Agreenco

PROPLAN TECHNOLOGIES (PTY) LTD: WASTE CLASSIFICATION REPORT

2022

PROPLAN TECHNOLOGIES

Prepared for: Proplan Technologies (Pty) Ltd.

Prepared by: Agreenco Environmental Projects (Pty) Ltd.

PROJECT INFORMATION

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EXECUTIVE SUMMARY

Agreenco Environmental Projects (Pty) Ltd (Agreenco) was appointed by Proplan Technologies (Pty) Ltd. (Proplan) to conduct a waste classification. The need for a waste classification was triggered by a phase 1 shallow soil engineering geological assessment conducted towards the end of 2021 by Rocksoil Consult (Pty) Ltd. (Rocksoil) on Zandfontein Jr 317 portions 36 and 216. During the evaluation, fly-Ash and Slag fill were encountered at four of the nine test pits. The report indicated that the material could be hazardous and should be analysed.

The two key objectives of the testing and analyses were to classify the waste material samples according to NEMWA (R. 635 & R. 636) and determine the acid generation potential of the material.

Three samples were analysed according to the procedures described in the National Environmental Management: Waste Act (Act No. 59 of 2008) (NEMWA). The norms and standards for waste classification and liner identification as stipulated in regulations no. R. 635 and R. 636 of NEMWA were applied. Additional analyses (not prescribed in NEMWA) have also been conducted on the sampled material. Based on the characteristics of Ash and Slag, inorganic residue, no organic compounds were tested as part of the assessment.

The results show that some of the elements found in the sampled material have a total concentration (TC) exceeding the minimum total concentration threshold (TCT0). There were no exceedances for the LCT1, LCT2 and LCT3 or TCT1 and TCT2. The sampled materials were classified, and liner and landfill type were determined based on comparing the LC and TC with the LCT and the TCT, respectively. A summary of the results is tabulated below.

	Slag	Ash	G5 Ash
LC >LCT0 (Distilled water)	None	None	None
TC > TCT0	Cr, Ni, V	As, B, Ba, Co, Cu, Ni,	As, Ba, Cu, Pb
Multiple criteria	none	none	none
Waste classification	Type 3	Type 3	Type 3
Landfill type	Class C liner or GLB+	Class C liner or GLB+	Class C liner or GLB+

Additional analyses performed on the sampled material indicate that all three samples have the potential to generate acid. Considering the rock classification, both the Ash and G5 Ash classify as Type I rock, which is potentially acid-forming, while the Slag has moderate acid-forming potential. When the results were compared to the NPR screening criteria, all the samples were likely to generate AMD. The material should be removed and disposed of at a suitable licenced site (GLB+).

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DECLARATION OF INDEPENDENCE AND QUALITY

This report is free from any external prejudice or influence and is dedicated to accurately and precisely presenting the results of three samples collected on portion 36 and portion 216 of the farm Zandfontein JR 317. All of the work herein has been conducted by Agreenco Environmental Projects (Pty) Ltd and its associates. The work presented here is based on scientifically sound techniques and the interpretation of data.

TERMS OF REFERENCE

Agreenco Environmental Projects (Pty) Ltd (Agreenco) was appointed by Proplan Technologies (Pty) Ltd. (Proplan) to undertake waste classification testing and analyses on Slag and fly Ash that was recorded during a previous Geotechnical assessment on Zandfontein JR 317 portion 36 and 216. The waste classification process as stipulated in the National Environmental Management Waste Act has been used. This report presents the results obtained from the analyses.

1. INTRODUCTION AND PROJECT BACKGROUND

Agreenco Environmental Projects (Pty) Ltd (Agreenco) was appointed by Proplan Technologies (Pty) Ltd. (Proplan), to conduct a waste classification of fly-ash and slag found on the properties, Zandfontein Jr 317 portion 36 and 216.

A phase 1 shallow soil engineering geological assessment was conducted towards the end of 2021 by Rocksoil Consult (Pty) Ltd. (Rocksoil) on the aforementioned properties. During the assessment, fly-ash and slag fill was encountered at various depths at four of the nine test pits. One of the report's key recommendations was to conduct a contamination assessment of the site.

The following report constitutes a Phase 1 waste classification in terms of the National Environmental Management Waste Act (Act 59 of 2008) (NEMWA) and the National Norms and Standards for Assessment of Waste for Landfill Disposal (No. R. 635 and R. 636). Based on the characteristics of Ash and Slag, inorganic residue, no organic compounds were tested as part of the assessment.

2. SITE OBSERVATIONS AND SAMPLING LOCALITIES

The site is surrounded by industrial developments to the north, east and west and an informal settlement to the south (Figure 1).

Figure 1: Locality map

The properties were not fenced, and it is speculated that the properties have been used as an illegal domestic landfill site by the informal settlement and other public members. Several burned waste piles were observed on site (Figure 2).

Figure 2: Burned waste pile

Figure 3: Asbestos

The two properties are undeveloped and are currently overgrown by many grass species, annual weeds, and alien invasive plants. The most predominant species found on site was Smelter's bush (*Flaveria bidentis*), which is usually indicative of elevated trace metal concentrations in the soil or substrate.

Asbestos (Figure 3) was also observed on site (25°43'5.04"S; 28° 7'4.75"E) and should be removed and disposed of accordingly.

As mentioned previously, slag and/or ash was encountered at four of the nine test pits that were excavated for the geotechnical assessment in 2021. The details concerning the test pits are tabulated in Table 1, and the localities in relation to the properties are depicted in Figure 4.

Table 1: Test pits where fly-ash/ slag fill was encountered

Test pit	Depth	Latitude	Longitude
TP02	0.60 – 1.8 m	-25.716929	28.117005
TP03	0 – 0.60 m	-25.717607	28.116501
TP08	0-0.50 m	-25.716836	28.115303
TP10	0 – 1.1 m	-25.716284	28.116627

Figure 4: 2021 Test pit sites

All four of the test pits were assessed on 1 March 2022 and the slag or ash has been removed almost entirely in most instances, apart from TP10 and TP2. At TP8 and TP03 only the soil surface was dusted with Ash-like material. The materials recorded at TP02 and TP10 were similar (Ash).

2.1. Sampling localities

Three (3) composite samples were collected on 1 March 2022 from the two properties. The details of the sampled material are contained in Table 2.

Table 2: Sampling site descriptions

Photograph	Description
	**Sample ID**: Slag **Latitude:** 25°43'1.38"S **Longitude:** 28° 7'3.88"E **Description**: Apart from the sampling location, no other Slag deposits were observed. The Slag seemed to have come from an external source and was disposed of on-site. The isolated Slag dump is roughly 1 m^2.
	**Sample ID**: Ash **Latitude:** 25°43'0.88"S **Longitude:** 28° 7'1.28"E **Description**: The sample was taken in the vicinity of the TP02 test pit. The Ash dump was 0.5 m^2. Similar material was observed at other localities on site.
	**Sample ID**: G5 Ash **Latitude:** 25°43'2.10"S **Longitude:** 28° 7'2.78"E **Description**: At the sampling site, the material was a mixture between G5 (gravel), Ash and old bricks. The heap was roughly 5.2 m^2. Similar material was observed at other localities on site.

The sampling localities are depicted in Figure 5.

Figure 5: Sampling localities

3. APPROACH

In terms of the National Environmental Management Laws Amendment Act 25 of 2014 – Government Notice 448 in Government Gazette 37713, dated 2 June 2014 (commencement date: 2 September 2014) mine residue stockpiles and deposits (MRSD) are regulated as waste by the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) and are included in the definition of Waste as listed in Schedule 3 of NEMWA.

According to the Regulations Regarding the Planning and Management of Residue Stockpiles and Residue Deposits from prospecting, mining, exploration, or production operation (GN R. 632 of 24 July 2015), MRSD needs to be assessed according to:

- Waste Assessment as per the National Norms and Standards for the Assessment of Waste for Landfill Disposal (GN R.635 of 23 August 2013) (WCMR); and
- Identification of the barrier design as per the National Norms and Standards for Disposal of Waste to Landfill (GN R.636 of 23 August 2013).

In terms of Regulation 8 of the WCMR, waste must be assessed in accordance with the Norms and Standards for Assessment of Waste for Landfill Disposal prior to the disposal of waste to disposal facilities or landfills (GN R.635 promulgated on 23 August 2013). In terms of these Norms and Standards, the appropriate landfill and/or barrier requirements for waste storage/disposal can be determined by following the prescribed and appropriate leach test protocols. The results must be assessed against the four levels of thresholds for leachable and total concentrations, which in combination, determines the waste type. The terminology is as follows:

- LC means the leachable concentration of a particular contaminant in a waste, expressed as mg/l;
- TC means the total concentration of a particular contaminant in a waste, expressed as mg/kg;
- LCT means the leachable concentration thresholds for contaminants in a waste (LCT0, LCT1, LCT2, LCT3); and
- TCT means the total concentration thresholds for contaminants in a waste (TCT0, TCT1, and TCT2).

Figure 6 shows the flow diagram of the process to be followed to determine the waste type.

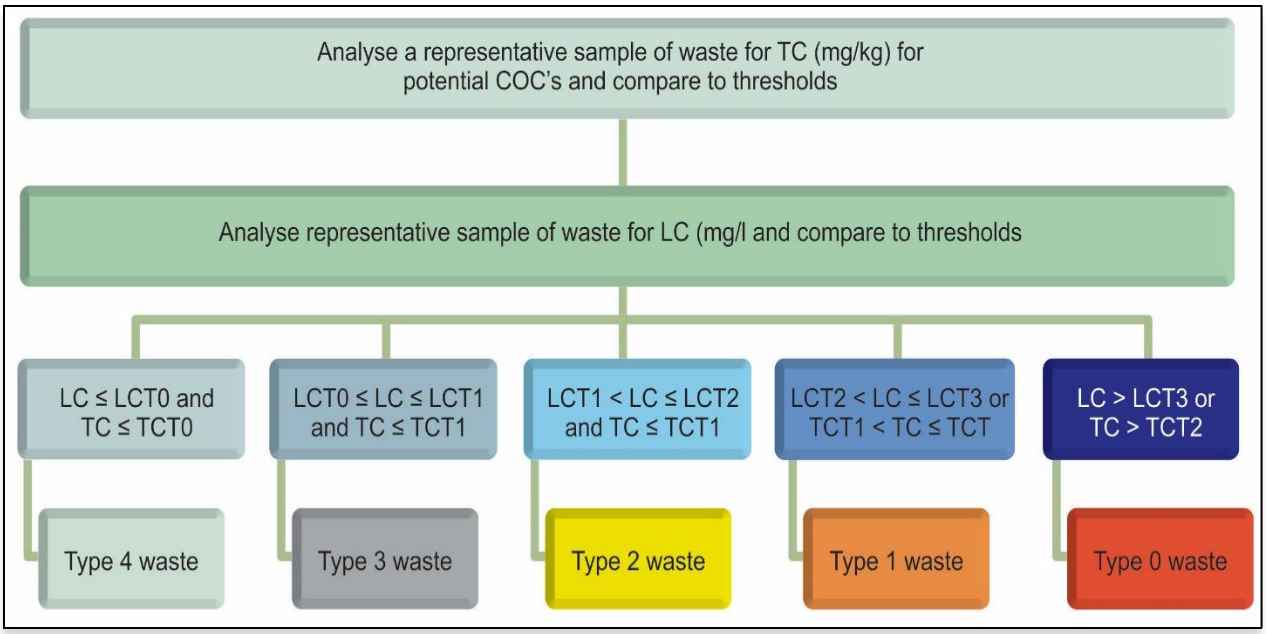

Figure 6: Flow diagram for waste assessment according to the GN R.635

4. METHODOLOGY

The samples were analysed by Waterlab (Pty) Ltd. a SANAS accredited laboratory (Facility accreditation number: T0391). The following analyses were conducted on the four samples provided:

4.1. Acid-base accounting

This test provides insight into whether sulphidic materials can produce acid. Acid-base accounting is the balance between the acid production and acid consumption characteristics of the material. The applied methods were:

- **Acid Potential (AP); Synonyms**: Maximum Potential Acidity (MPA)

Method: Total S(%) (Leco Analyzer) x 31.25.

- **Neutralisation Potential (NP):** Synonyms: Gross Neutralization Potential (GNP); Syn: Acid Neutralisation Capacity (ANC) (The capacity of a sample to consume acid).

Method: Fizz Test; Acid-Base Titration (Sobek & Modified Sobek (Lawrence) Methods)

- **Nett Neutralization Potential (NNP):** Synonyms: Nett Acid Production Potential (NAPP) Calculation: NNP = NP – AP; NAPP = ANC – MPA.
- **Neutralising Potential Ratio (NPR):**

Calculation: NPR = NP: AP.

4.2. Nett acid generation (NAG)

This is an important analytical tool that supplements static and kinetic tests for the assessment of acid generation risks of rock. Samples analysed with Single Addition NAG test as per Prediction Manual for Drainage Chemistry from Sulphidic Geological Materials.

4.3. Sulphur speciation

The objective of sulphur speciation is to determine the oxidisable capacity of the materials, which will be an indication of the acid generation potential of the materials.

4.4. Total and leachable concentrations

Leachable concentration refers to the leachable concentration of a particular element in waste either under alkaline, acidic or neutral conditions. The total concentration refers to the inherent concentration of chemical elements in waste. The test method includes using reagent/distilled or acid rainwater with a

1:20 liquid to solid ratio for the leach tests. The total concentrations were determined by using an HNO_3:HF digestion method. The dry mass used was 0.25 grams to 100 ml of liquid for digestion.

5. RESULTS AND DISCUSSIONS

The laboratory results of the samples collected in March 2022 are discussed in the following section. A copy of the laboratory results can be found in Appendix A.

5.1. Acid-base accounting

The acid-base accounting results are tabulated below in Table 3, where the green represents non-acid generating material or has the potential to neutralise the acid. The samples highlighted in orange have the potential to generate acid or are intermediate acid-forming, according to Table 4.

Table 3: Results from acid-base accounting.

Acid-Base Accounting Modified Sobek (EPA-600)	Sample Identification		
	Slag	Ash	G5 Ash
Paste pH	7.9	6.0	5.3
Total Sulphur (%) (LECO)	0.06	0.42	0.36
Acid Potential (AP) (kg/t)	1.79	13	11
Neutralization Potential (NP)	1.75	4.00	4.25
Nett Neutralization Potential (NNP)	-0.038	-9.06	-7.03
Neutralising Potential Ratio (NPR) (NP : AP)	0.979	0.306	0.377
Rock Type	II	I	I

The following criteria apply under Acid-Base Accounting:

- If NNP (NP – AP) < 0, the sample has the potential to generate acid.
- If NNP (NP – AP) > 0, the sample has the potential to neutralise the acid produced.

The type of rock in terms of acid generation is classified in the following table (Table 4).

Table 4: Rock classification for acid generation

Waste Type	Acid Forming Potential	Criteria
Type I	Potentially Acid Forming	Total S(%) > 0.25% and NP:AP ratio 1:1 or less

Type II	Intermediate	Total S(%) > 0.25% and NP:AP ratio 1:3 or less
Type III	Non-Acid Forming	Total S(%) < 0.25% and NP:AP ratio 1:3 or greater

The guidelines for Neutralising Potential Ratio (NPR) screening criteria based on ABA (Price et al., 1997; Usher et al., 2003) is tabulated below.

Table 5: Classification according to NPR

Potential for ARD	Initial NPR Screening Criteria	Comments
Likely	**< 1:1**	Likely AMD generating
Possibly	**1:1 – 2:1**	Possibly AMD generating if NP is insufficiently reactive or is depleted at a faster rate than sulphides
Low	**2:1 – 4:1**	Not potentially AMD generating unless significant preferential exposure of sulphides along fracture planes, or extremely reactive sulphides in combination with insufficiently reactive NP
None	**>4:1**	No further AMD testing is required unless materials are to be used as a source of alkalinity

All the samples have the potential to generate acid, based on the acid-base accounting resulting. Considering the rock classification (Table 4), both the Ash and G5 Ash classify as Type I rock, which is potentially acid-forming, while the Slag has moderate acid-forming potential. When the results are compared to the NPR screening criteria, all the samples are likely to generate AMD.

5.2. Nett acid generation

The nett acid generation at different pH values (4,5, and 7) is presented in Tables 6 and 7, respectively. Table 8 tabulates the criteria to interpret the NAG results.

Table 6: Net acid generation at pH 4.5

Net Acid Generation	Sample Identification: pH 4.5		
	Slag	Ash	G5 Ash
NAG pH: (H_2O_2)	4.6	6.3	6.5
NAG *(kg H_2SO_4 / t)*	<0.1	<0.1	<0.1

Table 7: Net acid generation at pH 7

Net Acid Generation	Sample Identification: pH 7		
	Slag	Ash	G5 Ash
NAG pH: (H_2O_2)	4.6	6.3	6.5
NAG *(kg H_2SO_4/ t)*	11	2.55	1.96

Table 8: Interpretation of the NAG test results (AMIRA 2002)

NAG pH	NAG (kg H_2SO_4/t)	Acid Production Potential
>4.5	**0**	Non-acid forming (NAF)
4.5	**5**	Potentially acid forming - lower capacity (PAF-LC)
< 4.5	**> 5**	Potentially acid forming (PAF)

Based on the interpretation of the NAG results, all the samples have no acid generating potential under acidic pH conditions. Under neutral pH conditions, Ash and G5 Ash have potentially acid-forming potential at a lower capacity, and Slag has acid-forming potential at a higher capacity.

5.3. Sulphur speciation

The classification according to sulphur content (%S) presents as follows (Table 9):

Table 9: Sulphur speciation results

Sulphur Speciation*	Sample Identification		
	Slag	Ash	G5 Ash
Total Sulphur (%) (ELTRA)	0.06	0.42	0.36
Sulphide Sulphur (%)	0.05	0.32	0.21
Sulphate Sulphur as S (%)	<0.01	0.10	0.15

Notes:

Samples analysed with Pyrolysis at 550°C as per Prediction Manual for Drainage Chemistry from Sulphidic Geological Materials MEND Report 1.20.1. Multiply Sulphate Sulphur to calculate SO_4 % by 2.996.

For sustainable long-term acid generation, at least 0.3% Sulphide-S is needed. Values below this can yield acidity, but it is likely to be only of short-term significance. From these facts, and using the NPR values, a number of rules can be derived:

1) Samples with less than 0.3% Sulphide-S have insufficient oxidisable Sulphide-S to sustain acid generation.

2) NPR ratios of >4:1 are considered to have enough neutralising capacity.

3) NPR ratios of 3:1 to 1:1 are considered inconclusive.

4) NPR ratios below 1:1 with Sulphide-S above 3% are potentially acid-generating. (Soregaroli & Lawrence, 1998; Usher et al., 2003)

Based on the results, only the Ash sample exceeded the sulphide sulphur content of 0.3%, which is the criteria for material having the potential to generate acid over the long term. This indicated that sufficient sulphur is present to sustain acid generation.

5.4. Total and Leachable Concentrations

The total concentrations of Constituents of Concern (CoCs) (*aqua regia* digestion) compared to TCT levels are indicated in Table 10. The concentration of Cr, Ni and V in the Slag sample exceeded the TCT0 levels and the As, B, Ba, Co, Cu and Ni concentrations in the Ash sample. The G5 Ash sample exceeded the TCT0 thresholds for As, Ba, Cu and Pb. No parameters in any of the samples exceeded the TCT1 or TCT2 levels.

Table 10: Total concentrations (mg/kg)

Sample Number	Total Concentration Threshold Limits			Slag	Ash	G5 Ash
Digestion	TCT0 mg/kg	TCT1 mg/kg	TCT2 mg/kg			
Units	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
As, Arsenic	5.8	500	2000	0.800	9.60	11
B, Boron	150	15000	6000	<10	157	106
Ba, Barium	62.5	6250	25000	14	297	250
Cd, Cadmium	7.5	260	1040	<0.400	<0.400	<0.400
Co, Cobalt	50	5000	20000	140	88	29
Cr_{Total}, Chromium Total	46000	800000	N/A	71200	194	2760
Cu, Copper	16	19500	78000	<4.00	42	26
Hg, Mercury	0.93	160	640	<0.400	<0.400	<0.400

Sample Number	Total Concentration Threshold Limits			Slag	Ash	G5 Ash
Digestion	TCT0 mg/kg	TCT1 mg/kg	TCT2 mg/kg			
Mn, Manganese	1000	25000	100000	664	382	378
Mo, Molybdenum	40	1000	4000	<10	<10	<10
Ni, Nickel	91	10600	42400	306	116	59
Pb, Lead	20	1900	7600	2.00	11	24
Sb, Antimony	10	75	300	<0.400	0.400	1.20
Se, Selenium	10	50	200	<0.400	<0.400	0.400
V, Vanadium	150	2680	10720	572	90	99
Zn, Zinc	240	160000	640000	107	<10	<10
Cr(VI), Chromium (VI)	6.5	500	2000	3.10	<2	<2
Total Fluoride	100	10000	40000	<0.5	20.20	38.00
Total Cyanide as CN	14	10500	42000	<1.55	<1.55	<1.55

The leachable concentrations of CoCs compared to the LCT levels are depicted in Table 11, and none of the parameter concentrations exceeded the LCT0 levels.

Table 11: Leachable concentrations (mg/l) (distilled water)

Analyses	Leachable Concentration Threshold Limits				Slag	Ash	G5 Ash
	LCT0	LCT1	LCT2	LCT3			
Units	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**
As, Arsenic	0.01	0.5	1	4	<0.001	<0.001	0.002
B, Boron	0.5	25	50	200	<0.025	0.068	<0.025
Ba, Barium	0.7	35	70	280	<0.025	0.048	0.027
Cd, Cadmium	0.003	0.15	0.3	1.2	<0.001	<0.001	<0.001
Co, Cobalt	0.5	25	50	200	<0.025	<0.025	<0.025
Cr_{Total}, Chromium Total	0.1	5	10	40	<0.025	<0.025	<0.025
Cr(VI), Chromium (VI)	0.05	2.5	5	20	0.010	<0.010	<0.010
Cu, Copper	2.0	100	200	800	<0.010	<0.010	<0.010
Hg, Mercury	0.006	0.3	0.6	2.4	<0.001	<0.001	<0.001
Mn, Manganese	0.5	25	50	200	<0.025	<0.025	<0.025

Analyses	**Leachable Concentration Threshold Limits**				**Slag**	**Ash**	**G5 Ash**
	LCT0	**LCT1**	**LCT2**	**LCT3**			
Units	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**
Mo, Molybdenum	0.07	3.5	7	28	<0.025	<0.025	<0.025
Ni, Nickel	0.07	3.5	7	28	<0.025	<0.025	<0.025
Pb, Lead	0.01	0.5	1	4	<0.001	<0.001	<0.001
Sb, Antimony	0.02	1.0	2	8	<0.001	<0.001	<0.001
Se, Selenium	0.01	0.5	1	4	<0.001	<0.001	<0.001
V, Vanadium	0.2	10	20	80	<0.025	<0.025	<0.025
Zn, Zinc	5.0	250	500	2000	<0.025	<0.025	<0.025
Total Dissolved Solids	1000	12 500	25 000	100 000	46	216	<10
Chloride as Cl	300	15 000	30 000	120 000	<2	<2	<2
Sulphate as SO_4	250	12 500	25 000	100 000	<2	127	18
Nitrate as N	11	550	1100	4400	0.1	0.2	<0.1
Fluoride as F	1.5	75	150	600	<0.2	0.3	0.4
Total Cyanide as CN	0.07	3.5	7	28	<0.07	<0.07	<0.07
pH	-	-	-	-	7.2	7.1	6.6
Paste pH	-	-	-	-	7.9	6.0	5.3

5.5. Waste Classification According to NEMWA (GNR 635 and 636)

The results presented in Table 10 and Table 11 has been used to conduct the waste classification. Section 7 of NEMWA National Norms and Standards for the Assessment of Waste for Landfill Disposal (No. R 635) provides the criterion for determining waste types for landfill disposal. The type of waste is determined as follows:

Type 0 waste: LC > LCT3 or TC > TCT2

Type 1 waste: LCT2 < LC ≤ LCT3 or TCT1 < TC ≤TCT2

Type 2 waste: LCT1 < LC ≤ LCT2 and TC ≤ TCT1

Type 3 waste: LCT0 < LC ≤ LCT1 and TC ≤ TCT1

Type 4 waste: LC ≤ LCT0 and TC ≤ TCT0

Wastes with all element or chemical substance leachable concentration levels for metal ions and inorganic anions below or equal to the LCT0 limits are Type 3 waste, irrespective of the total concentration of elements or chemical substances in the waste, provided that:

- All chemical substance concentration levels are below the total concentration limits for organics and pesticides provided in section 7(2)(e)
- The inherent physical and chemical character of the waste is stable and will not change over time; and,
- The waste is disposed of in a landfill without any other waste.

It should be noted that no organics or pesticides were analysed, and the samples had acid generating potential.

Table 10 and Table 11 above show that none of the LC and TC exceeded LCT1, 2 and 3 or TCT1 and 2; however, some exceedances for TCT0 were noted. A summary showing which elements or chemical substances in the sampled materials exceeded the LCT and TCT limits is tabulated below (Table 12).

Table 12: Summary of the results showing elements with LC and or TC above LCT0 and TCT0

	Slag	**Ash**	**G5 Ash**
LC >LCT0 (Distilled water)	None	None	None
TC > TCT0	Cr, Ni, V	As, B, Ba, Co, Cu, Ni,	As, Ba, Cu, Pb
Multiple criteria	none	none	none
Waste classification	Type 3	Type 3	Type 3
Landfill type	Class C-GLB+	Class C-GLB+	Class C-GLB+

In terms of section 7(2)(d) and (e), Type 3 Wastes are: Wastes with any element or chemical substance concentration above the LCT0 but below or equal to the LCT1 limits and all TC concentrations below or equal to the TCT1 limits (LCT0 < LC ≤ LCT1 and TC ≤ TCT1). Type 4 Wastes are wastes with all elements or chemical substance concentrations below the LCT0 and TCT0 (LC ≤ LCT0 and TC ≤ TCT0). Consequently, all the samples fall under Type 3 Waste.

In terms of Section 4(1) of the NEMWA National Norms and Standards for Disposal of Waste to Landfill (No. R636), Type 3 waste may only be disposed of at a Class C landfill designed in accordance with section 3(1) and (2) of the Norms and Standards, or, subject to section 3(4), may be disposed of at a landfill site designed in accordance with the requirements for a GLB+ landfill as specified in the Minimum Requirements for Waste disposal by Landfill (2^{nd} Ed., DWAF, 1998).

6. CONCLUSION

Three different materials from the site, were sampled on 1 March 2022 and were analysed for this waste classification. The waste classification was undertaken to inform Proplan of the nature of the waste to determine whether the material can be used as infill material or if the material should be removed and disposed of according to legislation. Analyses have been conducted on Ash, Ash and a gravel (G5) matrix mix and Slag. The results were used to classify the material according to the norms and standards provided in the National Environmental Management Waste Act.

The results indicate that the total concentrations for some elements were higher than the TCT0 limits stipulated in NEMWA in all three samples. Therefore, the sampled materials are regarded as waste type 3 and should be disposed of at a landfill site designed in accordance with the requirements for a GLB+ landfill. Organic compounds or pesticides were not analysed as part of the assessment. The additional analyses also indicated that all of the tested materials have acid generating potential and the inherent chemical properties of the material are questioned.

7. REFERENCES

All the analyses were conducted by Waterlab (Pty) Limited and their associates.

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Appendix 1: Laboratory results

WATERLAB (Pty) Ltd

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CERTIFICATE OF ANALYSES
NET ACID GENERATION

Date received: 2022-03-01 **Date completed: 2022-03-17**
Project number: 1000 **Report number: 107806** **Order number:**

Client name: Agreenco Environmental **Contact person: Ernestine Schmidhuber**
Address: P.O Box 19896, Noordbrug, 2522 **Email: ernestine.schmidhuber@agreencogroup.com**
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Net Acid Generation	**Sample Identification: pH 4.5**			
	Slag	**Ash**	**G5 Ash**	**G5 Ash**
Sample Number	**154676**	**154677**	**154678**	**154678 D**
NAG pH: (H_2O_2)	4.6	6.3	6.5	6.5
NAG (kg H_2SO_4 / t)	<0.1	<0.1	<0.1	<0.1

Net Acid Generation	**Sample Identification: pH 7**			
	Slag	**Ash**	**G5 Ash**	**G5 Ash**
Sample Number	**154676**	**154677**	**154678**	**154678 D**
NAG pH: (H_2O_2)	4.6	6.3	6.5	6.5
NAG (kg H_2SO_4 / t)	11	2.55	1.96	2.16

Notes:
- Samples analysed with Single Addition NAG test as per Prediction Manual For Drainage Chemistry from Sulphidic Geological Materials MEND Report 1.20.1.
- Please let me know if results do not correspond to other data.

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Geochemistry Project Manager

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CERTIFICATE OF ANALYSES
ACID – BASE ACCOUNTING
EPA-600 MODIFIED SOBEK METHOD

Date received: 2022-03-01 **Date completed: 2022-03-17**
Project number: 1000 **Report number: 107806** **Order number:**

Client name: Agreenco Environmental **Contact person: Ernestine Schmidhuber**
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Acid – Base Accounting Modified Sobek (EPA-600)	Sample Identification			
	Slag	Ash	G5 Ash	G5 Ash
Sample Number	**154676**	**154677**	**154678**	**154678 D**
Paste pH	7.9	6.0	5.3	5.3
Total Sulphur (%) (LECO)	0.06	0.42	0.36	0.36
Acid Potential (AP) (kg/t)	1.79	13	11	11
Neutralization Potential (NP)	1.75	4.00	4.25	3.5
Nett Neutralization Potential (NNP)	-0.038	-9.06	-7.03	-7.85
Neutralising Potential Ratio (NPR) (NP : AP)	0.979	0.306	0.377	0.308
Rock Type	II	I	I	I

*** Negative 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 0.00.**

Please refer to Appendix (p.2) for a Terminology of terms and guidelines for rock classification

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Date received: 2022-03-01
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APPENDIX: TERMINOLOGY AND ROCK CLASSIFICATION

TERMINOLOGY (SYNONYMS)

- Acid Potential (AP) ; *Synonyms*: Maximum Potential Acidity (MPA)
  Method: Total S(%) (Leco Analyzer) x 31.25
- Neutralization Potential (NP) ; *Synonyms:* Gross Neutralization Potential (GNP) ; *Syn*: Acid Neutralization Capacity (ANC) (The capacity of a sample to consume acid)
  Method: Fizz Test ; Acid-Base Titration (Sobek & Modified Sobek (Lawrence) Methods)
- Nett Neutralization Potential (NNP) ; *Synonyms:* Nett Acid Production Potential (NAPP)
  Calculation: NNP = NP – AP ; NAPP = ANC – MPA
- Neutralising Potential Ratio (NPR)
  Calculation: NPR = NP : AP

CLASSIFICATION ACCORDING TO NETT NEUTRALISING POTENTIAL (NNP)

If NNP (NP – AP) < 0, the sample has the potential to generate acid
If NNP (NP – AP) > 0, the sample has the potential to neutralise acid produced

Any sample with NNP < 20 is potentiall acid-generating, and any sample with NNP > -20 might not generate acid (Usher *et al*., 2003)

ROCK CLASSIFICATION

TYPE I	Potentially Acid Forming	Total S(%) > 0.25% and NP:AP ratio 1:1 or less
TYPE II	Intermediate	Total S(%) > 0.25% and NP:AP ratio 1:3 or less
TYPE III	Non-Acid Forming	Total S(%) < 0.25% and NP:AP ratio 1:3 or greater

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CLASSIFICATION ACCORDING TO NEUTRALISING POTENTIAL RATIO (NPR)

Guidelines for screening criteria based on ABA (Price *et al*., 1997; Usher *et al*., 2003)

Potential for ARD	Initial NPR Screening Criteria	Comments
Likely	**< 1:1**	Likely AMD generating
Possibly	**1:1 – 2:1**	Possibly AMD generating if NP is insufficiently reactive or is depleted at a faster rate than sulphides
Low	**2:1 – 4:1**	Not potentially AMD generating unless significant preferential exposure of sulphides along fracture planes, or extremely reactive sulphides in combination with insufficiently reactive NP
None	**>4:1**	No further AMD testing required unless materials are to be used as a source of alkalinity

CLASSIFICATION ACCORDING TO SULPHUR CONTENT (%S) AND NEUTRALISING POTENTIAL RATIO (NPR)

For sustainable long-term acid generation, at least 0.3% Sulphide-S is needed. Values below this can yield acidity but it is likely to be only of short-term significance. From these facts, and using the NPR values, a number of rules can be derived:

1) Samples with less than 0.3% Sulphide-S are regarded as having insufficient oxidisable Sulphide-S to sustain acid generation.
2) NPR ratios of >4:1 are considered to have enough neutralising capacity.
3) NPR ratios of 3:1 to 1:1 are consider inconclusive.
4) NPR ratios below 1:1 with Sulphide-S above 3% are potentially acid-generating. (Soregaroli & Lawrence, 1998 ; Usher *et al*., 2003)

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CERTIFICATE OF ANALYSES
SULPHUR SPECIATION [o]

Date received: 2022-03-10
Project number: 1000
Report number: 107806
Date completed: 2022-03-17
Order number:

Client name: Agreenco Environmental
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Sulphur Speciation*	Sample Identification			
	Slag	Ash	G5 Ash	G5 Ash
Sample Number	**154676**	**154677**	**154678**	**154678 D**
Total Sulphur (%) [o]	0.06	0.42	0.36	0.36
Sulphide Sulphur (%) [o]	0.05	0.32	0.21	0.21
Sulphate Sulphur as S (%) [o]	<0.01	0.10	0.15	0.15

[o] = Outsourced

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CERTIFICATE OF ANALYSES
Digestion AS 4439.3

Date received:	**2022/03/01**		**Date completed:**	**2022/03/17**
Project number:	**1000**	**Report number: 107806**	**Order number:**	

Client name:	**Agreenco Environmental**	**Contact person:**	**Ernestine Schmidhuber**
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Analyses	Slag		Ash		G5 Ash				
Sample Number	154676		154677		154678		TCT0 mg/kg	TCT1 mg/kg	TCT2 mg/kg
Digestion	HNO3 : HF		HNO3 : HF		HNO3 : HF				
Dry Mass Used (g)	0.25		0.25		0.25				
Volume Used (mℓ)	100		100		100				
Units	mg/ℓ	mg/kg	mg/ℓ	mg/kg	mg/ℓ	mg/kg			
As, Arsenic	0.002	0.800	0.024	9.60	0.028	11	5.8	500	2000
B, Boron	<0.025	<10	0.392	157	0.266	106	150	15000	6000
Ba, Barium	0.036	14	0.742	297	0.625	250	62.5	6250	25000
Cd, Cadmium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	7.5	260	1040
Co, Cobalt	0.350	140	0.220	88	0.073	29	50	5000	20000
$Cr_{Total,}$ Chromium Total	178	71200	0.485	194	6.90	2760	46000	800000	N/A
Cu, Copper	<0.010	<4.00	0.104	42	0.065	26	16	19500	78000
Hg, Mercury	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	0.93	160	640
Mn, Manganese	1.66	664	0.954	382	0.945	378	1000	25000	100000
Mo, Molybdenum	<0.025	<10	<0.025	<10	<0.025	<10	40	1000	4000
Ni, Nickel	0.766	306	0.290	116	0.147	59	91	10600	42400
Pb, Lead	0.005	2.00	0.027	11	0.060	24	20	1900	7600
Sb, Antimony	<0.001	<0.400	0.001	0.400	0.003	1.20	10	75	300
Se, Selenium	<0.001	<0.400	<0.001	<0.400	0.001	0.400	10	50	200
V, Vanadium	1.43	572	0.224	90	0.247	99	150	2680	10720
Zn, Zinc	0.268	107	<0.025	<10	<0.025	<10	240	160000	640000
Inorganic Anions	mg/ℓ	mg/kg	mg/ℓ	mg/kg	mg/ℓ	mg/kg			
Cr(VI), Chromium (VI) Total [o]	---	3.10	---	<2	---	<2	6.5	500	2000
Total Fluoride [o]	---	<0.5	---	20.20	---	38.00	100	10000	40000
Total Cyanide as CN [o]	---	<1.55	---	<1.55	---	<1.55	14	10500	42000

[o] = Outsourced
UTD = Unable to determine

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