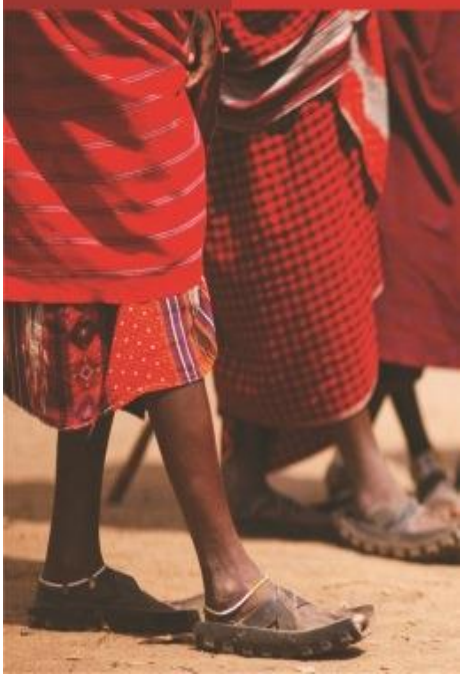

DIGBY WELLS
ENVIRONMENTAL

Exxaro Coal Pty (Ltd) Grootegeluk Short-Term Stockpiles Amendment Project

Geochemistry Report

Project Number:

EXX3666

Prepared for:

Exxaro Coal (Pty) Ltd (Grootegeluk)

September 2016

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This document has been prepared by Digby Wells Environmental.

Report Type:	**Geochemistry Report**
Project Name:	**Exxaro Coal Pty (Ltd) Grootegeluk Short-Term Stockpiles Amendment Project**
Project Code:	**EXX3666**

Name	Responsibility	Signature	Date
Andre van Coller	Geochemistry and reporting		27 September 2016
Lucas Smith	1st Review		20 June 2016
Brett Coutts	2nd Review		22 June 2016

EXECUTIVE SUMMARY

Exxaro Coal (Pty) Ltd (Exxaro), Grootegeluk Coal Mine (Grootegeluk) is contracted to supply coal to Eskom's Medupi and Matimba power stations, both in Lephalale, Limpopo Province. Off-take of Eskom coal has slowed due to construction delays and thus Exxaro requires additional stockpiling space to accommodate the excess coal on site. Digby Wells was requested by Exxaro Coal (Pty) Ltd to carry out for the proposed Short Term Stockpile Amendment at the Grootegeluk Mine.

Digby Wells Environmental (Digby Wells) was appointed by Exxaro (Pty) Ltd, Grootegeluk to amend the environmental authorisations for the Grootegeluk Infrastructure Expansion Project in 2014. The permitting documents were submitted to Limpopo Department of Economic Development, Environment and Tourism (LEDET) and Department of Mineral Resources (DMR).Exxaro were granted an Environmental Authorisation in October 2014 and August 2015.

The project has been subdivided into a 2 phased approach:

- Phase 1: Amendment to stockpile GG10A capacity with a temporary stockpile on the approved footprint area and Department of Water Affairs and Sanitation (DWS) approval for the use of temporary liners for five years.
- Phase 2: Section 102 Amendment process for the changes to the EMPR for the three stockpile areas including size, capacity and use. Some of these areas have not been covered in previous application or in previous studies or partially covered.

This report outlines and summarises the results of the geochemical specialist study that serves as additional information and motivation for the phases noted above.

Various geochemical tests in addition to those done by WSP for the waste classification were done with the purpose to serve as additional motivation to the methodology proposed by Exxaro in the implementation of their alternatives to the Class C and D liners for the GG7 to 8 and GG1 to 6 temporary stockpiles.

The following summary of the results and conclusions from the study:

Waste Classification

The material from the GG1 to GG6 process plants were sampled and submitted to an accredited laboratory (Jones Environmental Laboratory) for analysis by WSP Environmental (Pty) Ltd. The results of the test work are shown in Appendix B. The tests conducted were *aqua regia* digestion for total concentration and reagent water (distilled water) leaching procedure (20:1 ratio) in accordance with the National Environmental NEM:WA guidelines for mono-disposal (DEA, 2013). Based on the outcomes of the test work, the "waste" can be classed (Table 2-2) after comparison with the total concentration threshold (TCT) and leachable concentration threshold (LCT) values.

Based on the above, the material from GG1 to GG6 is classed as a Type 4 waste and should be disposed of or stored at a facility with a Class D liner. A conceptual design for a

Class D liner as given by the NEM: WA guidelines (DEA, 2013) are shown below in Figure 2-1.

The material from the GG7 to GG8 process plants were sampled and submitted to an accredited laboratory (Jones Environmental Laboratory) by WSP Environmental (Pty) Ltd. The results of the test work are shown in Appendix B. The tests conducted were *aqua regia* digestion for total concentration and reagent water (distilled water) leaching procedure (20:1 ratio) in accordance with the National Environmental NEM:WA guidelines for mono-disposal (DEA, 2013). Based on the outcomes of the test work, the "waste" can be classed (Table 2-2) after comparison with the total concentration threshold (TCT) and leachable concentration threshold (LCT) values.

Based on the above, the material from GG7 to GG8 is classed as a Type 3 waste and should be disposed of or stored at a facility with a Class C liner or a system with similar properties. A conceptual design for a Class C liner as given by the NEM: WA guidelines (DEA, 2013) are shown below in Figure 2-2.

Mineralogy

The main minerals are quartz, muscovite, kaolinite, microcline with calcite and pyrite. The dominant mineral or compound is however the carbonaceous material or coal. The mineralogy indicated by the XRD results is typical of the sandstone/siltstone/mudstone formations dominated by clay minerals and feldspar. Inclusions of calcite/dolomite rich in Ca and Mg are evidence of the depositional environment in which the formations formed, with high evaporation and weathering rates.

The combination of the various oxides like Al_2O_3 and Fe_2O_3 combined with the SiO_2 all contribute to the silicate and oxide minerals present in the coal material along with carbon reported in the table as lost on ignition (LOI) due to the carbon being burnt during the analysis. Cl, Ba, La, Zr, Cu, Sr, Zn and Ni are the dominant trace elements as would be expected in a crustal environment with enriched clay and silicate mineralogy.

Acid Producing Potential

The paste pH in the ABA results show that there were no acid generation prior to analysis. However based on the paste pH from the NAG results (preparation pH of 4.5) samples GG7-8 A and B and sample GG1-6 A is acid generating with GG1-6 B being a slightly lower risk for acid generation only based on the paste pH results. From the ABA results the total sulphur (>0.3%), NNP (<0) and NPR (<1) shows that all 4 samples are potentially acid generating. This is due the pyrite content and low neutralising potential.

All 4 samples are classed as acid generating (Rock type I). This is however normal for coal deposits and is the same in most deposits. Surface water management of storm water and runoff from the stockpiles are crucial in managing any acidic water and leachate from toe seepage. These specific stockpiles at Grootegeluk will however be compacted and will only be I operation for short period (5 years) and with the low rainfall in the area the risk of high volumes of AMD formation is low. Although the mean annual precipitation (MAP) in the Grootegeluk area is low, in some months high intensity rainfall can occur. With the

compaction of the coal during the stockpiling process[1] the permeability will be decreased and runoff increased. This last mentioned process will allow lower infiltration, but if high intensity rainfall events do take place for an extended period some AMD formation can potentially be observed as suggested by the lab tests.

Leachate Results

Almost all the metals are below detection in both tests with the exception of Ba, Ni and Mn. Ba and Ni are heavy metals commonly associated with the geology as trace elements. In both tests the concentrations leaching was however well below the guideline values and does not pose an environmental or health risk. Over time the load can potentially increase. However, with the continuous stockpiling and reclaiming as well as compaction to take place the risk of seepage is reduced.

The Mn concentrations are however slightly above the guideline values for drinking water. Manganese is a common element enriched in the earth's crust and does easily dissolve into water under a wide range of pH levels. However, at the expected rate of seepage and low rainfall at Grootegeluk the element should not leach out at these concentrations given by the lab tests which simulate a worst case scenario[2]. All other elements are below the guideline values for drinking water.

The TDS values are mostly dominated by the sulphate distribution but do not pose a risk at the levels they are detected in all samples under both test methods. There is not much of a difference between the leachate concentrations of the distilled water tests and that of the SPLP results, even though the SPLP is done at a lower more acidic pH of 4.8.

The above conclusions based on the laboratory results and information at hand show that the metal leach potential of the material is low and will further be reduced by compaction. The environmental risk for contamination of groundwater through seepage is low.

Recommendations

Based on the study results the following is recommended by Digby Wells Environmental:

- It is proposed that Exxaro designs the liner for the GG1 to 6 short-term stockpiles in line with the Class D liner;
- It is proposed that Exxaro designs the liner for the GG7 to 8 short-term stockpiles in line with the Class C liner requirements;

[1] Based on information provided by Exxaro the coal will be compacted in line with stockpile management guidelines. The coal will be compacted down to 101% of the natural density and lead to a reduced permeability.

[2] Static leachate tests performed by laboratories are done to simulate a worst case scenario. This involves the milling of samples down to very small particle sizes. This process increases the mineral surface areas open to interact with oxygen and water and in turn increase the reactivity of minerals.

- Exxaro should implement monitoring and quality control measures on a regular basis for the groundwater, surface water and coal material. This will allow the management of contaminants, if any, leaching and/or flowing from the stockpiles;
- Surface water management of storm water and runoff from the stockpiles should be implemented and are crucial in managing any acidic water and leachate from toe seepage; and
- Compaction of the coal material should be implemented as planned[3] to allow the permeability of the coal material to decrease and minimise any risk of seepage from the stockpiles further.

[3] Based on information provided by Exxaro the coal will be compacted in line with stockpile management guidelines. The coal will be compacted down to 101% of the natural density and lead to a reduced permeability.

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1 Introduction

Exxaro Coal (Pty) Ltd (Exxaro), Grootegeluk Coal Mine (Grootegeluk) is contracted to supply coal to Eskom's Medupi and Matimba power stations, both in Lephalale, Limpopo Province. Due to delays in the start-up of Medupi off-take of Eskom coal has slowed and Exxaro requires additional stockpiling space to accommodate the excess coal on site. Digby Wells was requested by Exxaro Coal (Pty) Ltd to carry out for the proposed Short Term Stockpile Amendment at the Grootegeluk Mine.

Digby Wells Environmental (Digby Wells) was appointed by Exxaro (Pty) Ltd, Grootegeluk to amend the environmental authorisations for the Grootegeluk Infrastructure Expansion Project in 2014. The permitting documents were submitted to Limpopo Department of Economic Development, Environment and Tourism (LEDET) and Department of Mineral Resources (DMR).Exxaro were granted an Environmental Authorisation in October 2014 and August 2015.

The project has been subdivided into a 2 phased approach:

- Phase 1: Amendment to stockpile GG10A capacity with a temporary stockpile on the approved footprint area and Department of Water Affairs and Sanitation (DWS) approval for the use of temporary liners for five years.
- Phase 2: Section 102 Amendment process for the changes to the EMPR for the three stockpile areas including size, capacity and use. Some of these areas have not been covered in previous application or in previous studies or partially covered.

This report outlines and summarises the results of the geochemical specialist study that serves as additional information and motivation for phases 1 and 2 mentioned above.

1.1 Project Description

Exxaro owns multiple mining operations, including Grootegeluk Coal Mine (hereafter Grootegeluk), which has been in operation since 1982 in the Limpopo Province. Grootegeluk is located approximately 18 km outside of Lephalale and is contracted to supply coal to Eskom's Matimba power station and the Medupi power station. Due to delays in the start-up of Medupi the off-take of Eskom coal has slowed and Exxaro requires additional stockpiling space to accommodate the excess coal on site.

Exxaro applied to expand certain infrastructure within the mine boundary area, referred to as the Grootegeluk Coal Mine Infrastructure Expansion Project. Exxaro submitted Applications in terms of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) and Minerals and Petroleum Resources Development Act (MPRDA), 2002 (Act No. 28 of 2002) to include the following activities / expansions within the mine boundary:

- Expansion of the rail loop, load out stations and associated infrastructure;
- Expansion of the existing coal stockyard and stockpiles;
- Expansion of the fuel storage depot;

- Expansion of beneficiation plants and associated infrastructure;
- New road and conveyors to fines recovery area;
- New gate and hard park area; and
- Expansion of ancillary infrastructure and new 33 kV power line.

The aforementioned 2014 amendment was also associated with the expansion of the existing coal product stockpiles. The following stockpiles and stockyards were included in the applications and approved:

- GG 6/2 stockyard;
- GG 10 stockyards;
  - Conical Stock pile;
  - Stockyard A and
  - Stockyard B;
- Multi-product overflow stockyard

The Grootegeluk Coal Mine Infrastructure Expansion Project was authorised in terms of the NEMA and the Environmental Impact Assessment Regulations of 2010[4], (which have been repealed). The Limpopo Department of Economic Development, Environment and Tourism (LEDET), and the Record of Decision are dated 27 October 2014, with reference number 12/1/9/1-W89 (Plan 1, Appendix A). The Department of Mineral Resources (DMR) Environmental Management Programme (EMP) Amendment approval was granted on the 28 August 2015.

Exxaro proposed a phased authorisation approach for the amendments that are being requested. Exxaro proposes to amend the existing Authorisation relevant to the Grootegeluk Mine Infrastructure Expansion Project (which included the expansion of the GG10 Stockyards and several other stockpile areas).

The purpose of these amendments is to allow Exxaro to legally stockpile Eskom-grade coal currently being mined from the upper coal benches at the Grootegeluk Mine. In summary the two phases included the following:

- Phase 1: Amendment of the GG10A stockyard for temporary use - The amendment of the GG10A stockyard area with the capacity of 400,000m^3 to include the alternative of a temporary 2 Mt compacted Power Station Coal Stockpile in the same footprint area.
- Phase 2: Amend the GG10B stockyard area - The amendment of the GG10B stockyard to include the additional area inside the loop not originally included. To also amend the use of the multi-product overflow stockpiles to stacking and loading

[4] Dated 18 June 2010

areas. The additional 1.1mil stockpiles area in the footprint of the original Coke and Co-gen area will need to be included as an additional area.

Further to what has been noted above regarding the requested amendment, Exxaro received approval from Department of Water Affairs (DWS) and DMR for Phase 1 of the project on the 5th May 2016 and 7th July 2016 respectively. This part of the project and associated specialist studies conducted is in support of the Phase 2 amendment that is being requested for in terms Section 31 of the 2014 NEMA Regulations applies as this is an amendment to an existing Environmental Authorisation. Thus the information contained within this specialist report is specific to the Phase 2 amendment process, however does make reference to Phase 1 with respect to the areas assessed.

The purpose of this Project is to utilise the Laydown Area, GG10B, and Multiproduct Stockyard footprints to stock excess Eskom-grade coal only, for an approximate period of five years, until the Medupi power station is fully operational. This project also includes the extension of the GG10B Stockyard footprint by approximately 12 hectares (ha) by including the internal area of the discontinued rail loop. The assumed grade of coal to be placed on this proposed consolidated stockpile area has been classified as Type 3 waste, requiring a Class C liner (Section 2, and Appendix B). It is assumed the amount of coal to be stockpiled in this area will total six megatons.

The proposed changes will require authorisation in terms of Regulation 31 of the NEMA, as well as a Section 21(g) Authorisation in terms of the National Water Act, 1998 (Act No 36 of 1998).

1.2 Deliverables

The following deliverables forms part of this study:

- Laboratory analysis and data interpretations; and
- Geochemical report with conclusions and recommendations.

1.3 Scope of Work and Methodology

The following scope of work and methodology was followed.

1.3.1 Desktop Study

A study of the proposed project plans, project descriptions, existing data and permits was done to evaluate the exact extent of the study needed. The main document reviewed was the technical memo and laboratory results prepared by WSP for the waste classification purposes (discussed in section 2 of this report and attached in Appendix B).

1.3.2 Laboratory Analysis

Digby Wells submitted a total of four (4) samples; two per stockpile extension, for geochemical testing with the results to be interpreted and serve as input into the waste

classification and liner motivation. At the start of the project Digby Wells was provided with the samples and they were submitted for:

- X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF);
- Acid base accounting (ABA and Net acid generation (NAG) tests;
- Aqua regia digestion; and
- Distilled water and Synthetic Precipitation Leachate Procedures (SPLP) to determine the leachability of any elements present in high concentrations.

2 Desktop Review: Waste Classification

Material from Plant GG1 to 6 will be temporarily stockpiled at the GG10A stockyard while material from GG7 to 8 will be stockpiled at the GG10B stockyard. Waste classification was done on both material streams from the plants feeding the line to the two mentioned stockyards.

During phase 1 the stockpile material for GG1 to 6 was classified according to the latest NEM: WA guidelines by WSP (Appendix B) (WSP 2015). A short summarising memo on the outcome of the classification was done by Digby Wells (Appendix C) to allow for an application for the GG1 to 6 materials to be stockpiled on the GG10A stockyard footprint which has already been approved. Furthermore, a second material stream was sampled from GG7 to 8 for the purposes of determining the liner requirements for the GG10 Stockpile B during the temporary stockpile period of 5 years.

The containment barriers prescribed for waste do not consider the product loadings, excavation and transport from stockpiles and thus are not generally appropriate for coal handling facilities (WSP, 2015).

Although the product is not seen as waste, the classification of the material was undertaken to confirm the liner requirements as required by the DWS and DEA.

2.1 Legislative Guidelines

On 2 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). 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 in the amended NEM: WA guidelines:

- R634 – Waste Classification and Management Regulations;

- 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 NEMWA 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.

2.2 Waste Classification Methodology

Total Concentration values were determined by *aqua regia* digestion and analysis with ICP methods. 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 reagent water leaching procedure.

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.

In the Regulation, the terms "Total Concentration Threshold" and "TCT" mean the total concentration threshold limit for particular elements or chemical substances in a waste, expressed as mg/kg, prescribed in section 6 of the Norms and Standards. The terms "Leachable Concentration Threshold" and "LCT" mean the leachable concentration threshold limit for particular elements and chemical substances in a waste, expressed as mg/l, prescribed in section 6 of these Norms and Standards.

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 assessed 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 2-1.

Table 2-1: Waste Type for Landfill Disposal

Waste Type	Element or chemical substance concentration	Disposal
0	LC > LCT3 **OR** TC > TCT2	Not allowed
1	LCT2 < LC ≤ LCT3 **OR** TCT1 < TC ≤ TCT2	Class A or Hh:HH landfill
2	LCT1 < LC ≤ LCT2 **AND** TC ≤ TCT1	Class B or GLB+ landfill
3	LCT0 < LC ≤ LCT1 **AND** TC ≤ TCT1	Class C or GLB- landfill
4	LC ≤ LCT0 **AND** TC ≤ TCT0 for metal ions and inorganic anions **AND** all chemical substances are below the total concentration limits provided for organics and pesticides listed	Class D or GLB- landfill

2.3 GG1 to 6 Material Waste Classification

The material from the GG1 to GG6 process plants were sampled and submitted to an accredited laboratory (Jones Environmental Laboratory) for analysis by WSP Environmental (Pty) Ltd. The results of the test work are shown in Appendix B. The tests conducted were *aqua regia* digestion for total concentration and reagent water (distilled water) leaching procedure (20:1 ratio) in accordance with the National Environmental NEM:WA guidelines for mono-disposal (DEA, 2013). Based on the outcomes of the test work, the “waste” can be classed (Table 2-2) after comparison with the total concentration threshold (TCT) and leachable concentration threshold (LCT) values.

Table 2-2: Classification of GG1 to 6 materials

Test	Purpose	Results (All parameters considered)	Classification
GG 1- 6			
Aqua regia digestion	Total Concentration (TC)	TC<TCT0	Type 4
Reagent water leach test	Leachable Concentration (LC)	LC<LCT0	Type 4

Based on the above, the material from GG1 to GG6 is classed as a Type 4 waste (WSP 2015) and should be disposed of or stored at a facility with a Class D liner. A conceptual design for a Class D liner as given by the NEM: WA guidelines (DEA 2013) are shown in Figure 2-1.

(d) Class D Landfill:

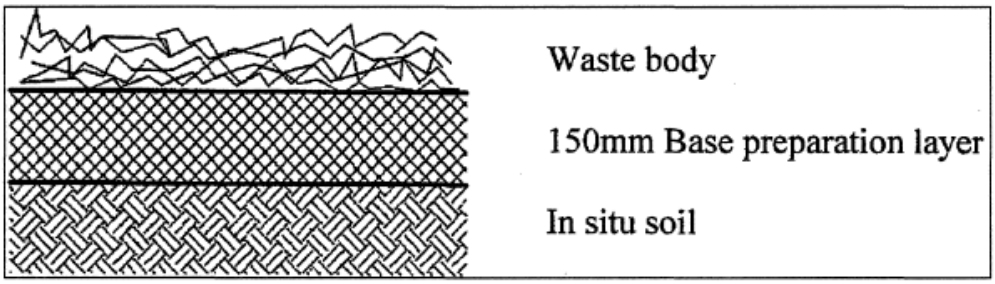


Figure 2-1: Minimum design requirements for a Class D liner (DEA, 2013)

It is proposed that Exxaro designs the liner for the GG1 to 6 short-term stockpiles in line with the Class D liner requirements. Exxaro will also implement monitoring and quality control measures on a regular basis for groundwater, surface water and coal material. This will allow the management of contaminants, if any, leaching and/or flowing from the stockpiles.

2.4 GG7 to 8 Material Waste Classification

The material from the GG7 to GG8 process plants were sampled and submitted to an accredited laboratory (Jones Environmental Laboratory) for analysis by WSP Environmental (Pty) Ltd. The results of the test work are shown in Appendix B. The tests conducted were *aqua regia* digestion for total concentration and reagent water (distilled water) leaching procedure (20:1 ratio) in accordance with the National Environmental NEM:WA guidelines for mono-disposal (DEA 2013). Based on the outcomes of the test work, the “waste” can be classed (Table 2-3) after comparison with the total concentration threshold (TCT) and leachable concentration threshold (LCT) values.

Table 2-3: Classification of GG7 to 8 materials

Test	Purpose	Results (All parameters considered)	Classification
GG 7- 8			
Aqua regia digestion	Total Concentration (TC)	TCT0<TC<TCT1	Type 3
Reagent water leach test	Leachable Concentration (LC)	LC<LCT0	Type 4

Based on the above, the material from GG7 to GG8 is classed as a Type 3 waste (WSP 2015) and should be disposed of or stored at a facility with a Class C liner or a system with similar properties. A conceptual design for a Class C liner as given by the NEM: WA guidelines (DEA 2013) are shown in Table 2-3.

(c) Class C Landfill:

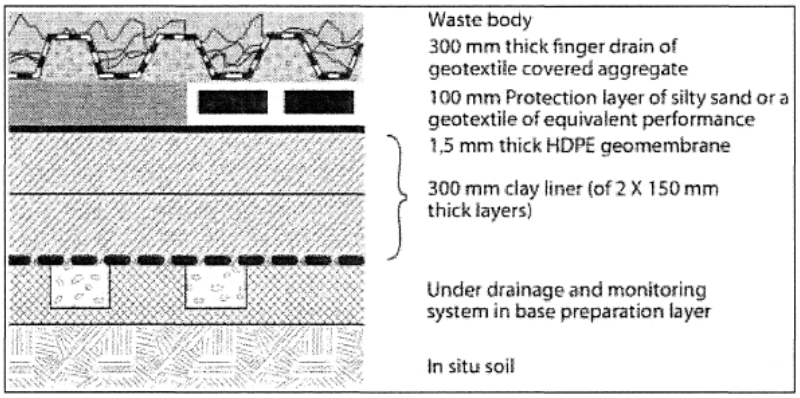


Figure 2-2: Minimum design requirements for a Class C liner (DEA, 2013)

It is proposed that Exxaro designs the liner for the GG7 to 8 short-term stockpiles in line with the Class C liner requirements. However, a system with similar properties has been proposed by Exxaro that is more cost effective. The data and interpretations presented in the remainder of this document serves as motivation along with the groundwater contaminant transport models presented in the groundwater specialist study report for the newly designed liner system to be implemented.

3 Geochemical Test Description and Purpose

Additional geochemical tests were done by Digby Wells (2016) to serve as additional motivation in support of the methodology proposed by Exxaro in the implementation of their alternatives to the prescribed Class C and D liners. The following paragraphs and sub section present the laboratory test methodologies and summarise the results for the 4 processed coal samples submitted by Digby Wells. The samples were from the product streams coming from the open pit through GG1 to 8.

The laboratory test to determine the potential for rock samples to produce ARD are generally grouped into two categories; static and kinetic tests. Static tests are relatively simple, inexpensive and rapid and enable initial screening of waste material in terms of the potential to produce ARD.

Static testing provides an indication of whether a particular sample has the potential to generate ARD and the elements that may leach from sample, whereas kinetic testing provides more confidence in the static test findings, as well as providing an indication of the time scale of the ARD and metal leaching.

All tests provide information on the chemical behaviour of a material and help in calculating reaction rates and input parameters into geochemical models.

3.1 XRD and XRF

XRF is an X-ray method used to determine the elemental composition of a material that allows for the evaluation of a materials chemical compound distribution, as well as the various trace element concentrations. XRD allows for the measurement of the crystal structures within a sample to determine the mineralogical composition of the material that allows the specialist to determine whether any reactive solids will lead to environmental risks through the study of the various minerals.

3.2 ABA and NAG

Acid-Base Accounting (ABA) is a first order classification procedure whereby the acid-neutralising potential and acid-generating potential of rock samples are determined, and the difference (Net Neutralising Potential) is calculated. This procedure includes NAG tests that evaluate the Net Acid Generation and neutralising potential of the material to evaluate the potential of the material to counter acid production. The Net Neutralising Potential, and/or the ratio of neutralising potential to acid-generation potential, is compared with a predetermined value, or set of values, to divide samples into categories that either require, or do not require further determinative acid potential generation test work.

3.3 Leachate Tests and Total Elemental Analysis

Leachate tests are done to simulate the heavy metal and anion leachate potential of soils, waste material and waste water left in-situ under the expected conditions, with the solution type and pH determined based on guidelines or the expected conditions on site. These tests

will simulate and evaluate the potential of any heavy metal or ion contamination from the waste material that will be produced. The leachate tests are used to evaluate the leachability of material that will be mono- or co-disposed.

The leachate tests done on the Grootegeluk samples were divided into two methods:

- Distilled water leachate procedure:
  - A distilled water extraction is prescribed as the preferred method to extract dissolvable metals and ions from waste material.
- Synthetic Precipitation Leachate Procedure (SPLP):
  - The SPLP was designed to simulate material sitting in-situ (in or on top of the ground surface) exposed to rainfall with an assumption that the rainfall is slightly acidic.

Total Concentration values were determined by *aqua regia* digestion and analysis with ICP methods to determine the complete chemical make-up of the material before being leached or altered.

4 Laboratory Results and Interpretations

4.1 Rock Mineralogy and Chemical Composition

Table 4-1 gives the XRD mineralogy results for the coal samples. As per the oxide and trace element distributions (Table 4-2 and Table 4-3) that predict the potential mineralogy within the XRD results, the main minerals are quartz, muscovite, kaolinite, microcline with calcite and pyrite. The dominant mineral or compound is however carbonaceous material or coal. The carbon material is however logged and reported by the laboratory equipment as graphite as this is the crystalline mineral form of carbon.

The mineralogy indicated by the XRD results is typical of the sandstone/siltstone/mudstone formations dominated by clay minerals and feldspar. Inclusions of calcite/dolomite rich in Ca and Mg are evidence of the depositional environment in which the formations formed, with high evaporation and weathering rates. Calcite and dolomite however also form during syn- and post depositional coal forming processes. The dolomite mineralogy indicated in the XRD results is a carbonate phase containing both Mg and Ca.

The kaolinite mineralogy can be due to the weathering of k-feldspar with an exposure of these minerals to atmospheric conditions leading to further formation of kaolinite during the formation period within the host rocks that are dominated by k-feldspar and other silicate minerals. The breakdown of feldspar is a pH buffering reaction, however further weathering sequences leading to the formation of secondary gibbsite from kaolinite is not a buffering reaction.

Pyrite is present in all samples and is associated with the depositional environment in which the coal formation occurred. The presence of pyrite can potentially lead to ARD formation. The potential ARD formation will be further discussed in the section on the ABA and NAG.

The mineralogy in the coal samples can be chemically described through the mineral formulas given below:

- Calcite $CaCO_3$
- Kaolinite $Al_2(Si_2O_5)(OH)_4$
- Muscovite $KAl_2(Si_3Al)O_{10}(OH,F)_2$
- Pyrite FeS_2
- Quartz SiO_2
- Siderite $FeCO_3$

The presence of siderite in the formations indicate that the original oxidation states are still stable with the main iron phase being ferrous iron (Fe(II)). Siderite can potentially act as a neutraliser under certain conditions, but with higher alkaline conditions and pH levels being elevated the weathering reaction of siderite can lead to acid production. The dissolution of siderite produces Fe^{2+} and HCO_3^- and combined with ferrous iron oxidation under elevated pH levels gives of protons in conditions where bicarbonate is stable. More acidic environments give aqueous conditions where carbonic acid is stable and no net acid production will occur (Dold 2005).

The minerals discussed above are all made up of chemical combinations or bonds of various oxides and trace elements (Table 4-2 and Table 4-3). The combination of the various oxides like Al_2O_3 and Fe_2O_3 combined with the SiO_2 all contribute to the silicate and oxide minerals present in the coal material along with carbon reported in the table as lost on ignition (LOI) due to the carbon being burnt during the analysis. Cl, Ba, La, Zr, Cu, Sr, Zn and Ni are the dominant trace elements as would be expected in a crustal environment with enriched clay and silicate mineralogy.

Table 4-1: XRD Result Summary - Minerals

Mineral	GG7-8 A	GG7-8 B	GG1-6 A	GG1-6 B
	Amount (weight %)			
Calcite	0.05	0.01	0.58	0.97
Dolomite	1.26	1.01	1.56	1.58
Coal	65.24	72.47	59.67	58.16
Kaolinite	25.92	23.29	19.99	19.72
Muscovite	2.24	1.77	2.11	2.21
Pyrite	1.28	0.58	0.66	0.80
Quartz	3.94	0.85	14.47	12.85
Siderite	0.08	0.02	0.96	3.71

Table 4-2: XRF Result Summary – Major Oxides

Major Oxides	Weight %			
	GG7-8 A	GG7-8 B	GG1-6 A	GG1-6 B
SiO_2	11.14	8.74	20.38	17.40
TiO_2	0.35	0.39	0.36	0.35
Al_2O_3	7.39	7.30	7.96	7.91
Fe_2O_3	1.21	0.58	1.90	3.81
MnO	0	0	0.02	0.05
MgO	0.25	0.18	0.25	0.40
CaO	0.81	0.32	0.83	1.38
Na_2O	0.05	<0.01	0.02	0.03
K_2O	0.17	0.11	0.34	0.28
P_2O_5	0.06	0.05	0.06	0.10
Cr_2O_3	0	0	0.01	0.01
SO_3	0.24	0.07	0.15	0.06
LOI	77.50	81.64	67.70	67.22
Total	99.23	99.41	100.11	99.08
H_2O-	0.04	0.60	0.14	0.09

Table 4-3: XRF Result Summary – Major Trace Elements

Major Trace Elements	Concentration (ppm)			
	GG7-8 A	GG7-8 B	GG1-6 A	GG1-6 B
As	9.62	8.98	8.42	6.12
Ba	88.70	86.30	91.60	92.50
Bi	1.38	1.75	1.48	1.53
Cd	<3.04	<3.04	<3.04	<3.04
Ce	<3.08	<3.08	19.90	16.10
Cl	122	125	123	122
Co	<0.56	<0.56	<0.56	<0.56
Cs	1.38	1.40	1.33	1.31
Cu	28.40	114	55.50	60.60
Ga	11.10	9.27	13.30	16.90
Ge	<0.50	<0.50	<0.50	<0.50
Hf	6.38	6.49	6.38	6.39
Hg	<1.00	<1.00	<1.00	<1.00
La	95	97.80	84.90	65.60
Lu	1.70	1.68	1.88	2.20

Major Trace Elements	Concentration (ppm)			
	GG7-8 A	GG7-8 B	GG1-6 A	GG1-6 B
Mo	2.48	2.54	2.46	2.47
Nb	<2.15	<2.15	<2.15	<2.15
Nd	54	58.50	49.40	40.70
Ni	29.60	30.70	20.50	27.50
Pb	<2.03	<2.03	<2.03	<2.03
Rb	8.90	5.64	18.30	14
Sb	<1.48	<1.48	<1.48	<1.48
Sc	18.70	17.10	18.20	21.70
Se	0.83	1.12	0.50	0.62
Sm	9.32	7.80	10.40	14.90
Sn	4.57	3.72	4.91	7.06
Sr	68.60	60.50	57.90	66.30
Ta	1	0.76	1.05	1
Te	0.53	<0.16	0.83	2.21
Th	5.34	5.97	4.39	3.37
Tl	2.33	2.31	2.22	2.18
U	2.39	2.48	2.35	2.46
V	<7.60	<7.60	<7.60	<7.60
W	6.86	6.86	6.87	6.91
Y	16	15.90	17.70	17.60
Yb	4.27	2.96	4.59	6.78
Zn	47	87.60	51.60	54
Zr	77.80	78.60	98	86.50

4.2 Acid Generation Potential

From the ABA and NAG test results presented in Table 4-4 and Table 4-5 the following can be concluded:

- The paste pH in the ABA results shows that there was no acid generation prior to analysis. However, based on the paste pH from the NAG results (preparation pH of 4.5) samples GG7-8 A and B and sample GG1-6 A is acid generating with GG1-6 B being a slightly lower risk for acid generation only based on the paste pH results;
- From the ABA results the total sulphur (>0.3%), NNP (<0) and NPR (<1) shows that all 4 samples are potentially acid generating;
- This is due the pyrite content and low neutralising potential;

- All 4 samples are classed as acid generating (Rock type I). This is however normal for coal deposits and is the same in most deposits;
- Management of storm water and runoff from the stockpiles are crucial in managing any acidic water and leachate from toe seepage; and
- The stockpiles at Grootegeluk will however be for short periods (5 years) and with the low rainfall in the area the risk of high volumes of AMD formation is very low.

Table 4-4: Acid Base Accounting Results

Modified Sobek (EPA-600)	GG7-8 A	GG7-8 B	GG1-6 A	GG1-6 B
Paste pH	7	7.1	7.2	7.3
Total Sulphur (%) (LECO)	2.27	1.34	1.79	1.64
Acid Potential (AP) (kg/t)	71	42	56	51
Neutralization Potential (NP)	15	11	17	27
Nett Neutralization Potential (NNP)	-56	-31	-39	-24
Neutralizing Potential Ratio (NPR) (NP : AP)	0.216	0.258	0.304	0.53
Rock Type	I	I	I	I

Table 4-5: Net Acid Generation Results

Net Acid Generation	Sample Identification: pH 4.5			
	GG7-8 A	GG7-8 B	GG1-6 A	GG1-6 B
NAG pH: (H_2O_2)	2.7	2.7	3	4.8
NAG (kg H_2SO_4 / t)	16	40	11	<0.01
Net Acid Generation	**Sample Identification: pH 7**			
	GG7-8 A	**GG7-8 B**	**GG1-6 A**	**GG1-6 B**
NAG pH: (H_2O_2)	4.5	4.5	4.5	4.8
NAG (kg H_2SO_4 / t)	21	36	24	2.94

4.3 Leachate Test Results

Both distilled water leachate and SPLP tests were performed on samples representing each stockpile. These results are shown in Appendix D and also compared against SANS 2015 drinking water standards as a reference point to determine any potential elements at risk in Table 4-6.

From the leachate tests the following can be concluded:

- Almost all the metals are below detection in both tests with the exception of Ba, Ni and Mn;
- Ba and Ni are heavy metals commonly associated with the geology as trace elements. In both tests the concentration leaching out was well below the guideline values and does not pose an environmental or health risk;
- The Mn concentrations are however slightly above the guideline values for drinking water. Manganese is a common element enriched in the earth's crust and does easily dissolve in water under a wide range of pH levels. However, at the expected rate of seepage and low rainfall at Grootegeluk the element should not leach out at these concentrations given by the laboratory tests, which simulates a worst case scenario. Although the mean annual precipitation (MAP) in the Grootegeluk area is low, in some months high intensity rainfall can occur. With the compaction of the coal during the stockpiling process[5] the permeability will be decreased and runoff increased. This last mentioned process will allow lower infiltration but if high intensity rainfall events does take place for an extended period some AMD formation can potentially be observed as suggested by the lab tests;
- All other elements are below the guideline values for drinking water;
- The TDS values are mostly dominated by the sulphate distribution, but does not pose a risk at the levels detected in all samples under both test methods;
- There is not much of a difference between the leachate concentrations of the distilled water tests and that of the SPLP results. Even though the SPLP is done at a lower more acidic pH of 4.8; and
- The above conclusions based on the laboratory results and information at hand show that the metal leach potential of the material is low and will further be reduced by compaction. The environmental risk for contamination of groundwater through seepage is low.

[5] Based on information provided by Exxaro the coal will be compacted in line with stockpile management guidelines. The coal will be compacted down to 101% of the natural density and lead to a reduced permeability.

Table 4-6: Distilled water and SPLP leachate results (mg/L)

Parameter	SANS 2015 Drinking water guidelines	Distilled water		SPLP	
		GG7-8	GG1-6	GG7-8	GG1-6
As, Arsenic	≤ 0.01	<0.010	<0.010	<0.010	<0.010
B, Boron	≤ 2.4	<0.025	<0.025	<0.025	<0.025
Ba, Barium	≤ 0.7	<0.025	0.043	0.03	0.044
Cd, Cadmium	≤ 0.003	<0.005	<0.005	<0.005	<0.005
Co, Cobalt	N/A	<0.025	<0.025	<0.025	<0.025
Cr total	≤ 0.05	<0.025	<0.025	<0.025	<0.025
Cu, Copper	≤ 2	<0.010	<0.010	<0.010	<0.010
Hg, Mercury	≤ 0.006	<0.001	<0.001	<0.001	<0.001
Mn, Manganese	≤ 0.4	0.692	0.431	1.03	0.668
Mo, Molybdenum	N/A	<0.025	<0.025	<0.025	<0.025
Ni, Nickel	≤ 0.07	0.038	<0.025	0.041	<0.025
Pb, Lead	≤ 0.01	<0.010	<0.010	<0.010	<0.010
Sb, Antimony	≤ 0.02	<0.010	<0.010	<0.010	<0.010
Se, Selenium	≤ 0.04	<0.010	<0.010	<0.010	<0.010
V, Vanadium	N/A	<0.025	<0.025	<0.025	<0.025
Zn, Zinc	≤ 5	<0.025	<0.025	<0.025	<0.025
Uranium as U	≤ 0.03	<0.001	<0.001	<0.001	<0.001
Hexavalent Chromium as Cr^{6+}	N/A	<0.010	<0.010	<0.010	<0.010
Chloride as Cl	≤ 300	<2	2	<2	2
Sulphate as SO_4	≤ 500	134	417	202	445
Nitrate as N	≤ 11	0.1	0.8	0.1	0.8
F, Fluoride	≤ 1.5	<0.2	0.4	<0.2	0.3
Total Dissolved Solids at 180 ˚C	≤ 1 200	230	636	318	702
Bicarbonate as HCO_3 (calc)	N/A	43.9	34.1	43.9	43.9
Carbonate as CO_3 (calc)	N/A	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	N/A	36	28	36	36

5 Conclusions

From the geochemical tests and interpretations the following can be concluded:

- The main minerals are quartz, muscovite, kaolinite, microcline with calcite and pyrite;
- The dominant mineral or compound is however carbonaceous material or coal;
- The mineralogy indicated by the XRD results is typical of the sandstone/siltstone/mudstone formations dominated by clay minerals and feldspar. Inclusions of calcite/dolomite rich in Ca and Mg are evidence of the depositional environment in which the formations formed, with high evaporation and weathering rates;
- The combination of the various oxides like Al_2O_3 and Fe_2O_3 combined with the SiO_2 all contribute to the silicate and oxide minerals present in the coal material along with carbon material reported in the table as lost on ignition (LOI) due to the carbon being burnt during the analysis;
- Cl, Ba, La, Zr, Cu, Sr, Zn and Ni are the dominant trace elements as would be expected in a crustal environment with enriched clay and silicate mineralogy;
- The paste pH in the ABA results shows that there was no acid generation prior to analysis. However, based on the paste pH from the NAG results (preparation pH of 4.5) samples GG7-8 A and B and sample GG1-6 A are acid generating with GG1-6 B being a slightly lower risk in terms of acid generation;
- From the ABA results the total sulphur (>0.3%), NNP (<0) and NPR (<1) show that all 4 samples are potentially acid generating;
- This is due the pyrite content and low neutralising potential;
- All 4 samples are classed as acid generating (Rock type I). This is however normal for coal deposits and is the same in most deposits;
- Management of storm water and runoff from the stockpiles are crucial in managing acidic water and leachate from toe seepage; and
- The stockpiles at Grootegeluk will however be for short periods (5 years) and with the low rainfall in the area the risk of high volumes of AMD formation is low. Although the mean annual precipitation (MAP) in the Grootegeluk area is low, in some months high intensity rainfall can occur. With the compaction of the coal during the stockpiling process[6] the permeability will be decreased and runoff increased. This last mentioned process will allow lower infiltration but if high intensity rainfall events do take place for an extended period some AMD formation can potentially be observed as suggested by the lab tests.

[6] Based on information provided by Exxaro the coal will be compacted in line with stockpile management guidelines. The coal will be compacted down to 101% of the natural density and lead to a reduced permeability.

From the leachate tests the following can be concluded:

- Almost all the metals are below detection in both tests with the exception of Ba, Ni and Mn;
- Ba and Ni are heavy metals commonly associated with the geology as trace elements. In both tests the concentration leaching out was well below the guideline values and does not pose an environmental or health risk;
- The Mn concentrations are however slightly above the guideline values for drinking water. Manganese is a common element enriched in the earth's crust and easily dissolves in water under a wide range of pH levels. However, at the expected rate of seepage and low rainfall at Grootegeluk the element should not leach out at these concentrations given by the lab tests which simulate a worst case scenario[7];
- All other elements are below the guideline values for drinking water;
- The TDS values are dominated by the sulphate distribution, but do not pose a risk at the levels they are detected in all samples under both test methods;
- There is not much of a difference between the leachate concentrations of the distilled water tests and that of the SPLP results. Even though the SPLP is done at a lower more acidic pH of 4.8; and
- The above conclusions show that the metal leach potential of the material is low and will further be reduced by compaction and thus the environmental risk for contamination of groundwater through seepage is low.

6 Recommendations

Based on the study results the following is recommended by Digby Wells Environmental:

- It is proposed that Exxaro designs the liner for the GG1 to 6 short-term stockpiles in line with the Class D liner requirements;
- It is proposed that Exxaro designs the liner for the GG7 to 8 short-term stockpiles in line with the Class C liner requirements;
- Exxaro should implement monitoring and quality control measures on a regular basis for groundwater, surface water and coal material. This will allow the management of contaminants, if any, leaching and/or flowing from the stockpiles;
- Management of storm water and runoff from the stockpiles should be implemented and are crucial in managing acidic water and leachate from toe seepage; and

[7] Static leachate tests performed by laboratories are done to simulate a worst case scenario. This involves the milling of samples down to very small particle sizes. This process increases the mineral surface areas open to interact with oxygen and water and in turn increase the reactivity of minerals.

- Compaction of the coal material should be implemented as planned to allow the permeability of the coal material to decrease and minimise any risk of seepage from the stockpiles further.

7 References

DEA, 2013. *National Norms and Standards for the Disposal of Waste to Landfill*.

Dold, B., 2005. Basic Concepts of Environmental Geochemistry of Sulfide Mine-Waste. *Society of Economic Geologists*.

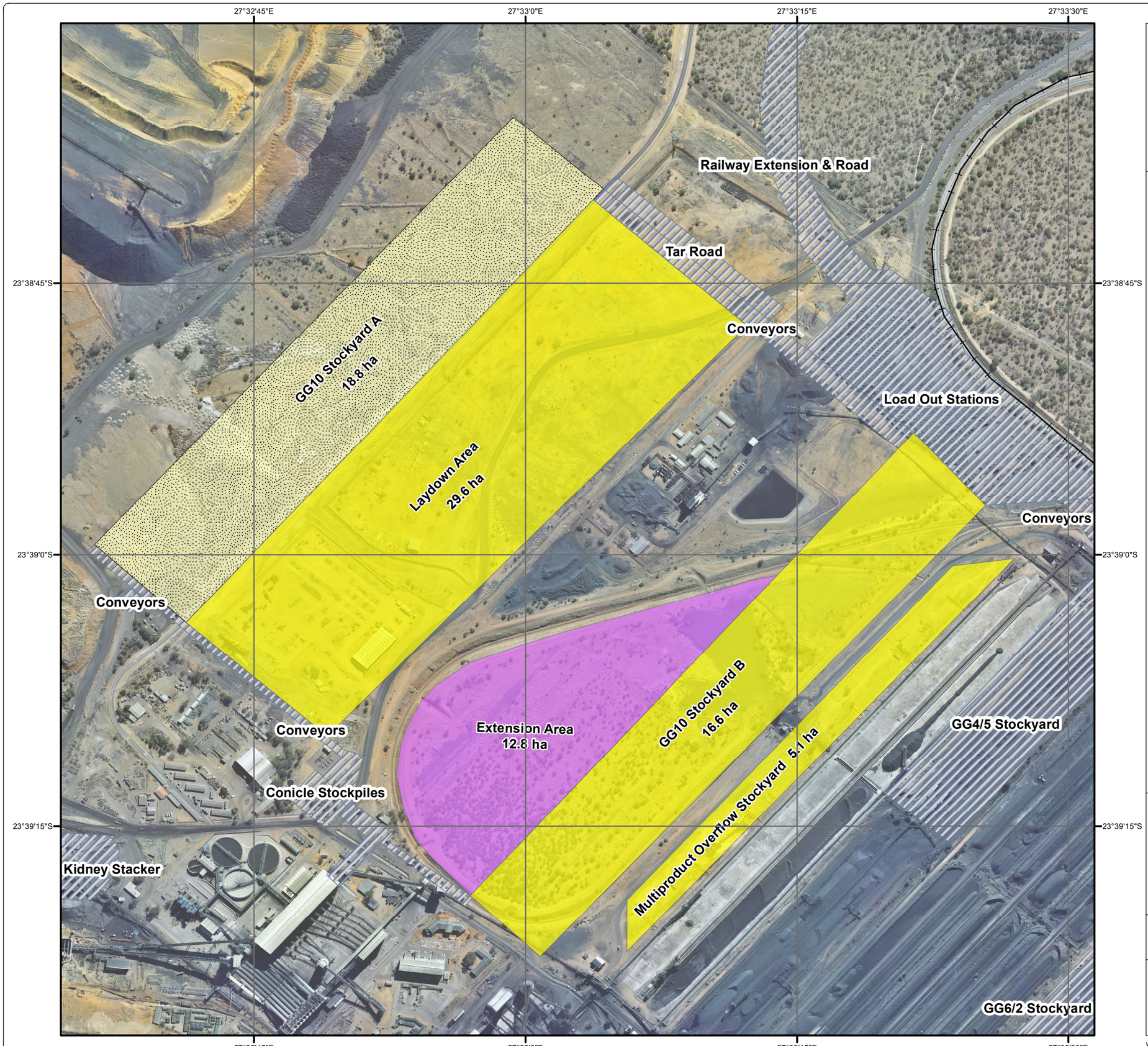
WSP, 2015. *Exxaro Grootegeluk Waste Classification: Coal Product*.

Appendix A: Plans

Plan 1

Exxaro Grootegeluk Amendment Project

Proposed Infrastructure Layout



Legend

Proposed Infrastructure

- GG10 Stockyard A
- Infrastructure Amendment Project
- Extension Area

Existing Infrastructure

- Existing Railway Line
- Existing Infrastructure

DIGBY WELLS ENVIRONMENTAL

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Projection: Transverse Mercator	Ref #: jcf.EXX3666.201604.165
Datum: WGS 1984	Revision Number: 2
Central Meridian: 27°E	Date: 05/04/2016

N

0 50 100 200 300

Metres

1:6,500

www.digbywells.com

Appendix B: WSP Report

Reference: Exxaro Grootegeluk Waste Classification: Coal Product

WSP Environmental (Pty) Ltd

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WSP Environmental (Pty) Ltd
Registered Number: 1995/08790/07

**A member of the WSP Global Inc.
Offices worldwide**

09 December 2015

Exxaro Grootegeluk Coal Mine

Dear Filomaine Swanepoel,

RE : Coal Product Waste Classification

Following receipt of two coal samples (GG 1-6 & GG 7-8) WSP Environmental (Pty) Ltd (WSP) arranged for the samples to undergo laboratory analysis in terms of GN 635 to determine their SANS 10234 classification and landfill type profile. It is understood that this was undertaken in response to a directive issued by the Department of Water and Sanitation (DWS) to determine temporary liner requirements for coal product storage beds as contained within GN 636.

To the best of WSP's knowledge, there exists no legislated requirements for a) the installation of specific liner systems for coal product beds or b) authorisations for the. The DWS is presumably motivated by the requirement to protect water resources from potential contamination sources.

Due to the fact that the coal streams in question are stockpiled products and not waste, management of the coal cannot be undertaken in terms of the waste legislation; with GN 634 explicitly clear in its purpose to regulate classification, management and disposal requirements of waste. Furthermore, GN 636 states that its purpose is to determine the requirements for the disposal of waste to landfill. The containment barriers prescribed for wastes do not consider the product loadings, excavation and transport from stockpiles and thus are not generally appropriate for coal handling facilities.

Nevertheless, type profiling of the coal streams (Appendix A) indicated that coal streams GG 1-6 and GG 7-8 would be profiled as Type 4 and Type 3 wastes respectively, suitable for disposal to a Class D and Class C landfill. Additionally, SANS 10234 classifications of the coal product streams were undertaken (Appendix B), for which both streams were determined to be non-hazardous. The results of the leaching tests conclude that the coal has an insignificant proportion of leachable heavy metals and salts and is considered to be chemically inert as a stockpile. The risk to water resources is considered to be very low if this an active stockpile and is not left to chemically weather over years of non-use.

In terms of appropriate environmental management of the coal stockpiles, WSP recommends that the coal is stockpiled on an impermeable hard standing surface (i.e. cement/concrete). Cognisance should be given to potentially turbid coal-dust contaminated stormwater arising from rainfall events; and an appropriate stormwater management system should be implemented to capture such dirty stormwater.

Yours faithfully

Zaffar Hussain
Environmental Consultant

Appendix A: Type Profiles of GG 1-6 and GG 7-8

WSP Environmental (Pty) Ltd: Screening Waste Type Profiling & Disposal Prohibition Appraisal

Based on National Norms and Standards for the Assessment of Waste for Landfill Disposal GNR. 635 (23 August 2013)

Source of Waste:	Exxaro Grootegeluk, Exxaro Grootegeluk Coal Mine, Power Station Coal GG1-6
Waste Matrix (Liquid / Solid):	Solid
Leachate Preparation (Solids Only):	Non-Putrescible (Mono-Disposal): Reagent Water

Substance	Concentration (ppm) - Solid/Total				Waste Type (based on TCTs and subject to LCTs)	Concentration (ppm) - Leachate/Liquid					Waste Type (based on LCTs and subject to TCTs)
	TCT0	TCT1	TCT2	Assessed Concentration		LCT0	LCT1	LCT2	LCT3	Assessed Concentration	
Metal Ions											
Arsenic	5.8	500	2000	5.3	2, 3 or 4 - LCT Dependent	0.01	0.5	1	4		
Boron	150	15000	60000	16.57	2, 3 or 4 - LCT Dependent	0.5	25	50	200		
Barium	62.5	6250	25000	27	2, 3 or 4 - LCT Dependent	0.7	35	70	280		
Cadmium	7.5	260	1040	0.1	2, 3 or 4 - LCT Dependent	0.003	0.15	0.3	1.2		
Cobalt	50	5000	20000	3.3	2, 3 or 4 - LCT Dependent	0.5	25	50	200		
Chromium	46000	800000	-	2.7	2, 3 or 4 - LCT Dependent	0.1	5	10	40		
Chromium (Hexavalent)	6.5	500	2000			0.05	2.5	5	20		
Copper	16	19500	78000	11	2, 3 or 4 - LCT Dependent	2	100	200	800		
Mercury	0.93	160	640			0.006	0.3	0.6	2.4		
Manganese	1000	25000	100000	261	2, 3 or 4 - LCT Dependent	0.5	25	50	200	0.076	4
Molybdenum	40	1000	4000	0.6	2, 3 or 4 - LCT Dependent	0.07	3.5	7	28		
Nickel	91	10600	42400	5.2	2, 3 or 4 - LCT Dependent	0.07	3.5	7	28		
Lead	20	1900	7600	14	2, 3 or 4 - LCT Dependent	0.01	0.5	1	4		
Antimony	10	75	300			0.02	1	2	8		
Selenium	10	50	200			0.01	0.5	1	4		
Vanadium	150	2680	10720	11	2, 3 or 4 - LCT Dependent	0.2	10	20	80		
Zinc	240	160000	640000	45	2, 3 or 4 - LCT Dependent	5	250	500	2000	0.006	4
Inorganic Anions											
Total Dissolved Solids	-	-	-	Not Applicable		1000	12500	25000	100000	41	4
Chloride	-	-	-	Not Applicable		300	15000	30000	120000		
Sulphate	-	-	-	Not Applicable		250	12500	25000	100000		
Nitrate	-	-	-	Not Applicable		11	550	1100	4400		
Fluoride	100	10000	40000	0.5	2, 3 or 4 - LCT Dependent	1.5	75	150	600		
Cyanide	14	10500	42000			0.07	3.5	7	28		
Organics											
Benzene	-	10	40			-	0.01	0.02	0.08		
Benzo(a)pyrene	-	1.7	6.8	0.137	2, 3 or 4 - LCT Dependent	-	0.035	0.07	0.28		
Carbon tetrachloride	-	4	16			-	0.2	0.4	1.6		
Chlorobenzene	-	8800	35200			-	5	10	40		
Chloroform	-	700	2800			-	15	30	120		
2-Chlorophenol	-	2100	8400			-	15	30	120		
Bis(2-ethylhexyl)phthalate	-	40	160			-	0.5	1	4		
1.2-Dichlorobenzene	-	31900	127600			-	5	10	40		
1.4-Dichlorobenzene	-	18400	73600			-	15	30	120		
1.2-Dichloroethane	-	3.7	14.8			-	1.5	3	12		
1.1-Dichloroethene	-	150	600			-	0.35	0.7	2.8		
1.2-Dichloroethene	-	3750	15000			-	2.5	5	20		
Dichloromethane	-	16	64			-	0.25	0.5	2		
2.4-Dichlorophenol	-	800	3200			-	10	20	80		
2.4-Dinitrotoluene	-	5.2	20.8			-	0.065	0.13	0.52		
Ethylbenzene	-	540	2160			-	3.5	7	28		
Formaldehyde	-	2000	8000			-	25	50	200		
Hexachlorobutadiene	-	2.8	5.4			-	0.03	0.06	0.24		
Methyl Ethyl Ketone (2-Butanone)	-	8000	32000			-	100	200	800		
Methyl Tertiary Butyl Ether	-	1435	5740			-	2.5	5	20		
Nitrobenzene	-	45	180			-	1	2	8		
Total PAHs	-	50	200	2.225	2, 3 or 4	-	-	-	-	Not Applicable	
>C6-C9	-	650	2600			-	-	-	-	Not Applicable	
>C10-C36	-	10000	40000	32	2, 3 or 4	-	-	-	-	Not Applicable	
Phenol	-	560	2240			-	7	14	56		
Polychlorinated Biphenyls (PCBs)	-	12	48			-	0.025	0.05	0.2		
Styrene	-	120	480			-	1	2	8		
1.1.1.2-Tetrachloroethane	-	400	1600			-	5	10	40		
1.1.2.2-Tetrachloroethane	-	5	20			-	0.65	1.3	5.3		
Tetrachloroethene	-	200	800			-	0.25	0.5	2		
Toluene	-	1150	4600			-	35	70	280		
Trichlorobenzenes (Sum)	-	3300	13200			-	3.5	7	28		
1.1.1-Trichloroethane	-	1200	4800			-	15	30	120		
1.1.2-Trichloroethane	-	48	192			-	0.06	1	4		
Trichloroethene	-	11600	46400			-	0.25	2	8		
2.4.6-Trichlorophenol	-	1770	7080			-	10	20	80		
Vinyl chloride	-	1.5	6			-	0.015	0.03	0.12		
Xylenes (Sum)	-	890	3560			-	25	50	200		
Pesticides											
Aldrin + Dieldrin	0.05	1.2	4.8			-	0.015	0.03	0.03		
DDT + DDD + DDE	0.05	50	200			-	1	2	2		
2.4-Dichlorophenoxyacetic Acid (2,4-D)	0.05	120	480			-	1.5	3	3		
Chlordane	0.05	4	16			-	0.05	0.1	0.1		
Heptachlor	0.05	1.2	4.8			-	0.015	0.03	0.03		

Supplementary Consideration for Confirmation of Type 4 Waste Type

Organics	Concentration (mg/kg), unless stated		Assessed Concentration	Satisfy Type 4
	Threshold			
	Metals (all concentrations <TCT0 & LCT0):		As above	Yes
	Anions (all concentrations <TCT0 & LCT0):		As above	Yes
Total Organic Carbon	(%)	3	52.02	No
BTEX (Sum)	6			To Clarify
Polychlorinated Biphenyls (PCBs)	1			To Clarify
Mineral Oil (>C10-C40)	500			To Clarify
Pesticides				
Aldrin + Dieldrin	0.05			To Clarify
DDT + DDD + DDE	0.05			To Clarify
2,4-Dichlorophenoxyacetic Acid (2,4-D)	0.05			To Clarify
Chlordane	0.05			To Clarify
Heptachlor	0.05			To Clarify

Notes to Waste Type Profiling

1. The final waste type is determined from the highest type calculated for any individual substance, whether this be based on Total (TCT) or Leachable (LCT) concentrations.
2. Where a number of waste types are applicable for any given substance (i.e. the consideration of TCTs in isolation cannot result in a Type 4 profile), the final waste type is determined by considering both the TCT and LCT analytical data simultaneously.
3. Only where laboratory analysis has resulted in positive identification of substances (i.e. above laboratory limits of detection) have these been compared to their respective TCTs and LCTs (i.e. substances determined to be at concentrations less than laboratory limits of detection have been assumed to be irrelevant for determining the waste type).
4. Notwithstanding disposal prohibitions, profiling of liquid wastes is undertaken by comparing the analytical results obtained directly from the liquid media to the LCT thresholds given that liquid wastes cannot provide a leachate extract for analysis.

Overall Screened Waste Type *(notwithstanding potential disposal prohibitions, see below)*	Category of Landfill *(Based on GNR. 636, 23 August 2013)*
Type 4 Waste	**Class D / GLB-**

Disposal Prohibitions *(notwithstanding other potential restrictions associated with Waste Type)*

PCBs > 50ppm	PCBs (ppm):			Not applicable, PCBs not detected
Explosive, corrosive or oxidising according to SANS 10234			No	Not applicable
pH <6 or >12	pH:	6.72	No	Not applicable
Flashpoint <61° Celsius	Flashpoint (°C):	>70	No	Not applicable
Moisture Content > 40%	Moisture Content (%):	0.8	No	Not applicable
Hazardous with Calorific Value >10MJ/kg	CV (MJ/kg):	26	No	Landfill disposal to be prohibited by August 2017
Hazardous with Total Organic Carbon >6%	TOC (%):	52.02	No	Landfill disposal to be prohibited by August 2028
Brine (high salt content) >5% TDS	TDS (%):	N/A	N/A	Not applicable to a solid waste
Leachable TDS >100 000mg/l	TDS (mg/l):	41	No	Not applicable

End of Waste Type Profiling & Disposal Prohibition Appraisal

WSP Environmental (Pty) Ltd: Screening Waste Type Profiling & Disposal Prohibition Appraisal

Based on National Norms and Standards for the Assessment of Waste for Landfill Disposal GNR. 635 (23 August 2013)

Source of Waste:	Exxaro Grootegeluk, Exxaro Grootegeluk Coal Mine, Power Station Coal GG7-8
Waste Matrix (Liquid / Solid):	Solid
Leachate Preparation (Solids Only):	Non-Putrescible (Mono-Disposal): Reagent Water

Substance	Concentration (ppm) - Solid/Total				Waste Type (based on TCTs and subject to LCTs)	Concentration (ppm) - Leachate/Liquid					Waste Type (based on LCTs and subject to TCTs)
	TCT0	TCT1	TCT2	Assessed Concentration		LCT0	LCT1	LCT2	LCT3	Assessed Concentration	
Metal Ions											
Arsenic	5.8	500	2000	1.4	2, 3 or 4 - LCT Dependent	0.01	0.5	1	4		
Boron	150	15000	60000	8.79	2, 3 or 4 - LCT Dependent	0.5	25	50	200		
Barium	62.5	6250	25000	96	2 or 3 - LCT Dependent	0.7	35	70	280		
Cadmium	7.5	260	1040			0.003	0.15	0.3	1.2		
Cobalt	50	5000	20000	6.5	2, 3 or 4 - LCT Dependent	0.5	25	50	200		
Chromium	46000	800000	-	2.5	2, 3 or 4 - LCT Dependent	0.1	5	10	40		
Chromium (Hexavalent)	6.5	500	2000			0.05	2.5	5	20		
Copper	16	19500	78000	11	2, 3 or 4 - LCT Dependent	2	100	200	800		
Mercury	0.93	160	640			0.006	0.3	0.6	2.4		
Manganese	1000	25000	100000	128	2, 3 or 4 - LCT Dependent	0.5	25	50	200		
Molybdenum	40	1000	4000	0.2	2, 3 or 4 - LCT Dependent	0.07	3.5	7	28		
Nickel	91	10600	42400	10.6	2, 3 or 4 - LCT Dependent	0.07	3.5	7	28		
Lead	20	1900	7600	7	2, 3 or 4 - LCT Dependent	0.01	0.5	1	4		
Antimony	10	75	300			0.02	1	2	8		
Selenium	10	50	200			0.01	0.5	1	4		
Vanadium	150	2680	10720	11	2, 3 or 4 - LCT Dependent	0.2	10	20	80		
Zinc	240	160000	640000	24	2, 3 or 4 - LCT Dependent	5	250	500	2000	0.005	4
Inorganic Anions											
Total Dissolved Solids	-	-	-	Not Applicable		1000	12500	25000	100000	30	4
Chloride	-	-	-	Not Applicable		300	15000	30000	120000		
Sulphate	-	-	-	Not Applicable		250	12500	25000	100000		
Nitrate	-	-	-	Not Applicable		11	550	1100	4400		
Fluoride	100	10000	40000	0.5	2, 3 or 4 - LCT Dependent	1.5	75	150	600		
Cyanide	14	10500	42000			0.07	3.5	7	28		
Organics											
Benzene	-	10	40			-	0.01	0.02	0.08		
Benzo(a)pyrene	-	1.7	6.8	0.479	2, 3 or 4 - LCT Dependent	-	0.035	0.07	0.28		
Carbon tetrachloride	-	4	16			-	0.2	0.4	1.6		
Chlorobenzene	-	8800	35200			-	5	10	40		
Chloroform	-	700	2800			-	15	30	120		
2-Chlorophenol	-	2100	8400			-	15	30	120		
Bis(2-ethylhexyl)phthalate	-	40	160			-	0.5	1	4		
1.2-Dichlorobenzene	-	31900	127600			-	5	10	40		
1.4-Dichlorobenzene	-	18400	73600			-	15	30	120		
1.2-Dichloroethane	-	3.7	14.8			-	1.5	3	12		
1.1-Dichloroethene	-	150	600			-	0.35	0.7	2.8		
1.2-Dichloroethene	-	3750	15000			-	2.5	5	20		
Dichloromethane	-	16	64			-	0.25	0.5	2		
2.4-Dichlorophenol	-	800	3200			-	10	20	80		
2.4-Dinitrotoluene	-	5.2	20.8			-	0.065	0.13	0.52		
Ethylbenzene	-	540	2160			-	3.5	7	28		
Formaldehyde	-	2000	8000			-	25	50	200		
Hexachlorobutadiene	-	2.8	5.4			-	0.03	0.06	0.24		
Methyl Ethyl Ketone (2-Butanone)	-	8000	32000			-	100	200	800		
Methyl Tertiary Butyl Ether	-	1435	5740			-	2.5	5	20		
Nitrobenzene	-	45	180			-	1	2	8		
Total PAHs	-	50	200	7.935	2, 3 or 4	-	-	-	-	Not Applicable	
>C6-C9	-	650	2600			-	-	-	-	Not Applicable	
>C10-C36	-	10000	40000	54	2, 3 or 4	-	-	-	-	Not Applicable	
Phenol	-	560	2240			-	7	14	56		
Polychlorinated Biphenyls (PCBs)	-	12	48			-	0.025	0.05	0.2		
Styrene	-	120	480			-	1	2	8		
1.1.1.2-Tetrachloroethane	-	400	1600			-	5	10	40		
1.1.2.2-Tetrachloroethane	-	5	20			-	0.65	1.3	5.3		
Tetrachloroethene	-	200	800			-	0.25	0.5	2		
Toluene	-	1150	4600			-	35	70	280		
Trichlorobenzenes (Sum)	-	3300	13200			-	3.5	7	28		
1.1.1-Trichloroethane	-	1200	4800			-	15	30	120		
1.1.2-Trichloroethane	-	48	192			-	0.06	1	4		
Trichloroethene	-	11600	46400			-	0.25	2	8		
2.4.6-Trichlorophenol	-	1770	7080			-	10	20	80		
Vinyl chloride	-	1.5	6			-	0.015	0.03	0.12		
Xylenes (Sum)	-	890	3560			-	25	50	200		
Pesticides											
Aldrin + Dieldrin	0.05	1.2	4.8			-	0.015	0.03	0.03		
DDT + DDD + DDE	0.05	50	200			-	1	2	2		
2.4-Dichlorophenoxyacetic Acid (2,4-D)	0.05	120	480			-	1.5	3	3		
Chlordane	0.05	4	16			-	0.05	0.1	0.1		
Heptachlor	0.05	1.2	4.8			-	0.015	0.03	0.03		

Supplementary Consideration for Confirmation of Type 4 Waste Type

Organics	Concentration (mg/kg), unless stated		Satisfy Type 4
	Threshold	Assessed Concentration	
Metals (all concentrations <TCT0 & LCT0):		As above	No
Anions (all concentrations <TCT0 & LCT0):		As above	Yes
Total Organic Carbon	(%) 3	63.48	No
BTEX (Sum)	6		To Clarify
Polychlorinated Biphenyls (PCBs)	1		To Clarify
Mineral Oil (>C10-C40)	500		To Clarify
Pesticides			
Aldrin + Dieldrin	0.05		To Clarify
DDT + DDD + DDE	0.05		To Clarify
2,4-Dichlorophenoxyacetic Acid (2,4-D)	0.05		To Clarify
Chlordane	0.05		To Clarify
Heptachlor	0.05		To Clarify

Notes to Waste Type Profiling

1. The final waste type is determined from the highest type calculated for any individual substance, whether this be based on Total (TCT) or Leachable (LCT) concentrations.
2. Where a number of waste types are applicable for any given substance (i.e. the consideration of TCTs in isolation cannot result in a Type 4 profile), the final waste type is determined by considering both the TCT and LCT analytical data simultaneously.
3. Only where laboratory analysis has resulted in positive identification of substances (i.e. above laboratory limits of detection) have these been compared to their respective TCTs and LCTs (i.e. substances determined to be at concentrations less than laboratory limits of detection have been assumed to be irrelevant for determining the waste type).
4. Notwithstanding disposal prohibitions, profiling of liquid wastes is undertaken by comparing the analytical results obtained directly from the liquid media to the LCT thresholds given that liquid wastes cannot provide a leachate extract for analysis.

Overall Screened Waste Type *(notwithstanding potential disposal prohibitions, see below)*	Category of Landfill *(Based on GNR. 636, 23 August 2013)*
Type 3 Waste	**Class C / GLB+**

Disposal Prohibitions *(notwithstanding other potential restrictions associated with Waste Type)*

PCBs > 50ppm	PCBs (ppm):			Not applicable, PCBs not detected
Explosive, corrosive or oxidising according to SANS 10234			No	Not applicable
pH <6 or >12	pH:	6.62	No	Not applicable
Flashpoint <61° Celsius	Flashpoint (°C):	>70	No	Not applicable
Moisture Content > 40%	Moisture Content (%):	0.4	No	Not applicable
Hazardous with Calorific Value >10MJ/kg	CV (MJ/kg):	21	No	Landfill disposal to be prohibited by August 2019
Hazardous with Total Organic Carbon >6%	TOC (%):	63.48	No	Landfill disposal to be prohibited by August 2028
Brine (high salt content) >5% TDS	TDS (%):	N/A	N/A	Not applicable to a solid waste
Leachable TDS >100 000mg/l	TDS (mg/l):	30	No	Not applicable

End of Waste Type Profiling & Disposal Prohibition Appraisal

Appendix B: SANS 10234 Classifications of GG 1-6 and GG 7-8

WSP Environmental (Pty) Ltd: Material Classification (SANS 10234:2008; Edition 1.1)

WSP Reference:	46831, 0001	**Prepared For:**	Exxaro Grootegeluk
Material Source:	Exxaro Grootegeluk Coal Mine		
Geographic Coordinates:	23°40' 18.78"S 27° 31'2 8.30"E		
Production Process:	Pow er Station Coal GG1-6		

General Appearance	Classification Summary
Coal	**Not Hazardous (General)**

Applicable Hazard Statement Codes

Composition & Quantitative Classification

Composition assessed in general accordance w ith the follow ing hierarchy:

1. *South African National Standard, Globally Harmonised System of Classification and Labelling of Chemicals (GHS), SANS 10234:2008, Edition 1.1; and,*
2. *European Regulation (EC) No. 1272/2008, 'Classification, Labelling and Packaging of Substances and Mixtures (CLP Regulation).*

Hazard Statement Codes for individual ingredients are sourced from:

1. Supplement to SANS 10234:2008 Edition 1;
2. Table 3.1 of Annex VI of the CLP Regulations;
3. European Chemicals Agency, Classification & Labelling Inventory Database; or,
4. Product (Material) Safety Data Sheet.

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
Physical Hazard Statements								
H200	**Unstable explosive**	0	0	If >0% then classified under H200 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H201	**Explosive; mass explosion hazard**	0	0	If >0% then classified under H201 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H202	**Explosive; severe projection hazard**	0	0	If >0% then classified under H202 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H203	**Explosive; fire blast or projection hazard**	0	0	If >0% then classified under H203 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H204	**Fire or projection hazard**	0	0	If >0% then classified under H204 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H205	**May explode in fire**	0	0	If >0% then classified under H205 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H220	**Extremely flammable gas**	0	0	If >0% then classified under H220 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H221	**Flammable gas**	0	0	If >0% then classified under H221 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H222	**Extremely flammable aerosol**	0	0	If >0% then classified under H222 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H223	**Flammable aerosol**	0	0	If >0% then classified under H223 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H224	**Extremely flammable liquid and vapour**	0	0	If >0% then classified under H224 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H225	**Highly flammable liquid and vapour**	0	0	If >0% then classified under H225 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H226	**Flammable liquid and vapour**	0	0	If >0% then classified under H226 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H227	**Combustible liquid**	0	0	If >0% then classified under H227 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H228	**Flammable solid**	0	0	If >0% then classified under H228 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H229	**Pressurised container: may burst if heated**	0	0	Relevant only for pressurised containers	Not applicable	Not applicable	No	
H230	**May react explosively even in the absence of air**	0	0	If >0% then classified under H230 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H231	**May react explosively even in the absence of air at elevated pressure and/or**	0	0	If >0% then classified under H231 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H240	**Heating may cause an explosion**	0	0	If >0% then classified under H240 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H241	**Heating may cause a fire or explosion**	0	0	If >0% then classified under H241 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H242	**Heating may cause a fire**	0	0	If >0% then classified under H242 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H250	**Catches fire spontaneously if exposed to air**	0	0	If >0% then classified under H250 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H251	**Self-heating; may catch fire**	0	0	If >0% then classified under H251 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H252	**Self-heating in large quantities; may catch fire**	0	0	If >0% then classified under H252 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
		0	0	If >0% then classified under H260 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H260	In contact with water releases flammable gases that may ignite spontaneously	0.0076	76.1	Element-specific assessment Concentration of aluminium phosphide required to evolve sufficient volume of phosphine in contact with water to render hazardous; based on stoichiometry	No analysis for aluminium	Not applicable	No	
		1.177	11773	Element-specific assessment Concentration of free caesium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for caesium	Not applicable	No	
		0.061	614.7	Element-specific assessment Concentration of free lithium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for lithium	Not applicable	No	
		0.108	1076	Element-specific assessment Concentration of free magnesium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	All magnesium assumed to be bound/ complexed	Not applicable	No	
		0.346	3463	Element-specific assessment Concentration of free potassium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	All potassium assumed to be bound/ complexed	Not applicable	No	
		0.757	7571	Element-specific assessment Concentration of free rubidium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for rubidium	Not applicable	No	
		0.204	2036	Element-specific assessment Concentration of free sodium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	All sodium assumed to be bound/ complexed	Not applicable	No	
		0.388	3881	Element-specific assessment Concentration of free strontium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for strontium	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H261	**In contact with water releases flammable gas**	0	0	If >0% then classified under H261 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
		0.608	6082	***Element-specific assessment*** Concentration of free barium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	All barium assumed to be bound/ complexed	Not applicable	No	
		0.177	1775	***Element-specific assessment*** Concentration of free calcium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	All calcium assumed to be bound/ complexed	Not applicable	No	
		0	0	***Compound-specific assessment*** Ferrosilicon may evolve sufficient hydrogen in contact with water to render hazardous; based on ratio of iron:silicon	Ferrosilicon not identified	Not applicable	No	
		0.696	6964	***Element-specific assessment*** Concentration of free gadolinium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for gadolinium	Not applicable	No	
		0.666	6659	***Element-specific assessment*** Concentration of free samarium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for samarium	Not applicable	No	
H270	**May cause or intensify fire; oxidiser**	0	0	If >0% then classified under H270 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H271	**May cause a fire or explosion; strong oxidiser**	0	0	If >0% then classified under H271 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H272	**May intensify fire; oxidiser**	0	0	If >0% then classified under H272 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H280	**Contains gas under pressure; may explode if heated**	0	0	If >0% then classified under H280 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H281	**Contains refrigerated gas; may cause cryogenic burns or injury**	0	0	If >0% then classified under H281 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H290	**May be corrosive to metals**	0	0	If >0% then classified under H290 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
Health Hazard Statements								
H300	**Fatal if swallowed**	1	10000	If cumulative/additive >1% classified under H300 (Category 1 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H301	**Toxic if swallowed**	1	10000	If individual substance >1% classified under H301 (Category 3 Acute Toxicity); pending further assessment	5.26	Further assessment not necessary	No	
H302	**Harmful if swallowed**	1	10000	If individual substance >1% classified under H302 (Category 4 Acute Toxicity); pending further assessment	9068.46	Further assessment not necessary	No	
H303	**May be harmful if swallowed**	1	10000	If individual substance >1% classified under H303 (Category 5 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H304	**May be fatal if swallowed and enters airways**	1	10000	If cumulative/additive >1% classified under H304 (Category 1 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H305	**May be harmful if swallowed and enters airways**	1	10000	If individual substance >1% classified under H305 (Category 5 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H310	**Fatal in contact with skin**	1	10000	If cumulative/additive >1% classified under H310 (Category 1 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H311	**Toxic in contact with skin**	1	10000	If individual substance >1% classified under H311 (Category 3 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H312	**Harmful in contact with skin**	1	10000	If individual substance >1% classified under H312 (Category 4 Acute Toxicity); pending further assessment	9068.46	Further assessment not necessary	No	
H313	**May be harmful in contact with skin**	1	10000	If individual substance >1% classified under H313 (Category 5 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H314	**Causes severe skin burns and eye damage**	1	10000	If cumulative/additive >1% classified under H314 (Category 1 Skin Corrosion/Irritant); pending further assessment	406.50	Further assessment not necessary	No	
		≤2 pH Units ≥11.5		***pH-specific assessment*** If ≤2 or ≥11.5 pH then classified as corrosive	6.72	Not applicable	No	
H315	**Causes skin irritation**	1	10000	If cumulative/additive >1% classified under H315 (Category 3 Skin Corrosion/Irritant), >10% then Category 2; pending further assessment	6365.68	Further assessment not necessary	No	
H316	**Causes mild skin irritation**	10	100000	If cumulative/additive >10% classified under H316 (Category 3 Skin Corrosion/Irritant); pending further assessment	No substances identified	Not applicable	No	
H317	**May cause an allergic skin reaction**	1	10000	If individual substance >1% classified under H317 (Category 1 Skin Sensitisation); pending further assessment	6.56	Further assessment not necessary	No	
H318	**Causes severe eye damage**	1	10000	If cumulative/additive >1% classified under H318 (Category 2 Skin/Eye Sensitisation); pending further assessment	6365.38	Further assessment not necessary	No	
H319	**Causes severe eye irritation**	10	100000	If cumulative/additive >10% classified under H319 (Category 2 Eye Sensitisation); pending further assessment	14.34	Further assessment not necessary	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H320	**Causes eye irritation**	10	100000	If cumulative/additive >10% classified under H320 (Category 2 Eye Sensitisation); pending further assessment	No substances identified	Not applicable	No	
H330	**Fatal if inhaled**	1	10000	If cumulative/additive >1% classified under H330 (Category 1 Acute Toxicity); pending further assessment	0.099	Further assessment not necessary	No	
H331	**Toxic if inhaled**	1	10000	If individual substance >1% classified under H331 (Category 3 Acute Toxicity); pending further assessment	5.26	Further assessment not necessary	No	
H332	**Harmful if inhaled**	1	10000	If individual substance >1% classified under H332 (Category 4 Acute Toxicity); pending further assessment	9068.46	Further assessment not necessary	No	
H333	**May be harmful if inhaled**	1	10000	If individual substance >1% classified under H333 (Category 5 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H334	**May cause allergy or asthma symptoms or breathing difficulties if inhaled**	0.1	1000	If individual substance >0.1% classified under H334 (Category 1 Respiratory Sensitisation); pending further assessment	No substances identified	Not applicable	No	
H335	**May cause respiratory irritation**	20	200000	If cumulative/additive >20% classified under H335 under Generic Limits; pending further assessment	6379.72	Further assessment not necessary	No	
H336	**May cause drowsiness or dizziness**	20	200000	If cumulative/additive >20% classified under H336 under Generic Limits; pending further assessment	No substances identified	Not applicable	No	
H340	**May cause genetic defects**	0.1	1000	If individual substance >0.1% classified under H340 (Category 1 Mutagen); pending further assessment	0.14	Further assessment not necessary	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H341	**Suspected of causing genetic defects**	1	10000	If individual substance >1% classified under H341 (Category 2 Mutagen); pending further assessment	No substances identified	Not applicable	No	
H350	**May cause cancer**	0.1	1000	If individual substance >0.1% classified under H350 (Category 1 Carcinogen); pending further assessment	6.56	Further assessment not necessary	No	
H351	**Suspected of causing cancer**	0.1	1000	If individual substance >0.1% classified under H351 (Category 2 Carcinogen); pending further assessment	31.74	Further assessment not necessary	No	
H360	**May damage fertility or the unborn child**	0.1	1000	If individual substance >0.1% classified under H360 (Category 1 Teratogen); pending further assessment	13.89	Further assessment not necessary	No	
H361	**Suspected of damaging fertility or the unborn child**	0.1	1000	If individual substance >0.1% classified under H361 (Category 2 Teratogen); pending further assessment	No substances identified	Not applicable	No	
H361d	**Suspected of damaging the unborn child**	0.1	1000	If individual substance >0.1% classified under H361d; pending further assessment	No substances identified	Not applicable	No	
H362	**May cause harm to breast-fed children**	0.1	1000	If individual substance >0.1% classified under H362 (Additional Category Teratogen); pending further assessment	No substances identified	Not applicable	No	
H370	**Causes damage to organs**	1	10000	If individual substance >1% classified under H370 (Category 1 Single Exposure); pending further assessment	No substances identified	Not applicable	No	
H371	**May cause damage to organs**	1	10000	If individual substance >1% classified under H371 (Category 2 Single Exposure); pending further assessment	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H372	**Causes damage to organs through prolonged or repeated exposure**	1	10000	If individual substance >1% classified under H372 (Category 1 Repeat Exposure); pending further assessment	14.34	Further assessment not necessary	No	
H373	**May cause damage to organs through prolonged or repeated exposure**	1	10000	If individual substance >1% classified under H373 (Category 2 Repeat Exposure); pending further assessment	13.89	Further assessment not necessary	No	
		0.005	50	***PCB-specific assessment*** If PCBs are present >0.005% then classified hazardous under H373	No substances identified	Not applicable	No	
Environmental Hazard Statements								
H400	**Very toxic to aquatic life**	1	10000	If cumulative/additive >1% classified under H400 (Category 1 Acute Aquatic Toxicity); pending further assessment	91.39	Further assessment not necessary	No	
H401	**Toxic to aquatic life**	25	250000	If modified cumulative/additive >25% classified under H401 (Category 2 Acute Aquatic Toxicity); pending further assessment	913.92	Further assessment not necessary	No	
H402	**Harmful to aquatic life**	25	250000	If modified cumulative/additive >25% classified under H402 (Category 3 Acute Aquatic Toxicity); pending further assessment	9139.24	Further assessment not necessary	No	
H410	**Very toxic to aquatic life with long lasting effects**	1	10000	If cumulative/additive >1% classified under H410 (Category 1 Chronic Aquatic Toxicity); pending further assessment	91.39	Further assessment not necessary	No	
H411	**Toxic to aquatic life with long lasting effects**	25	250000	If modified cumulative/additive >25% classified under H411 (Category 2 Chronic Aquatic Toxicity); pending further assessment	913.92	Further assessment not necessary	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H412	**Harmful to aquatic life with long lasting effects**	25	250000	If modified cumulative/additive >25% classified under H412 (Category 3 Chronic Aquatic Toxicity); pending further assessment	9139.24	Further assessment not necessary	No	
H413	**May cause long lasting harmful effects to aquatic life**	25	250000	If modified cumulative/additive >25% classified under H413 (Category 4 Chronic Aquatic Toxicity); pending further assessment	97.96	Further assessment not necessary	No	
H420	**Harms public health and the environment by destroying ozone in the upper atmosphere**	0.1	1000	If individual substance >0.1% classified under H420 (Category 1). Substances based on Annexes to the Montreal Protocol.	No substances identified	Not applicable	No	

Assumptions and Comments

1. Acute Toxicity Estimates (ATE) have not been derived from LD50 data or conversion factors presented in SANS 10234; classification has been based on generic screening thresholds. Where more detailed assessment is recommended, appropriate LD50 should be sourced based on current available data.
2. Ecotoxicity for Category 1 Acute and Chronic Hazards have assumed 1% threshold and additive compounds rather than utilisation of Modification Factors presented in SANS 10234. Where more detailed assessment is recommended, this should follow the mixture-specific principles defined in SANS 10234.
3. Classification does not include European Union (EU Codes), or other territory specific, Hazard Statement Codes that may be applicable outside of the Republic of South Africa.
4. Only where data is presented, or where laboratory analysis has resulted in positive identification of compounds (i.e. above laboratory limits of detection), have the applicable Hazard Statement Codes been appraised (i.e. substances determined to be at concentrations less than laboratory limits of detection have been assumed to be absent).
5. Unless exact speciation has been established through detailed analysis (i.e. X-Ray Fluorescence (XRF), X-Ray Diffraction (XRD)), classification has been based on reasonable assumptions of substances most-likely present based on expected behaviour within the material - it is recognised that this may not be applicable in all instances and, for clarity, a list of the individual substances appraised where assumptions have been made are listed below.
6. Hazard Statement Codes for individual substances have been sourced from either i) SANS 10234, ii) CLP Regulations, iii) European Chemicals Agency C&L Inventory Database, or iv) appraised existing (M)SDS.
7. Where laboratory analysis has reported concentrations on a dry weight basis, these have been converted to take account of sample moisture content using the formula:
Wet Weight Concentration = Dry Weight Concentration x ((100 - %moisture content)/100).
8. Where assessment has been undertaken on liquids, it has been assumed that 1-litre (volume) is equivalent to 1-kg (mass).
9. For additional details in respect of the individual substances that may render any given material type as hazardous, reference should be made to the appropriate Safety Data Sheet (SDS) which takes account of this classification or, if the SDS has not been prepared by WSP, the Waste Management Summary Report relevant for this classification.

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
List of Assumed Substances								
Arsenic Compounds, Barium Oxide, Cadmium Compounds, Calcium Oxide, Chromium, Cobalt (ii) Oxide, Copper (i) Oxide, Fluoride, Iron (ii) Oxide, Lead Compounds, Magnesium Sulphate, Manganese Dioxide, Molybdenum, Nickel (ii) Oxide, Potassium Oxide, Sodium Oxide, Sulphur, Vanadium (ii) Oxide, Zinc Oxide, Diesel Range Organics (DRO),				

End of Material Classification

WSP Environmental (Pty) Ltd: Material Classification (SANS 10234:2008; Edition 1.1)

WSP Reference:	46831, 0001	**Prepared For:**	Exxaro Grootegeluk
Material Source:	Exxaro Grootegeluk Coal Mine		
Geographic Coordinates:	23°40' 18.78"S 27° 31'2 8.30"E		
Production Process:	Pow er Station Coal GG7-8		

General Appearance	**Classification Summary**
Coal	**Not Hazardous (General)**

Applicable Hazard Statement Codes

Composition & Quantitative Classification

Composition assessed in general accordance w ith the follow ing hierarchy:

1. *South African National Standard, Globally Harmonised System of Classification and Labelling of Chemicals (GHS), SANS 10234:2008, Edition 1.1; and,*
2. *European Regulation (EC) No. 1272/2008, 'Classification, Labelling and Packaging of Substances and Mixtures (CLP Regulation).*

Hazard Statement Codes for individual ingredients are sourced from:

1. Supplement to SANS 10234:2008 Edition 1;
2. Table 3.1 of Annex VI of the CLP Regulations;
3. European Chemicals Agency, Classification & Labelling Inventory Database; or,
4. Product (Material) Safety Data Sheet.

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
Physical Hazard Statements								
H200	**Unstable explosive**	0	0	If >0% then classified under H200 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H201	**Explosive; mass explosion hazard**	0	0	If >0% then classified under H201 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H202	**Explosive; severe projection hazard**	0	0	If >0% then classified under H202 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H203	**Explosive; fire blast or projection hazard**	0	0	If >0% then classified under H203 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H204	**Fire or projection hazard**	0	0	If >0% then classified under H204 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H205	**May explode in fire**	0	0	If >0% then classified under H205 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H220	**Extremely flammable gas**	0	0	If >0% then classified under H220 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H221	**Flammable gas**	0	0	If >0% then classified under H221 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H222	**Extremely flammable aerosol**	0	0	If >0% then classified under H222 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H223	**Flammable aerosol**	0	0	If >0% then classified under H223 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H224	**Extremely flammable liquid and vapour**	0	0	If >0% then classified under H224 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H225	**Highly flammable liquid and vapour**	0	0	If >0% then classified under H225 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H226	**Flammable liquid and vapour**	0	0	If >0% then classified under H226 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H227	**Combustible liquid**	0	0	If >0% then classified under H227 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H228	**Flammable solid**	0	0	If >0% then classified under H228 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H229	**Pressurised container: may burst if heated**	0	0	Relevant only for pressurised containers	Not applicable	Not applicable	No	
H230	**May react explosively even in the absence of air**	0	0	If >0% then classified under H230 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H231	**May react explosively even in the absence of air at elevated pressure and/or**	0	0	If >0% then classified under H231 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H240	**Heating may cause an explosion**	0	0	If >0% then classified under H240 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H241	**Heating may cause a fire or explosion**	0	0	If >0% then classified under H241 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H242	**Heating may cause a fire**	0	0	If >0% then classified under H242 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H250	**Catches fire spontaneously if exposed to air**	0	0	If >0% then classified under H250 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H251	**Self-heating; may catch fire**	0	0	If >0% then classified under H251 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H252	**Self-heating in large quantities; may catch fire**	0	0	If >0% then classified under H252 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
		0	0	If >0% then classified under H260 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H260	In contact with water releases flammable gases that may ignite spontaneously	0.0076	76.1	Element-specific assessment Concentration of aluminium phosphide required to evolve sufficient volume of phosphine in contact with water to render hazardous; based on stoichiometry	No analysis for aluminium	Not applicable	No	
		1.177	11773	Element-specific assessment Concentration of free caesium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for caesium	Not applicable	No	
		0.061	614.7	Element-specific assessment Concentration of free lithium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for lithium	Not applicable	No	
		0.108	1076	Element-specific assessment Concentration of free magnesium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	All magnesium assumed to be bound/ complexed	Not applicable	No	
		0.346	3463	Element-specific assessment Concentration of free potassium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	All potassium assumed to be bound/ complexed	Not applicable	No	
		0.757	7571	Element-specific assessment Concentration of free rubidium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for rubidium	Not applicable	No	
		0.204	2036	Element-specific assessment Concentration of free sodium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	All sodium assumed to be bound/ complexed	Not applicable	No	
		0.388	3881	Element-specific assessment Concentration of free strontium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for strontium	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H261	**In contact with water releases flammable gas**	0	0	If >0% then classified under H261 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
		0.608	6082	***Element-specific assessment*** Concentration of free barium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	All barium assumed to be bound/ complexed	Not applicable	No	
		0.177	1775	***Element-specific assessment*** Concentration of free calcium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	All calcium assumed to be bound/ complexed	Not applicable	No	
		0	0	***Compound-specific assessment*** Ferrosilicon may evolve sufficient hydrogen in contact with water to render hazardous; based on ratio of iron:silicon	Ferrosilicon not identified	Not applicable	No	
		0.696	6964	***Element-specific assessment*** Concentration of free gadolinium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for gadolinium	Not applicable	No	
		0.666	6659	***Element-specific assessment*** Concentration of free samarium required to evolve sufficient volume of hydrogen in contact with water to render hazardous; based on stoichiometry	No analysis for samarium	Not applicable	No	
H270	**May cause or intensify fire; oxidiser**	0	0	If >0% then classified under H270 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H271	**May cause a fire or explosion; strong oxidiser**	0	0	If >0% then classified under H271 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H272	**May intensify fire; oxidiser**	0	0	If >0% then classified under H272 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H280	**Contains gas under pressure; may explode if heated**	0	0	If >0% then classified under H280 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H281	**Contains refrigerated gas; may cause cryogenic burns or injury**	0	0	If >0% then classified under H281 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	
H290	**May be corrosive to metals**	0	0	If >0% then classified under H290 unless further information and/or testing proves otherwise	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
Health Hazard Statements								
H300	**Fatal if swallowed**	1	10000	If cumulative/additive >1% classified under H300 (Category 1 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H301	**Toxic if swallowed**	1	10000	If individual substance >1% classified under H301 (Category 3 Acute Toxicity); pending further assessment	1.39	Further assessment not necessary	No	
H302	**Harmful if swallowed**	1	10000	If individual substance >1% classified under H302 (Category 4 Acute Toxicity); pending further assessment	5879.30	Further assessment not necessary	No	
H303	**May be harmful if swallowed**	1	10000	If individual substance >1% classified under H303 (Category 5 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H304	**May be fatal if swallowed and enters airways**	1	10000	If cumulative/additive >1% classified under H304 (Category 1 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H305	**May be harmful if swallowed and enters airways**	1	10000	If individual substance >1% classified under H305 (Category 5 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H310	**Fatal in contact with skin**	1	10000	If cumulative/additive >1% classified under H310 (Category 1 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H311	**Toxic in contact with skin**	1	10000	If individual substance >1% classified under H311 (Category 3 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H312	**Harmful in contact with skin**	1	10000	If individual substance >1% classified under H312 (Category 4 Acute Toxicity); pending further assessment	5879.30	Further assessment not necessary	No	
H313	**May be harmful in contact with skin**	1	10000	If individual substance >1% classified under H313 (Category 5 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H314	**Causes severe skin burns and eye damage**	1	10000	If cumulative/additive >1% classified under H314 (Category 1 Skin Corrosion/Irritant); pending further assessment	135.60	Further assessment not necessary	No	
		≤2 pH Units ≥11.5		***pH-specific assessment*** If ≤2 or ≥11.5 pH then classified as corrosive	6.62	Not applicable	No	
H315	**Causes skin irritation**	1	10000	If cumulative/additive >1% classified under H315 (Category 3 Skin Corrosion/Irritant), >10% then Category 2; pending further assessment	3905.02	Further assessment not necessary	No	
H316	**Causes mild skin irritation**	10	100000	If cumulative/additive >10% classified under H316 (Category 3 Skin Corrosion/Irritant); pending further assessment	No substances identified	Not applicable	No	
H317	**May cause an allergic skin reaction**	1	10000	If individual substance >1% classified under H317 (Category 1 Skin Sensitisation); pending further assessment	13.44	Further assessment not necessary	No	
H318	**Causes severe eye damage**	1	10000	If cumulative/additive >1% classified under H318 (Category 2 Skin/Eye Sensitisation); pending further assessment	3904.87	Further assessment not necessary	No	
H319	**Causes severe eye irritation**	10	100000	If cumulative/additive >10% classified under H319 (Category 2 Eye Sensitisation); pending further assessment	14.40	Further assessment not necessary	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H320	**Causes eye irritation**	10	100000	If cumulative/additive >10% classified under H320 (Category 2 Eye Sensitisation); pending further assessment	No substances identified	Not applicable	No	
H330	**Fatal if inhaled**	1	10000	If cumulative/additive >1% classified under H330 (Category 1 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H331	**Toxic if inhaled**	1	10000	If individual substance >1% classified under H331 (Category 3 Acute Toxicity); pending further assessment	1.39	Further assessment not necessary	No	
H332	**Harmful if inhaled**	1	10000	If individual substance >1% classified under H332 (Category 4 Acute Toxicity); pending further assessment	5879.30	Further assessment not necessary	No	
H333	**May be harmful if inhaled**	1	10000	If individual substance >1% classified under H333 (Category 5 Acute Toxicity); pending further assessment	No substances identified	Not applicable	No	
H334	**May cause allergy or asthma symptoms or breathing difficulties if inhaled**	0.1	1000	If individual substance >0.1% classified under H334 (Category 1 Respiratory Sensitisation); pending further assessment	No substances identified	Not applicable	No	
H335	**May cause respiratory irritation**	20	200000	If cumulative/additive >20% classified under H335 under Generic Limits; pending further assessment	3919.26	Further assessment not necessary	No	
H336	**May cause drowsiness or dizziness**	20	200000	If cumulative/additive >20% classified under H336 under Generic Limits; pending further assessment	No substances identified	Not applicable	No	
H340	**May cause genetic defects**	0.1	1000	If individual substance >0.1% classified under H340 (Category 1 Mutagen); pending further assessment	0.48	Further assessment not necessary	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H341	**Suspected of causing genetic defects**	1	10000	If individual substance >1% classified under H341 (Category 2 Mutagen); pending further assessment	No substances identified	Not applicable	No	
H350	**May cause cancer**	0.1	1000	If individual substance >0.1% classified under H350 (Category 1 Carcinogen); pending further assessment	13.44	Further assessment not necessary	No	
H351	**Suspected of causing cancer**	0.1	1000	If individual substance >0.1% classified under H351 (Category 2 Carcinogen); pending further assessment	53.78	Further assessment not necessary	No	
H360	**May damage fertility or the unborn child**	0.1	1000	If individual substance >0.1% classified under H360 (Category 1 Teratogen); pending further assessment	6.97	Further assessment not necessary	No	
H361	**Suspected of damaging fertility or the unborn child**	0.1	1000	If individual substance >0.1% classified under H361 (Category 2 Teratogen); pending further assessment	No substances identified	Not applicable	No	
H361d	**Suspected of damaging the unborn child**	0.1	1000	If individual substance >0.1% classified under H361d; pending further assessment	No substances identified	Not applicable	No	
H362	**May cause harm to breast-fed children**	0.1	1000	If individual substance >0.1% classified under H362 (Additional Category Teratogen); pending further assessment	No substances identified	Not applicable	No	
H370	**Causes damage to organs**	1	10000	If individual substance >1% classified under H370 (Category 1 Single Exposure); pending further assessment	No substances identified	Not applicable	No	
H371	**May cause damage to organs**	1	10000	If individual substance >1% classified under H371 (Category 2 Single Exposure); pending further assessment	No substances identified	Not applicable	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H372	**Causes damage to organs through prolonged or repeated exposure**	1	10000	If individual substance >1% classified under H372 (Category 1 Repeat Exposure); pending further assessment	14.40	Further assessment not necessary	No	
H373	**May cause damage to organs through prolonged or repeated exposure**	1	10000	If individual substance >1% classified under H373 (Category 2 Repeat Exposure); pending further assessment	6.97	Further assessment not necessary	No	
		0.005	50	***PCB-specific assessment*** If PCBs are present >0.005% then classified hazardous under H373	No substances identified	Not applicable	No	
Environmental Hazard Statements								
H400	**Very toxic to aquatic life**	1	10000	If cumulative/additive >1% classified under H400 (Category 1 Acute Aquatic Toxicity); pending further assessment	59.16	Further assessment not necessary	No	
H401	**Toxic to aquatic life**	25	250000	If modified cumulative/additive >25% classified under H401 (Category 2 Acute Aquatic Toxicity); pending further assessment	591.64	Further assessment not necessary	No	
H402	**Harmful to aquatic life**	25	250000	If modified cumulative/additive >25% classified under H402 (Category 3 Acute Aquatic Toxicity); pending further assessment	5916.37	Further assessment not necessary	No	
H410	**Very toxic to aquatic life with long lasting effects**	1	10000	If cumulative/additive >1% classified under H410 (Category 1 Chronic Aquatic Toxicity); pending further assessment	59.16	Further assessment not necessary	No	
H411	**Toxic to aquatic life with long lasting effects**	25	250000	If modified cumulative/additive >25% classified under H411 (Category 2 Chronic Aquatic Toxicity); pending further assessment	591.64	Further assessment not necessary	No	

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
H412	**Harmful to aquatic life with long lasting effects**	25	250000	If modified cumulative/additive >25% classified under H412 (Category 3 Chronic Aquatic Toxicity); pending further assessment	5916.37	Further assessment not necessary	No	
H413	**May cause long lasting harmful effects to aquatic life**	25	250000	If modified cumulative/additive >25% classified under H413 (Category 4 Chronic Aquatic Toxicity); pending further assessment	72.60	Further assessment not necessary	No	
H420	**Harms public health and the environment by destroying ozone in the upper atmosphere**	0.1	1000	If individual substance >0.1% classified under H420 (Category 1). Substances based on Annexes to the Montreal Protocol.	No substances identified	Not applicable	No	

Assumptions and Comments

1. Acute Toxicity Estimates (ATE) have not been derived from LD50 data or conversion factors presented in SANS 10234; classification has been based on generic screening thresholds. Where more detailed assessment is recommended, appropriate LD50 should be sourced based on current available data.
2. Ecotoxicity for Category 1 Acute and Chronic Hazards have assumed 1% threshold and additive compounds rather than utilisation of Modification Factors presented in SANS 10234. Where more detailed assessment is recommended, this should follow the mixture-specific principles defined in SANS 10234.
3. Classification does not include European Union (EU Codes), or other territory specific, Hazard Statement Codes that may be applicable outside of the Republic of South Africa.
4. Only where data is presented, or where laboratory analysis has resulted in positive identification of compounds (i.e. above laboratory limits of detection), have the applicable Hazard Statement Codes been appraised (i.e. substances determined to be at concentrations less than laboratory limits of detection have been assumed to be absent).
5. Unless exact speciation has been established through detailed analysis (i.e. X-Ray Fluorescence (XRF), X-Ray Diffraction (XRD)), classification has been based on reasonable assumptions of substances most-likely present based on expected behaviour within the material - it is recognised that this may not be applicable in all instances and, for clarity, a list of the individual substances appraised where assumptions have been made are listed below.
6. Hazard Statement Codes for individual substances have been sourced from either i) SANS 10234, ii) CLP Regulations, iii) European Chemicals Agency C&L Inventory Database, or iv) appraised existing (M)SDS.
7. Where laboratory analysis has reported concentrations on a dry weight basis, these have been converted to take account of sample moisture content using the formula:
Wet Weight Concentration = Dry Weight Concentration x ((100 - %moisture content)/100).
8. Where assessment has been undertaken on liquids, it has been assumed that 1-litre (volume) is equivalent to 1-kg (mass).
9. For additional details in respect of the individual substances that may render any given material type as hazardous, reference should be made to the appropriate Safety Data Sheet (SDS) which takes account of this classification or, if the SDS has not been prepared by WSP, the Waste Management Summary Report relevant for this classification.

Hazard Statement Code	Hazard Statement	Threshold (%)	Threshold (ppm)	Threshold and Test Comments	Assessment Concentration (ppm)	Outcome(s) of Further Testing	Hazardous (Yes / No)	Additional Comments
List of Assumed Substances								
Arsenic Compounds, Barium Oxide, Boron Sulphide, Calcium Oxide, Chromium, Cobalt (ii) Oxide, Copper (i) Oxide, Fluoride, Iron (ii) Oxide, Lead Compounds, Magnesium Sulphate, Manganese Dioxide, Molybdenum, Nickel (ii) Oxide, Potassium Oxide, Sodium Oxide, Sulphur, Vanadium (ii) Oxide, Zinc Oxide, Diesel Range Organics (DRO),				

End of Material Classification

Appendix C: Waste Classification Memo for GG 1 to 6

DIGBY WELLS
ENVIRONMENTAL

To:	The Regional Manager Department of Mineral Resources Limpopo Province	**Date:**	May 2015
From:	Digby Wells Environmental	**Proj #:**	EXX3666
RE:	**Environmental Authorisation Amendment Application in terms of Regulation 29 (a) of the NEMA, for Grootegeluk Mine GG1-6 Coal at GG10A Stockyard** **LEDET Reference: 12/1/9/1-W89** **Mining Right Reference: LP 30/5/1/3/2/1 (46) EM**		

Dear Mr Kolani,

Digby Wells Environmental (hereafter Digby Wells) has been appointed by Exxaro Grootegeluk Coal Mine (hereafter Exxaro) as the consultant to perform a geochemical and waste classification assessment for the GG1 to 6 short-term stockpiles, as well as submit an amendment to the Grootegeluk Mine Infrastructure Expansion Project Environmental Authorisation to stockpile this material. Proof of payment for the Application is attached in Appendix A.

Exxaro hereby formally requests an amendment to the Environmental Authorisation relevant to the Grootegeluk Coal Mine Infrastructure Expansion Project, Limpopo Department of Economic Development, Environment and Tourism (LEDET) reference number 12/1/9/1-W89, and Mining Right reference number for the Grootegeluk Mine LP 30/5/1/3/2/1 (46) EM. The amendment being requested has been considered in terms of Regulation 29 (a) of R 982 of the Environmental Impact Assessment Regulations, 2014, (the EIA Regulations 2014) promulgated in terms of the National Environmental Management Act, 1998 (NEMA)[1] which stipulates:

"29. An environmental authorisation may be amended by following the process prescribed in this Part if the amendment-

[1] Regulation 982, Environmental Impact Assessment Regulations under the NEMA, promulgated on 4 December 2014.

(a) will not change the scope of a valid environmental authorisation nor increase the level or nature of the impact, which impact was initially assessed and considered when [the] application was made for an environmental authorisation."

Exxaro is requesting permission to use the footprint of the GG10A Stockyard (which has not yet been constructed) for the construction of a short-term compacted coal stockpile of a larger capacity, for a period of five years, and thereafter construct the permanent GG10A Stockyard.

1 Project Background

Exxaro has an operational mine, namely Grootegeluk Coal Mine, near Lephalale in the Limpopo Province. The Grootegeluk Coal Mine is also contracted to supply coal to the Eskom Medupi and Matimba Power stations from the upper benches of coal at the mine. In 2014, Exxaro applied to expand certain infrastructure within the mine boundary area, referred to as the Grootegeluk Coal Mine Infrastructure Expansion Project. Exxaro submitted Applications in terms of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) and Minerals and Petroleum Resources Development Act (MPRDA), 2002 (Act No. 28 of 2002) to include the following activities / expansions within the mine boundary:

- Expansion of the rail loop, load out stations and associated infrastructure;
- Expansion of the existing coal stockyard and stockpiles;
- Expansion of the fuel storage depot;
- Expansion of beneficiation plants and associated infrastructure;
- New road and conveyors to fines recovery area;
- New gate and hard park area; and
- Expansion of ancillary infrastructure and new 33 kV power line.

The aforementioned 2014 amendment was also associated with the expansion of the existing coal product stockpiles. The following stockpiles and stockyards were included in the applications and approved:

- GG 6/2 stockyard;
- GG 10 stockyards;
  - Conical Stock pile;
  - Stockyard A (to which this amendment applies); and
  - Stockyard B.
- Multi-product overflow stockyard

The Grootegeluk Coal Mine Infrastructure Expansion Project was authorised in terms of the NEMA and the Environmental Impact Assessment Regulations of 2010[2], (which have been repealed). The LEDET, and the Record of Decision is dated 27 October 2014, with reference number 12/1/9/1-W89.

The Grootegeluk Coal Mine Infrastructure Expansion Project included the development of the GG10 A and B stockyards to accommodate the increase in production of multi-product coal (benches 2 to 10), which was estimated to be 2 million tonnes (Mt) per annum. The GG10A stockyard area. GG10A has an approved capacity of 400,000 m^3. The delay in ramp up at the Medupi power station has resulted in the need for increased stockpiling capacity of power station coal at the Grootegeluk Mine, since Eskom has decreased off-take from the existing stockpiles. Exxaro, however, cannot leave the upper benches of coal in situ and still be able to access the lower benches to continue supplying Exxaro's other clients (power stations, steel industry, cement industry, factories and farming).

To accommodate the excess Eskom-grade coal, Exxaro proposes to stockpile the coal in an approved Stockyard footprint for a period of five years. Exxaro will not construct a permanent Stockyard liner for this duration as the liner for the stockpile will only be in use for the five-year stockpiling period and then destroyed. To ensure Exxaro is compliant with the relevant legislation, a waste classification was undertaken to determine the type of liner required for this short-term stockpile. The locality and infrastructure plan is attached in Appendix B.

2 Applicant Details

The proposed activity of increasing the quantity of coal to be stockpiled at the GG10A stockyard within the same footprint area as part of Phase 1 of the project will take place within the mining footprint at the Grootegeluk Mine on the farm Daarby 458 LQ. The contact details of the Applicant are set out in Table 1 below:

Table 1: Details of the Applicant

Name of person to whom the environmental authorisation was issued:	Exxaro Coal (Pty) Ltd.	
Contact person:	Mr JL Wepener	
Postal address:	PO Box 178	
	Lephalale	
	Postal code:	0555

[2] Dated 18 June 2010

Telephone:	014 763 9100		
E-mail:	johan.wepener@exxaro.com	Fax:	014 763 9108
Magisterial District or Town:	Lephalale Magisterial District		
Departmental reference number of the previous environmental authorisation in respect of which an amendment is applied for:	12/1/9/1-W89		

3 Legal Requirements

3.1 Approved Listed Activities

The Grootegeluk Mine Infrastructure Expansion Project was approved in terms of the 2010 NEMA Regulations and the Record of Decision is attached hereto as Appendix C. Refer to Table 2 below for the approved Listed Activities relevant to the 2014 Expansion Project.

Table 2: Approved Listed Activities

Activity/ies for which authorisation was granted:	Activity No. 18 of R. 544: *The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from* *(i) a watercourse;* *(ii) the sea;* *(iii) the seashore;* *(iv) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater-* *but excluding where such infilling, depositing, dredging, excavation, removal or moving* *(i) is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or* *(ii) occurs behind the development setback line*. Activity No. 22 of R. 544: *The construction of a road, outside urban areas, with a reserve wider than 13,5 meters or, where no reserve exists where the road is wider than 8 metres.* Activity No. 28 of R 544: *The expansion of existing facilities for any process or activity where such expansion will result in the need for a new, or amendment of, an existing permit or license in terms of national or provincial legislation*

	governing the release of emissions or pollution, excluding where the facility, process or activity is included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case that Act will apply. Activity No. 42 of R. 544: *The expansion of facilities for the storage, or storage and handling, of a dangerous good, where the capacity of such storage facility will be expanded by 80 cubic metres or more.* Activity No. 53 of R. 544: *The expansion of railway lines, stations or shunting yards where there will be an increased development footprint –* *excluding:* *(i) railway lines, shunting yards and railway stations in industrial complexes or zones;* *(ii) underground railway lines in mines; and* *(iii) additional railway lines within the reserve of an existing railway line.*

3.2 DMR Amendment to the ROD

The stockpile volume in the approved Environmental Authorisation (12/1/9/1-W89) is 400,000 m^2 and Exxaro accordingly seeks consent to have the volume increased to 2 Mt. The quantity of coal will be increased through constructing a compacted stockpile, without the equipment and infrastructure required for a stockyard area. Thus the GG10A stockyard footprint area will be sufficient.

The Grootegeluk Coal Mine Infrastructure Expansion Project, to which the Environmental Authorisation and subsequent Amendment pertains, includes the construction of the GG10 stockyards (two stockyards known as GG10A and GG10B). The necessity of the GG10 stockyards came about due to the existing GG7 Plant being modified to cater for an increase in metallurgical coal production. The modified GG7 plant, now referred to as the GG10 plant, has been approved to produce the following products once constructed:

Small nuts:

- 50 mm to + 25 mm; and
- 10% to 15% ash content.

Peas:

- -25 mm to +10 mm; and
- 10% to 15% ash content.

Power station coal:

- -10 mm; and as per the current design.

Exxaro is applying to amend the Environmental Authorisation to reflect that Exxaro has the option (alternative) to store up to 2 Mt of power station coal within the GG10A stockyard footprint, as excess power station coal ultimately destined for Eskom. Therefore, the amendment to the Environmental Authorisation will be to increase the quantity of coal through constructing a compacted stockpile without the equipment required for a stockyard area. Thus the GG10A stockyard area will be able to accommodate the additional 2 Mt of coal, for short-term storage. To establish the type of liner to be constructed to prevent potential surface water and groundwater pollution, a waste classification was undertaken. The liner and the waste classification of the coal are discussed in below.

3.3 Liner Requirements

The Legislative requirements regarding the type of liner required for coal stockpiles is undertaken in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM:WA) and the NEM:WA guidelines for mono-disposal[3] (DEA, 2013).

[3] NEMWA Act 59 of 2008, Norms and Standards for Assessment prior to Landfill Disposal in terms of Regulation 5(2)(c) of the Regulations.

Although the product is not seen as a waste the classification of the material was undertaken to advice on liner requirements as required by the Department of Water and Sanitation (DWS) and Department of Environmental Affairs (DEA).

3.3.1 Legislative Guideline

On 2 June 2014, the NEM:WA, 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). 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 in the amended NEM: WA guidelines:

- R634 – Waste Classification and Management Regulations
- 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.

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.

3.3.2 Waste Classification Methodology

Total Concentration values were determined by *aqua regia* digestion and analysis with ICP methods.

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 reagent water leaching procedure.

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.

In the Regulation, the terms "Total Concentration Threshold" and "TCT" mean the total concentration threshold limit for particular elements or chemical substances in a waste, expressed as mg/kg, prescribed in section 6 of the Norms and Standards. The terms "Leachable Concentration Threshold" and "LCT" mean the leachable concentration threshold limit for particular elements and chemical substances in a waste, expressed as mg/l, prescribed in section 6 of these Norms and Standards.

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 assessed 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.

Table 1-1: Waste Type for Landfill Disposal

Waste Type	Element or chemical substance concentration	Disposal
0	LC > LCT3 **OR** TC > TCT2	Not allowed
1	LCT2 < LC ≤ LCT3 **OR** TCT1 < TC ≤ TCT2	Class A or Hh:HH landfill
2	LCT1 < LC ≤ LCT2 **AND** TC ≤ TCT1	Class B or GLB+ landfill
3	LCT0 < LC ≤ LCT1 **AND** TC ≤ TCT1	Class C or GLB- landfill
4	LC ≤ LCT0 **AND** TC ≤ TCT0 for metal ions and inorganic anions **AND** all chemical substances are below the total concentration limits provided for organics and pesticides listed	Class D or GLB- landfill

4 Technical Considerations for Linear Requirements

The containment barriers prescribed for wastes do not consider the product loading, excavation and transport from stockpiles and thus are not generally appropriate for coal handling facilities (WSP, 2015).

Although the product is not seen as waste, the classification of the material was undertaken to confirm the liner requirements as required by the DWS and DEA.

The material from the GG1 to GG6 process plants were sampled and submitted to an accredited laboratory (Jones Environmental Laboratory) by WSP Environmental (Pty) Ltd. The results of the test work are shown in Appendix D. The tests conducted were *aqua regia* digestion for total concentration and reagent water leaching procedure (20:1 ratio) in accordance with the National Environmental NEM:WA guidelines for mono-disposal (DEA, 2013). Based on the outcomes of the test work, the “waste” can be classed (as tabulated below) after comparison with the total concentration threshold (TCT) and leachable concentration threshold (LCT) values:

Test	Purpose	Results (All parameters considered)	Classification
GG 1- 6			
Aqua regia digestion	Total Concentration (TC)	TC<TCT0	Type 4
Reagent water leach test	Leachable Concentration (LC)	LC<LCT0	Type 4

Based on the above, the material from GG1 to GG6 is classed as a Type 4 waste and should be disposed of or stored at a facility with a Class D liner. A conceptual design for a Class D liner as given by the NEM: WA guidelines (DEA, 2013) are shown below in Figure 1.

(d) Class D Landfill:

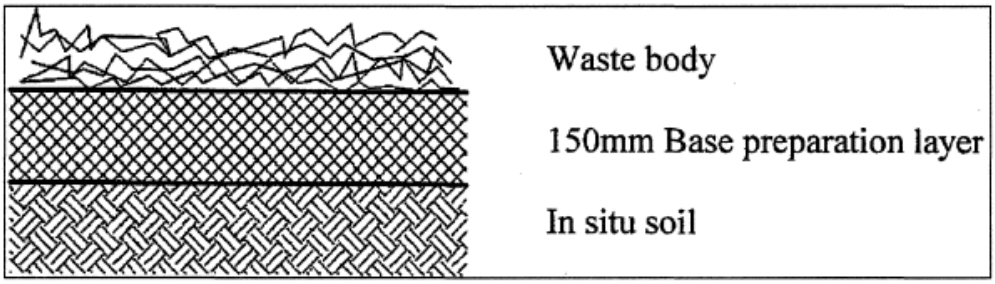

Figure 1: Minimum design requirements for a Class D liner (DEA, 2013)

It is proposed that Exxaro designs the liner for the GG1 to 6 short-term stockpiles in line with the Class D liner. Exxaro will also implement monitoring and quality control measures on a regular basis for the groundwater, surface water and coal material. This will allow the management of contaminants, if any, leaching and/or flowing from the stockpiles.

5 Consultation with the Department of Water and Sanitation

Exxaro approached the Department of Mineral Resources (DMR) on 29 September 2015 to discuss the proposed GG10A amendment. DMR agreed in principle to the proposed amendments to the GG10A stockyard area. The DMR encouraged Exxaro to consult with the DWS and LEDET prior to DMR making a decision on the Application. Exxaro met with the Limpopo Regional Office of the DWS on 08 December 2015 to present the proposed amendment to the GG10A stockyard and the proposed liner requirements. The Regional Office indicated that Exxaro will have to consult with the Civil Engineering Department of the National DWS Office and present the proposed alterations to the stockpile liner.

Exxaro met with the Civil Engineering Department of the National DWS on 18 January 2016 and a discussion was held around the liner requirements and the waste classification. The DWS officials indicated that, should the coal to be stockpiled at the GG10A stockyard footprint be classified as Type 4 waste, the liner requirements for Class D will be acceptable. As indicated in Section 4.1, the proposed stockpile will accommodate Type 4 waste only, and therefore, Exxaro can accede to the requirements of the DWS.

A memo providing the classification of the coal to be stockpiled at GG10A was submitted to the DWS on 22 March 2016 and DWS has provided approval to the proposed stockpile. Refer to Appendix E for the DWS Letter of Approval.

6 Consultation with Interested and Affected Parties

The consultation undertaken for the Grootegeluk Mine Infrastructure Expansion Project is deemed sufficient for the purposes of this Regulation 29 Amendment as the consultation process undertaken for the Basic Assessment met the requirements for public participation in terms of the NEMA. The placement of additional coal within an impacted area, where the footprint remains unchanged will have no added adverse effect on the rights and interests of stakeholders not previously addressed as part of the consultation process.

7 Potential Impacts and Motivation for Amendment

The proposed amendment does not increase the footprint of the GG10A stockyard, nor does it require modification of the infrastructure associated with the GG10A stockyard or any other mining infrastructure at the Grootegeluk Mine. Exxaro proposes to increase the height of the stockpile within the stockyard footprint to accommodate 2 Mt of coal. No additional impacts or increased impacts have been identified and impacts associated with this project have been assessed and mitigation measures proposed during the environmental authorisation phase of the Infrastructure Expansion Project.

8 Assessment of Potential Negative Environmental Impacts

The assessment of the impact of increasing the height of the stockpile at GG10A has been considered in terms of Regulation 29 (a) of R 982 of the EIA Regulations, 2014, which stipulates:

"29. An environmental authorisation may be amended by following the process prescribed in this Part if the amendment-

(a) will not change the scope of a valid environmental authorisation nor increase the level or nature of the impact, which impact was initially assessed and considered when [the] application was made for an environmental authorisation."

No potential negative environmental impacts are considered to occur due to increasing the height of the GG10A stockpile. The most likely impacts that could arise as a result of the increased height (and therefore volume) of the stockpile are considered to be a potential visual impact, surface water impact, and socio-economic impact. Other environmental aspects have been excluded from consideration due to the irrelevance of these aspects being affected by the proposed increased volume of the stockpile. The assessment of the relevant environmental aspects is discussed below.

8.1 Visual impact

The visual impact of the increased height of the stockpile has been considered as a possible negative impact; however, the predominant land use surrounding the mine consists of game farms and the Manketti Reserve situated within Grootegeluk Mine's own property. Furthermore, the identified visual receptors surrounding the Grootegeluk Mine include three residential areas, consisting of Marapong situated 6 km south-east, Onverwacht located 15 km to the south-east and Lephalale located approximately 20 km to the south-east. The proposed increased height of the stockpile is unlikely to result in a visual impact based on the locations and land use of the surrounding visual receptors. Furthermore, the Grootegeluk Mine has been in operation since 1981 and the active mining areas occupy an area of approximately 3,000 ha. The proposed stockpile will be located within the impacted mining area, thereby retaining the visual effect of the current mine land use. Furthermore, the identified visual receptors are accustomed to the visual impact of the mine, and thus unlikely to be further impacted by the increased height of the stockpile.

8.2 Surface water impact

The impacts to surface water have also been considered due to the increase in the amount of coal to be stored in the GG10A stockyard footprint. A surface water management plan (SWMP) was developed for the Grootegeluk Coal Mine Infrastructure Expansion Project, in 2014. This report, titled *Surface Water Assessments and Conceptual Storm Water Management Plan: Grootegeluk Mine*, compiled by Digby Wells Environmental and the SWMP will remain unchanged for the proposed new stockpile. In summary, the report assessed the potential impacts of the infrastructure amendments (including stockpiles and stockyards) which resulted in two findings / statements; namely that run-off from the stockpiles must be managed adequately and stockpile liners specifications must be compliant with relevant legislation. As discussed in Section 4.1 above, a class D liner is compliant with DWS specifications.

The SWMP report states the that an identified impact as a result of coal stockpiling is runoff contamination by coal fines from stockpiles; however, the runoff reports to the existing storm water drains and hence should be managed there. This implies that the impacts will be minimal as long as the SWMP is well managed. The impact assessment specific to the stockpiles and contained in the report is displayed in Table 3, below, and the finding of the assessment is an overall low impact.

Table 3: Impact rating for surface water run-off from stockpiles

Description of impact			Runoff contamination by coal fines from stockpiles		
Mitigation required			Ensure that the plant storm water drains are fully functional and this retains the impacts within the controlled system with no potential impacts to clean stormwater drainage systems		
Parameters	**Duration**	**Scale**	**Severity**	**Probability**	**Significance**
Pre-Mitigation	Project Life	Very limited	Limited damage	Improbable	low
	5	1	1	2	14
Post-Mitigation	Immediate	Very limited	Limited damage	Highly unlikely	low
	1	1	1	1	3

Taking the existing storm water management measures already established on site into consideration, as well as the updated SWMP which assessed the placement of the approved stockpiles, the increased stockpile height is unlikely to increase the impact rating established for the approved stockpile.

8.3 Socio-economic impact

The socio-economic impact of the amendment not being granted may result in Grootegeluk Mine no longer being able operate until the ramp-up takes effect at Medupi power station. Exxaro has saleable coal in Benches 6 to 10; however, these benches cannot be exploited without extracting Benches 2 to 5 (Eskom-grade coal). The Grootegeluk Mine is unable to access the lower benches of coal through underground mining methods as the upper benches of coal are too thick and therefore too heavy to be undermined. If the lower benches of coal cannot be extracted and sold to the respective markets, the Grootegeluk Mine cannot continue with production.

8.4 Other impacts considered

The current Exxaro Standard Operating Procedures for Dust Suppression and Coal Stockpile Maintenance and the SWMP (2014) will apply to the GG10A stockyard area once construction commences and for the duration (five years) for the short-term storage of coal.

8.4.1 Potential Positive Environmental Impacts

Coal will be stored legally in an impacted area, thereby not allowing further negative environmental impacts. The liner for the short-term stockpile will adhere to the requirements of a Class D liner, thereby preventing any carbonaceous surface and groundwater seepage. The continuation of mining at the Grootegeluk Mine will also result in a positive socio-economic impact.

9 Conclusion

No additional environmental impacts are foreseen or considered likely as a result of the proposed amendment to increase the height of the GG10A stockyard. The proposed amendment is a strategic solution to assist Exxaro in stockpiling Eskom-grade coal which is accumulating on site as a result of off-take from Eskom decreasing.

It is requested the DMR give consideration to the information contained within the memo and based on the approval by DWS and their requirements, that the DMR approve the amendment to utilise the GG10A stockyard footprint area for the construction of a short term compacted coal stockpile area for a period of 5 years.

10 References

DEA, 2013, National Norms and Standards for the Assessment of Waste for Landfill Disposal. Department of Environmental Affairs.

WSP, 2015, Exxaro Grootegeluk Waste Classification: Coal Product Report.

Regards,

Brett Coutts

Unit Manager: Rehabilitation

Appendix A: Application Proof of Payment

Appendix B: Locality and Infrastructure Map

Appendix C: LEDET Record of Decision

Appendix D: Waste Classification

Appendix E: DWS Letter of Approval

Appendix D: Laboratory Certificates

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CERTIFICATE OF ANALYSES
NET ACID GENERATION

Date received: 2015-11-19
Project number: 1000
Report number: 56012
Date completed: 2015-12-14
Order number: ---

Client name: Digby Wells Environmental
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Net Acid Generation	Sample Identification: pH 4.5				
	G6 7/8 Stockpile A	G6 7/8 Stockpile B	GG1-6 Stockpile A	GG1-6 Stockpile B	GG1-6 Stockpile B
Sample Number	**21866**	**21867**	**21868**	**21869**	**21869 D**
NAG pH: (H_2O_2)	2.7	2.7	3.0	4.8	4.9
NAG (kg H_2SO_4 / t)	16	40	11	<0.01	<0.01

Net Acid Generation	Sample Identification: pH 7				
	G6 7/8 Stockpile A	G6 7/8 Stockpile B	GG1-6 Stockpile A	GG1-6 Stockpile B	GG1-6 Stockpile B
Sample Number	**21866**	**21867**	**21868**	**21869**	**21869 D**
NAG pH: (H_2O_2)	4.5	4.5	4.5	4.8	4.8
NAG (kg H_2SO_4 / t)	21	36	24	2.94	2.74

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

Date received: 2015-11-19 **Date completed: 2015-12-14**
Project number: 1000 **Report number: 56012** **Order number: ---**

Client name: Digby Wells Environmental
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Acid – Base Accounting Modified Sobek (EPA-600)	Sample Identification				
	G6 7/8 Stockpile A	G6 7/8 Stockpile B	GG1-6 Stockpile A	GG1-6 Stockpile B	GG1-6 Stockpile B
Sample Number	**21866**	**21867**	**21868**	**21869**	**21869 D**
Paste pH	7.0	7.1	7.2	7.3	7.3
Total Sulphur (%) (LECO)	2.27	1.34	1.79	1.64	1.64
Acid Potential (AP) (kg/t)	71	42	56	51	51
Neutralization Potential (NP)	15	11	17	27	28
Nett Neutralization Potential (NNP)	-56	-31	-39	-24	-23
Neutralising Potential Ratio (NPR) (NP : AP)	0.216	0.258	0.304	0.530	0.554
Rock Type	I	I	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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EPA-600 MODIFIED SOBEK METHOD

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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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EPA-600 MODIFIED SOBEK METHOD

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CERTIFICATE OF ANALYSES
X-RAY FLUORESCENCE

Date received: 2015-11-19
Project number: 1000
Report number: 56012
Date completed: 2015-12-08
Order number: ---

Client name: Digby Wells Environmental
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Major Elements	Major Element Concentration (wt %)[s]			
	G6 7/8 Stockpile A	G6 7/8 Stockpile B	GG1-6 Stockpile A	GG1-6 Stockpile B
	21866	21867	21868	21869
SiO_2	11.14	8.74	20.38	17.4
TiO_2	0.35	0.39	0.36	0.35
Al_2O_3	7.39	7.3	7.96	7.91
Fe_2O_3	1.21	0.58	1.9	3.81
MnO	0	0	0.02	0.05
MgO	0.25	0.18	0.25	0.4
CaO	0.81	0.32	0.83	1.38
Na_2O	0.05	<0.01	0.02	0.03
K_2O	0.17	0.11	0.34	0.28
P_2O_5	0.06	0.05	0.06	0.1
Cr_2O_3	0	0	0.01	0.01
SO_3	0.24	0.07	0.15	0.06
LOI	77.5	81.64	67.7	67.22
Total	99.23	99.41	100.11	99.08
H_2O-	0.04	0	0.14	0.09

[s] =Results obtained from sub-contracted laboratory

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Trace Elements	Trace Element Concentration (ppm) [s]			
	G6 7/8 Stockpile A	G6 7/8 Stockpile B	GG1-6 Stockpile A	GG1-6 Stockpile B
	21866	21867	21868	21869
As	9.62	8.98	8.42	6.12
Ba	88.7	86.3	91.6	92.5
Bi	1.38	1.75	1.48	1.53
Cd	<3.04	<3.04	<3.04	<3.04
Ce	<3.08	<3.08	19.9	16.1
Cl	122	125	123	122
Co	<0.56	<0.56	<0.56	<0.56
Cs	1.38	1.4	1.33	1.31
Cu	28.4	114	55.5	60.6
Ga	11.1	9.27	13.3	16.9
Ge	<0.50	<0.50	<0.50	<0.50
Hf	6.38	6.49	6.38	6.39
Hg	<1.00	<1.00	<1.00	<1.00
La	95	97.8	84.9	65.6
Lu	1.7	1.68	1.88	2.2
Mo	2.48	2.54	2.46	2.47
Nb	<2.15	<2.15	<2.15	<2.15
Nd	54	58.5	49.4	40.7
Ni	29.6	30.7	20.5	27.5
Pb	<2.03	<2.03	<2.03	<2.03
Rb	8.9	5.64	18.3	14
Sb	<1.48	<1.48	<1.48	<1.48
Sc	18.7	17.1	18.2	21.7
Se	0.83	1.12	0.5	0.62
Sm	9.32	7.8	10.4	14.9
Sn	4.57	3.72	4.91	7.06
Sr	68.6	60.5	57.9	66.3
Ta	1	0.76	1.05	1
Te	0.53	<0.16	0.83	2.21
Th	5.34	5.97	4.39	3.37
Tl	2.33	2.31	2.22	2.18

Results continued on next page

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CERTIFICATE OF ANALYSES
X-RAY FLUORESCENCE

Date received: 2015-11-19
Project number: 1000
Report number: 56012
Date completed: 2015-12-08
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Email: karabo.lenkoe-magagula@digbywells.com

Trace Elements	Trace Element Concentration (ppm) [s]			
	G6 7/8 Stockpile A	G6 7/8 Stockpile B	GG1-6 Stockpile A	GG1-6 Stockpile B
	21866	21867	21868	21869
U	2.39	2.48	2.35	2.46
V	<7.60	<7.60	<7.60	<7.60
W	6.86	6.86	6.87	6.91
Y	16	15.9	17.7	17.6
Yb	4.27	2.96	4.59	6.78
Zn	47	87.6	51.6	54
Zr	77.8	78.6	98	86.5

[s] =Results obtained from sub-contracted laboratory

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CERTIFICATE OF ANALYSES
X-RAY DIFFRACTION

Date received: 2015-11-19
Project number: 1000
Report number: 56012
Date completed: 2015-12-07
Order number: ---

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Composition (%) [s]

G6 7/8 Stockpile A			G6 7/8 Stockpile B		
21866			21867		
Mineral	Amount (weight %)	Error	**Mineral**	Amount (weight %)	Error
Calcite	0.05	0.12	**Calcite**	0.01	0.05
Dolomite	1.26	0.26	**Dolomite**	1.01	0.23
Graphite	65.24	2.43	**Graphite**	72.47	1.92
Kaolinite	25.92	1.77	**Kaolinite**	23.29	1.56
Muscovite	2.24	0.39	**Muscovite**	1.77	0.36
Pyrite	1.28	0.14	**Pyrite**	0.58	0.11
Quartz	3.94	0.33	**Quartz**	0.85	0.14
Siderite	0.08	0.09	**Siderite**	0.02	0.07

Composition (%) [s]

GG1-6 Stockpile A			GG1-6 Stockpile B		
21868			21869		
Mineral	Amount (weight %)	Error	**Mineral**	Amount (weight %)	Error
Calcite	0.58	0.15	**Calcite**	0.97	0.21
Dolomite	1.56	0.24	**Dolomite**	1.58	0.26
Graphite	59.67	2.28	**Graphite**	58.16	2.82
Kaolinite	19.99	1.11	**Kaolinite**	19.72	1.32
Muscovite	2.11	0.33	**Muscovite**	2.21	0.36
Pyrite	0.66	0.12	**Pyrite**	0.8	0.12
Quartz	14.47	0.87	**Quartz**	12.85	0.93
Siderite	0.96	0.2	**Siderite**	3.71	0.33

[s] Results obtained from sub-contracted laboratory

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Note:

The material submitted was prepared for XRD analysis using a backloading preparation method
It was analysed with a PANalytical Empyrean diffractometer with PIXcel detector and fixed slits with Fe filtered Co-Kα radiation. The phases were identified using X'Pert Highscore plus software.
The relative phase amounts (weight%) were estimated using the Rietveld method. Errors are on the 3 sigma level in the column to the right of the amount (in weight per cent).

Comment:

- In case the results do not correspond to results of other analytical techniques, please let me know for further fine tuning of XRD results.
- Mineral names may not reflect the actual compositions of minerals identified, but rather the mineral group.
- Due to preferred orientation effects results may not be as accurate as shown in the table.
- Errors reported for phases occurring in minor amounts are sometimes larger than that of the quantity reported, indicating the possible absence of those phases.
- "Graphite" in one sample represents the organic carbon and should be regarded as semi-quantitative.
- Traces of additional phases may be present
- Amorphous phases, if present, were not taken into consideration during quantification

Ideal Mineral compositions	
Quartz	(SiO2)
Muscovite	(KAl3Si3O10(OH)2)
Kaolinite	(Al2(Si2O5)(OH)4)
Calcite	CaCO3
Pyrite	FeS2
Dolomite	Ca Mg (C O3)2
Siderite	FeCO3

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CERTIFICATE OF ANALYSES

TCLP / ACID RAIN / DISTILLED WATER EXTRACTIONS

Date received:	**19/11/2015**			**Date completed:**	**26/01/2016**
Project number:	**1000**	**Report number:**	**56012**	**Order number:**	**EXX3666**

Client name:	**Digby Wells Environmental**	**Contact person:**	**André van Coller**
Address:	**Digby Wells House, Turnberry Office Park,**	**Email:**	**andre.van.coller@digbywells.com**
	48 Grosvenor Road, Bryanston, 2191	**Contact person:**	**Karabo Lenkoe-Magagula**
Telephone:	**011 789 9495**	**Email:**	**karabo.lenkoe-magagula@digbywells.com**

Analyses	G6 7/8 Stockpile B		GG1-6 Stockpile B	
Sample Number	21867		21869	
TCLP / Acid Rain / Distilled Water / H_2O_2	Distilled Water		Distilled Water	
Dry Mass Used (g)	250		250	
Volume Used (mℓ)	1000		1000	
pH Value at 25˚C	7.7		7.7	
Inorganic Anions	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**
Total Dissolved Solids at 180 ˚C	230	920	636	2544
Bicarbonate as HCO3 (calc)	44	176	34	137
Carbonate as CO3 (calc)	<5	<20	<5	<20
Total Alkalinity as CaCO3	36	144	28	112
Chloride as Cl	<2	<8	2	8
Sulphate as SO4	134	536	417	1668
Nitrate as N	0.1	0.4	0.8	3.2
Fluoride as F	<0.2	<0.8	0.4	1.6
Hexavalent Chromium as Cr6+	<0.010	<0.04	<0.010	<0.04
Mercury as Hg	<0.001	<0.004	<0.001	<0.004
Uranium as U	<0.001	<0.004	<0.001	<0.004
ICP-OES Quant	See tab 56012 ICP DW		See tab 56012 ICP DW	
Acid Base Accounting	See attached report 56012 ABA		See attached report 56012 ABA	
Net Acid Generation	See attached report 56012 NAG		See attached report 56012 NAG	
X-ray Diffraction [s]	See attached report 56012 XRD		See attached report 56012 XRD	
X-ray Fluorescence [s]	See attached report 56012 XRF		See attached report 56012 XRF	

Analyses	G6 7/8 Stockpile A		GG1-6 Stockpile A	
Sample Number	21866		21868	
TCLP / Acid Rain / Distilled Water / H_2O_2	SPLP		SPLP	
Dry Mass Used (g)	250		250	
Volume Used (mℓ)	1000		1000	
pH Value at 25˚C	7.7		7.7	
Inorganic Anions	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**
Total Dissolved Solids at 180 ˚C	318	1272	702	2808
Bicarbonate as HCO3 (calc)	44	176	44	176
Carbonate as CO3 (calc)	<5	<20	<5	<20
Total Alkalinity as CaCO3	36	144	36	144
Chloride as Cl	<2	<8	2	8
Sulphate as SO4	202	808	445	1780
Nitrate as N	0.1	0.4	0.8	3.2
Fluoride as F	<0.2	<0.8	0.3	1.2
Hexavalent Chromium as Cr6+	<0.010	<0.04	<0.010	<0.04
Mercury as Hg	<0.001	<0.004	<0.001	<0.004
Uranium as U	<0.001	<0.004	<0.001	<0.004
ICP-OES Quant	See tab 56012 ICP SPLP		See tab 56012 ICP SPLP	
Acid Base Accounting	See attached report 56012 ABA		See attached report 56012 ABA	
Net Acid Generation	See attached report 56012 NAG		See attached report 56012 NAG	
X-ray Diffraction [s]	See attached report 56012 XRD		See attached report 56012 XRD	
X-ray Fluorescence [s]	See attached report 56012 XRF		See attached report 56012 XRF	

[s]=subcontracted

E. Botha
Geochemistry Project Manager

WATERLAB (PTY) LTD

CERTIFICATE OF ANALYSES

ICP-OES QUANTITATIVE ANALYSIS

Date received:	19/11/2015	**Date Completed:**	26/01/2016
Project number:	1000	**Report number:**	56012

Client name:	Digby Wells Environmental	**Contact person:**	André van Coller
Adress:	Digby Wells House, Turnberry Office Park,	**Email:**	andre.van.coller@digbywells.com
	48 Grosvenor Road, Bryanston, 2191	**Contact person:**	Karabo Lenkoe-Magagula
Telephone:	011 789 9495	**Email:**	karabo.lenkoe-magagula@digbywells.com

Extract	Sample Dry Mass	Volume	Mass (g/l)	Factor
Distilled Water	250	1000	250	4

Sample Id	Sample number	Al	Al	As	As	B	B
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.100	<0.400	<0.010	<0.040	<0.025	<0.100
G6 7/8 Stockpile B	21867	<0.100	<0.400	<0.010	<0.040	<0.025	<0.100
GG1-6 Stockpile B	21869	<0.100	<0.400	<0.010	<0.040	<0.025	<0.100

Sample Id	Sample number	Ba	Ba	Ca	Ca	Cd	Cd
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<1	<4	<0.005	<0.020
G6 7/8 Stockpile B	21867	<0.025	<0.100	34	136	<0.005	<0.020
GG1-6 Stockpile B	21869	0.043	0.172	129	516	<0.005	<0.020

Sample Id	Sample number	Co	Co	Cr	Cr	Cu	Cu
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.025	<0.100	<0.010	<0.040
G6 7/8 Stockpile B	21867	<0.025	<0.100	<0.025	<0.100	<0.010	<0.040
GG1-6 Stockpile B	21869	<0.025	<0.100	<0.025	<0.100	<0.010	<0.040

Sample Id	Sample number	Fe	Fe	K	K	Mg	Mg
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.5	<2.0	<1	<4
G6 7/8 Stockpile B	21867	<0.025	<0.100	1.2	4.7	20	80
GG1-6 Stockpile B	21869	<0.025	<0.100	3.9	15.8	23	92

Sample Id	Sample number	Mn	Mn	Mo	Mo	Na	Na
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.025	<0.100	<1	<8
G6 7/8 Stockpile B	21867	0.692	2.77	<0.025	<0.100	<1	<8
GG1-6 Stockpile B	21869	0.431	1.72	<0.025	<0.100	5	20

Sample Id	Sample number	Ni	Ni	Pb	Pb	Sb	Sb
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.010	<0.040	<0.010	<0.040
G6 7/8 Stockpile B	21867	0.038	0.152	<0.010	<0.040	<0.010	<0.040
GG1-6 Stockpile B	21869	<0.025	<0.100	<0.010	<0.040	<0.010	<0.040

Sample Id	Sample number	Se	Se	V	V	Zn	Zn
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.010	<0.040	<0.025	<0.100	<0.025	<0.100
G6 7/8 Stockpile B	21867	<0.010	<0.040	<0.025	<0.100	<0.025	<0.100
GG1-6 Stockpile B	21869	<0.010	<0.040	<0.025	<0.100	<0.025	<0.100

WATERLAB (PTY) LTD

CERTIFICATE OF ANALYSES

ICP-OES QUANTITATIVE ANALYSIS

Date received: 19/11/2015 **Date Completed:** 26/01/2016
Project number: 1000 **Report number:** 56012

Client name: Digby Wells Environmental
Adress: Digby Wells House, Turnberry Office Park, 48 Grosvenor Road, Bryanston, 2191
Telephone: 011 789 9495

Contact person: André van Coller
Email: andre.van.coller@digbywells.com
Contact person: Karabo Lenkoe-Magagula
Email: karabo.lenkoe-magagula@digbywells.com

Extract	Sample Dry Mass	Volume	Mass (g/l)	Factor
SPLP	250	1000	250	4

Sample Id	Sample number	Al	Al	As	As	B	B
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.100	<0.400	<0.010	<0.040	<0.025	<0.100
G6 7/8 Stockpile A	21866	<0.100	<0.400	<0.010	<0.040	<0.025	<0.100
GG1-6 Stockpile A	21868	<0.100	<0.400	<0.010	<0.040	<0.025	<0.100

Sample Id	Sample number	Ba	Ba	Ca	Ca	Cd	Cd
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<1	<4	<0.005	<0.020
G6 7/8 Stockpile A	21866	0.030	0.120	52	208	<0.005	<0.020
GG1-6 Stockpile A	21868	0.044	0.176	143	572	<0.005	<0.020

Sample Id	Sample number	Co	Co	Cr	Cr	Cu	Cu
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.025	<0.100	<0.010	<0.040
G6 7/8 Stockpile A	21866	<0.025	<0.100	<0.025	<0.100	<0.010	<0.040
GG1-6 Stockpile A	21868	<0.025	<0.100	<0.025	<0.100	<0.010	<0.040

Sample Id	Sample number	Fe	Fe	K	K	Mg	Mg
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.5	<2.0	<1	<4
G6 7/8 Stockpile A	21866	<0.025	<0.100	1.3	5.05	26	104
GG1-6 Stockpile A	21868	<0.025	<0.100	3.9	15.77	24	96

Sample Id	Sample number	Mn	Mn	Mo	Mo	Na	Na
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.025	<0.100	<1	<8
G6 7/8 Stockpile A	21866	1.03	4.12	<0.025	<0.100	<1	<8
GG1-6 Stockpile A	21868	0.668	2.67	<0.025	<0.100	5	20

Sample Id	Sample number	Ni	Ni	Pb	Pb	Sb	Sb
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.010	<0.040	<0.010	<0.040
G6 7/8 Stockpile A	21866	0.041	0.164	<0.010	<0.040	<0.010	<0.040
GG1-6 Stockpile A	21868	<0.025	<0.100	<0.010	<0.040	<0.010	<0.040

Sample Id	Sample number	Se	Se	V	V	Zn	Zn
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.010	<0.040	<0.025	<0.100	<0.025	<0.100
G6 7/8 Stockpile A	21866	<0.010	<0.040	<0.025	<0.100	<0.025	<0.100
GG1-6 Stockpile A	21868	<0.010	<0.040	<0.025	<0.100	<0.025	<0.100

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CERTIFICATE OF ANALYSES

TOTALS

Date received:	19/11/2015			**Date completed:**	2016/01/26
Project number:	1000	**Report number:**	56012	**Order number:**	EXX3666

Client name:	Digby Wells Environmental	**Contact person:**	André van Coller
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Telephone:	011 789 9495	**Email:**	karabo.lenkoe-magagula@digbywells.com

Analyses	G6 7/8 Stockpile A		GG1-6 Stockpile A	
Sample Number	21866		21868	
Digestion	Aqua Regia		Aqua Regia	
Dry Mass Used (g)	0.1		0.1	
Volume Used (mℓ)	50		50	
Units	mg/ℓ	mg/kg	mg/ℓ	mg/kg
Mercury as Hg	<0.010	<5.00	<0.010	<5.00
ICP-OES Quant	See tab ICP AQR		See tab ICP AQR	
Total Fluoride [s]	---	166	---	179
Total Hexavalent Chromium as Cr^{6+} [s]	---	<5	---	<5

[s]=subcontracted

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Geochemistry Project Manager

WATERLAB (PTY) LTD

CERTIFICATE OF ANALYSES

ICP-OES QUANTITATIVE ANALYSIS

Date received: 19/11/2015 **Date Completed:** 26/01/2016
Project number: 1000 **Report number:** 56012

Client name: Digby Wells Environmental **Contact person:** André van Coller
Address: Digby Wells House, Turnberry Office Park, **Email:** andre.van.coller@digbywells.com
48 Grosvenor Road, Bryanston, 2191 **Contact person:** Karabo Lenkoe-Magagula
Telephone: 011 789 9495 **Email:** karabo.lenkoe-magagula@digbywells.com

Extract	Sample Dry Mass	Volume	Mass (g/l)	Factor
Aqua Regia	0.1	50	2	500

Sample Id	Sample number	As	As	B	B	Ba	Ba
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.010	<5.00	<0.025	<12.5	<0.025	<12.5
G6 7/8 Stockpile A	21866	<0.010	<5.00	<0.025	<12.5	0.040	20
GG1-6 Stockpile A	21868	<0.010	<5.00	<0.025	<12.5	0.045	23

Sample Id	Sample number	Cd	Cd	Co	Co	Cr	Cr
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.003	<1.2	<0.025	<12.5	<0.025	<12.5
G6 7/8 Stockpile A	21866	<0.003	<1.2	<0.025	<12.5	<0.025	<12.5
GG1-6 Stockpile A	21868	<0.003	<1.2	<0.025	<12.5	<0.025	<12.5

Sample Id	Sample number	Cu	Cu	Mn	Mn	Mo	Mo
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.010	<5.00	<0.025	<12.5	<0.025	<12.5
G6 7/8 Stockpile A	21866	<0.010	<5.00	<0.025	<12.5	<0.025	<12.5
GG1-6 Stockpile A	21868	<0.010	<5.00	0.037	19	<0.025	<12.5

Sample Id	Sample number	Ni	Ni	Pb	Pb	Sb	Sb
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<12.5	<0.010	<5.00	<0.020	<8.00
G6 7/8 Stockpile A	21866	<0.025	<12.5	<0.010	<5.00	<0.020	<8.00
GG1-6 Stockpile A	21868	<0.025	<12.5	<0.010	<5.00	<0.020	<8.00

Sample Id	Sample number	Se	Se	V	V	Zn	Zn
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.010	<5.00	<0.025	<12.5	<0.025	<12.5
G6 7/8 Stockpile A	21866	<0.010	<5.00	<0.025	<12.5	<0.025	<12.5
GG1-6 Stockpile A	21868	<0.010	<5.00	<0.025	<12.5	<0.025	<12.5