SOIL AND CONTAMINATED LAND ASSESSMENT FOR THE PROPOSED SAB GLASS BOTTLE MANUFACTURING PLANT

Portion 1 of Portion 238, Leeukuil Ext 5, Vereeniging, Gauteng

Prepared for: The South African Breweries (Pty) Limited (SAB)

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SLR

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I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
All the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

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Name of company (if applicable):

29 September 2018

Date:

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BASIS OF REPORT

EXECUTIVE SUMMARY

SLR Consulting (South Africa) (Pty) Ltd (SLR), an independent environmental consulting firm, has been appointed by The South African Breweries (Pty) Limited (SAB) to undertake a Technical Specialist Soil and Contaminated Land Study in support of an Environmental Impact Assessment EIA for the construction and operation of a SAB's Glass Bottle Manufacturing Plant in the Emfuleni Local Municipality of the Gauteng Province, South Africa. The preferred site is located on a portion of portion 238 of the Farm Leeuwkuil 596 IQ, Vereeniging.

The primary objective is to assess and determine the risk assessment on the soil, land use and agriculture potential due to the construction of SAB's Glass Bottle Manufacturing Plant. On the 30th of November, 2017, SLR performed a Basic Soil and Contaminated Land Assessment Phase 1 at Portion 1 of Portion 238 of the Farm Leeuwkuil 596 IQ, Vereeniging.

All the soil in the area can be classified as Sterkspruit Form 1200 Bethulie Family. The Sterkspruit Form occurs on the footslopes and consists of an orthic A horizon with a prismacutanic B horizon. These soils are duplex soils. These soils developed a strong structure in the B horizon with a marked increase in clay content compared to the overlying horizon which is separated by a clear or abrupt boundary. The B horizon is sufficiently hard and dense to be an impediment to both root growth and water movement and are highly susceptible to erosion.

These soils are considered to have a low agricultural potential. The rooting depth is limited by the prismacutanic B horizon and the soils are highly erodible due to the high Na content. These soils should be managed carefully to limit erosion.

No major external organic or trace element sources are indicated and concentrations are considered to represent baseline conditions. Site specific baseline concentrations were calculated for future reference.

The construction of the SAB's Glass Bottle Manufacturing Plant will result in soil being removed from the site. This could result in a permanent loss if not mitigated. In addition, compaction and/or erosion of soils could occur. Through proper topsoil stripping and management the impacted soil can be utilised for beneficial uses. Through proper traffic and movement control during construction and operation impact on soil outside the removal area can be limited. Soils could also be lost through contamination. Measures should be implemented to limit risks of soil contamination by construction and operational materials used on site. Any contaminated soil that occurs should be remediated appropriately. Waste should be handled in a manner that will not contaminate soil resources and littering should be avoided. Relevant procedures relating to soil management, spill prevention and clean-up and waste management should be in place at the start of construction. If proper management procedures are in place the mitigated impact on soil would result in an overall low significance rating.

It is expected that the proposed plant could be in operation for an extended period of time and therefore decommissioning and closure of the plant has not been considered in this assessment. It is assumed that if and/or when this is required an assessment of this phase will be undertaken to inform the decommissioning and closure process.

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ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
CEC	Cation Exchange Capacity is the total capacity of a soil to hold exchangeable cations. Given in cmol(+)/kg.
cm	Centimetres
cmol(+)/kg	Centimoles of positive charge per kilogram of soil, numerically equal to milliequivalents per 100 g of soil (me/100g). This takes account of the different valencies and atomic weights of different cations.
DILs	Dutch Intervention Levels
DWA	Department of Water Affairs (currently known as DWS)
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
ESP	Exchangeable sodium percentage – the percentage of the cation exchange capacity of the soil (expressed in cmol(+)/kg soil) that is occupied by sodium (expressed in cmol(+)/kg soil).
HASP	Health and Safety Plan
H&S	Health and Safety
km	Kilometre
LQR	Land Quality and Remediation
m	Meters
mm	Millimetres
m amsl	Metres above mean sea level
m bgl	Meters below ground level
MDL	Method detection limit
mg/L	Milligrams per litre
P – Bray 1	The available phosphorus in soil using the Bray No 1 solution as extractant. The Bray No 1 solution is an acidic Ammonium Fluoride solution.
pH	Potential of Hydrogen – defined as the decimal logarithm of the reciprocal of the hydrogen ion activity, $a_{H}+$, in a solution

Acronym / Abbreviation	Definition
$pH(H_2O)$	pH measured in a 1:2.5 soil : distilled water solution
ppm	Parts per million
%	Percentage or g/100g
QA/QC	Quality Assurance and Quality Control
SAR	Sodium adsorption ratio – this is a measure of the quality of salts in solution where Na, Ca and Mg are expressed in mmol(+)/I. The formula: $SAR = \frac{Na+}{\sqrt{(\frac{Ca^{2+} + Mg^{2+}}{2})}}$
SLR SA	SLR Consulting (South Africa) (Pty) Ltd
S-Value	Sum of exchangeable (as opposed to soluble) Ca, Mg, Na and K, expressed in cmol(+)/kg soil
µg/L	Micrograms per litre

1. INTRODUCTION

SLR Consulting (South Africa) (Pty) Ltd (SLR), an independent environmental consulting firm, has been appointed by SAB to undertake a Technical Specialist Soil and Contaminated Land Study in support of an Environmental Impact Assessment EIA for the construction and operation of a Glass Bottle Manufacturing Plant in the Emfuleni Local Municipality of the Gauteng Province, South Africa. The preferred site is located on a portion of portion 238 of the Farm Leeuwkuil 596 IQ, Vereeniging (**Figure 1**). The conceptual design brief of the process equipment and design principles for a Greenfield glass bottle manufacturing facility is outlined in Appendix A.

This report follows the Soil and Contaminated Land Field Assessment conducted on the 30th of November, 2017 and details the risk assessment on the soil, land use and agriculture potential due to the construction of SAB's Glass Bottle Manufacturing Plant.

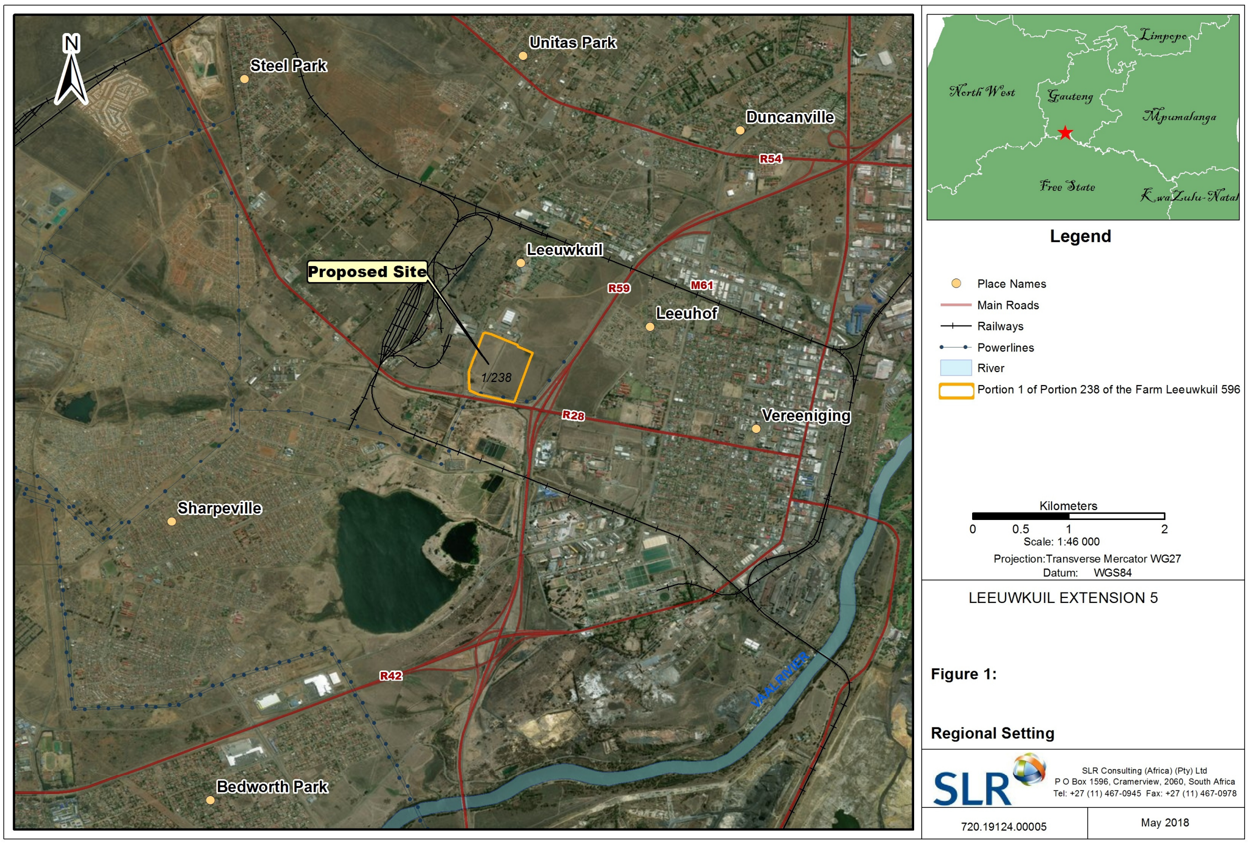


Figure 1: Locality Map

2. OBJECTIVE

The primary objective is to assess and determine the risk assessment on the soil, land use and agriculture potential due to the construction of SAB's Glass Bottle Manufacturing Plant.

3. SITE DESCRIPTION

A background site description is presented in **Table 1**.

Table 1: Site Description

Aspect	Description	
Site Land use	Historic	The Site has been used as a livestock grazing ground for at least the past 28 years. The land was acquired by SAB in 1983. Land use prior to 1983 is unknown (satellite imagery dates back to 2010).
	Current	Vacant Land.
Site Surface	Cover	Site surfacing is short grassland cover.
	Drainage	There is a manmade drainage on the southern boundary of this site and a channel which divides the site in east and west portions. The site gently slopes to the East, towards the R59 provincial road to Vereeniging town.
Surrounding Land Use	North	SAB Depot located adjacent north of the site followed by nursery school. The Department of Roads and Transport is located 500m north of the northern site boundary Telkom and Open Serve properties a further 100m north. Residential properties (Correctional Services Staff Housing) located approximately 600m north north east to the north site boundary. Prison located approximately 930m north north east of the northern site boundary. Industrial area located approximately 1200m from the northern site boundary. Residential areas located approximately 1500m from the northern site boundary.
	North East	Open grassland adjacent to the site. Substation approximately 600m from the northern site boundary. R59 road approximately 750m from the northern site boundary then a residential area.
	East	Open grassland adjacent to the site. R59 road approximately 500m from the eastern site boundary followed by open grassland. The Eureka School, hostel, and sports grounds approximately 1km east of the eastern site boundary.
	South East	Open grassland adjacent to the site. A bridge approximately 400m from southern boundary. Industrial area a further 400m away.
	South	R28 followed by the informal livestock fair and Leeuwkuil Water Care works approximately 300m from the southern site boundary.

Aspect	Description	
	South West	Lager Street followed by open grassland. Industrial area approximately 600m from the southern site boundary.
	West	Lager Street followed by Vereeniging Fresh Produce Market approximately 80 west of the site. Transnet Industrial Railway 650m from the western site boundary.
	North West	Lager Street followed by Vereeniging Fresh Produce Market. Open grassland and then historical asphalt storage yard approximately 670m from the northern site boundary. A residential area a further 600m away.
Geography	Elevation	Approximately 1 451m above mean sea level.
	Surface waters	No surface waters were identified within 500m of the site.
Geology	Superficial	Alluvium (clay, silt and sand).
	Bedrock	The geology of the area is shale, sandstone, coal and mudstone of the Ecca Group of the Karoo Supergroup. The Karoo sediments are underlain by dolomites of the Malmani Sub-group of the Chuniespoort Group, Transvaal Supergroup. The Ecca sediments encountered during the site assessment was intercalated shales and quartzitic sandstone, with the quartzitic sandstone predominating, and some occurrence of mudstone.
Climate	The area is in a warm summer-rainfall region, with dry winters and frequent frost. Rainfall is approximately 559mm per year occurring mainly between October to March.	
Nearby Underground Structures	Underground utilities in the vicinity of the site include telephone, storm sewer, sanitary sewer, water and electrical lines. An underground electrical line is present on the site and connected to the sub-station.	
Other Observations	Nearby protected biodiversity zones	Leeuwkuil Nature Reserve 1600m south of the site.
	Nearby heritage and archaeological sites	None present.
	Nearby sensitive environments	Nursery school located approximately 200m from the northern site boundary

4. METHODOLOGY

On the 30th of November, 2017, SLR performed a Basic Soil and Contaminated Land Assessment Phase 1 at Portion 1 of Portion 238 of the Farm Leeuwkuil 596 IQ, Vereeniging (**Figure 2**).

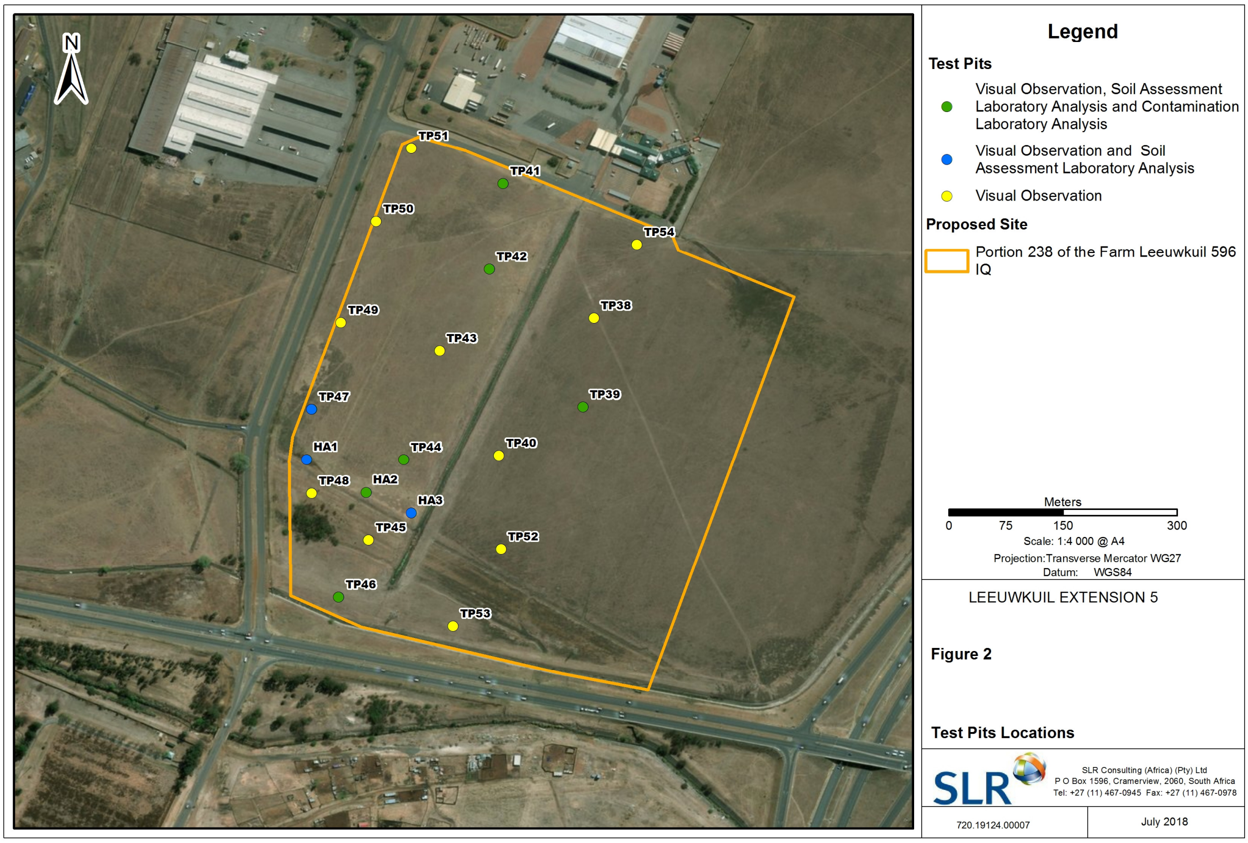


Figure 2: Test Pit Locations

Test Pit (TP) locations were selected by the SLR SA Geotechnical Engineering team across the site. From these locations, the SLR SA Land Quality and Remediation (LQR) team identified select test pits to be sampled for further laboratory analysis for the two types of soil assessments; the Basic Soil Assessment, and the Contaminated Land Assessment. Selection of the test pits to be sampled was completed through the review of google earth aerial photographs to identify areas with visual differences in the soils. All test pit locations were visually assessed and classified to determine soil types and soil properties.

Some test pits were selected to be sampled for analysis for basic soil properties (**Table 2**). Test pits were also selected for analysis for the contaminated land assessment (**Table 3**).

Table 2: Test Pits and Sampling Depth for the Soil Assessment

Test Pit Numbers	Sampling Depth (m)
HA1	0.0 - 0.30
HA2	0.0 - 0.40
HA3	0.0 - 0.30
TP39A	0.10 - 0.70
TP39B	1.0 - 1.90
TP41A	0.10 - 0.70
TP41B	0.95 - 1.80
TP42A	0.10 - 0.80
TP42B	1.0 - 1.50
TP44A	0.10 - 0.60
TP44B	0.90 - 1.50
TP46A	0.10 - 0.40
TP46B	0.60 - 1.30
TP47A	0.10 - 0.50
TP47B	0.10 - 0.50

Table 3: Test Pits and Sampling Depth for the Contaminated Soil Assessment

Test Pit Numbers	Sampling Depth (m)
HA2	0.0 - 0.40
TP39A	0.10 - 0.70
TP41A	0.10 - 0.70
TP42A	0.1 - 0.80
TP44A	0.10 - 0.60
TP46A	0.10 - 0.40

5. RESULTS AND INTERPRETATION

5.1 SOIL PROFILES DESCRIPTION

Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC) (Land Type Survey Staff, 1972 – 2006). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (The Soil Classification Working Group, 1991).

The area in which the site is located falls under Land Type Bb23 and occurs on the footslopes. The footslopes of this land type are dominated by Mispa, Rensburg, Herschel, Albany and Sterkspruit soil forms.

A total of seventeen (17) test pits were excavated. Two (2) typical profile sequences were identified and classified. The soils are classified as a Sterkspruit Form 1200 Bethulie Family. The Sterkspruit Form occurs on the footslopes and consists of an orthic A horizon with sharp transition to the prismacutanic B horizon. These soils are known to be duplex soils. The soils in the area have developed a strong structure in the B horizon with a marked increase in clay content compared to the overlying horizon which is separated by a clear or abrupt boundary. The B horizon is sufficiently hard and dense to be an impediment to both root growth and water movement and is highly susceptible to erosion.

Due to the change in the landscape as a result of the road construction a wet area has developed to the south east of the site but does not indicate an historic wetland area. Drainage design should account for this.

5.1.1 Typical Soil Profile 1

The following Test Pits had a similar soil profile: TP38, TP39, TP40, TP41, TP45, TP46, TP52 and TP53. A typical soil profile description is presented in **Table 4** and photo log in **Figure 3**.

Table 4: Description of Typical Soil Profile 1

Depth (m)	Soil Texture	Compaction/ Consistency	Odour and Staining	Structure	Colour	Water Content
0 – (0.56-0.89)	Sandy Clay Loam	Stiff	None	Intact	Black (10YR 2/1) orthic A horizon	Dry
(0.56-0.89) – (1.42 -2.36)	Clay	Stiff	None	Intact	Dark greyish brown (2.5Y /2) prismacutanic B horizon	Dry
(1.42 - 2.36) – (2.88 – 3.88)	Sandy Clay to Gravelly Sandy Clay	Very Stiff - Stiff	None	Intact	Dark greyish brown (2.5Y 4/2)	Dry
(2.88 – 3.88) – (3.95-4.17)	Sandy Clay to Gravelly Sandy Clay	Stiff	None	Intact	Dark greyish brown (2.5Y 4/2) Dark Grey, with white and yellow-brown mottling, quarztitic gravels and cobbles, calcrete nodules, residual gritstone	Dry
(3.95-4.17) – ((4.08-4.12) – 4.25))	Sandstone to Gritstone	N/A	N/A	N/A	(10YR 7/1) Light Grey, medium grained rock, thinly bedded sandstone, moderate to highly weathered matrix supported gritsone	Dry

Typical Soil Profile 1			
			
Plate 1	Black sandy clay loam in TP46.	**Plate 2**	Dark greyish brown clay in TP46.
			
Plate 3	Dark greyish brown sandy clay to gravelly sandy clay in TP53.	**Plate 4**	Dark greyish brown sandy clay to gravelly sandy clay, with gravel and cobble sized quartzite in TP53.
			
Plate 5	Calcrete nodules in TP53.	**Plate 6**	Medium grained, thinly bedded sandstone in TP53.

Typical Soil Profile 1			
			
Plate 7	Quartzite cobble in TP53.	**Plate 8**	Residual gritstone in TP53.

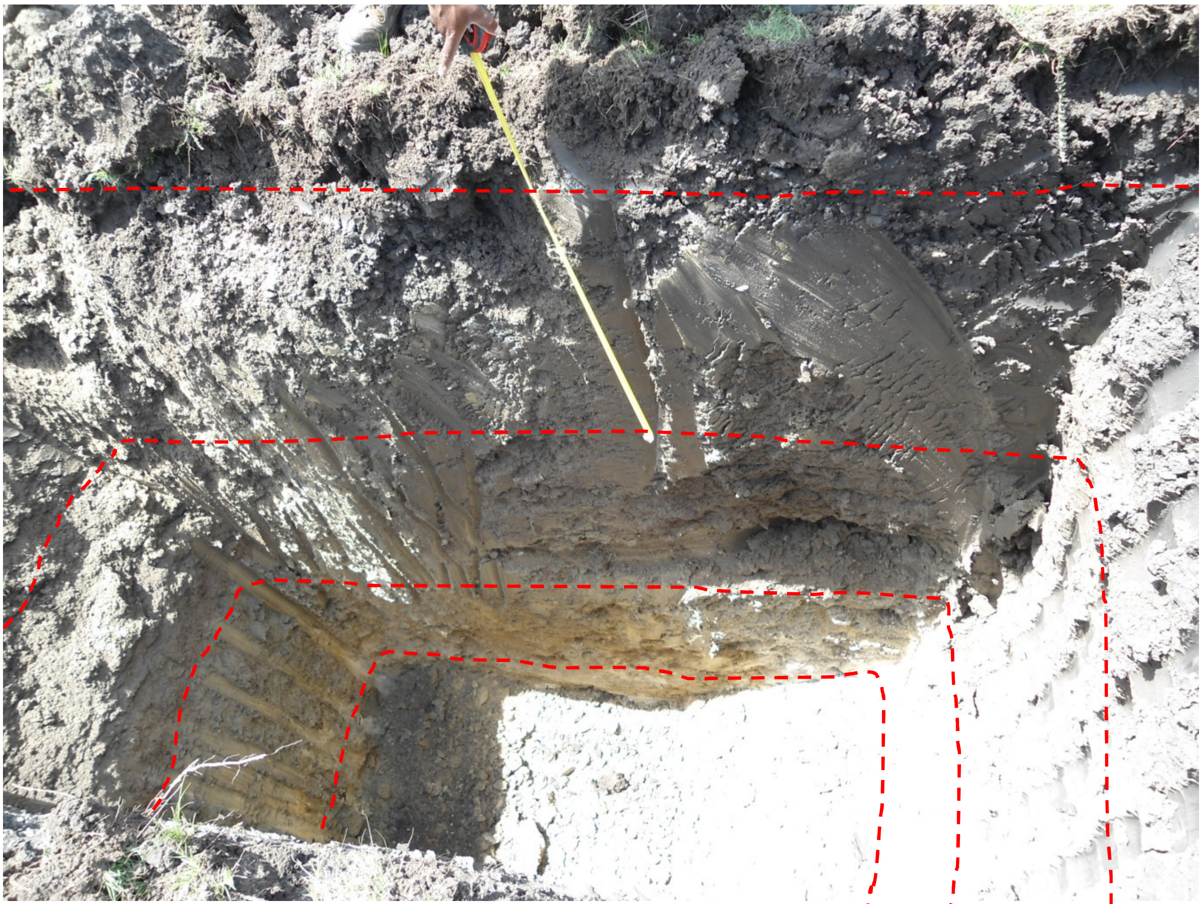



Plate 9	Typical Soil Profile 1 with the 5 different layers demarcated (TP53).		

Figure 3: Photos for Typical Soil Profile Sequence 1

5.1.2 Typical Soil Profile 2

The following Test Pits had a similar soil profile: TP42, TP43, TP44, TP47, TP48, TP49, TP50, TP51 and TP54. A generalised soil profile description is presented in **Table 5** and photo log in **Figure 4.**

Table 5: Description of Typical Soil Profile 2

Depth (m)	Soil Texture	Compaction/ Consistency	Odour and Staining	Structure	Colour	Water Content
0 – (0.64-0.98)	Sandy Clay Loam	Stiff	None	Intact	Very dark grey (10YR 3/1) orthic A horizon	Dry - Moist
(0.64-0.98) – (1.45-1.85)	Sandy Clay	Firm - Stiff	None	Intact	Light olive brown (2.5Y 5/3), with Prismacutanic B horizon	Dry - Moist
(1.45-1.85) – (2.42-3.64)	Sandy Clay	Firm - Stiff	None	Intact	Light olive brown (2.5Y 5/3, speckled white, ferricrete nodules	Dry - Moist
((2.42-3.64) – (3.92 – 4.45)	Sandy Clay	Firm - Stiff	None	Intact	Light brownish grey (2.5Y 6/2), with yellow-brown mottling, calcrete nodules, residual gritsone	Dry - Moist

Typical Soil Profile 2

Plate 10	Very dark grey sandy clay loam in TP50.	Plate 11	Light olive brown, with grey mottling sandy clay in TP47.

Typical Soil Profile 2			
			
Plate 12	Light olive brown, speckled white sandy clay with ferricrete nodules in TP47.	**Plate 13**	Light brownish grey with yellow-brown mottling sandy clay, with ferricrete nodules and calcrete nodules in TP50.
			
Plate 14	Typical Soil Profile 2 with the 4 different layers demarcated (TP47).		

Figure 4: Photos for Typical Soil Profile 2

5.2 ANALYTICAL RESULTS

5.2.1 Soil physical characteristics

The soils show an accumulation of clay in the B horizon. According to USDA texture classification system the A horizon has a sandy clay loam, sandy clay to clay texture while the B horizon has a sandy clay to clay texture (). There is at least a 20% clay content increase between the A and B horizons.

Table 6: Particle Size Analysis and USDA Texture Classification

Sample No.	> 2mm	Sand	Silt	Clay	USDA Texture
	(%)	(% < 2mm)			
HA1	0.49	39.16	7.12	53.71	Clay
HA 2	6.71	47.41	12.76	39.83	Sandy Clay
HA3	4.75	49.69	15.83	34.48	Sandy Clay
TP39A	0.03	51.49	14.42	34.10	Sandy Clay Loam
TP39B	0.25	41.37	7.23	51.40	Clay
TP41A	0.15	11.24	83.34	5.42	Silt
TP41B	3.12	49.97	6.89	43.14	Sandy Clay
TP42A	0.51	45.87	12.38	41.74	Sandy Clay
TP42B	0.45	28.49	10.87	60.64	Clay
TP44A	0.83	50.80	9.61	39.59	Sandy Clay
TP44B	2.20	44.64	6.52	48.84	Clay
TP46A	0.08	59.31	8.47	32.21	Sandy Clay Loam
TP46B	0.30	43.32	3.34	53.35	Clay
TP47A	1.05	58.32	12.08	29.60	Sandy Clay Loam
TP47B	1.13	47.33	6.85	45.82	Sandy Clay

Field capacity is the amount of water held in the soil after excess water has drained away and the rate at which the downward movement of water has decreased. The soil has a very high field capacity and this means that it can hold water for long periods. The soils have a high bulk density and this indicates that they have low organic carbon which can be seen in **Table 7**, the carbon content of the samples is concentrated in the A horizon with the A horizons having more than 1% and the B horizon having less than 0.5% carbon.

Table 7: Field Capacity Bulk Density and Percent Carbon

Sample No.	Field	Bulk Density	Walkley Black
	Capacity (%)	g/ml	%C
HA1	69.39	1.41	0.80
HA 2	71.67	1.26	2.41

Sample No.	Field	Bulk Density	Walkley Black
HA3	65.41	1.40	1.80
TP39A	61.53	1.43	1.12
TP39B	73.46	1.46	0.02
TP41A	60.16	1.46	1.51
TP41B	65.94	1.49	0.14
TP42A	65.89	1.44	1.18
TP42B	84.29	1.35	0.10
TP44A	70.28	1.41	1.43
TP44B	79.03	1.41	0.25
TP46A	61.55	1.45	1.35
TP46B	77.63	1.44	0.16
TP47A	57.78	1.36	1.55
TP47B	63.39	1.39	0.43

The nutrient status of the soils is given in **Table 8**. The averages of the constituents were compared to general fertility guidelines from the Fertilizer Association of South Africa, 2003 (

Table 9).

The average cation concentrations of K and Ca are intermediate, i.e., they have concentrations in the normal ranges for soils. K has concentrations closer to the lower threshold while Ca has concentrations closer to the high threshold.

The average cation concentration of Mg and Na are higher than the guideline used. The concentrations of both Mg and Na are higher in the B horizon as compared to the A horizon. The higher concentrations of Mg and Na in the B horizon show accumulation of sodium and magnesium. The high Mg concentration indicates the tendency of these soils to disperse. The Na and Mg accumulation in this B-horizon which is typical of duplex soils.

The average P concentration is below the guideline utilised and indicates that the soil is unlikely to have been cultivated in the past.

The soil pH ranges from 6.27 to 8.08 indicating a slightly acidic to alkaline condition, with a neutral average pH of 7.06 (**Table 10** and

Table 11). The Electrical Conductivity (EC) ha an average of 152 mS/m.

Table 8: Nutrient Status

Sample No.	Ca	Mg	K	Na	P
	(mg/kg)				
HA1	2919.50	1680.50	137.00	81.50	2.36
HA 2	3047.00	886.50	63.00	47.50	5.33

Sample No.	Ca	Mg	K	Na	P
HA3	2891.00	966.00	32.00	43.50	3.11
TP39A	2258.50	724.50	24.50	117.00	1.35
TP39B	2765.50	1342.00	45.50	655.50	0.83
TP41A	1629.50	596.00	73.50	98.00	1.65
TP41B	2528.50	1386.50	63.50	806.50	0.82
TP42A	2410.50	854.50	43.00	135.50	6.38
TP42B	2922.00	1515.00	66.50	573.50	1.21
TP44A	2851.50	1148.50	33.00	196.00	1.47
TP44B	3089.00	1788.50	56.50	717.50	0.93
TP46A	2190.00	1166.50	43.50	492.50	1.86
TP46B	2784.50	1849.50	54.50	1421.00	1.01
TP47A	2337.00	944.00	112.00	71.00	2.06
TP47B	2656.50	1658.00	47.00	485.00	1.06
Average	2618.70	1233.77	59.67	396.10	2.10

Table 9: Nutrient Fertility Compared to Fertility Guidelines

Nutrients	Low	High	Average of soils (mg/kg)	Status
Potassium (K)	<40	>250	60	Intermediate
Calcium (Ca)	<200	>3000	2619	Intermediate
Magnesium (Mg)	<50	>300	1234	High
Sodium (Na)	<50	>200	396	High
Phosphorus (P)	<8	>35	2	Low

Table 10: pH range classification

pH(H_2O)		Average of soils (mg/kg)	Status
Very Acid	<4	7.06	Neutral
Acid	5-5.9		
Slightly Acid	6-6.7		
Neutral	6.8-7.2		
Slightly Alkaline	7.3-8		
Alkaline	>8		

Table 11: pH and EC Values

Sample No.	pH(H_2O)	EC (mS/m)
HA1	7.56	24
HA 2	6.27	39
HA3	7.34	59
TP39A	6.45	126
TP39B	7.76	257
TP41A	6.45	34
TP41B	7.43	321
TP42A	6.48	56
TP42B	7.87	124
TP44A	6.54	119
TP44B	6.98	266
TP46A	6.67	111
TP46B	7.36	550
TP47A	6.71	33
TP47B	8.08	156
Average	7.06	152

The exchangeable sodium percentage (ESP) is higher in the B horizon than in the A horizon and this indicates sodium accumulation in this horizon (**Table 12**). This is further supported by the higher Sodium Adsorption Ratios (SAR) in this horizon (**Table 13**). This accumulation is potentially due to natural soil forming process with accumulation of clay and salts in the B-horizons.

Table 12: Exchangeable Cations

Sample No.	Ca	Mg	K	Na	S-value	ESP
	(cmol(+)/kg)					
HA1	14.57	13.83	0.35	0.35	29.11	1.22
HA 2	15.20	7.30	0.16	0.21	22.87	0.90
HA3	14.43	7.95	0.08	0.19	22.65	0.84
TP39A	11.27	5.96	0.06	0.51	17.80	2.86
TP39B	13.80	11.05	0.12	2.85	27.81	10.25
TP41A	8.13	4.91	0.19	0.43	13.65	3.12

Sample No.	Ca	Mg	K	Na	S-value	ESP
TP41B	12.62	11.41	0.16	3.51	27.70	12.66
TP42A	12.03	7.03	0.11	0.59	19.76	2.98
TP42B	14.58	12.47	0.17	2.49	29.71	8.39
TP44A	14.23	9.45	0.08	0.85	24.62	3.46
TP44B	15.41	14.72	0.14	3.12	33.40	9.34
TP46A	10.93	9.60	0.11	2.14	22.78	9.40
TP46B	13.89	15.22	0.14	6.18	35.43	17.44
TP47A	11.66	7.77	0.29	0.31	20.03	1.54
TP47B	13.26	13.65	0.12	2.11	29.13	7.24

Table 13: Saturated Paste Extract Cations

Sample No.	Na	Mg	K	Ca	SAR
	mmol(+)/l				
HA1	0.68	0.83	0.05	0.81	0.75
HA2	0.61	1.03	0.05	1.94	0.50
HA3	0.94	1.85	0.05	3.44	0.58
TP39A	5.84	3.12	0.05	4.43	3.01
TP39B	15.02	5.93	0.04	8.35	5.62
TP41A	1.64	1.03	0.10	1.08	1.60
TP41B	20.47	8.58	0.05	8.11	7.09
TP42A	2.52	1.38	0.05	1.95	1.95
TP42B	6.67	2.71	0.03	3.65	3.74
TP44A	4.71	3.34	0.04	4.23	2.42
TP44B	13.30	7.34	0.04	8.01	4.80
TP46A	7.20	2.18	0.06	1.84	5.07
TP46B	40.29	16.50	0.06	11.70	10.73
TP47A	1.19	1.10	0.10	1.16	1.12
TP47B	7.60	5.36	0.04	4.35	3.45

5.2.2 Contaminated Land Evaluation

Six (6) samples were analysed for potential organic contaminants. The analysed samples were all from the top horizon of the soil. **Table 14** shows the analysed constituents with concentrations above the laboratory detection limits. The complete laboratory results can be found in Appendix A. The samples were screened against the South African Soil Screening Values (SSVs) and the Dutch Intervention Levels (DILs).

All of the analytes which had organic constituent concentrations above their respective laboratory detection limits did not exceed any of the screening guidelines utilised.

Table 14: Soil Organic Analysis

	Phenanthrene	Pyrene	Benzo(bk) fluoranthene	Dibenzo(ah) anthracene	Benzo(b) fluoranthene	Di-n-butyl phthalate	Anthracene	Fluoranthene	Benzo(a) anthracene	Chrysene	Indeno(123cd)pyrene	Benzo(ghi)perylene	Benzo(k)fluoranthene
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Sample ID													
TP44A	0.045	0.075	0.054	0.013	0.039	0.144	0.031	0.078	0.02	0.03	0.021	0.03	0.015
HA2	<0.01	0.024	<0.01	<0.01	<0.01	<0.1	<0.01	0.023	0.011	<0.01	<0.01	<0.01	<0.01
TP46A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TP39A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TP41A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TP42A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SSV1 All Land.Uses Protective of the Water Resource	NG	5.3	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
SSV2 informal Residential	NG	920	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
SSV2 Standard Residential	NG	1900	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
SSV2 Commercial/ industrial	NG	15000	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Dutch Intervention Levels	NG	NG	NG	NG	NG	NG	40						

Trace element concentrations in the profiles are presented in **Table 15** and **Table 16**. There is scientific evidence that the screening values published in GN R.331 of 2014 can both over and underestimate the perceived risk. A number of studies have been conducted estimating baseline concentrations for South African soils. The data from these studies was used to compare the site data with (Herselman, 2007; Herselman et al, 2005; Steyn et al, 2006, Steyn and Herselman, 2011 and Herselman et al, 2012). The data indicates:

- SSV1 is exceeded for copper (Cu) in all samples except for TP42B, manganese (Mn) in HA2, HA3 and TP44A and lead (Pb) in HA2 and HA3.
- SSV2 (informal resident) was exceeded for manganese (Mn) in HA2, HA3 and TP44A.
- DILs were exceeded for chromium (Cr) in all samples except for TP42B.
- South African Baseline concentrations were exceeded for mercury (Hg) in TP39A and TP44A.
- SSV2 (standard residential) and SSV2 (commercial/ industrial) were not exceeded by any of the samples.

The DIL were set taking into account Dutch soil conditions; however, South African soils generally have high clay contents and therefore higher trace element background concentrations. The South African SSVs were set using a risk based approach and in general considering sandy conditions. All the samples exceeding the SSV and

DIL levels did not exceed the South African Baseline concentrations. No major external sources are indicated and values are considered to be baseline conditions. The concentrations that exceed baseline concentrations in TP39A and TP44A is most likely related to samples with high clay content and not considered to be indicative of a source. Based on this interpretation the site is not considered to be impacted by any trace element sources.

Table 15: Trace Element concentrations

Units / Sample ID (mg/kg)	Ag	Al	As	Au	B	Ba	Be	Bi	Ca
HA1	0.20	18 440	1.61	ND	1.35	173.30	0.73	0.18	4 550
HA2	0.32	18 920	3.34	0.04	4.63	281.40	1.00	0.28	7 524
HA3	0.24	15 890	2.58	ND	1.71	173.70	0.71	0.25	6 062
TP39A	0.23	19 150	1.97	0.06	3.99	70.14	0.78	0.23	3 583
TP39B	0.12	11 670	1.50	0.00	1.84	426.40	0.69	0.17	8 361
TP41A	0.20	8 665	2.40	0.01	3.01	109.20	0.67	0.23	2 642
TP41B	0.16	20 580	2.00	ND	1.27	452.90	0.88	0.18	12 060
TP42A	0.25	16 860	1.81	0.00	1.96	73.02	0.74	0.22	3 250
TP42B	0.13	9 810	1.41	ND	-0.18	620.20	0.71	0.19	5 611
TP44A	0.21	14 910	2.16	0.01	2.16	142.80	0.78	0.18	4 861
TP44B	0.14	17 780	1.68	0.01	1.66	87.43	0.73	0.16	4 350
TP46A	0.18	15 470	1.95	0.01	3.71	97.41	0.69	0.16	2 937
TP46B	0.20	21 660	1.97	0.11	2.06	285.40	0.88	0.18	6 647
TP47A	0.22	14 060	2.38	0.01	1.76	88.62	0.67	0.21	3 654
TP47B	0.20	17 280	1.74	ND	1.76	88.10	0.67	0.16	3 707
SSV1 All Land Uses Protective of the Water Resource	NG	NG	5.80	NG	NG	NG	NG	NG	NG
SSV2 informal Residential	NG	NG	23.00	NG	NG	NG	NG	NG	NG
SSV2 Standard Residential	NG	NG	47.00	NG	NG	NG	NG	NG	NG
SSV2 Commercial/ industrial	NG	NG	150.00	NG	NG	NG	NG	NG	NG
Dutch Intervention Levels	3.00	NG	11.00	NG	NG	125	6	NG	NG
South African Baseline Concentrations	NG	NG	11.10	NG	NG	NG	NG	NG	NG

Units / Sample ID (mg/kg)	Cd	Co	Cu	Cr	Hg	Fe	K	Mo	Mg
HA1	0.05	10.38	23.05	135.20	0.05	16 490	940.6	0.52	5 380
HA2	0.12	20.10	29.28	144.80	0.10	18 540	828.8	1.13	4 359
HA3	0.08	17.70	27.32	130.90	0.06	15 420	611.4	1.01	3 424
TP39A	0.03	8.64	21.55	133.50	0.58	16 280	615.7	0.80	2 615
TP39B	0.01	9.97	16.95	86.19	0.17	10 710	543.3	0.27	3 708
TP41A	0.06	9.88	20.12	79.00	0.09	11 680	612.3	0.54	1 306
TP41B	0.03	8.98	20.79	142.20	0.05	16 870	1 123.0	0.56	4 746
TP42A	0.03	10.86	21.04	129.80	0.05	14 680	670.9	0.77	2 181
TP42B	0.02	9.87	14.63	71.74	0.12	8 458	578.7	0.37	4 126
TP44A	0.05	15.74	22.73	125.50	0.27	13 860	580.7	0.65	3 691
TP44B	0.04	12.37	21.05	121.70	0.03	15 420	744.8	0.36	5 958
TP46A	0.04	12.23	21.02	125.70	0.04	13 880	657.1	0.65	2 919
TP46B	0.03	10.49	23.50	144.20	0.03	18 260	827.7	0.43	7 545
TP47A	0.05	12.50	21.31	125.60	0.06	13 810	721.5	0.91	2 717
TP47B	0.03	17.68	21.16	127.60	0.03	15 020	645.8	0.54	4 708
SSV1 All Land Uses Protective of the Water Resource	7.5	300	16	46 000	0.93	NG	NG	NG	NG
SSV2 informal Residential	15.0	300	1 100	46 000	0.93	NG	NG	NG	NG
SSV2 Standard Residential	32.0	630	2 300	96 000	1.00	NG	NG	NG	NG
SSV2 Commercial/ industrial	260.0	5 000	19 000	790 000	6.50	NG	NG	NG	NG
Dutch Intervention Levels	2.4	48	38	76	2.00	NG	NG	40.00	NG
South African Baseline Concentrations	2.7	68.5	117	353	0.20	NG	NG	NG	NG

Table 16: Trace Element Concentrations (Cont.)

	Mn	Na	Ni	P	Pb	Pd	Pt	Rb	Sb	Se	Sr	Ti	Th	Tl	U	V	Zn
Units	mg/kg																
Sample ID																	
HA1	386.9	369.1	26.27	91.23	12.81	0.45	0.01	32.63	0.14	0.95	29.38	153.30	7.42	0.25	0.35	32.35	25.19
HA2	799.9	163.5	35.67	240.70	24.76	0.64	0.02	26.51	0.33	1.39	85.57	431.60	9.46	0.32	1.33	47.31	46.15
HA3	740.4	340.4	30.77	157.60	22.90	0.47	0.08	23.15	0.24	1.12	38.32	356.60	7.55	0.30	0.95	40.23	43.70
TP39A	237.4	553.4	23.17	101.80	13.43	0.45	0.01	25.58	0.14	1.12	27.37	280.90	7.86	0.27	0.79	38.36	23.22
TP39B	354.0	825.7	23.14	40.64	11.24	0.48	0.01	19.76	0.02	0.94	32.98	26.00	8.10	0.19	0.71	32.98	15.02
TP41A	352.6	152.8	19.52	153.00	19.26	0.47	0.01	23.36	0.02	1.08	35.45	34.15	7.92	0.16	0.93	34.69	23.82
TP41B	248.9	1 239.0	29.81	49.00	8.95	0.52	0.01	39.97	0.15	0.93	41.57	241.50	7.02	0.27	0.46	37.47	19.95
TP42A	325.4	424.4	21.80	144.70	13.56	0.41	0.02	30.67	0.14	1.03	27.53	224.40	7.98	0.25	0.86	34.31	21.13
TP42B	424.9	979.9	19.60	32.10	11.97	0.46	0.01	19.45	0.02	0.83	42.34	13.41	10.62	0.18	0.64	32.19	12.90
TP44A	767.7	319.1	26.89	107.00	15.23	0.47	0.01	22.37	0.15	1.18	40.81	166.80	8.17	0.24	0.66	37.96	21.85
TP44B	566.0	719.6	27.52	38.73	11.86	0.36	0.01	22.33	0.11	0.87	25.87	267.80	7.32	0.21	0.64	36.65	22.87
TP46A	420.7	557.1	27.76	122.50	12.45	0.34	0.01	20.96	0.16	0.97	27.04	234.40	5.55	0.21	0.66	36.88	23.97
TP46B	385.9	1 913.0	30.67	46.86	9.03	0.41	0.01	26.00	0.15	0.89	42.53	354.60	6.95	0.24	0.89	45.03	24.74
TP47A	417.5	380.3	23.00	149.50	15.23	0.42	0.01	21.93	0.20	1.09	42.13	208.70	7.29	0.22	0.82	36.83	25.85
TP47B	730.5	764.4	35.54	49.58	12.92	0.37	0.01	20.76	0.13	1.10	24.62	237.30	6.83	0.29	0.40	38.57	20.55
SSV1 All Land Uses Protective of the Water Resource	740	NG	91	NG	20	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	150	240
SSV2 informal Residential	740	NG	620	NG	110	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	150	9 200
SSV2 Standard Residential	1 500	NG	1 200	NG	230	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	320	19 000
SSV2 Commercial/ industrial	12 000	NG	10 000	NG	1 900	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	2 600	150 000
Dutch Intervention Levels	NG	NG	42	NG	106	NG	NG	NG	3	20	NG	NG	NG	3	NG	50	144
South African Baseline Concentrations	2 759	NG	159	NG	65.8	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	361	115

For future reference the baseline concentration for the soils was calculated using the geometric mean and the square of the geometric standard deviation (**Table 17**). The upper limit of the baseline concentration represents the 0.975 percentile of all values in the data set. These concentrations can be used as a baseline for the area to compare future assessments against.

Table 17: Baseline Metal Thresholds

Metal	Baseline Threshold	Metal	Baseline Threshold
	mg/kg		mg/kg
Ag	0.34	Mn	921
Al	28648	Na	2240
As	3.08	Ni	39.45
Au	0.13	P	365
B	4.25	Pb	23.22
Ba	606	Pd	0.62

Metal	Baseline Threshold	Metal	Baseline Threshold
Be	0.92	Pt	0.04
Bi	0.26	Rb	34.65
Ca	10648	Sb	0.88
Cd	0.11	Se	1.35
Co	18.51	Sr	66.71
Cu	29.42	Ti	1900
Cr	199	Th	10.13
Hg	0.32	Tl	0.35
Fe	22797	U	1.43
K	1008	V	45.97
Mo	1.25	Zn	45.98
Mg	8884		

6. AGRICULTURAL POTENTIAL

The soils in this area are considered to have a low agricultural potential. The rooting depth is limited by the prismacutanic B horizon and the soils are highly erodible due to the high Na content. These soils should be managed carefully to limit erosion.

7. IMPACT ASSESSMENT

7.1 ASSESSMENT CRITERIA

The following assessment criteria (**Table 18**) will be used for the impact assessment.

Table 18: Impact assessment criteria

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the	**VL**	A part of the site/property.

EXTENT of impacts	**L**	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
			EXTENT				
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			VL	**L**	**M**	**H**	**VH**
INTENSITY = VL							
DURATION	Very long	**VH**	Low	Low	Medium	Medium	High
	Long term	**H**	Low	Low	Low	Medium	Medium
	Medium term	**M**	Very Low	Low	Low	Low	Medium
	Short term	**L**	Very low	Very Low	Low	Low	Low
	Very short	**VL**	Very low	Very Low	Very Low	Low	Low
INTENSITY = L							
DURATION	Very long	**VH**	Medium	Medium	Medium	High	High
	Long term	**H**	Low	Medium	Medium	Medium	High
	Medium term	**M**	Low	Low	Medium	Medium	Medium
	Short term	**L**	Low	Low	Low	Medium	Medium
	Very short	**VL**	Very low	Low	Low	Low	Medium
INTENSITY = M							
DURATION	Very long	**VH**	Medium	High	High	High	Very High
	Long term	**H**	Medium	Medium	Medium	High	High
	Medium term	**M**	Medium	Medium	Medium	High	High
	Short term	**L**	Low	Medium	Medium	Medium	High
	Very short	**VL**	Low	Low	Low	Medium	Medium
INTENSITY = H							
DURATION	Very long	**VH**	High	High	High	Very High	Very High
	Long term	**H**	Medium	High	High	High	Very High
	Medium term	**M**	Medium	Medium	High	High	High
	Short term	**L**	Medium	Medium	Medium	High	High
	Very short	**VL**	Low	Medium	Medium	Medium	High
INTENSITY = VH							
DURATION	Very long	**VH**	High	High	Very High	Very High	Very High
	Long term	**H**	High	High	High	Very High	Very High
	Medium term	**M**	Medium	High	High	High	Very High
	Short term	**L**	Medium	Medium	High	High	High
	Very short	**VL**	Low	Medium	Medium	High	High
			VL	**L**	**M**	**H**	**VH**
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			EXTENT				

PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**VH**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Probable	**H**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Possible/ frequent	**M**	**Very Low**	**Very Low**	**Low**	**Medium**	**High**
	Conceivable	**L**	**Insignificant**	**Very Low**	**Low**	**Medium**	**High**
	Unlikely/ improbable	**VL**	**Insignificant**	**Insignificant**	**Very Low**	**Low**	**Medium**
			VL	**L**	**M**	**H**	**VH**
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

7.2 LIST OF ACTIVITIES FOR THE SITE

Below are the proposed activities for the site, they have been broken down into the construction phase and operational phase activities. During the construction phase the activities that will impact the soil will mainly be the construction of the plant and surrounding buildings. The activities that have the potential to impact on the soil during the operational phase are constant vehicle movement and potential chemical spillages.

7.2.1 Construction Phase

1. Site Preparation and clearance.
2. Contractor yard operation.
3. Earthworks.
4. Construction.

7.2.2 Operational Phase (Bottle Manufacturing Plant)

1. Delivery Truck and Equipment Operation.
2. Handling of Chemicals and Materials.
3. Waste Management.

7.3 IMPACT ASSESSMENT

7.3.1 Construction Phase

During construction soils can be impacted through removal, compaction, erosion and/or contamination which could result in a permanent loss of agricultural soil resources if not mitigated. **Table 19** shows the results of the impact assessment.

1. **Site Preparation and Clearance:**

Initially when construction starts there will be clearance of vegetation and the removal of the topsoil in preparation for the construction of the foundation. Run-off and erosion is increased due to the lack of vegetation soil cover. The soils are erodible and loss of soil can occur quickly if not managed. The soil structure and horizons are permanently destroyed and any agricultural potential is lost. The agricultural potential of the soils is considered to be low to moderate. The site is also located in an area earmarked for commercial/industrial development in terms of the municipalities spatial planning and is surrounding by commercial and industrial type activities. The significance of this is rated as medium.

2. **Contractor Yard Operation:**

The construction contractor's yard has the potential to cause soil pollution through activities such as storing and handling of hazardous materials, accidental oil or fuel spills and handling of solid waste materials. The significance of this is rated as medium.

3. **Earthworks:**

Soil will be removed permanently for construction. Soils are not considered to be high potential agricultural land but soil functioning will be lost. Heavy duty equipment and trucks will be required for earthworks and other construction activities. This could cause dust generation. Accidental oil or fuel spills can occur. Traffic outside the dig area can affect other soil areas. Soil being removed can potentially be beneficially used if properly handled. Increased likelihood of erosion due to exposed soil areas and channelling and pooling of water. The significance of this is rated as medium as although there would be a permanent loss of current soil functioning, the soil are of low agricultural potential and in and in an area earmarked for commercial/industrial development

4. **Construction**

Operation of heavy duty vehicles and equipment will be operational during construction. Dust generation due to construction activities can occur. Accidental oil and fuel spills can occur. Traffic outside the building area can cause compaction of soil. Storage and handling of building material on soil will cause compaction. Compaction and contamination with concrete and other materials can impact the soil. Before storm water management and landscaping has been implemented an increase likelihood of erosion exists. The significance of this is rated as being medium.

Table 19: Constructon Phase Impact Assessment

Potential Impact	Intensity	Duration	Extent	Consequence	Probability	Significance
Site Preparation and Clearance	M	H	L	H	VH	**M**
Contractors Yard Operation	M	H	VL	M	VH	**M**
Earthworks	M	H	L	M	VH	**M**
Construction	M	H	L	M	VH	**M**

7.3.2 Operational Phase

During operations soils can be impacted through compaction, erosion and/or contamination which could contribute to overall loss of soil resources if not mitigated. **Table 20** shows the results of the assessment criteria used.

1. **Deliver Truck and Equipment Operation.**

Traffic outside designated areas can compact and destroy soil structure. Oil or fuel spills can occur. The significance of this is rated as being medium.

2. **Handling of Chemicals and Materials.**

There chemical delivery and storage can cause soil contamination if an incident occurs. The significance of this is rated as being medium.

3. **Waste Management.**

Waste generated during operations if not managed properly can cause soil contamination. The significance of this is rated as medium.

Table 20: Operational Phase Impacts

Potential Impact	Intensity	Duration	Extent	Consequence	Probability	Significance
Delivery Truck and Equipment Operation	L	H	L	M	M	**M**
Handling of Chemicals	M	H	L	M	M	**M**
Waste Management	M	H	VL	M	M	**M**

8. MITIGATION

8.1 CONSTRUCTION PHASE

Below are potential mitigation measures during the construction phase and their impacts assessment. Activities that require mitigation include:

1. Site Preparation and Clearance
2. Contractors Yard Operation
3. Earthworks
4. Construction

Soil and spill management plans and waste management practises for the site are outlined in **Table-21**, **Table-22** and **Table-23** below. These will be developed into procedures for the site prior to construction. **Table-24** shows the results of the impact assessment with mitigation implemented.

Table-21: Site-specific soil management plan

Steps	Factors to consider	Detail
Delineation of areas to be stripped		Stripping will only occur where soils are to be disturbed by project activities or infrastructure. The disturbance area will be below 20ha. This area will be delineated at the start of construction.
Delineation of stockpiling areas	Location	Stockpiling areas will be located near to the end use of the soil to limit handling and to promote reuse of soils in the correct areas.
	Designation of the areas	Soil stockpiles will be clearly marked on the ground and on the site layout map.
Stripping and handling of soils	Utilisable soil	The top 1m of soil removed during earthworks should be considered as topsoil. As far as possible this soil must be used on site and in the landscaping of the site. Excess top soil should not be disposed indiscriminately and alternative beneficial uses should be identified.
	Handling	Soils should be handled in dry weather conditions as far as practically possible so as to minimise erosion and cause as little compaction as possible. Movement of soils should be done in single actions wherever possible to reduce compaction, increase the viability of the seed bank and protect the soil structure.

Steps	Factors to consider	Detail
Vegetation		Vegetation should be removed in a staged manner, where possible, to limit erosion. It is recommended that all vegetation be stripped and stored as part of the utilizable soil. Any protected species should be removed with the soil and used in landscaping.
Stockpile management	Height and slope	Soil stockpile height should be restricted to between 4 and 5 metres to avoid compaction and damage to the underlying soils. For extra stability and erosion protection, the stockpiles may be benched.
	Movement on stockpiles	Equipment, human and animal movement on top of the soil stockpiles will be limited to avoid topsoil compaction and subsequent damage to the soils and seedbank.
	Erosion and storm water control	Soil stockpiles should include run-off and erosion (by water and wind) control measures especially where stockpiles will remain for more than 1 year and/or one rainy season. Stockpiles should be established with storm water controls.
	Monitoring	Routine monitoring of the stockpile areas should take place.
Protection of soils, where possible	Movement control	Operation of heavy vehicles and machinery including delivery of materials should be confined to selected sites to minimise compaction of soils. No unnecessary off-site driving will be allowed.
	Erosion control	Where water is discharged to the environment, controls which reduce the velocity and erosive energy of these waters will be implemented.
	Contamination control	As per the spill prevention and management plan.
	Dust control	Water should be sprayed on the access roads to suppress dust. Re-vegetate areas as quickly as possible to limit erosion and dust formation.
	Remediation	Any contaminated soil should be remediated appropriately. Options could include *in-situ* bio-remediation (where feasible), bio-remediation at a dedicated area within the site (<500kg treatment capacity) or removal and disposal in accordance with SANS 10234 (classification and offsite disposal at a permitted hazardous waste facility).
	Waste	A waste management plan should be implemented for the site.
Rehabilitation and landscaping	Placement of soil	After construction open areas that remain should loosened to alleviate compaction and vegetated as quickly as possible.
		Placement of topsoil should be done in consultation with a specialist and in a manner that supports the use of the landscaped/rehabilitated area.
		The utilisable soil will be redistributed in a manner that achieves an approximate uniform stable thickness consistent with the landscaped/rehabilitated area and will attain a free draining surface profile.
	Vegetation	Only indigenous species should be used and if any protected plants were removed from the footprint, these should be incorporated into the landscaping of the site.
	Erosion control	Erosion control measures will be implemented to ensure that the topsoil is not washed or blown away and that erosion gulleys do not develop prior to vegetation establishment.

Table-22: Spill prevention and management plan

Steps	Factors to consider	Detail
Prevention and management	Containment	Dedicated areas will be provided for fixing, washing of and refueling of equipment and machinery. These areas should be surfaced and bunded to contain spills at source and with sufficient capacity to contain 110% of total spilled materials. Where required silt/oil traps should be installed. Where activities are required away from these areas appropriate bases and containment must be used.
		Handling and storage of chemicals and materials will be undertaken in designated areas. These areas should be covered, surfaced and bunded to contain spills at source and with sufficient capacity to contain 110% of total spilled materials.

Steps	Factors to consider	Detail
	Incident management	An incident response register and procedure should be developed. Any spills should be reported to the Site Manager and cleaned up immediately. The clean-up process will be informed by the type, size and location of the spill.
		Any major spillage incidents will be handled in accordance with an emergency response procedure. The procedure should cater for: – notification of relevant parties; – immediate cut off of the source if the spill is originating from a pump, pipeline or valve and the infrastructure 'made safe'; – containment of the spill (e.g. construct temporary earth bund around source); – pump excess hazardous liquids on the surface to temporary containers (e.g. drums, mobile tanker, etc.) for appropriate disposal; – remove hazardous substances from damaged infrastructure to an appropriate storage area before it is removed/repaired.
	Waste	Handle waste in line with the management practises below.

Table-23: Waste management practises for domestic and industrial waste

Items to be considered		Intentions
General	Specific	
Classification and record keeping	General	The waste management procedure for the site will cover the storage, handling and transportation of waste to and from the site. The site will ensure that the contractor's responsible are made aware of these procedures.
	Waste opportunity analysis	In line with DWEA's strategy to eliminate waste streams in the longer term, the site will assess each waste type to see whether there are alternative uses for the material. This will be done as a priority before the disposal option.
	Classification	Wastes (except those listed in Annexure 1 of the Waste Regulations) will be classified in accordance with SANS 10234 within one hundred and eighty (180) days of generation. Waste will be re-classified every five (5) years, or within 30 days of modification to the process or activity that generated the waste, changes in raw materials or other inputs, or any other variation of relevant factors.
	Safety data sheets	The site will maintain, where required in terms of the Regulations, the safety data sheets for hazardous waste (prepared in accordance with SANS 10234).
	Inventory of wastes produced	The site will keep an accurate and up to date record of the management of the waste they generate, which records must reflect: – the classification of the wastes; – the quantity of each waste generated, expressed in tons or cubic metres per month; – the quantities of each waste that has either been re-used, recycled, recovered, treated or disposed of; and – by whom the waste was managed.
	Labelling and inventory of waste produced	Any container or storage impoundment holding waste must be labelled, or where labelling is not possible, records must be kept, reflecting: – the date on which waste was first placed in the container; – the date on which waste was placed in the container for the last time when the container was filled, closed, sealed or covered; – the dates when, and quantities of, waste added and waste removed from containers or storage impoundments, if relevant; – the specific category or categories of waste in the container or storage impoundment as identified in terms of the National Waste Information Regulations, 2012; and – the classification of the waste in terms of Regulation 4 once it has been completed (if required).

Items to be considered		Intentions
General	Specific	
	Disposal record	Written evidence of safe disposal of waste will be kept.
	Record keeping	Records will be retained for a period of at least 5 years and will be made available to the Department on request.
Waste management	Collection points	Designated waste collection points will be established on site. Care will be taken to ensure that there will be sufficient collection points with adequate capacity and that these are serviced frequently.
	Temporary storage	General waste will be temporarily stored in designated skips and removed by an approved contractor for disposal at a licensed facility. Hazardous wastes will be temporarily stored in suitable containers/areas before removal by an approved waste contractor and disposed in a licenced facility. Waste storage/stockpiling areas must have an impervious floor, be bunded and have a drainage system for collection and containment of water from the area.
	Mixing of wastes	Waste will not be mixed or treated where this would reduce the potential for re-use, recycling or recovery; or result in treatment that is not controlled and not permanent. Waste may be blended or pre-treated to enable potential for re-use, recycling, recovery or treatment; or reduce the risk associated with the management of the waste.
	Litter	Keep the site clean of litter.
Disposal	Off site waste disposal facilities	Waste will be disposed of at appropriate permitted waste disposal facilities.
		Unless collected by the municipality, the site must ensure that their waste is assessed in accordance with the Norms and Standards for Assessment of Waste for Landfill Disposal set in terms of section 7(1) of the Waste Act prior to the disposal of the waste to landfill.
		Unless collected by the municipality, the site must ensure that the disposal of their waste to landfill is done in accordance with the Norms and Standards for Disposal of Waste to Landfill set in terms of section 7(1) of the Waste Act.
Waste transport	Contractor	A qualified waste management subcontractor will undertake the waste transport. The contractor will provide an inventory of each load collected and of proof of disposal at a licensed facility.
Banned practices	Long-term stockpiling	Stockpiling of waste is a temporary measure.
	Burying	No wastes will be buried on site.
	Burning	Waste may only be burned in legally approved incinerators.

Table-24: Construction Phase Impact Assessment with Mitigation

Potential Impact	Intensity	Duration	Extent	Consequence	Probability	Significance
Site Preparation and Clearance	M	L	VL	L	M	**VL**
Contractors Yard Operation	M	L	VL	L	M	**VL**
Earthworks	M	L	VL	M	M	**VL**
Construction	M	L	VL	L	M	**VL**

8.2 OPERATIONAL PHASE

Below are potential mitigation measures during the operational phase and their impacts assessment. Activities that require mitigation include:

1. Delivery Trucks and Equipment Operation
2. Handling of Chemicals and Materials

3. Waste management

Soil and spill management plans and waste management practises for the site are outlined in **Table-21**, **Table-22** and **Table-23** above. The procedures developed prior to construction will cater for the operational phase as well. **Table-25** shows the results of the impact assessment with mitigation implemented.

Table-25: Operational Phase Impact Assessment with Mitigation

Potential Impact	Intensity	Duration	Extent	Consequence	Probability	Significance
Delivery Truck and Equipment Operation	L	L	VL	L	L	**VL**
Handling of Chemicals and Materials	L	L	VL	L	L	**VL**
Waste Management	L	L	VL	L	L	**VL**

9. CONCLUSION

SAB's Glass Bottle Manufacturing Plant will result in soil being removed permanently from the site. Through proper topsoil stripping and management (implementation of topsoil management plan) the impacted soil can be utilised for beneficial uses. Through proper traffic control during construction and operation impact on soil outside the removal area can be limited. Soils could also be lost through contamination. Measures should be implemented to limit risks of soil contamination by construction and operational materials used on site. Any contaminated soil that occurs should be remediated appropriately. Waste should be handled in a manner that will not contaminate soil resources and littering should be avoided. Relevant procedures relating soil management, spill prevention and clean-up and waste management procedure should be in place at the start of construction. If proper management procedures are in place the mitigated impact on soil would result in an overall low significance rating.

It is expected that the proposed plant could be in operation for an extended period of time and therefore decommissioning and closure of the plant has not been considered in this assessment. It is assumed that if and/or when this is required an assessment of this phase will be undertaken to inform the decommissioning and closure process.

Livhuwani Ravhura
(Report Author)

Carl Steyn
(Project Manager)

Carl Steyn
(Reviewer)

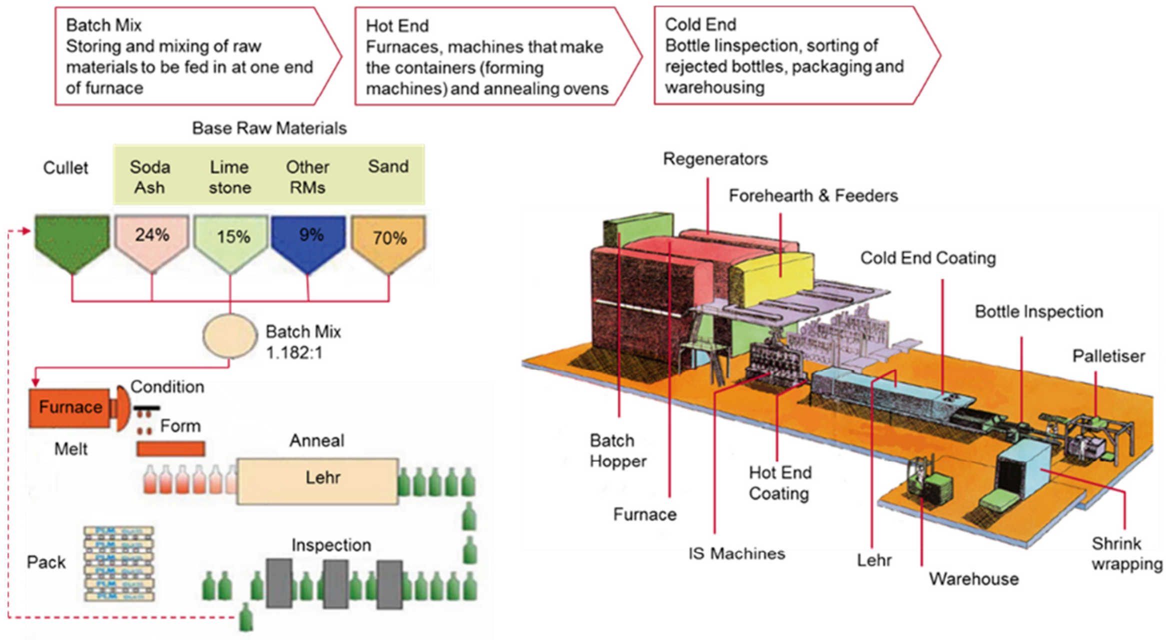
APPENDIX A: CONCEPTUAL DESIGN BRIEF OF THE PROCESS EQUIPMENT AND DESIGN PRINCIPLES FOR A GREENFIELD GLASS BOTTLE MANUFACTURING FACILITY

Glass is a non-crystalline amorphous solid made of the fusion of diverse non-organic oxides found in Sand, Soda Ash, Limestone and other raw materials. These materials are stored in independent silos at site in a building usually called Batch Plant. The building is typically separate from the main manufacturing building to reduce dust contamination within the plant as these are handled. Provisions to minimize dusting are part of the design including enclosed building, conveying and dust collectors. The storage capacity was been set to 7 days for Sand and 15 days for other raw materials. The batch plant has a footprint of ~2 100 m^2. It is sized so it is able to supply the furnaces in 16 operating hours per day. The materials are weighted in scales to a predetermined recipe and transported to the batch mixer. The mixed batch is elevated by a bucket elevator and later conveyed across to the Main Manufacturing Building.

This building is separated into three general areas: Furnace, Hot End and Cold End. In the Furnace areas, it is where raw materials are melted into glass in furnaces reaching temperatures of 1 530 C utilizing natural gas as a heat source. For this project, two furnaces are being specified. One furnace for green glass with a capacity to melt 390 metric tons per day (mtpd), and a second furnace for amber glass for 530 tpd. As glass is melted and degassed, it then needs to be cooled down to a temperature where the viscosity will allow forming of a glass container. This glass cooling is done while the glass is channelled to the glass forming machines in a system described as working end or refiner, and forehearths. This is the start of the Hot End area, at the end of the forehearths, where glass is metered and formed into drops or gobs which are at a temperature of 1 185 C. These gobs are delivered to the forming machine whereby with mechanical and pneumatic manipulation, glass is transitioned to form a glass container. This glass container will exit the forming machine at about 630 C where the viscosity of the glass is high enough that the bottle is self-supporting. The bottles are hot end coated to enhance surface resistance to scratches and they enter into an annealing lehr where the temperature of the bottles is reduced in a controlled way to avoid internal stresses to an exit temperature of 120 C where it is cold end coated allowing the bottle a surface lubricity that reduces bottle handling problems. This is the start of the Cold End area, where bottles are 100% inspected for 86 classified defects categorized as Critical, Major and Minor. This inspection process is performed by a number of machines that utilize laser and high intensity light sensors, as well as high definition vision systems all integrated a series of computers that process the signals or images. Other tests are conducted at the glass laboratory where high precision equipment will measure capacity, dimensions, impact and pressure resistance, and other tests. Beyond the Cold End area, bottles go to packaging where automated palletizers will arrange bottles on tiers on top of pallets to a height of 9-12 tiers depending on each bottles specifications. Bottles that do not meet specifications are conveyed back to the furnace area where hammer mills will crush the bottle to 3-5mm fragments and these are added to the batch mix to be fed to the furnaces. At this stage, the bottle manufacturing process is complete. The Main Manufacturing Building covers an area of approximately 30 to 45 000 m^2.

The warehouse area is approximately 56 to 81 000 m^2. Storage of bottles will be in plastic wrapped bulk pallets up to 3 pallets high. Pallets are mobilized using single or dual fork lift-trucks.

For clarity, illustration of the glass process:



Drawing of the proposed glassworks.

APPENDIX B: ANALYTICAL RESULTS

Exova Jones Environmental South Africa

Unit D2/5
9 Quantum Road
Firgrove Business Park
Somerset West
7130
South Africa

SLR South Africa Ltd
Block 7
Fourways Manor Office Park
2191, Cnr Roos and Macbeth Streets, Fourways
Johannesburg
2060
South Africa

Attention :	Carl Steyn
Date :	19th December, 2017
Your reference :	720.19124.00005
Our reference :	Test Report 17/20275 Batch 1
Location :	Leeuwkuil Veeriniging
Date samples received :	8th December, 2017
Status :	Final report
Issue :	1

Eleven samples were received for analysis on 8th December, 2017 of which six 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 Exova Jones Environmental (UK), which is ISO 17025 accredited under UKAS (4225) or Exova Jones Environmental (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.

Compiled By:

Paul Boden BSc
Project Manager

Client Name: SLR South Africa Ltd
Reference: 720.19124.00005
Location: Leeuwkuil Veeriniging
Contact: Carl Steyn
JE Job No.: 17/20275

Report : Solid

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

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1	3	4	6	8	10							
Sample ID	TP44A	HA2	TP46A	TP39A	TP41A	TP42A							
Depth	0.10-0.60	0.00-0.40	0.10-0.45	0.10-0.70	0.10-0.70	0.10-0.80							
COC No / misc													
Containers	V	V	V	V	V	V							
Sample Date	29/11/2017	01/12/2017	30/11/2017	30/11/2017	30/11/2017	29/11/2017							
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil							
Batch Number	1	1	1	1	1	1					LOD/LOR	Units	Method No.
Date of Receipt	08/12/2017	08/12/2017	08/12/2017	08/12/2017	08/12/2017	08/12/2017							
Natural Moisture Content	15.8	<0.1	15.0	18.9	14.4	17.6					<0.1	%	PM4/PM0

Client Name:	SLR South Africa Ltd	**SVOC Report :**	**Solid**
Reference:	720.19124.00005		
Location:	Leeuwkuil Veeriniging		
Contact:	Carl Steyn		
JE Job No.:	17/20275		

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1	3	4	6	8	10			
Sample ID	TP44A	HA2	TP46A	TP39A	TP41A	TP42A			
Depth	0.10-0.60	0.00-0.40	0.10-0.45	0.10-0.70	0.10-0.70	0.10-0.80			
COC No / misc									
Containers	V	V	V	V	V	V			
Sample Date	29/11/2017	01/12/2017	30/11/2017	30/11/2017	30/11/2017	29/11/2017			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil			
Batch Number	1	1	1	1	1	1			
Date of Receipt	08/12/2017	08/12/2017	08/12/2017	08/12/2017	08/12/2017	08/12/2017	LOD/LOR	Units	Method No.
SVOC MS									
Phenols									
2-Chlorophenol #	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Methylphenol	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Nitrophenol	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4-Dichlorophenol #	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4-Dimethylphenol	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4,5-Trichlorophenol	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2,4,6-Trichlorophenol	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Chloro-3-methylphenol	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Methylphenol	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
4-Nitrophenol	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Pentachlorophenol	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Phenol #	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
PAHs									
2-Chloronaphthalene #	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
2-Methylnaphthalene #	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Naphthalene	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Acenaphthylene	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Acenaphthene	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Fluorene	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Phenanthrene #	45	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Anthracene	31	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Fluoranthene #	78	23	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Pyrene #	75	24	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(a)anthracene	20	11	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Chrysene	30	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(bk)fluoranthene	54	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(a)pyrene	<10	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Indeno(123cd)pyrene	21	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Dibenzo(ah)anthracene	13	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(ghi)perylene	30	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(b)fluoranthene	39	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Benzo(k)fluoranthene	15	<10	<10	<10	<10	<10	<10	ug/kg	TM16/PM8
Phthalates									
Bis(2-ethylhexyl) phthalate	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Butylbenzyl phthalate	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Di-n-butyl phthalate	144	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Di-n-Octyl phthalate	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Diethyl phthalate	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8
Dimethyl phthalate #	<100	<100	<100	<100	<100	<100	<100	ug/kg	TM16/PM8

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Client Name:	SLR South Africa Ltd	**SVOC Report :**	**Solid**
Reference:	720.19124.00005		
Location:	Leeuwkuil Veeriniging		
Contact:	Carl Steyn		
JE Job No.:	17/20275		

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1	3	4	6	8	10							
Sample ID	TP44A	HA2	TP46A	TP39A	TP41A	TP42A							
Depth	0.10-0.60	0.00-0.40	0.10-0.45	0.10-0.70	0.10-0.70	0.10-0.80							
COC No / misc													
Containers	V	V	V	V	V	V							
Sample Date	29/11/2017	01/12/2017	30/11/2017	30/11/2017	30/11/2017	29/11/2017							
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil							
Batch Number	1	1	1	1	1	1					LOD/LOR	Units	Method No.
Date of Receipt	08/12/2017	08/12/2017	08/12/2017	08/12/2017	08/12/2017	08/12/2017							
SVOC MS													
Other SVOCs													
1,2-Dichlorobenzene	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
1,2,4-Trichlorobenzene #	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
1,3-Dichlorobenzene	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
1,4-Dichlorobenzene	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
2-Nitroaniline	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
2,4-Dinitrotoluene	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
2,6-Dinitrotoluene	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
3-Nitroaniline	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
4-Bromophenylphenylether #	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
4-Chloroaniline	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
4-Chlorophenylphenylether	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
4-Nitroaniline	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Azobenzene	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Bis(2-chloroethoxy)methane	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Bis(2-chloroethyl)ether	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Carbazole	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Dibenzofuran #	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Hexachlorobenzene	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Hexachlorobutadiene #	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Hexachlorocyclopentadiene	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Hexachloroethane	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Isophorone #	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
N-nitrosodi-n-propylamine #	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Nitrobenzene #	<10	<10	<10	<10	<10	<10					<10	ug/kg	TM16/PM8
Surrogate Recovery 2-Fluorobiphenyl	114	116	113	111	106	109					<0	%	TM16/PM8
Surrogate Recovery p-Terphenyl-d14	107	105	98	96	88	91					<0	%	TM16/PM8

Client Name:	SLR South Africa Ltd	**VOC Report :**	**Solid**
Reference:	720.19124.00005		
Location:	Leeuwkuil Veeriniging		
Contact:	Carl Steyn		
JE Job No.:	17/20275		

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1	3	4	6	8	10							
Sample ID	TP44A	HA2	TP46A	TP39A	TP41A	TP42A							
Depth	0.10-0.60	0.00-0.40	0.10-0.45	0.10-0.70	0.10-0.70	0.10-0.80							
COC No / misc													
Containers	V	V	V	V	V	V							
Sample Date	29/11/2017	01/12/2017	30/11/2017	30/11/2017	30/11/2017	29/11/2017							
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil							
Batch Number	1	1	1	1	1	1					LOD/LOR	Units	Method No.
Date of Receipt	08/12/2017	08/12/2017	08/12/2017	08/12/2017	08/12/2017	08/12/2017							
VOC MS													
Dichlorodifluoromethane	<2	<2	<2	<2	<2	<2					<2	ug/kg	TM15/PM10
Methyl Tertiary Butyl Ether #	<2	<2	<2	<2	<2	<2					<2	ug/kg	TM15/PM10
Chloromethane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Vinyl Chloride	<2	<2	<2	<2	<2	<2					<2	ug/kg	TM15_A/PM10
Bromomethane	<1	<1	<1	<1	<1	<1					<1	ug/kg	TM15/PM10
Chloroethane #	<2	<2	<2	<2	<2	<2					<2	ug/kg	TM15/PM10
Trichlorofluoromethane #	<2	<2	<2	<2	<2	<2					<2	ug/kg	TM15/PM10
1,1-Dichloroethene (1,1 DCE) #	<6	<6	<6	<6	<6	<6					<6	ug/kg	TM15/PM10
Dichloromethane (DCM) #	<30	<30	<30	<30	<30	<30					<30	ug/kg	TM15/PM10
trans-1-2-Dichloroethene #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
1,1-Dichloroethane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
cis-1-2-Dichloroethene #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
2,2-Dichloropropane	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
Bromochloromethane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Chloroform #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
1,1,1-Trichloroethane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
1,1-Dichloropropene #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Carbon tetrachloride #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
1,2-Dichloroethane #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
Benzene #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Trichloroethene (TCE) #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
1,2-Dichloropropane #	<6	<6	<6	<6	<6	<6					<6	ug/kg	TM15/PM10
Dibromomethane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Bromodichloromethane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
cis-1-3-Dichloropropene	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
Toluene #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
trans-1-3-Dichloropropene	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
1,1,2-Trichloroethane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Tetrachloroethene (PCE) #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
1,3-Dichloropropane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Dibromochloromethane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
1,2-Dibromoethane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Chlorobenzene #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
1,1,1,2-Tetrachloroethane	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Ethylbenzene #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
p/m-Xylene #	<5	<5	<5	<5	<5	<5					<5	ug/kg	TM15/PM10
o-Xylene #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Styrene	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15_A/PM10
Bromoform	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Isopropylbenzene #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
1,1,2,2-Tetrachloroethane #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
Bromobenzene	<2	<2	<2	<2	<2	<2					<2	ug/kg	TM15/PM10
1,2,3-Trichloropropane #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
Propylbenzene #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
2-Chlorotoluene	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
1,3,5-Trimethylbenzene #	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
4-Chlorotoluene	<3	<3	<3	<3	<3	<3					<3	ug/kg	TM15/PM10
tert-Butylbenzene #	<5	<5	<5	<5	<5	<5					<5	ug/kg	TM15/PM10
1,2,4-Trimethylbenzene #	<6	<6	<6	<6	<6	<6					<6	ug/kg	TM15/PM10
sec-Butylbenzene #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
4-Isopropyltoluene #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
1,3-Dichlorobenzene #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
1,4-Dichlorobenzene #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
n-Butylbenzene #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
1,2-Dichlorobenzene #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
1,2-Dibromo-3-chloropropane #	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
1,2,4-Trichlorobenzene #	<7	<7	<7	<7	<7	<7					<7	ug/kg	TM15/PM10
Hexachlorobutadiene	<4	<4	<4	<4	<4	<4					<4	ug/kg	TM15/PM10
Naphthalene	<27	<27	<27	<27	<27	<27					<27	ug/kg	TM15/PM10
1,2,3-Trichlorobenzene #	<7	<7	<7	<7	<7	<7					<7	ug/kg	TM15/PM10
Surrogate Recovery Toluene D8	101	101	110	104	107	96					<0	%	TM15/PM10
Surrogate Recovery 4-Bromofluorobenzene	88	79	102	92	94	87					<0	%	TM15/PM10

Client Name: SLR South Africa Ltd
Reference: 720.19124.00005
Location: Leeuwkuil Veeriniging
Contact: Carl Steyn

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason
No deviating sample report results for job 17/20275						

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.

JE Job No.: 17/20275

SOILS

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.

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. 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.

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.

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.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

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 UKAS requirement 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.

REPORTS FROM THE SOUTH AFRICA LABORATORY

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

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.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental 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

JE Job No: 17/20275

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
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465 and BS1377.	PM0	No preparation is required.				
TM15	Modified USEPA 8260. Quantitative Determination of Volatile Organic Compounds (VOCs) by Headspace GC-MS.	PM10	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes
TM15	Modified USEPA 8260. Quantitative Determination of Volatile Organic Compounds (VOCs) by Headspace GC-MS.	PM10	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.	Yes		AR	Yes
TM16	Modified USEPA 8270. Quantitative determination of Semi-Volatile Organic compounds (SVOCs) by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.			AR	Yes
TM16	Modified USEPA 8270. Quantitative determination of Semi-Volatile Organic compounds (SVOCs) by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM15_A	Modified USEPA 8260. Quantitative Determination of Volatile Organic Compounds, Vinyl Chloride & Styrene by Headspace GC-MS.	PM10	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes

NORTH-WEST UNIVERSITY
ECO-ANALYTICA

Eco Analytica
P.O. Box 19140
NOORDBRUG 2522
Tel: (018) 293 3900

SLR

19/1/2018

Nutrient Status

Sample	Ca	Mg	K	Na	P	$pH(H_2O)$	Walkley Black	EC
no.			(mg/kg)				%C	(mS/m)
TP01A 0.2 - 0.4	716.0	92.0	71.5	0.5	2.1	5.63	0.85	21
TP01B 1.10 - 1.50	509.5	258.5	41.0	57.0	1.6	5.85	0.40	67
TP32A 0.1 - 0.5	924.5	144.0	118.5	0.5	1.4	6.02	1.25	31
TP32B 0.6 - 1.1	642.5	244.0	6.0	0.5	0.9	5.87	0.48	18
TP27A 0.1 - 0.5	593.0	111.5	121.5	7.5	1.4	5.67	0.95	29
TP27B 0.7 - 1.1	612.5	210.0	31.0	0.5	1.3	5.50	0.50	17
TP20A 0.1 - 0.41	505.0	89.5	84.5	7.5	1.1	5.60	0.77	22
TP20B 0.6 - 0.8	619.5	238.5	7.0	15.0	1.4	5.74	0.53	18
TP15A 0.2 - 0.5	668.0	93.0	130.0	12.5	1.0	6.15	0.75	19
TP15B 0.8 - 1.2	476.5	290.0	67.0	169.5	1.3	6.16	0.38	73
TP12A 0.1 - 0.5	511.0	105.0	114.5	14.5	1.7	5.92	0.75	19
TP12B 0.8 - 1,1	502.0	279.0	17.5	76.5	0.8	5.89	0.34	83
TP31A 0.1 - 0.25	583.5	168.0	246.0	15.5	16.5	5.89	1.07	51
TP31B 0.4 - 0.9	679.0	214.0	149.0	34.5	16.9	6.50	0.55	28
TP03A 0.1 - 0.35	591.5	109.5	62.0	13.0	1.6	5.71	0.71	17
TP03B 0.5 - 0.65	752.5	310.5	99.0	25.5	1.3	5.71	0.65	14
TP06A 0.1 - 0.25	367.0	86.5	74.5	14.0	1.4	5.73	0.71	18
TP06B 0.35 - 0.45	445.0	240.0	130.5	0.5	1.1	5.65	0.44	9
TP25A 0.1 - 0.3	460.0	86.5	84.5	0.5	1.4	5.98	0.93	23
TP25B 0.6 - 1,0	449.0	227.5	17.5	46.5	0.9	5.66	0.34	81
TP28A 0.1 - 0.4	955.5	616.5	29.5	364.0	1.3	7.12	0.79	78
TP28B 0.6 - 0.9	1294.0	1346.5	85.5	1343.0	1.1	7.82	0.16	366
TP34A 0.05 - 0.1	807.5	112.0	111.5	0.5	2.4	6.72	1.25	21
TP34B 0.2 - 0.3	427.5	67.5	35.5	0.5	1.6	6.59	0.50	16
TP37A 0.1 - 0.5	561.5	97.5	108.0	0.5	2.8	6.27	1.04	24
TP37B 0.8 - 1.3	387.5	129.0	50.5	1.5	1.4	5.96	0.53	19
TP44A 0.1 - 0.6	2851.5	1148.5	33.0	196.0	1.5	6.54	1.43	119
TP44B 0.9 - 1.5	3089.0	1788.5	56.5	717.5	0.9	6.98	0.25	266
HA 2.0 - 0.4	3047.0	886.5	63.0	47.5	5.3	6.27	2.41	39
TP46A 0.1 - 0.4	2190.0	1166.5	43.5	492.5	1.9	6.67	1.35	111
TP46B 0.6 - 1.3	2784.5	1849.5	54.5	1421.0	1.0	7.36	0.16	550
TP39A 0.1 - 0.7	2258.5	724.5	24.5	117.0	1.4	6.45	1.12	126
TP39B 1.0 - 1.9	2765.5	1342.0	45.5	655.5	0.8	7.76	0.02	257
TP41A 0.1 - 0.7	1629.5	596.0	73.5	98.0	1.7	6.45	1.51	34
TP41B 0.95 - 1.8	2528.5	1386.5	63.5	806.5	0.8	7.43	0.14	321
TP42A 0.1 - 0.8	2410.5	854.5	43.0	135.5	6.4	6.48	1.18	56
TP42B 1.0 - 1.5	2922.0	1515.0	66.5	573.5	1.2	7.87	0.10	124
TP47A 0.1 - 0.5	2337.0	944.0	112.0	71.0	2.1	6.71	1.55	33
TP47B 0.8 - 1.3	2656.5	1658.0	47.0	485.0	1.1	8.08	0.43	156
HA1 0 - 0.3	2919.5	1680.5	137.0	81.5	2.4	7.56	0.80	24
HA3 0 - 0.3	2891.0	966.0	32.0	43.5	3.1	7.34	1.80	59

Exchangeable cations

Sample no.	Ca	Mg	K	Na	CEC	S-value	Field Capacity (%)	pH(H_2O)	Bulk Densit g/ml
	(cmol(+)/kg)								
TP01A 0.2 - 0.4	3.57	0.76	0.18	0.00		4.52	46.75	5.63	1.54
TP01B 1.10 - 1.50	2.54	2.13	0.11	0.25		5.02	39.25	5.85	1.62
TP32A 0.1 - 0.5	4.61	1.19	0.30	0.00		6.10	55.39	6.02	1.47
TP32B 0.6 - 1.1	3.21	2.01	0.02	0.00		5.23	57.36	5.87	1.56
TP27A 0.1 - 0.5	2.96	0.92	0.31	0.03		4.22	47.91	5.67	1.57
TP27B 0.7 - 1.1	3.06	1.73	0.08	0.00		4.87	52.18	5.50	1.44
TP20A 0.1 - 0.41	2.52	0.74	0.22	0.03		3.51	45.43	5.60	1.58
TP20B 0.6 - 0.8	3.09	1.96	0.02	0.07		5.14	54.91	5.74	1.45
TP15A 0.2 - 0.5	3.33	0.77	0.33	0.05		4.49	46.66	6.15	1.57
TP15B 0.8 - 1.2	2.38	2.39	0.17	0.74		5.67	58.64	6.16	1.46
TP12A 0.1 - 0.5	2.55	0.86	0.29	0.06		3.77	45.39	5.92	1.61
TP12B 0.8 - 1,1	2.50	2.30	0.04	0.33		5.18	59.11	5.89	1.41
TP31A 0.1 - 0.25	2.91	1.38	0.63	0.07		4.99	51.74	5.89	1.47
TP31B 0.4 - 0.9	3.39	1.76	0.38	0.15		5.68	48.34	6.50	1.44
TP03A 0.1 - 0.35	2.95	0.90	0.16	0.06		4.07	42.55	5.71	1.57
TP03B 0.5 - 0.65	3.75	2.56	0.25	0.11		6.68	47.53	5.71	1.57
TP06A 0.1 - 0.25	1.83	0.71	0.19	0.06		2.80	43.87	5.73	1.52
TP06B 0.35 - 0.45	2.22	1.98	0.33	0.00		4.53	46.71	5.65	1.53
TP25A 0.1 - 0.3	2.30	0.71	0.22	0.00		3.23	41.73	5.98	1.49
TP25B 0.6 - 1,0	2.24	1.87	0.04	0.20		4.36	52.86	5.66	1.42
TP28A 0.1 - 0.4	4.77	5.07	0.08	1.58		11.50	54.83	7.12	1.53
TP28B 0.6 - 0.9	6.46	11.08	0.22	5.84		23.60	79.21	7.82	1.39
TP34A 0.05 - 0.1	4.03	0.92	0.29	0.00		5.24	47.12	6.72	1.46
TP34B 0.2 - 0.3	2.13	0.56	0.09	0.00		2.78	39.78	6.59	1.61
TP37A 0.1 - 0.5	2.80	0.80	0.28	0.00		3.88	46.24	6.27	1.47
TP37B 0.8 - 1.3	1.93	1.06	0.13	0.01		3.13	44.04	5.96	1.55
TP44A 0.1 - 0.6	14.23	9.45	0.08	0.85		24.62	70.28	6.54	1.41
TP44B 0.9 - 1.5	15.41	14.72	0.14	3.12		33.40	79.03	6.98	1.41
HA 2.0 - 0.4	15.20	7.30	0.16	0.21		22.87	71.67	6.27	1.26
TP46A 0.1 - 0.4	10.93	9.60	0.11	2.14		22.78	61.55	6.67	1.45
TP46B 0.6 - 1.3	13.89	15.22	0.14	6.18		35.43	77.63	7.36	1.44
TP39A 0.1 - 0.7	11.27	5.96	0.06	0.51		17.80	61.53	6.45	1.43
TP39B 1.0 - 1.9	13.80	11.05	0.12	2.85		27.81	73.46	7.76	1.46
TP41A 0.1 - 0.7	8.13	4.91	0.19	0.43		13.65	60.16	6.45	1.46
TP41B 0.95 - 1.8	12.62	11.41	0.16	3.51		27.70	65.94	7.43	1.49
TP42A 0.1 - 0.8	12.03	7.03	0.11	0.59		19.76	65.89	6.48	1.44
TP42B 1.0 - 1.5	14.58	12.47	0.17	2.49		29.71	84.29	7.87	1.35
TP47A 0.1 - 0.5	11.66	7.77	0.29	0.31		20.03	57.78	6.71	1.36
TP47B 0.8 - 1.3	13.26	13.65	0.12	2.11		29.13	63.39	8.08	1.39
HA1 0 - 0.3	14.57	13.83	0.35	0.35		29.11	69.39	7.56	1.41
HA3 0 - 0.3	14.43	7.95	0.08	0.19		22.65	65.41	7.34	1.40

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

19/1/2018 **Particle Size Distribution**

Sample no.	> 2mm (%)	Sand	Silt	Clay
			(% < 2mm)	
TP01A 0.2 - 0.4	0.3	78.6	10.4	11.0
TP01B 1.10 - 1.50	38.0	65.1	9.1	25.8
TP32A 0.1 - 0.5	0.4	78.5	8.0	13.5
TP32B 0.6 - 1.1	8.5	63.8	6.5	29.7
TP27A 0.1 - 0.5	0.2	78.9	7.9	13.2
TP27B 0.7 - 1.1	3.7	69.1	6.0	24.8
TP20A 0.1 - 0.41	0.2	81.5	5.4	13.0
TP20B 0.6 - 0.8	8.6	76.4	3.5	20.1
TP15A 0.2 - 0.5	0.2	81.4	7.8	10.8
TP15B 0.8 - 1.2	4.7	61.9	6.4	31.7
TP12A 0.1 - 0.5	1.5	78.1	8.2	13.7
TP12B 0.8 - 1,1	0.3	63.1	3.5	33.4
TP31A 0.1 - 0.25	13.2	75.2	12.0	12.8
TP31B 0.4 - 0.9	8.9	65.4	8.9	25.7
TP03A 0.1 - 0.35	3.4	81.1	7.9	11.0
TP03B 0.5 - 0.65	25.5	63.9	4.4	31.7
TP06A 0.1 - 0.25	0.2	86.4	5.3	8.3
TP06B 0.35 - 0.45	9.6	79.1	3.5	17.4
TP25A 0.1 - 0.3	1.4	84.2	5.3	10.5
TP25B 0.6 - 1,0	0.7	74.5	0.9	24.7
TP28A 0.1 - 0.4	0.1	65.0	13.2	21.8
TP28B 0.6 - 0.9	4.5	48.7	6.4	44.9
TP34A 0.05 - 0.1	7.1	84.0	9.9	6.1
TP34B 0.2 - 0.3	4.6	90.9	2.6	6.6
TP37A 0.1 - 0.5	3.5	85.8	5.0	9.2
TP37B 0.8 - 1.3	2.8	82.5	2.8	14.7
TP44A 0.1 - 0.6	0.8	50.8	9.6	39.6
TP44B 0.9 - 1.5	2.2	44.6	6.5	48.8
HA 2.0 - 0.4	6.7	47.4	12.8	39.8
TP46A 0.1 - 0.4	0.1	59.3	8.5	32.2
TP46B 0.6 - 1.3	0.3	43.3	3.3	53.3
TP39A 0.1 - 0.7	0.0	51.5	14.4	34.1
TP39B 1.0 - 1.9	0.2	41.4	7.2	51.4
TP41A 0.1 - 0.7	0.1	11.2	83.3	5.4
TP41B 0.95 - 1.8	3.1	50.0	6.9	43.1
TP42A 0.1 - 0.8	0.5	45.9	12.4	41.7
TP42B 1.0 - 1.5	0.5	28.5	10.9	60.6
TP47A 0.1 - 0.5	1.0	58.3	12.1	29.6
TP47B 0.8 - 1.3	1.1	47.3	6.9	45.8
HA1 0 - 0.3	0.5	39.2	7.1	53.7
HA3 0 - 0.3	4.7	49.7	15.8	34.5

This laboratory participates in the following quality control schemes:

International Soil-Analytical Exchange (ISE), Wageningen, Nederland.

SLR

Microwave digested (Ethos UP, Magna Analytical) with EPA3051A method and results were obtained by using Agilent ICP-MS - *mg/kg*

18/1/2018

Sample:	TP44A 0.1 - 0.6	TP44B 0.9 - 1.5	HA 2.0 - 0.4	TP46A 0.1 - 0.4	TP46B 0.6 - 1.3	TP39A 0.1 - 0.7	TP39B 1.0 - 1.9	TP41A 0.1 - 0.7	TP41B 0.95 - 1.8	TP42A 0.1 - 0.8	TP42B 1.0 - 1.5	TP47A 0.1 - 0.5	TP47B 0.8 - 1.3	HA1 0 - 0.3	HA3 0 - 0.3
	mg/kg	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Be 9	0.7783	0.7286	0.9966	0.6939	0.8767	0.7812	0.6934	0.6735	0.8847	0.7414	0.7143	0.6686	0.6675	0.7261	0.7134
B 11	2.163	1.655	4.631	3.712	2.055	3.993	1.841	3.005	1.265	1.958	-0.1797	1.761	1.76	1.349	1.71
Na 23	319.1	719.6	163.5	557.1	1913	553.4	825.7	152.8	1239	424.4	979.9	380.3	764.4	369.1	340.4
Mg 24	3691	5958	4359	2919	7545	2615	3708	1306	4746	2181	4126	2717	4708	5380	3424
Al 27	14910	17780	18920	15470	21660	19150	11670	8665	20580	16860	9810	14060	17280	18440	15890
P 31	107	38.73	240.7	122.5	46.86	101.8	40.64	153	49	144.7	32.1	149.5	49.58	91.23	157.6
K 39	580.7	744.8	828.8	657.1	827.7	615.7	543.3	612.3	1123	670.9	578.7	721.5	645.8	940.6	611.4
Ca 43	4861	4350	7524	2937	6647	3583	8361	2642	12060	3250	5611	3654	3707	4550	6062
Ti 47	166.8	267.8	431.6	234.4	354.6	280.9	26	34.15	241.5	224.4	13.41	208.7	237.3	153.3	356.6
V 51	37.96	36.65	47.31	36.88	45.03	38.36	32.98	34.69	37.47	34.31	32.19	36.83	38.57	32.35	40.23
Cr 53	125.5	121.7	144.8	125.7	144.2	133.5	86.19	79	142.2	129.8	71.74	125.6	127.6	135.2	130.9
Mn 55	767.7	566	799.9	420.7	385.9	237.4	354	352.6	248.9	325.4	424.9	417.5	730.5	386.9	740.4
Fe 57	13860	15420	18540	13880	18260	16280	10710	11680	16870	14680	8458	13810	15020	16490	15420
Co 59	15.74	12.37	20.1	12.23	10.49	8.636	9.971	9.882	8.978	10.86	9.87	12.5	17.68	10.38	17.7
Ni 60	26.89	27.52	35.67	27.76	30.67	23.17	23.14	19.52	29.81	21.8	19.6	23	35.54	26.27	30.77
Cu 63	22.73	21.05	29.28	21.02	23.5	21.55	16.95	20.12	20.79	21.04	14.63	21.31	21.16	23.05	27.32
Zn 66	21.85	22.87	46.15	23.97	24.74	23.22	15.02	23.82	19.95	21.13	12.9	25.85	20.55	25.19	43.7
As 75	2.156	1.683	3.339	1.948	1.968	1.968	1.504	2.401	1.997	1.814	1.413	2.38	1.742	1.61	2.577
Se 82	1.183	0.8659	1.393	0.9747	0.885	1.115	0.9436	1.078	0.9295	1.028	0.8313	1.094	1.1	0.945	1.115
Rb 85	22.37	22.33	26.51	20.96	26	25.58	19.76	23.36	39.97	30.67	19.45	21.93	20.76	32.63	23.15
Sr 88	40.81	25.87	85.57	27.04	42.53	27.37	32.98	35.45	41.57	27.53	42.34	42.13	24.62	29.38	38.32
Mo 95	0.6501	0.3567	1.126	0.6453	0.433	0.7982	0.2747	0.5394	0.5615	0.7747	0.3746	0.9119	0.5403	0.5154	1.014
Pd 105	0.4674	0.3557	0.6373	0.344	0.4104	0.4526	0.4779	0.4698	0.5198	0.4111	0.4644	0.4206	0.3697	0.4459	0.4715
Ag 107	0.2099	0.135	0.3171	0.1842	0.2016	0.2272	0.1207	0.2016	0.1576	0.2522	0.1254	0.2213	0.1955	0.2024	0.2381
Cd 111	0.04863	0.03733	0.1219	0.03804	0.03212	0.02639	0.01408	0.05727	0.02727	0.02982	0.01858	0.05183	0.02917	0.04751	0.08437
Sb 121	0.1491	0.1095	0.3345	0.1553	0.1522	0.137	0.02268	0.01927	0.1509	0.1429	0.0181	0.2015	0.1348	0.1365	0.2389
Ba 137	142.8	87.43	281.4	97.41	285.4	70.14	426.4	109.2	452.9	73.02	620.2	88.62	88.1	173.3	173.7
Pt 195	0.01372	0.01189	0.01566	0.01042	0.01281	0.01414	0.01308	0.01128	0.01452	0.01514	0.01137	0.01331	0.01433	0.01361	0.08356
Au 197	0.009394	0.006684	0.04116	0.00976	0.1129	0.06223	0.003974	0.005563	ND	0.002221	ND	0.01365	ND	ND	ND
Hg 202	0.2743	0.03444	0.1035	0.04358	0.03246	0.5778	0.1668	0.08804	0.05237	0.05128	0.1158	0.05858	0.02782	0.05019	0.06226
Tl 205	0.2389	0.2063	0.3153	0.2101	0.2406	0.2677	0.1928	0.1649	0.2708	0.2512	0.1819	0.2245	0.2887	0.2501	0.3007
Pb 208	15.23	11.86	24.76	12.45	9.033	13.43	11.24	19.26	8.946	13.56	11.97	15.23	12.92	12.81	22.9
Bi 209	0.1829	0.1595	0.2788	0.1626	0.179	0.2338	0.1682	0.2258	0.1788	0.2164	0.1886	0.2118	0.1586	0.1815	0.2474
Th 232	8.167	7.316	9.464	5.546	6.945	7.86	8.099	7.918	7.024	7.983	10.62	7.286	6.829	7.42	7.546
U 238	0.6646	0.6389	1.329	0.6608	0.8945	0.7878	0.7078	0.9283	0.4643	0.8569	0.6363	0.8198	0.4018	0.3458	0.9493

SATURATED PASTE

	TP44A 0.1 - 0.6	TP44B 0.9 - 1.5	HA 2.0 - 0.4	TP46A 0.1 - 0.4	TP46B 0.6 - 1.3	TP39A 0.1 - 0.7	TP39B 1.0 - 1.9	TP41A 0.1 - 0.7	TP41B 0.95 - 1.8	TP42A 0.1 - 0.8	TP42B 1.0 - 1.5	TP47A 0.1 - 0.5	TP47B 0.8 - 1.3	HA1 0 - 0.3	HA3 0 - 0.3
	mg/l	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*
Na 23	108.4	305.9	14.04	165.5	926.7	134.4	345.4	37.8	470.9	57.9	153.4	27.36	174.9	15.57	21.62
Mg 24	40.1	88.05	12.36	26.21	198	37.44	71.21	12.34	102.9	16.52	32.51	13.22	64.34	9.948	22.14
K 39	1.596	1.646	2.039	2.23	2.222	1.937	1.736	3.775	1.911	1.784	1.165	3.842	1.517	1.925	1.867
Ca 43	84.65	160.2	38.79	36.87	234	88.51	167	21.54	162.1	39.09	72.99	23.12	86.97	16.16	68.74

APPENDIX C: NEMA APPENDIX 6 SPECIALIST REPORTING REQUIREMENTS CHECKLIST

Item	NEMA Regulations (2014): Appendix 6	Relevant Section in Report
1(a) (i)	Details of the specialist who prepared the report	Appendix D
1(a) (ii)	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix D
1(b)	A declaration that the person is independent in a form as may be specified by the competent authority	At start of document
1(c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 4
1(d)	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 4
1(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 4
1(f)	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 7
1(g)	An identification of any areas to be avoided, including buffers	Section 5 & 7
1(h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	The entire area contains one soil type (Sterkspruit) and a map is unnecessary
1(i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5, 6, 7 and 8 contain all assumptions made in the discussion
1(j)	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 7
1(k)	Any mitigation measures for inclusion in the EMPr	Section 8
1(l)	Any conditions for inclusion in the environmental authorisation	Mitigation measures in Section 8 must be included in the EA
1(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Requirements for the management and control of the soil are given in Section 8 and proposed topsoil and waste

Item	NEMA Regulations (2014): Appendix 6	Relevant Section in Report
		management plans should contain control measures that should be monitored for implementation.
1(n)(i)	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and	Section 9 concludes that the proposed activity should be authorised
1(n) (ii)	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Mitigation measures in Section 8 must be included in the EA
1(o)	A description of any consultation process that was undertaken during the course of carrying out the study	No consultation was deemed necessary for the study
1(p)	A summary and copies if any comments that were received during any consultation process	No consultation was deemed necessary for the study
1(q)	Any other information requested by the competent authority.	N/A

APPENDIX D: CURRICULUM VITAE

CURRICULUM VITAE

CARL STEYN

TECHNICAL DISCIPLINE MANAGER

Oil and Gas, Land Quality Remediation , Africa

QUALIFICATIONS

MSc(Agric)	1995	Soil Science

EXPERTISE

- Contaminated Land
- Soil Science
- Modelling
- Data Science
- Analytical Methodology
- Project Integration
- Training

Summary of Experience and Capability

Carl is a Technical Discipline Manage with SLR Consulting and is responsible for the Lan Quality and Remediation Team. He has over 20 years' experience in Land Quality and Remediation, both in management ad as an experienced consultant.

Carl managed a wide range of major Contaminated Land projects for major industrial and mining sites through Africa. Since 1993 he has been involved in more than 30 technical assessments and modelling of site environmental norms and standards in South Africa.

Carl has been consulting since 2008. Prior to this he was a research manager and actively involved in skills development. His focus on data science permits enables him to link data models to site understanding and typical flow and transport models. He has integrated the geochemistry, water flow, analysis data and modelling aspects in a number of projects to assist in clarifying the understanding and numerating risk to human health and ecology.

PROJECTS

Evaluation of potential impacts of onsite contamination sources for final. (2011 - 2016)	Integration of Source-Pathway-Receptor understanding, quantification of risk and setting of performance criteria through the integration of several modelling tools.
Design and feasibility assessment of enhancing a wetland system to manage onsite contamination sources. (2016)	Developed the geochemistry understanding of the system and modelling to determine the likelihood of achieving the required outcomes for different design options.
Steel industry contamination assessment and remediation planning for 15 sites across Germiston (2011 - 2016)	Ongoing advisory of legal requirements, site assessments and remediation planning for the sites.

Nelspruit Closure and rehabilitation of an industrial site (2010 - 2016)	Geochemical understanding of the site conditions, requirement for remediation and setting of performance criteria
Phase I and II assessment for a power station (2015 - 2016)	Phase I and II Contaminated Land Assessment.
Steelpoort Chrome smelter: Contamination assessment and remediation requirements (2008 - 2016)	Source-Pathway-Receptor assessment and soil contamination assessment.
Middelburg Chrome smelter: Source-pathway-receptor assessment and probabilistic modelling (2015 - 2016)	Source-Pathway-Receptor assessment and integrated modelling.
Gold mine in Mali: Advisory on remediation requirements as part of a sale negotiation. (2015 - 2016)	Assessment of environmental condition and data to assess the potential requirement for future remediation.
Independent baseline and contamination assessment and advisory for a legal firm as part of a litigation process (2016)	Source, soil and groundwater baseline and contamination assessment.
Contamination land assessment for a due diligent assessment for sale of a platinum mine in the Rustenburg area (2015)	Contaminated land and baseline assessment
Site assessment of downstream oil and gas sites (2016 - ongoing)	Assessment of environmental condition, VER and risk assessment

MEMBERSHIPS

PrSciNat	Professional Natural Scientist (PrSciNat) in Soil Science with South African Council for Natural Scientific Professions (Reg. No. 40022/02)
SSSSA	Soil Science Society of South Africa (SSSSA)
IAIA	International Association for Impact Assessments (IAIA) South Africa Affiliate

PUBLICATIONS

Papenfus, M., Tesfamariam, E.H., de Jager, P.C., Steyn, C.E. & Herselman, J.E. 2015. Using soil-specific partition coefficients to improve accuracy of the new South African guideline for contaminated land. Water SA, 41(1): 9-14.

Steyn, CE. & Herselman, JE. 2006. Trace element concentrations in soils under different land uses in Mpumalanga Province, South Africa. S. Afr. J. Plant Soil.23:230-236

Herselman, JE., Steyn, CE. & Snyman HG., 2006. Dedicated land disposal of wastewater sludge in South Africa: Leaching of trace elements and nutrients. Water Science and Technology., 54: 139 -149

Steyn, CE & Herselman, JE. 2005. Trace elements in developing countries using South Africa as case study. Commun. Soil Sci. Plant Anal. 36: 155-168

Herselman, JE., Steyn, CE. & Fey, M.V. 2005. Baseline concentration of Cd, Co, Cr, Cu, Pb, Ni and Zn in surface soils of South Africa. South African Journal of Science, 101: 509-512.

Steyn, CE. 1994. The bioavailability of certain heavy metals in selected organic products. M.Sc. (Agric) thesis. Department of Plant Production and Soil Science. University of Pretoria.

Steyn, CE., Van der Watt, HvH. and Claassens, AS. 1996. On the permissible nickel concentration for South African soils. South African Journal of Science. 92,359-363.

Steyn, CE. & Herselman, E. 2016. Manganese Soil Screening Values: Aspects for Consideration, NICOLA Conference 1 & 2 November 2016, Johannesburg.

Steyn, CE. & Herselman, E. 2016. New Legislative Drivers: Using the Opportunity Towards Sustainable Decision Making. IAIAsa 2016 National Conference 17-19 August 2016, Port Elizabeth.

Steyn, CE., Herselman, E. & Snyman, H. 2015. Proposal for refinement of Phase 1 Soil Screening. NICOLA Conference 3 & 4 August 2015, Johannesburg.

Steyn, CE. & Snyman, H. 2014. Practical Considerations in the Implementation of the GN R. 331 of 2014. Nicola Conference 2014, Johannesburg.

Papenfus, M., Tesfamariam, EH., de Jager, PC., Steyn, CE. & Herselman, JE. 2013. Using soil specific Kd values to improve accuracy of the new South African guidelines for contaminated land. 13th Biannual Groundwater Division Conference, 17 to 19 September 2013, Durban, South Africa.

	Herselman, JE. & Steyn, CE. 2012 The importance of soil properties and baseline concentrations in soil screening for compliance with NEMWA. WasteCon Conference East London 2012.
	Steyn, CE. & Herselman, JE. 2011. A Critical comparison of South African background soil trace element concentrations and the proposed framework for the management of contaminated land screening values. International Conference on Groundwater: Our Source of Security in and Uncertain Future, GWD, GSSA & IAH. 19 – 21 September 2011. Pretoria, South Africa
	Steyn, CE. 2007. Soil Zinc in South Africa – Status and Implications. Invited paper: Technical symposium of the International Zinc Association – Southern Africa (IZASA) in collaboration with the Fertilizer Society of South Africa (FSSA). 16 August 2007. Pretoria
	Steyn, CE., Kirsten, WFA., Lazenby, E., van Zyl, AJ. Jansen van Rensburg, HG. Claassens, AS. & Barnard, RO. 2007. Comparison of soil extraction methods for multi-trace element analysis in South African soils. Combined Congress of SSSA, SASCP & SASHS. 22-25 January 2007. Badplaas, South Africa
	Herselman, JE., Steyn, CE. & Snyman, HG. 2006. Background to metal limits for the new South African guidelines on agricultural use of sewage sludge. Combined Congress of SSSSA & SASCP. 23 -26 January 2006. Durban, South Africa
	Steyn, CE. Claassens, AS. & Barnard, RO. 2006. Influence of soil composition on mineral food composition in the OR Tambo District Municipality, Eastern Cape Province, South Africa. Combined Congress of SSSSA & SASCP. 23 -26 January 2006. Durban, South Africa
	Steyn, CE., Herselman, JE. & Snyman, HG. 2004. Local factors that influence the scientific basis of the new South African sludge guidelines. WISA Workshop on New Sewage Sudge Guidelines. WISA. April 2004. Cape Town, South Africa.
	Steyn, CE., Hersleman, JE., Claassens, AS. & Barnard, RO. 2004. Micronutrient content in South African crops and soil – Implications for development. Keynote Presentation: 15th International Symposium of the International Scientific Centre of Fertilizers (CIEC). 27 -30 September 2004.
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