5	ug/l	UK_TM30/UK_PM14
Dissolved Zinc	292	106	124	114	14	23	35	32			<3	ug/l	UK_TM30/UK_PM14
Sulphate as SO4*	33.7	89.8	264.7	96.9	3.4	76.2	6.5	1.3			<0.5	mg/l	UK_TM38/UK_PM0
Chloride*	2.5	3.3	3.0	3.8	19.0	28.0	0.7	<0.3			<0.3	mg/l	UK_TM38/UK_PM0
Nitrate as NO3*	<0.2	<0.2	<0.2	1.5	2.0	1.2	0.4	0.4			<0.2	mg/l	UK_TM38/UK_PM0
Hexavalent Chromium*	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006			<0.006	mg/l	UK_TM38/UK_PM0
Fluoride*	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3			<0.3	mg/l	UK_TM173/UK_PM0
Ammoniacal Nitrogen as NH3*	0.30	0.23	1.11	0.04	0.08	0.19	1.02	0.80			<0.03	mg/l	UK_TM38/UK_PM0
pH of leaching fluid	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0			<	pH units	NONE/PM80
Total Dissolved Solids	179	304	562	781	-	-	-	-			<35	mg/l	SA_TM20/SA_PM80
Total Dissolved Solids	-	-	-	-	4962	4380	518	<35			<35	mg/l	TM20/PM0

Element Materials Technology

Notification of Deviating Samples

Client Name: Soil Advisory Services
Reference: SAS20230906 & SAS20230112
Location: N/A
Contact: Ilse Snyman

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analysis	Reason
No deviating sample report results for job 24/460 & 24/8459						

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating. Only analyses which are accredited are recorded as deviating if set criteria are not met.
It is a requirement under ISO 17025 that we inform clients if samples are deviating i.e. outside what is expected. A deviating sample indicates that the sample 'may' be compromised but not necessarily will be compromised. The result is still accredited and our analytical reports will still show accreditation on the relevant analytes.

SOILS and ASH

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. Asbestos samples are retained for 6 months.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C. Ash samples are dried at 37°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overesitimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

STACK EMISSIONS

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation for Dioxins and Furans and Dioxin like PCBs has been performed on XAD-2 Resin, only samples which use this resin will be within our MCERTS scope.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a requirement of our Accreditation Body for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.
Laboratory records are kept for a period of no less than 6 years.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

Customer Provided Information

Sample ID and depth is information provided by the customer.

Age of Diesel

The age of release estimation is based on the nC17/pristane ratio only as prescribed by Christensen and Larsen (1993) and Kaplan, Galperin, Alimi et al., (1996).
Age estimation should be treated with caution as it can be influenced by site specific factors of which the laboratory are not aware.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above quantitative calibration range. The result should be considered the minimum value and is indicative only. The actual result could be significantly higher.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range
AA	x5 Dilution

EMT Job No: 24/460 & 24/8459

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
NONE	No Method Code	SA_PM80	A 20:1 ratio of leaching fluid to as received soil, is leached for 18 hours. The client can choose to use any of the following leaching fluids a) deionised water b) pH5 c) pH 5/pH2.9 depending on pH of sample d) pH9.2			AR	No
SA_TM19	Determination of pH by bench pH meter	SA_PM0	No preparation is required.			AR	No
SA_TM20	Modified BS 1377-3: 1990 Gravimetric determination of Total Dissolved Solids	SA_PM80	A 20:1 ratio of leaching fluid to as received soil, is leached for 18 hours. The client can choose to use any of the following leaching fluids a) deionised water b) pH5 c) pH 5/pH2.9 depending on pH of sample d) pH9.2			AR	No
SA_TM27	Major ions by Ion Chromatography	SA_PM0	No preparation is required.				
SA_TM27	Major ions by Ion Chromatography	SA_PM0	No preparation is required.			AR	No
SA_TM28	Determination of Electrical Conductivity with hand held manual conductivity probe.	SA_PM0	No preparation is required.			AR	No
SA_TM32	Determination of Alkalinity by titration of the sample with a standard solution of acid by visual detection of end points.	SA_PM0	No preparation is required.				No
UK_TM173	Analysis of fluoride by ISE (Ion Selective Electrode) using modified ISE method 340.2	UK_PM0	No preparation is required.				No
UK_TM21	Modified USEPA 415.1. Determination of Total Organic Carbon or Total Carbon by combustion in an Eltra TOC furnace/analyser in the presence of oxygen. The CO2 generated is quantified using infra-red detection.	UK_PM24	Dried and ground solid samples are washed with hydrochloric acid, then rinsed with deionised water to remove the mineral carbon before TOC analysis.				Yes
UK_TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	UK_PM14	Analysis of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for dissolved metals and acidified if required.				No

EMT Job No: 24/460 & 24/8459

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
UK_TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	UK_PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.				Yes
UK_TM38	Soluble Ion analysis using the Thermo Aquakem Photometric Automatic Analyser. Modified US EPA methods 325.2, 375.4, 365.2, 353.1, 354.1	UK_PM0	No preparation is required.				No
UK_TM38	Soluble Ion analysis using the Thermo Aquakem Photometric Automatic Analyser. Modified US EPA methods 325.2, 375.4, 365.2, 353.1, 354.1	UK_PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.				Yes
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.	PM0	No preparation is required.			AR	
TM20	Modified BS 1377-3:1990/USEPA 160.1/3 (TDS/TS: 1971) Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.			AR	No
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM0	No preparation is required.			AR	No
TM75	Modified US EPA method 310.1 (1978). Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.			AR	No
TM76	Modified US EPA method 120.1 (1982). Determination of Specific Conductance by Metrohm automated probe analyser.	PM0	No preparation is required.			AR	No
NONE	No Method Code	PM80	A 20:1 ratio of leaching fluid to as received soil is leached for 18 hours. The client can choose to use any of the following leaching fluids a) deionised water b) pH5 c) pH 5/pH2.9 (depending on pH of sample) d) pH9.2. Filtered sample is through a 0.45um filter			AR	No

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Soil Advisory Services (PTY) Ltd
8 Landau Terrace
Richmond
Johennesburg
South Africa

Attention :	Ilse Snyman
Date :	10th October, 2024
Your reference :	SAS20230906
Our reference :	Test Report 24/16797 Batch 1
Location :	-
Date samples received :	2nd October, 2024
Status :	Final Report
Issue :	202410100901

Four samples were received for analysis on 2nd October, 2024 of which four were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

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

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

The greenhouse gas emissions generated (in Carbon – Co2e) to obtain the results in this report are estimated as:

Scope 1&2 emissions - 10.715 kg of CO2

Authorised By:

Paul Boden BSc
Senior Project Manager

Client Name: Soil Advisory Services (PTY) Ltd
Reference: SAS20230906
Location: -
Contact: Ilse Snyman
EMT Job No: 24/16797

Report : Solid

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-2	3-4	5-6	7-8							LOD/LOR	Units	Method No.
Sample ID	P7.1	P7.2	P7.3	P7.4									
Depth													
COC No / misc													
Containers	B	B	B	B									
Sample Date	19/09/2024	19/09/2024	19/09/2024	19/09/2024									
Sample Type	Soil	Soil	Soil	Soil									
Batch Number	1	1	1	1									
Date of Receipt	02/10/2024	02/10/2024	02/10/2024	02/10/2024									
Aluminium	11610	5920	8690	25850							<50	mg/kg	TM30/PM15
Antimony	<1	1	<1	1							<1	mg/kg	TM30/PM15
Arsenic #	7.2	18.2	5.3	7.7							<0.5	mg/kg	TM30/PM15
Barium #	423	157	342	485							<1	mg/kg	TM30/PM15
Beryllium	1.0	1.0	0.7	1.6							<0.5	mg/kg	TM30/PM15
Bismuth	<5	<5	<5	<5							<5	mg/kg	TM30/PM15
Cadmium #	<0.1	<0.1	<0.1	<0.1							<0.1	mg/kg	TM30/PM15
Calcium	35760	19530	20780	25720							<500	mg/kg	TM30/PM15
Chromium #	45.6	63.3	72.5	109.9							<0.5	mg/kg	TM30/PM15
Cobalt #	8.8	8.9	7.1	13.2							<0.5	mg/kg	TM30/PM15
Copper #	35	30	29	47							<1	mg/kg	TM30/PM15
Iron	14320	10330	13220	27340							<20	mg/kg	TM30/PM15
Lead #	25	58	7	17							<5	mg/kg	TM30/PM15
Lithium	6	<5	<5	11							<5	mg/kg	TM30/PM15
Magnesium	9980	3614	5506	12980							<25	mg/kg	TM30/PM15
Manganese #	577	393	546	878							<1	mg/kg	TM30/PM15
Mercury #	<0.1	<0.1	<0.1	<0.1							<0.1	mg/kg	TM30/PM15
Molybdenum #	<0.1	0.2	<0.1	<0.1							<0.1	mg/kg	TM30/PM15
Nickel #	24.0	28.1	20.2	39.1							<0.7	mg/kg	TM30/PM15
Phosphorus	96	91	115	125							<10	mg/kg	TM30/PM15
Potassium	6193	3170	4941	12250							<5	mg/kg	TM30/PM15
Selenium #	<1	<1	<1	<1							<1	mg/kg	TM30/PM15
Silver	<1	<1	<1	<1							<1	mg/kg	TM30/PM15
Sodium	1476	1013	1504	2819							<5	mg/kg	TM30/PM15
Strontium	130	54	81	137							<5	mg/kg	TM30/PM15
Tellurium	<5	<5	<5	<5							<5	mg/kg	TM30/PM15
Thallium	<1	<1	<1	<1							<1	mg/kg	TM30/PM15
Tin	<1	<1	<1	1							<1	mg/kg	TM30/PM15
Titanium	67	42	80	177							<5	mg/kg	TM30/PM15
Vanadium	48	58	36	106							<1	mg/kg	TM30/PM15
Boron (Aqua Regia Soluble)	7.31	3.70	<0.25	13.64							<0.25	mg/kg	TM30/PM15
Zinc #	33	41	27	37							<5	mg/kg	TM30/PM15
Zirconium	<5	<5	<5	7							<5	mg/kg	TM30/PM15
Total Organic Carbon #	0.64	0.13	1.10	0.74							<0.02	%	TM21/PM24

Please see attached notes for all abbreviations and acronyms

Element Materials Technology

Client Name: Soil Advisory Services (PTY) Ltd
Reference: SAS20230906
Location: -
Contact: Ilse Snyman
EMT Job No: 24/16797

Report : ASLP (20:1) - Reagent Water

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

EMT Sample No.	1-2	3-4	5-6	7-8							LOD/LOR	Units	Method No.
Sample ID	P7.1	P7.2	P7.3	P7.4									
Depth													
COC No / misc													
Containers	B	B	B	B									
Sample Date	19/09/2024	19/09/2024	19/09/2024	19/09/2024									
Sample Type	Soil	Soil	Soil	Soil									
Batch Number	1	1	1	1									
Date of Receipt	02/10/2024	02/10/2024	02/10/2024	02/10/2024									
Dissolved Aluminium	360	351	343	1083							<20	ug/l	TM30/PM14
Dissolved Antimony	3	<2	<2	<2							<2	ug/l	TM30/PM14
Dissolved Arsenic	19.0	6.8	24.2	19.4							<2.5	ug/l	TM30/PM14
Dissolved Barium	7	12	15	10							<3	ug/l	TM30/PM14
Dissolved Beryllium	<0.5	<0.5	<0.5	<0.5							<0.5	ug/l	TM30/PM14
Dissolved Bismuth	<5	<5	<5	<5							<5	ug/l	TM30/PM14
Dissolved Boron	<12	<12	<12	13							<12	ug/l	TM30/PM14
Dissolved Cadmium	<0.5	<0.5	<0.5	<0.5							<0.5	ug/l	TM30/PM14
Dissolved Calcium	1.4	1.3	2.0	1.1							<0.2	mg/l	TM30/PM14
Dissolved Chromium	<1.5	<1.5	<1.5	3.2							<1.5	ug/l	TM30/PM14
Dissolved Cobalt	<2	<2	<2	<2							<2	ug/l	TM30/PM14
Dissolved Copper	<7	<7	10	<7							<7	ug/l	TM30/PM14
Dissolved Lead	<5	<5	<5	<5							<5	ug/l	TM30/PM14
Dissolved Iron	285	291	351	891							<20	ug/l	TM30/PM14
Dissolved Magnesium	0.5	0.5	0.8	0.6							<0.1	mg/l	TM30/PM14
Dissolved Lithium	<5	<5	<5	<5							<5	ug/l	TM30/PM14
Dissolved Manganese	<2	<2	<2	7							<2	ug/l	TM30/PM14
Dissolved Mercury	<1	<1	<1	<1							<1	ug/l	TM30/PM14
Dissolved Molybdenum	<2	<2	<2	<2							<2	ug/l	TM30/PM14
Dissolved Nickel	<2	<2	4	3							<2	ug/l	TM30/PM14
Dissolved Potassium	10.6	7.6	10.8	9.8							<0.1	mg/l	TM30/PM14
Dissolved Phosphorus	14	9	36	161							<5	ug/l	TM30/PM14
Dissolved Selenium	<3	<3	<3	<3							<3	ug/l	TM30/PM14
Dissolved Silver	<5	<5	<5	<5							<5	ug/l	TM30/PM14
Dissolved Sodium	39.0	30.2	45.3	57.3							<0.1	mg/l	TM30/PM14
Dissolved Strontium	8	10	15	7							<5	ug/l	TM30/PM14
Dissolved Tellurium	<5	<5	<5	<5							<5	ug/l	TM30/PM14
Dissolved Thallium	<3	<3	<3	<3							<3	ug/l	TM30/PM14
Dissolved Tin	<5	<5	<5	<5							<5	ug/l	TM30/PM14
Dissolved Titanium	36	87	13	53							<5	ug/l	TM30/PM14
Dissolved Vanadium	58.4	29.4	64.7	247.2							<1.5	ug/l	TM30/PM14
Dissolved Zinc	<3	<3	<3	<3							<3	ug/l	TM30/PM14
Dissolved Zirconium	<5	<5	<5	<5							<5	ug/l	TM30/PM14
Total Dissolved Sulphur as S	2478	2306	2314	1291							<10	ug/l	TM30/PM14
Sulphate as SO4	9.2	7.1	<0.5	<0.5							<0.5	mg/l	TM38/PM0
Fluoride	0.5	<0.3	0.3	0.5							<0.3	mg/l	TM173/PM0
Chloride	3.4	2.2	9.2	4.5							<0.3	mg/l	TM38/PM0
Nitrate as NO3	0.3	<0.2	0.6	0.5							<0.2	mg/l	TM38/PM0
Ammoniacal Nitrogen as NH4	0.33	<0.03	0.27	0.04							<0.03	mg/l	TM38/PM0
Total Alkalinity as CaCO3	96	74	94	128							<1	mg/l	TM75/PM0

Element Materials Technology

Client Name: Soil Advisory Services (PTY) Ltd
Reference: SAS20230906
Location: -
Contact: Ilse Snyman
EMT Job No: 24/16797

Report : ASLP (20:1) - Reagent Water

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-2	3-4	5-6	7-8							LOD/LOR	Units	Method No.
Sample ID	P7.1	P7.2	P7.3	P7.4									
Depth													
COC No / misc													
Containers	B	B	B	B									
Sample Date	19/09/2024	19/09/2024	19/09/2024	19/09/2024									
Sample Type	Soil	Soil	Soil	Soil									
Batch Number	1	1	1	1									
Date of Receipt	02/10/2024	02/10/2024	02/10/2024	02/10/2024									
Electrical Conductivity @25C	113	165	233	276							<2	uS/cm	TM76/PM0
Total Dissolved Solids	142	111	170	188							<35	mg/l	TM20/PM0
pH	9.28	9.22	8.88	9.45							<0.01	pH units	TM73/PM0

Please see attached notes for all abbreviations and acronyms

All solid results are expressed on a dry weight basis unless stated otherwise.

Element Materials Technology

Notification of Deviating Samples

Client Name: Soil Advisory Services (PTY) Ltd
Reference: SAS20230906
Location: -
Contact: Ilse Snyman

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analysis	Reason
No deviating sample report results for job 24/16797						

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating. Only analyses which are accredited are recorded as deviating if set criteria are not met.
It is a requirement under ISO 17025 that we inform clients if samples are deviating i.e. outside what is expected. A deviating sample indicates that the sample 'may' be compromised but not necessarily will be compromised. The result is still accredited and our analytical reports will still show accreditation on the relevant analytes.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 24/16797

SOILS and ASH

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. Asbestos samples are retained for 6 months.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C. Ash samples are dried at 35°C ±5°C.

Where Mineral Oil is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overesitimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil is quoted, this refers to Total Aliphatics C10-C40.

STACK EMISSIONS

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation for Dioxins and Furans and Dioxin like PCBs has been performed on XAD-2 Resin, only samples which use this resin will be within our MCERTS scope.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a requirement of our Accreditation Body for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.
Laboratory records are kept for a period of no less than 6 years.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

Customer Provided Information

Sample ID and depth is information provided by the customer.

Age of Diesel

The age of release estimation is based on the nC17/pristane ratio only as prescribed by Christensen and Larsen (1993) and Kaplan, Galperin, Alimi et al., (1996).
Age estimation should be treated with caution as it can be influenced by site specific factors of which the laboratory are not aware.

Tentatively Identified Compounds (TICs)

Where Tentatively Identified Compounds (TICs) are reported, up to 10 Tentatively Identified Compounds will be listed where there is found to be a greater than 80% match with the NIST library. The reported concentration is determined semi-quantitively, with a matrix specific limit of detection. Note, other compounds may be present but are not reported.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above quantitative calibration range. The result should be considered the minimum value and is indicative only. The actual result could be significantly higher.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

EMT Job No: 24/16797

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM20	Modified BS 1377-3:1990/USEPA 160.1/3 (TDS/TS: 1971) Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.			AR	No
TM21	Modified BS 7755-3:1995, ISO10694:1995 Determination of Total Organic Carbon or Total Carbon by combustion in an Eltra TOC furnace/analyser in the presence of oxygen. The CO2 generated is quantified using infra-red detection. Organic Matter (SOM) calculated as per EA MCERTS Chemical Testing of Soil.	PM24	Preparation of Soil and Marine Sediment Samples for Total Organic Carbon.	Yes		AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma-Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM14	Preparation of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for Dissolved metals, and remain unfiltered for Total metals then acidified			AR	No
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma-Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 degrees Celsius. Samples containing asbestos are not dried and ground.			AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma-Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 degrees Celsius. Samples containing asbestos are not dried and ground.	Yes		AD	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) - All anions comparable to BS ISO 15923-1: 2013l	PM0	No preparation is required.			AR	No
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM0	No preparation is required.			AR	No
TM75	Modified US EPA method 310.1 (1978). Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.			AR	No
TM76	Modified US EPA method 120.1 (1982). Determination of Specific Conductance by Metrohm automated probe analyser.	PM0	No preparation is required.			AR	No
TM173	Analysis of fluoride by ISE (Ion Selective Electrode) using modified ISE method 9214 - 340.2 (EPA 1998)	PM0	No preparation is required.			AR	No

NORTH-WEST UNIVERSITY
ECO-ANALYTICA

Eco Analytica
P.O. Box 19140
NOORDBRUG 2522
Tel: 018-285 2732/3/4

SOIL ADVISORY SERVICES

2024/05/02

Nutrient Status

Sample no.	Ca	Mg	K	Na	P	Sat Paste pH	pH(KCl)	EC (mS/m)
	(mg/kg)							
P2-S1						6.24		335
P2-S2.1						5.78		368
P2-S2.2						5.94		405
P2-S3						7.10		480

Exchangeable cations

Sample no.	Ca	Mg	K	Na	CEC	S-value	Base saturation (%)	pH(H_2O)	pH(KCl)
	(cmol(+)/kg)								
P2-S1					7.53				
P2-S2.1					13.49				
P2-S2.2					21.65				
P2-S3					10.20				

HANDBOOK OF STANDARD SOIL TESTING METHODS FOR ADVISORY PURPOSES

Exchangeable cations: 1M NH_4-Asetaat pH=7
CEC: 1 M Na-asetaat pH=7
Extractable, Exchangeable micro-elements: 0.02M $(NH_4)_2$ EDTA.H_2O

EC: Saturated Extraction
pH H_2O/KCl: 1:2.5 Extraction
Phosphorus: P-Bray 1 Extraction

Particle Size Distribution

Sample no.	> 2mm (%)	Sand	Silt	Clay
		(% < 2mm)		
P2-S1	19.4	87.0	6.7	6.3
P2-S2.1	0.1	9.0	28.9	62.1
P2-S2.2	5.9	15.4	35.8	48.8
P2-S3	14.8	81.5	9.4	9.0

NORTH-WEST UNIVERSITY
ECO-ANALYTICA

Eco Analytica
P.O. Box 19140
NOORDBRUG 2522
Tel: 018-285 2732/3/4

SOIL ADVISORY SERVICES (NL)

#######

Nutrient Status

Sample no.	Ca	Mg	K	Na	P	pH Sat Paste	pH(KCl)	EC (mS/m)
	(mg/kg)							
P1-S1.1						7.51		673
P1-S1.2						6.58		863
P1S2						7.30		331
P1S3						4.34		58

Exchangeable cations

Sample no.	Ca	Mg	K	Na	CEC	S-value	Base saturation (%)	pH(H_2O)	pH(KCl)
	(cmol(+)/kg)								
P1-S1.1					26.50				
P1-S1.2					33.35				
P1S2					19.43				
P1S3					21.06				

HANDBOOK OF STANDARD SOIL TESTING METHODS FOR ADVISORY PURPOSES

Exchangeable cations: 1M NH_4-Asetaat pH=7
CEC: 1 M Na-asetaat pH=7
Extractable, Exchangeable micro-elements: 0.02M $(NH_4)_2$ EDTA.H_2O

EC: Saturated Extraction
pH H_2O/KCl: 1:2.5 Extraction
Phosphorus: P-Bray 1 Extraction

Particle Size Distribution

Sample no.	> 2mm (%)	Sand (% < 2mm)	Silt (% < 2mm)	Clay (% < 2mm)
P1-S1.1	13.2	52.0	1.8	46.2
P1-S1.2	19.7	38.9	5.4	55.7
P1S2	11.5	61.5	4.7	33.8
P1S3	4.2	22.4	39.4	38.2

WATERLAB (PTY) LTD

Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891

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P.O. Box 283, 0020

Telephone: +2712 – 349 – 1066
Facsimile: +2712 – 349 – 2064
Email: accounts@waterlab.co.za

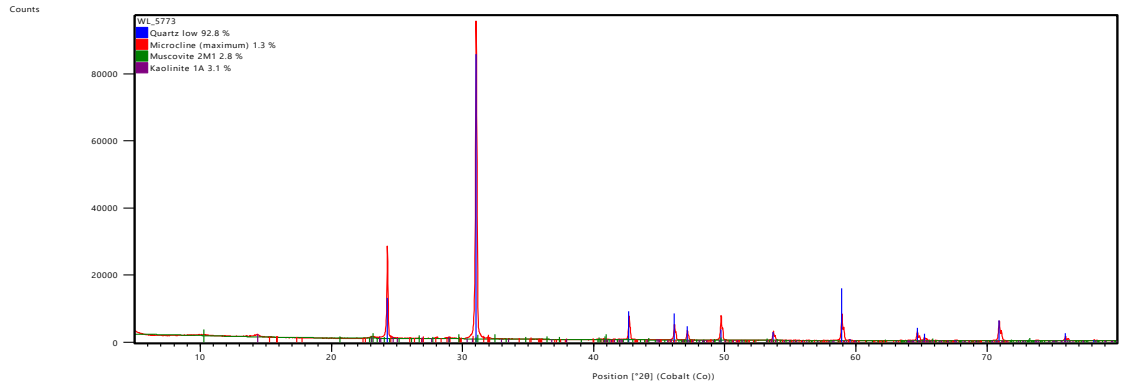
CERTIFICATE OF ANALYSES
X-RAY DIFFRACTION [o]

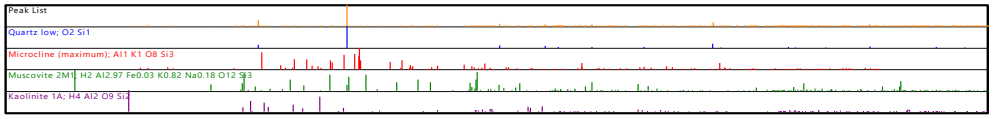
Date received:	**2024/04/22**			**Date completed:**	**2024/05/06**
Project number:	**1000**	**Report number:**	**131523**	**Order number:**	**SAS20230906**

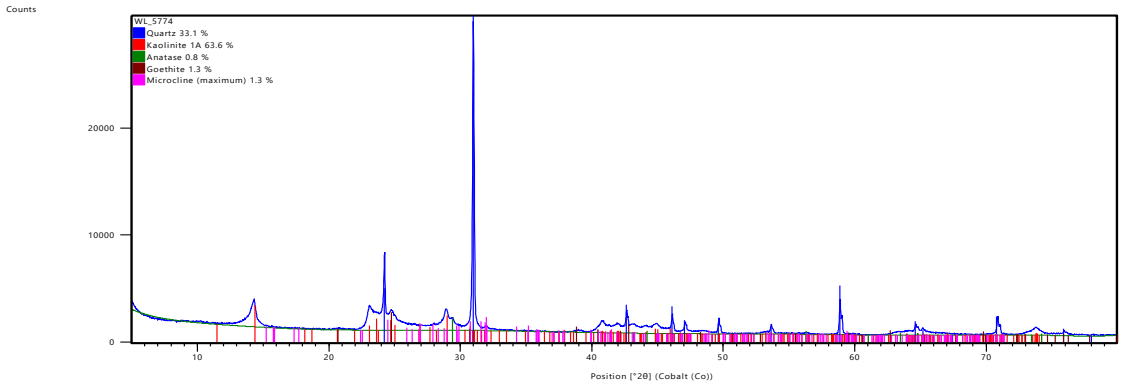
Client name:	**Soil Advisory Services**	**Contact person:**	**Ilse Snyman**
Address:	**8 Landau Terrace, Richmond, Johannesburg, 2092**	**Email:**	**ilse@soiladvisory.co.za**
Telephone:	**---**	**Cell:**	**072 237 9214**

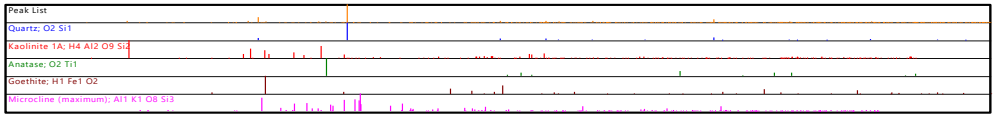
Analyses	**Sample Identification:**	
	P2-S1	**P2-S2.1**
Sample Number	**24-5773**	**24-5774**
Mineral Amount (weight %)	**Composition (%) [o]**	
Quartz	92.76	33.11
Microcline	1.33	1.26
Muscovite	2.84	0
Kaolinite	3.08	63.61
Anatase	0	0.76
Goethite	0	1.26

[o] = Outsourced









Note:

The material was prepared for XRD analysis using a back loading preparation method.
Diffractograms were obtained using a Malvern Panalytical Aeris diffractometer with PIXcel detector and fixed slits with Fe filtered Co-Kα radiation.
The phases were identified using X'Pert Highscore plus software.

The relative phase amounts (weight %) were estimated using the Rietveld method.

Comment:

- In case the results do not correspond to results of other analytical techniques, please let me know for further fine tuning of XRD results.
- Mineral names may not reflect the actual compositions of minerals identified, but rather the mineral group.
- Smectite, lizardite (serpentine), vermiculite, chlorite and kaolinite peaks overlap and further test would be necessary to distinguish. Identification is largely based on peak shapes and positions.
- Due to preferred orientation and crystallite size effects, results may not be as accurate as shown.
- Traces of additional phases may be present. Amounts below 0.5 weight % may be unreliable.
- Amorphous phases, if present, were not taken into consideration during quantification.

Ideal Mineral compositions:

Compound Name	Chemical Formula
Anatase	TiO2
Goethite	Fe2O3.H2O
Kaolinite	Al4(OH)8(Si4O10)
Microcline	KAlSi3O8
Muscovite	KAl2((OH)2AlSi3O10)
Quartz	SiO2

S. Laubscher

Assistant Geochemistry Project Manager

WATERLAB (PTY) LTD

Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891

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CERTIFICATE OF ANALYSES

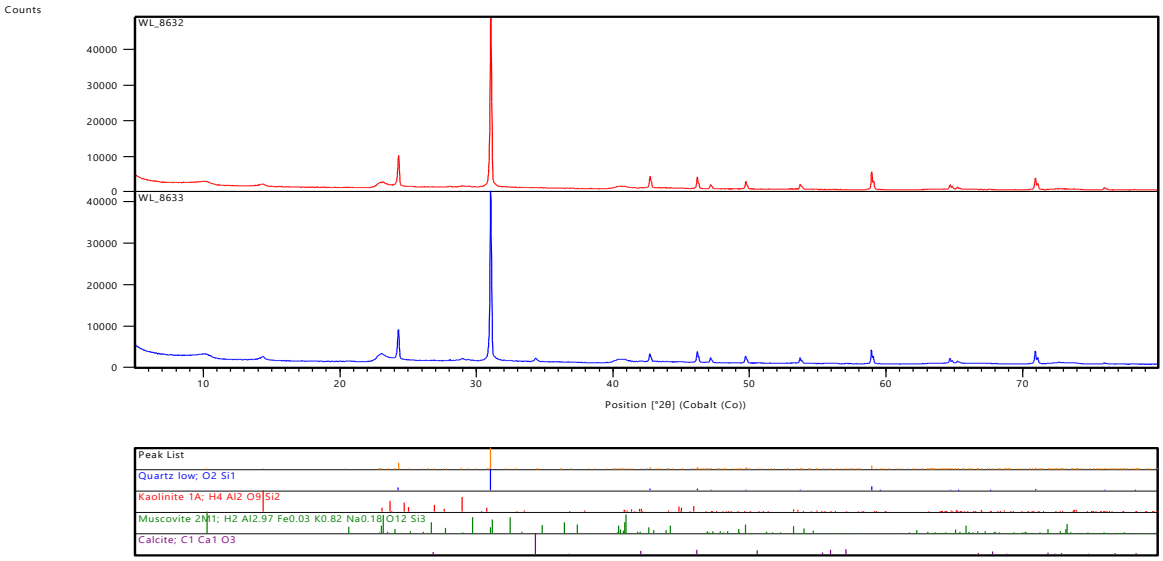
X-RAY DIFFRACTION [o]

Date received:	**2024/05/17**			**Date completed:**	**2024/06/05**
Project number:	**1000**	**Report number:**	**132513**	**Order number:**	**SAS20230906**

Client name:	**Soil Advisory Services**	**Contact person:**	**Ilse Snyman**
Address:	**8 Landau Terrace, Richmond, Johannesburg, 2092**	**Email:**	**ilse@soiladvisory.co.za**
Telephone:	**---**	**Cell:**	**072 237 9214**

Analyses	**Sample Identification:**	
	P1-S1.1	**P1-S1.2**
Sample Number	**24-8632**	**24-8633**
Mineral Amount (weight %)	**Composition (%) [o]**	
Quartz	75.1	62.7
Kaolinite	7.9	13.6
Muscovite	17.1	22.4
Calcite	0.0	1.4

[o] = Outsourced



Note:

The material was prepared for XRD analysis using a back-loading preparation method.
Diffractograms were obtained using a Malvern Panalytical Aeris diffractometer with a PIXcel detector and fixed slits with Fe-filtered Co-Kα radiation.
The phases were identified using X'Pert Highscore Plus software.
The relative phase amounts (weight %) were estimated using the Rietveld method.

Comment:

- If the results do not correspond to those of other analytical techniques, please let me know for further fine-tuning of XRD results.
- Mineral names may not reflect the actual compositions of minerals identified, but rather the mineral group. Muscovite may represent muscovite and/or illite.
- Due to preferred orientation and crystallite size effects, results may not be as accurate as shown.
- Smectite, lizardite (serpentine), vermiculite, chlorite, and kaolinite peaks overlap, and further tests would be necessary to distinguish them. Identification is largely based on peak shapes and positions.
- Traces of additional phases may be present. Amounts below 0.5 weight % may be unreliable.
- Amorphous phases, if present, were not considered during quantification.

Ideal Mineral compositions:

Compound Name	**Chemical Formula**
Calcite	CaCO3
Kaolinite	Al2Si2O5(OH)4
Muscovite	KAl2((OH)2Al Si3 O10)
Quartz	SiO2

E. Botha
Geochemistry Project Manager

WATERLAB (PTY) LTD

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CERTIFICATE OF ANALYSES
SULPHUR SPECIATION

Date received:	**2024/04/22**			**Date completed:**	**2024/05/06**
Project number:	**1000**	**Report number:**	**131523**	**Order number:**	**SAS20230906**

Client name:	**Soil Advisory Services**	**Contact person:**	**Ilse Snyman**
Address:	**8 Landau Terrace, Richmond, Johannesburg, 2092**	**Email:**	**ilse@soiladvisory.co.za**
Telephone:	**---**	**Cell:**	**072 237 9214**

Analyses	Sample Identification				
	P2-S1	P2-S2.1	P2-S2.2	P2-S3	P2-S3
Sample Number	**24-5773**	**24-5774**	**24-5775**	**24-5776**	**24-5776 D**
Total Sulphur (%) (ELTRA)	0.02	0.11	0.34	0.12	0.13
Sulphate Sulphur as S (%)	<0.01	0.10	0.32	0.09	0.10
Sulphide Sulphur (%)	0.02	0.01	0.01	0.03	0.03

Notes:

- Samples analysed with Pyrolysis at 550°C as per Prediction Manual For Drainage Chemistry from Sulphidic Geological Materials MEND Report 1.20.1. Multiply Sulphate Sulphur to calculate SO4 % by 2.996. Please see the method for interferences.
- Organic Sulphur is not taken into account and may be included in the results.
- Please let me know if results do not correspond to other data.

S. Laubscher

Assistant Geochemistry Project Manager

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CERTIFICATE OF ANALYSES

SULPHUR SPECIATION [o]

Date received:	**2024/05/17**			**Date completed:**	**2024/07/08**
Project number:	**1000**	**Report number:**	**132513**	**Order number:**	**SAS20230906**

Client name:	**Soil Advisory Services**	**Contact person:**	**Ilse Snyman**
Address:	**8 Landau Terrace, Richmond, Johannesburg, 2092**	**Email:**	**ilse@soiladvisory.co.za**
Telephone:	**---**	**Cell:**	**072 237 9214**

Analyses	Sample Identification				
	P1-S1.1	P1-S1.1	P1-S1.2	P1S2	P1S3
Sample Number	**24-8632**	**24-8632 D**	**24-8633**	**24-8634**	**24-8635**
Total Sulphur (%) [o]	0.063	0.063	0.072	0.022	0.059
Sulphate Sulphur as S (%) [o]	0.017	0.018	0.005	<0.002	0.015
Sulphide Sulphur (%) [o]	0.046	0.044	0.067	0.002	0.044

Notes:

- Samples analysed with Pyrolysis at 550°C as per Prediction Manual For Drainage Chemistry from Sulphidic Geological Materials MEND Report 1.20.1. Multiply Sulphate Sulphur to calculate SO4 % by 2.996. Please see the method for interferences.
- Organic Sulphur is not taken into account and may be included in the results.
- Please let me know if results do not correspond to other data.

S. Laubscher

Assistant Geochemistry Project Manager

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TEST REPORT

S24/0266

SOIL ADVISORY SERVICES (Pty) Ltd

For: 8 LANDAU TERRACE RICHMOND
JOHANNESBURG
2092

Date: 2024-04-29

Attention: Ilse Snyman (MSc, Pr.Sci. Nat (Soil Science))

Your Reference: SAS20230906

Sample(s)	Test(s) Conducted	Date requested	Test Method(s) used	Sampling method & Date	Test(s) done at	Test(s) dates
S24/0266/1	• Falling Head Permeability	2024-04-24	• *ASTM D2434		Soillab Pretoria	2024-04-24 2024-04-29
S24/0266/2	• Falling Head Permeability	2024-04-24	• *ASTM D2434			

Note:
**** Decision rule not be applied to the Colto Classification, please enquire if required.
*** Non-standard aggregate sizes used in test. Generally smaller aggregates will produce lower values and the larger sizes higher values.
** Used tap water to wash and not distilled water.
* Not SANAS Accredited:
Results marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this laboratory / certification body / inspection body.
Sample and sampling environmental conditions will only be noted if it is abnormal, not according to test method specification or can have an influence on the final result.
The test results are only applicable to the samples tested.

I accept this document
Miss EB Lefoka
Technical Signatory (Geolab)

Falling Head Permeability

Project:	SAS20230906
Client:	Soil Advisory Services
Geolab Job Nr:	S24-0266
Date:	2024/04/27
Test Mothod:	ASTM D2434:1974

		Remoulded to:							
Sample Number:	**Depth: m**	**Dry Density: kg/m³**	**w %**	**H1 cm**	**H2 cm**	**Time h**	**m**	**s**	**Permeability cm/s**
P2-S1		1684	12,8	60	38	3	1	9	3,66E-06
P2-S2.1		2124	6,1	60	25	19	49	2	1,05E-06

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Falling Head Permeability

Project:	SAS20230906
Client:	Soil Advisory Services
Geolab Job Nr:	S24-0336
Date:	2024/07/04
Test Mothod:	ASTM D2434:1974

		Remoulded to:							
Sample Number:	**Bulk Density kg/m³**	**Dry Density: kg/m³**	**w %**	**H1 cm**	**H2 cm**	**Time h**	**m**	**s**	**Permeability cm/s**
P1-S1.1	1496,52	1304	14,8	60	30	0	0	56	1,07E-03
P1-S1.2	1523,44	1328	14,7	60	30	0	0	52	1,11E-03

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