

# DIGBY WELLS

## ENVIRONMENTAL

<b>To:</b>	Renee Van Aardt	<b>Date:</b>	21 August 2015
<b>From:</b>	Karabo Lenkoe-Magagula	<b>Proj #:</b>	BHP 2690
<b>RE:</b>	<b>Waste Classification Report</b>		

Dear Renee,

The following is a summary of the waste classification results associated with BHP Weltevreden project.

## 1 Waste Classification

Eight geology samples were collected from South 32 for geochemistry analysis in order to classify the future waste rock material in accordance with the NEM:WA Regulations (2013) by comparison with total (TCT) and leachable concentration (LCT) thresholds. Total Concentration values were determined by XRF while the leachable concentrations were prepared by a leachate of 1:20 solids per reagent water.

### 1.1 Introduction

#### 1.1.1 Legislative Guidelines

On the 2<sup>nd</sup> of June 2014 the National Environmental Management: Waste Amendment Act (NEMWA), 2014 (Act No, 26 of 2014) was published, which for the first time included “residue deposits” and “residue stockpiles” under the environmental waste legislation (previously mining residue was covered under the MPRDA). A new regulation, Planning and Management of residue stockpiles and residue deposit was included into the NEMWA in July 2015. The purpose of these regulations is to regulate the planning and the management of residue stockpiles and residue deposits from a prospecting, mining, exploration or production operation.

Mine waste are listed under Schedule 3, under the category “Hazardous Waste”, therefore the understanding is that mine waste are considered to be hazardous unless the applicant can prove that the waste is non-hazardous.

As residue deposits and residue stockpiles are considered to be waste, they are regulated by the following regulations, both promulgated on 23 August 2013. The pollution control barrier shall be defined by the:

- R635 – National norms and standards for assessment of waste for landfill disposal; and

- R636 – National norms and standards for disposal of waste to landfill.

According to these regulations, waste that is generated must be classified in accordance with SANS 10234 within 180 days of generation. Waste that has already been generated, but not previously classified must be classified within 18 months of the date of commencement of the regulations. The norms and standards specify the waste classification methodologies for determining the waste category, and the specifications for pollution control barrier systems (liners) for each of the waste categories.

The Department of Environmental Affairs (DEA) has published the following draft regulations:

- Notice 1005 of 2014 (14 November 2014): Proposed regulations regarding the planning and management of residue stockpiles and residue deposits from a prospecting, mining, exploration or production operation.

In terms of waste classification, these regulations state that residue stockpiles and residue deposits must be characterised to identify any potential risk to health or safety and environmental impact in terms of physical characteristics, chemical characteristics (toxicity, propensity to oxidise and decompose, propensity to undergo spontaneous combustion, pH and chemical composition of the water separated from the solids, stability and reactivity and the rate thereof, neutralising potential and concentration of volatile organic compounds), and mineral content.

In addition, the quality of seepage from residue facilities needs to be predicted:

- Notice 1006 of 2014 (14 November 2014): Proposed regulations to exclude a waste stream or a portion of a waste stream from the definition of waste.

These regulations state that waste generated from a source listed in Category A of Schedule 3 of NEM:WA may be excluded from being defined as hazardous on demonstration that the waste is non-hazardous in accordance with the Waste Management and Classification regulations. Exclusion of a waste stream from the definition of waste may be considered if it can be demonstrated that any contaminant of concern originating from the waste reaching the receptor will not exceed the acceptable environmental limits for any contaminant of concern for such a receptor. The acceptable environmental limits have not been defined.

### **1.1.2 Waste Classification Methodology**

Eight of the collected samples were analysed in order to classify the anticipated waste rock material in accordance with the NEMWA Regulations (2013) and NEMWA, 2014 (Act No, 26 of 2014, by comparison with total and leachable concentration thresholds.

Total Concentration values were determined by XRF methods by Waterlab Laboratory in Gauteng Province. Total Concentration Threshold limits are subdivided into three categories as follows:

- TCT0 limits based on screening values for the protection of water resources, as contained in the Framework for the Management of Contaminated Land (DEA, March 2010);
- TCT1 limits derived from land remediation values for commercial/industrial land (DEA, March 2010); and
- TCT2 limits derived by multiplying the TCT1 values by a factor of 4, as used by the Environmental Protection Agency, Australian State of Victoria.

Leachable concentration was determined by following the Australian Standard Leaching Procedure for Wastes, Sediments and Contaminated Soils (AS 4439,3-1997), as specified in the NEMWA Regulations (2013). The procedure recommends the use of reagent water for leaching of non-putrescible material that will be mono-filled. A leachate of 1:20 solids per reagent water was prepared and analysed by Waterlab Laboratory.

Leachable Concentration Threshold (LCT) limits are subdivided into four categories as follows:

- LCT0 limits derived from human health effect values for drinking water, as published by the Department of Water and Sanitation (DWS), South African National Standards (SANS), World Health Organization (WHO) or the United States Environmental Protection Agency (USEPA);
- LCT1 limits derived by multiplying LCT0 values by a Dilution Attenuation Factor (DAF) of 50, as proposed by the Australian State of Victoria;
- LCT2 limits derived by multiplying LCT1 values by a factor of 2; and
- LCT3 limits derived by multiplying the LCT2 values by a factor of 4.

GN R634 identifies waste classes (Waste Types 0 to 4) ranging from high risk to low risk, based on comparison of the total concentration (TC) and leachable concentration (LC) of individual constituents in the waste against the following threshold limits. Waste is classified by comparison of the total and leachable concentration of elements and chemical substances in the waste material to TCT and LCT limits as specified in the National Norms and Standards for Waste Classification and the National Norms and Standards for Disposal to Landfill as per Table 1-1 and Table 1-2.



**Table 1-1: Waste Classification Criteria**

<b>Waste Type</b>	<b>Total Concentrations</b>	<b>Leachable Concentrations</b>	<b>Disposal</b>
0	>TCT2	>LCT3	Not allowed
1	Between TCT1 and TCT2	Between LCT2 and LCT3	Class A or Hh:HH landfill
2	<TCT1	Between LCT1 and LCT2	Class B or GLB+ landfill
3	<TCT1	Between LCT0 and LCT1	Class C or GLB- landfill
4	<TCT0	<LCT0	Class D or GLB- landfill

**Table 1-2: Total and Leachable Concentration Threshold Limits**

Parameter	Unit	TCT0	TCT1	TCT2	Unit	LCT0	LCT1	LCT2	LCT3
As, Arsenic	mg/kg	5,8	500	2000	mg/l	0,01	0.5	1	4
B, Boron	mg/kg	150	15000	60000	mg/l	0,5	25	50	200
Ba, Barium	mg/kg	62,5	6250	25000	mg/l	0,7	35	70	280
Cd, Cadmium	mg/kg	7,5	260	1040	mg/l	0,003	0,15	0,3	1,2
Co, Cobalt	mg/kg	50	5000	20000	mg/l	0,5	25	50	200
Cr total	mg/kg	46000	800000	N/A	mg/l	0,1	5	10	40
Cr (IV), Chromium (IV)	mg/kg	6,5	500	2000	mg/l	0,05	2.5	5	20
Cu, Copper	mg/kg	16	19500	78000	mg/l	2	100	200	800
Hg, Mercury	mg/kg	0,93	160	640	mg/l	0,006	0,3	0,6	2,4
Mn, Manganese	mg/kg	1000	25000	100000	mg/l	0,5	25	50	200
Mo, Molybdenum	mg/kg	40	1000	4000	mg/l	0.07	3.5	7	28
Ni, Nickel	mg/kg	91	10600	42400	mg/l	0.07	3.5	7	28
Pb, Lead	mg/kg	20	1900	7600	mg/l	0.01	0.5	1	4
Sb, Antimony	mg/kg	10	75	300	mg/l	0.02	1	2	8
Se, Selenium	mg/kg	10	50	200	mg/l	0.01	0.5	1	4
V, Vanadium	mg/kg	150	2680	10720	mg/l	0.2	10	20	80
Zn, Zinc	mg/kg	240	160000	640000	mg/l	5	250	500	2000
Chloride as Cl	mg/kg	n/a	n/a	n/a	mg/l	300	15000	30000	120000
Sulphate as SO <sub>4</sub>	mg/kg	n/a	n/a	n/a	mg/l	250	12500	25000	100000
Nitrate as N	mg/kg	n/a	n/a	n/a	mg/l	11	550	1100	4400
F, Fluoride	mg/kg	100	10000	40000	mg/l	1,5	75	150	600

Parameter	Unit	TCT0	TCT1	TCT2	Unit	LCT0	LCT1	LCT2	LCT3
CN total, Cyanide total	mg/kg	14	10500	42000	mg/l	0,07	3,5	7	28

Notes: n/a: no threshold values

## 1.2 Results

Results of the analysis of TC and LC are shown in Table 1-3 and Table 1-4 respectively and compared to threshold concentrations published in the NEM:WA Waste Classification and Management Regulations.

### 1.2.1 Total Concentration

Based on the total concentration analysis of the core samples:

- A TCT0 threshold value for arsenic is exceeded in sample EBH02 TOPSOIL – SOFTS and EBH03 COMPOSITE INTERMEDIATE;
- A TCT0 threshold value for barium is exceeded in all samples; and
- A TCT0 threshold is exceeded for lead in all most all samples except EBH03 TOP SOIL-SOFTs and EBH03 OVERBURDEN.

### 1.2.2 Leachable Concentration Results

Based on the leachable concentration results, the leachable concentration of all constituents analysed in each of the eight samples were below the LCT0 threshold level.

Table 1-3: TCT classification for BHP Weltevreden Project samples

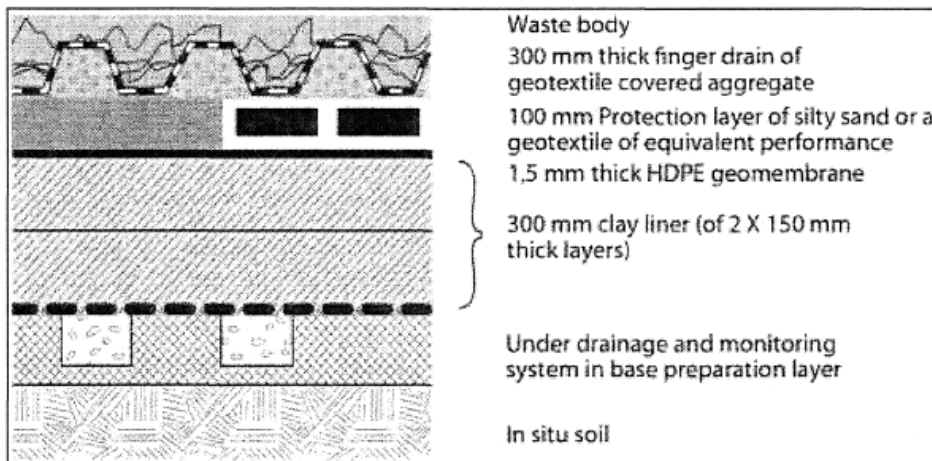
Parameter	Unit	TCT0	TCT1	TCT2	EBH01 OVERBURDEN	EBH01 COMPOSITE INTERMEDIATE	EBH02 TOPSOIL – SOFTS	EBH02 OVERBURDEN	EBH02 COMPOSITE	EBH03 TOPSOIL – SOFTS	EBH03 OVERBURDEN	EBH03 COMPOSITE INTERMEDIATE
As, Arsenic	mg/kg	5,8	500	2000	3,13	3,81	10,8	4,74	5,46	1,66	2,4	6,56
Ba, Barium	mg/kg	62,5	6250	25000	467	268	566	246	306	324	468	459
Co, Cobalt	mg/kg	50	5000	20000	<0,56	<0,56	<0,56	28,5	1	<0,56	<0,56	<0,56
Mo, Molybdenum	mg/kg	40	1000	4000	1,59	2,49	2,02	2,63	1,97	2,21	1,87	2,21
Pb, Lead	mg/kg	20	1900	7600	23,7	39,3	204	68	82,1	<2,03	4,16	105
Sb, Antimony	mg/kg	10	75	300	<1,48	<1,48	<1,48	<1,48	<1,48	<1,48	<1,48	<1,48
Se, Selenium	mg/kg	10	50	200	<0,36	<0,36	<0,36	<0,36	<0,36	<0,36	<0,36	<0,36
V, Vanadium	mg/kg	150	2680	10720	<7,60	<7,60	<7,60	<7,60	<7,60	<7,60	<7,60	<7,60
Zn, Zinc	mg/kg	240	160000	640000	48,4	69,2	62,8	61	73	48,4	66	75,6

Table 1-4: LCT classification for BHP Weltevreden Project samples

Parameter	Unit	LCT0	LCT1	LCT2	LCT3	EBH01 OVERBURDEN	EBH01 COMPOSITE INTERMEDIATE	EBH02 TOPSOIL – SOFTS	EBH02 OVERBURDEN	EBH02 COMPOSITE	EBH03 TOPSOIL – SOFTS	EBH03 OVERBURDEN	EBH03 COMPOSITE INTERMEDIATE
As, Arsenic	mg/l	0,01	0,5	1	4	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
B, Boron	mg/l	0,5	25	50	200	0,013	0,011	<0,010	0,017	0,011	<0,010	<0,010	<0,010
Ba, Barium	mg/l	0,7	35	70	280	0,056	0,18	0,016	0,019	<0,010	0,018	0,038	0,145
Co, Cobalt	mg/l	0,5	25	50	200	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Cr total	mg/l	0,1	5	10	40	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Mn, Manganese	mg/l	0,5	25	50	200	<0,025	<0,025	<0,025	<0,025	<0,025	<0,025	<0,025	<0,025
Mo, Molybdenum	mg/l	0,07	3,5	7	28	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Pb, Lead	mg/l	0,01	0,5	1	4	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Sb, Antimony	mg/l	0,02	1	2	8	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Se, Selenium	mg/l	0,01	0,5	1	4	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
V, Vanadium	mg/l	0,2	10	20	80	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Zn, Zinc	mg/l	5	250	500	2000	<0,010	<0,010	<0,010	<0,010	0,133	<0,010	<0,010	0,032
Chloride as Cl	mg/l	300	15000	30000	120000	<5	<5	<5	<5	<5	<5	<5	<5
Sulphate as SO <sub>4</sub>	mg/l	250	12500	25000	100000	<5	10	<5	<5	<5	7	<5	11
Nitrate as N	mg/l	11	550	1100	4400	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
F, Fluoride	mg/l	1,5	75	150	600	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2

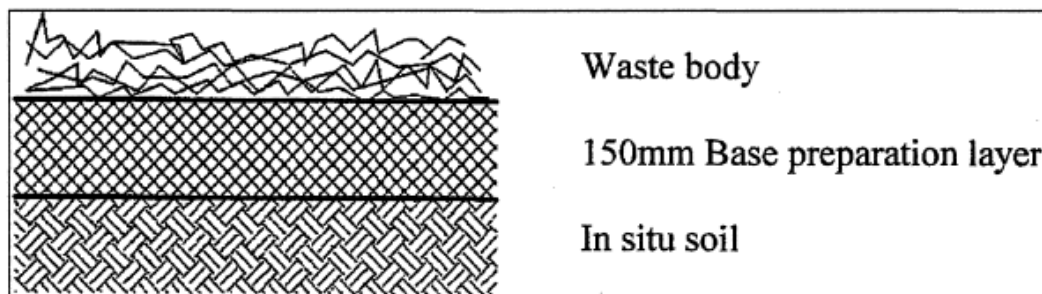
### 1.3 Conclusions

Based on the TC results only, the waste is classified as a Type 3 waste (i.e. low risk), and disposal should be into a Class C landfill or sites designed with liner requirements illustrated in Figure 1-1.



**Figure 1-1: Class C landfill site liner requirements**

Based on the LC results only, the waste is classified as a Type 4 waste (i.e. Inert waste), and should be disposed of at Class D landfill sites or sites designed with liner requirements illustrated in Figure 1-2.



**Figure 1-2: Class D landfill site liner requirements**

Based on **R 635**, Section 7, paragraph 6, waste with all elements or chemical substances leachable concentration levels for metal ions and inorganic anions below or equal to the LCT0 limits are considered to be Type 3 waste. This will apply irrespective of the total concentration of elements or chemical substances in the waste, provided that the inherent physical and chemical character of the waste is stable and will not change over time. For the study, a Class C landfill will be needed for disposal of the material based on the TC and LC results.

Regards,



Karabo Lenkoe-Magagula  
*Senior Hydrogeologist*